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RESEARCH ARTICLE

The impact of carbon pricing on international competitiveness in the case of Azerbaijan

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Abstract
This article examines the impact of carbon pricing on international competitiveness for Azerbaijan, utilizing different cointegration methods such as, ARDLBT, CCR, DOLS, and FMOLS to the data spanning from 2000 to 2019. The results of the various cointegration approaches are in line with each other. The estimation results revealed that domestic crude oil price as a proxy of carbon pricing has a positive and significant impact on the real effective exchange rate in Azerbaijan. This implies that a rise in domestic crude oil price raises the real effective exchange rate (appreciation of national currency). An increase in real effective exchange rate indicates a loss in international competitiveness. The study concludes that the Azerbaijani policymakers should implement carbon pricing measures (implicit) to decrease CO_2 emissions from energy heavy industries without harming the country's international competitiveness, as well as use more renewable energy in order to prevent higher pollution effects of fossil fuels.

Keywords Carbon pricing · Competitiveness · CO_2 · Cointegration tests · Azerbaijan

Introduction

Environmental sustainability is one of the three dimensions of sustainable development. Today, environmental protection is one of the biggest problems for all countries. Seventh Millennium Development Goal is "ensuring environmental sustainability" that imposes specific responsibilities on government, institutions, societies, policymakers, and individuals (United Nations, 2015). Since these responsibilities are global priorities, many researches attempted to find economical and energy-efficient methods to meet Sustainable Development Goals (Delanka-Pedige et al. 2020).

Greenhouse gases produced by man-made activities, such as burning fossil fuels, absorb heat, and create global warming, leading to changes in the climate system which results to the increase in global average temperature. Undebatable, this is one of the most pressing issues confronting humanity today. Since a result, global climate change is one of the most pressing policy problems of the century for all governments, as it jeopardizes society's well-being, complicates economic progress, and alters the natural environment. The United Nations Sustainable Development Summit in 2015 September noted in "Transforming our world: the 2030 agenda for sustainable development," according to the 13th Sustainable Development Goal, "The global character of climate change necessitates the broadest feasible international collaboration aimed at accelerating global greenhouse gas emissions reductions and addressing adaptation to climate change's harmful effects" (United Nations, 2015). Carbon dioxide takes significant part among other environmental pollutants. Based on the World Bank (2007), it is caused by the burning of fossil fuels and the production of cement, which account for over 60% of greenhouse gas emissions, which as a consequent cause the climate change (World Bank 2007). Carbon dioxide is created by the combustion of solid, liquid, and gas fuels, as well as gas flaring. Furthermore, the Intergovernmental Panel on Climate Change

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(IPCC) (2014) states that CO_2 emissions from fossil fuel combustion and industrial activities promoted approximately 78% of the rise in total greenhouse gases emission over the period of 1970–2010, with a similar percentage contribution during 2000–2010. In order to reach environmental sustainability around the world in terms of greenhouse gases, the Kyoto protocol was accepted in 1997 by many governments over the world, which puts commitment on developed countries to reduce emissions (Mikayilov et al. 2018).

The level of greenhouse gas emissions from developing economies has been sharply exceeding that of developed economies, which constituted approximately 50% of the world's overall CO_2 emissions in 2003. If the present level of energy consumption goes on, today's CO_2 trend is predicted to rise. It is the main reason that all policymakers should formulate effective policy actions in reducing CO_2 emissions. However, due to the differences between developed and developing economies and even distinctions between different economies within the same group, those policy measures will generally not be indistinguishable and should be analyzed for individual countries specifically, resource-rich developing countries. In terms of environmental deterioration, the important portion among the developing countries belongs to resource-rich (particularlyoil-exporting economies). Because these economies have plentiful natural resources (such as oil, gas, and coal) at low/subsidized prices, a focus on economic growth may lead to the wasteful and unregulated exploitation of these resources, resulting in significant climate deterioration (Hasanov et al., 2019). In this regard, the investigation of reducing CO_2 emmissions for oil-rich countries gains particular importance.

The basic goal of sustainable development is to reduce total emissions while maintaining high levels of economic development (Mikayilov et al. 2018). There, the carbon pricing policies would be more effective in reducing CO_2 emissions. The implementation of carbon prices policies can raise the cost of production and could negatively influence the competitiveness of energy intensive industries. In the literature, competitiveness has been widely discussed during the last decades. Krugman (1995) defined competitiveness as the equivalent of productivity. However, he states that competitiveness is a "wrong and dangerous definition" if it is implemented at the international level. Fagerberg (1988) stated international competitiveness as an ability to achieve central economic policy goals, particularly economic growth and higher employment, without running into balance-of-payment problems. Wignaraja (2003) defined competitiveness as the ability of an economy to produce what meet the test of international competition while increasing real GDP. In addition, Aiginger (2006) and Kao et al. (2008) described competitiveness as the skill to create welfare, the relative ability of an economy to produce and preserve an atmosphere in which firms can compete so that the level of wealth can be developed. The authors also recommend that each comprehensive valuation of competitiveness should cover an outcome estimation and a process assessment, on the one hand, and must be compared to other similar economies, conversely.

There are many researches examining the impact of carbon pricing on international competitiveness. The previous researchers use various proxies like, employment, productivity, output, innovation, inflation, exchange rate, and investment for international competitiveness. Among these researchers, Saddler et al. (2006) in the case of Australia, Pearce and McKibbin (2007), Rivers (2010) in the case of Canada, Mafizur (2011) in the case of Australia, and Grottera et al. (2015) in the case of G20 countries revealed a negative impact from carbon pricing to international competitiveness. In addition, some studies such as Reinaud (2008), Bassi et al. (2009) for the USA, Branger and Quirion (2014), Da Silva Freitas et al. (2016) for Brazil, Carbone and Rivers (2017), Dechezleprêtre and Sato (2017), Rentschlera et al. (2017) for Saudi Arabia, and Pradhana et al. (2017) for India reached the similar results. Also, in the case of U.K., Kneller and Manderson (2012) revealed a negative correlation, whereas Zhao (2011) demonstrates a statistically significant negative impact from carbon taxes to the international competitiveness of energy-intensive sectors. On the other hand, Dissou and Eyland (2011), Timilsina et al. (2013), Sbroiavacca et al. (2016), and Santos et al. (2018) conclude the positive impact of carbon pricing on competitiveness. Additionally, Rivers and Schaufele (2014) reached that there is no persuasive link. Moreover, the insiginificant relationship were revealed by Zhang and Baranzini (2004), Bataille et al. (2009), Clarke and Waschik (2012), Beale et al. (2015), and Aldy and Pizer (2015).

From the literature, the implementation of the Emission Trading System (ETS) and carbon taxation as carbon pricing measures (explicit) may not be as successful in transition economies and oil rich countries, due to the lack of socio-economic institutions, infrastructure, and regulatory frameworks. For this reason, the better way is to consider implicit carbon price policies. Empirical studies indicate that the implicit measures of carbon pricing (increasing the energy prices or removing fossil fuel energy incentives) are more suitable for developing economies and easier to apply as compared with explicit measures (ETS, carbon taxation, and so on). Due to associated infrastructure, the latter requires market establishments and legislation (Aldy and Stavins 2012; Klenert et al. 2018; Hasanov et al. 2020).

In developing countries (particularly resource-rich), reforming energy prices as an implicit carbon price measures might be implemented. The profit margins in some sectors cannot be preserved at previous levels with the removal of fossil fuel incentives. In developing countries, macro-econometric studies devoted to carbon pricing policy-international competitiveness nexus are necessary to measure the role of energy price mechanisms precisely and reliably. Also, it is needed to formulate mitigation policies that diminish any loss in competitiveness from the removal of fossil fuel incentives (Hasanov et al. 2020).

Azerbaijan is one of the most oil-rich countries yet gifted with abundant renewable energy resources, making it a special case for this study. In Azerbaijan, the total air pollutant emissions were 620 thousand tons in 2002. It was almost doubled and reached to 1122.0 thousand tons in 2019. The total air pollutant emissions increased by 80.9%, with an average 4.06% annual growth rate during 2002–2019 (SSCA 2021a). From the economic dimension of the development, Azerbaijan economy has been demonstrating a considerable economic growth since 2006. Over the period 1996–2019, Azerbaijani GDP increased by 29.9 times, from 2733 million manats in 1996 to 81,681 million manats in 2019 (SSCA 2020). Economic growth in turn, as other wings of sustainability, might cause negative impacts on environment through different channels. To sum up, a deteriorated environment and environmental resources have negative consequences for individuals, society, and nature. To maintain the balance of development factors, or to create sustainable development, resources must be used in an ecologically acceptable manner.

Considering the above-mentioned facts, it is necessary to evaluate the impact of carbon pricing policies on international competitiveness in Azerbaijani case employing time-series econometric methods. Therefore, the purpose of the current article is to investigate the impact of carbon price measure (implicit) on international competitiveness in the Republic of Azerbaijan by employing different cointegration methods such as the Bounds Testing Approach to Autoregressive Distributed Lagged (ARDBT), Canonical Cointegrating Regression (CCR), Dynamic Ordinary Least Squares (DOLS), and Fully Modified Ordinary Least Squares (FMOLS). The main contribution of the study is that it is only one time series analysis investigating the impact of carbon pricing policy (implicit) on international competitiveness in the case of Azerbaijan which can be useful for Azerbaijani policymakers to conduct policy regulations for reducing the CO_2 emissions. In addition, the study can encourage researchers to conduct the same study for the countries similar to Azerbaijan.

Model and data

Data and model specification

This article uses annual data between 2000 and 2019 for empirical estimation of relationship between carbon pricing and international competitiveness. The international competitiveness is dependent variable which proxied by real effective exchange rate. The real effective exchange rate was used as a proxy of international competitiveness in several previous studies, such as Chinn (2006), Bella et al. (2007), Eyraud (2009), Javed et al. (2016), Giordano (2019), and Razek and McQuinn (2021). An increase in real effective exchange rate shows that exports are more expensive while imports are cheaper, indicating a loss in international competitiveness.

For oil exporting countries, Habib and Kalamova (2007) proposed a framework in which the real exchange rate is a function of oil price and productivity (Hasanov et al. 2017). Several previous studies have employed a similar framework to investigate the exchange rate in oil-exporting countries. Such as Jahan-Parvar and Mohammadi (2008) in the case of 14 oil exporting economies, Egert (2009) in the case of former Soviet Union economies, Korhonen and Juurikkala (2009) in the case of 14 oil exporting economies, Nikbakht (2010) in the case of 7 OPEC members, Ito (2010) in the case of Russia, Hasanov (2010) in the case of Azerbaijan, Ahmad and Hernandez (2013) in the case of 12 oil producers and consumers, Kaplan and Aktash (2016) in the case of 5 economies, and Hasanov et al. (2017) in the case of Azerbaijan, Kazakhstan, and Russia utilized solely oil prices to estimate the exchange rate in their empirical investigation.

Considering the above-mentioned studies and country-specific features, the functional specifications in this article can be described below:

$$lnRER_t = \beta_0 + \beta_1 lncoilp_t + \beta_2 lnprod_t + \varepsilon_t$$

where, RER_t is real effective exchange rate as a proxy of international competitiveness, $coilp_t$ is domestic crude oil prices as proxy of carbon pricing, $prod_t$ is the relative productivity, and ε_t is an error term. All variables are in logarithmic form.

Real effective exchange rate (RER) is measured in terms of foreign currency per unit of domestic currency, hence a rise in RER indicates that the domestic currency has appreciated, which is computed as follow:

$$\text{RER} = \text{Et} \times (\text{P}/\text{P} *)$$

where E_t is the Nominal Effective Exchange Rate of domestic country and P is Consumer Price Index of Azerbaijan while P^* is the weighted average Consumer Price Index of main trading partners. The data of Real Effective Exchange Rate has been collected from the Central Bank of Azerbaijan (The Central Bank of Azerbaijan-CBAR, 2022).

Domestic crude oil price (coilp) is proxied by manats per tons of oil equivalent (TOE). This data collected from Tariff (price) Council of the Azerbaijan Republic (Tariff (price) Council of the Azerbaijan Republic (TCAR), 2021).

Relative productivity (prod) is computed below:

$$\text{prod} = \frac{GDP^D/EMP^D}{GDP^W/EMP^W}$$

where GDP^D and EMP^D represent real GDP and number of employed for Azerbaijan, respectively. GDP^W and EMP^W show real GDP and number of employed for the rest of the world. The data of GDP and number of employed have been collected from World Bank (World Bank (WB), 2021).

Methodology

The impact of carbon pricing on international competitiveness is analyzed by employing the cointegration techniques in this article. The steps of the empirical assessment are as follows: To verify for non-stationarity of variables, the unit root test is applied first. The Augmented Dickey Fuller (Dickey and Fuller 1981, ADF) unit root test is utilized to determine if variables are stationary or not.

Then, to evaluate the cointegration link between variables, the Bounds Testing Approach to Autoregressive Distributed Lagged (ARDLBT, Pesaran et al. 2001; Pesaran and Shin 1999), Engle-Granger and Phillips-Ouliaris tests are employed. In addition, the Autoregressive Distributed Lagged (ARDL) method is applied for estimation of long-run relationship among variables. As a result, one of the primary advantages of ARDL is that it is more resilient and performs better for small sample sizes, as is the case in this study. Also, the CCR, DOLS, and FMOLS are applied for robustness check.

The aforementioned approaches are not covered in depth in this article to save space and avoid overloading the readers with econometric terminology. Dickey and Fuller (1981), Phillips and Hansen (1990), Hansen (1992a, b), Park (1992), and Stock and Watson (1993), Pesaran et al. (2001), Pesaran and Shin (1999), and others provide detailed information on these tests and models.

Table 1 Results of ADF unit root tests

Variable	Panel A: Level		Panel B: 1st difference		Result
	k	Actual value (p value)	k	Actual value (p value)	
RER	0	−1.286 (0.613)	1	−3.439 (0.023)	I(1)
coilp	2	−0.159 (0.927)	1	−4.161 (0.005)	I(1)
prod	1	−2.346 (0.169)	1	−3.293 (0.031)	I(1)

Maximum lag order is two and optimal lag order (k) is determined using the Schwarz criteria

Empirical results

To assess the model variables' stationarity, the ADF test was used first. Table 1 shows the outcomes of the test. The findings of ADF unit-root test show that RER, coilp and prod are non-stationary at I(0) but stationary at I(1). As a result, we may infer that our variables are non-stationary in terms of levels but stationary in terms of first differences, allowing us to test for cointegration.

For cointegration relationship, the Bounds Testing Approach, Engle-Granger and Phillips-Ouliaris tests are applied and results are depicted in the Table 2. The *z*-statistics and tau-statistics of Engle-Granger and Phillips-Ouliaris tests reject the "Series are not cointegrated" null hypothesis. In addition, if the calculated *F* statistics is greater than the critical values for the upper bound, then the null hypothesis of "no cointegration" is rejected. Thus, the Bounds cointegration test findings approve existence of long-run cointegration relationship between variables.

As a result, using ARDL method, the long-run influence of carbon pricing on international competitiveness can be estimated after confirming the presence of cointegration link

Table 2 The results of Cointegration tests

Engle-Granger		Phillips-Ouliaris	Bounds Cointegration
Tau-statistic	−8.604 (0.00)	−8.099 (0.00)	Fw 23.79 Critical Values 10%3.43 4.47
z-statistic	−28.571 (0.00)	−30.360 (0.00)	5%4.26 5.47 1%6.18 7.87

P values are in parenthesis. F_w refers to *F*-statistics for Bounds Cointegration test; the critical values for the Bounds test are based on Narayan's (2005) critical values

Table 3 Long-run coefficients from the different methods

Methods	*coilp* Coefficients (*P* values)	*prod* Coefficients (*P* values)
ARDL	0.21 (0.002)	0.62 (0.009)
CCR	0.19 (0.038)	0.51 (0.000)
DOLS	0.22 (0.007)	0.51 (0.000)
FMOLS	0.18 (0.015)	0.49 (0.000)

Residuals Diagnostics and Mis-specification tests results of ARDL:

χ_SC^2 = 5.12 [0.77] χ_HETR^2 = 3.71[0.45] 〖JB〗_N = 1.40 [0.49] F_FF = 1.20 [0.29]

RERt is a dependent variable; χ_HETR^2 and χ_SC^2, refer to chi-squared statistics which reject the presence of heteroscedasticity and serial correlation problems in the residuals, accordingly; F_FF and 〖JB〗_N refer to *F*-statistic and Jarque–Bera to test the null hypotheses of no functional mis-specification and normal distribution, accordingly among the variables. Table 3 summarizes the findings of ARDL. The residuals of the evaluated specifications successfully meet Gauss-Markov criteria, according to residual diagnostics tests. Furthermore, the model's misspecification test findings revealed no misspecification issues. All residual diagnostics tests are reported for ARDL specification. To end, we also utilize use the CCR, DOLS, and FMOLS techniques to obtained more robust results. Table 3 summarizes the findings of CCR, DOLS, and FMOLS techniques.

As shown in Table 3, the findings of estimation revealed that there is a positive and statistically significant effect from domestic crude oil price to real effective exchange rate at 1% level. The results designate that a 1% increase in coilp, increase RER by 0.21%. Findings of current study coincide with the economic theory and expectations. From a theoretical perspective, the obtained findings indicate that an increase in the carbon price (increase the prices of energy products) will increase real effective exchange rate. An increase in real effective exchange rate shows that exports become expensive while imports become cheaper, subsequently reduce international competitiveness. In addition, prior studies conducted by Saddler et al. (2006) in the case of Australia, Pearce and McKibbin (2007), Rivers (2010) in the case of Canada, Mafizur (2011) in the case of Australia, Grottera et al. (2015) in the case of G20 countries, Bassi et al. (2009) for USA, Da Silva Freitas et al. (2016) for Brazil, Rentschlera et al. (2017) for Saudi Arabia, and Pradhana et al. (2017) for India found that an increase in carbon pricing cause a decline in international competitiveness.

Furthermore, the estimation findings show that at the 1% level, relative productivity has a positive and statistically significant influence on real effective exchange rate in Azerbaijan. Also several studies such as, De Broeck and Slok (2001), Kuralbayeva et al. (2001), Spatafora and Stavrev (2003), Koranchelian (2005), Zalduendo (2006), Egert et al. (2007), Oomes and Kalcheva (2007), Habib and Kalamova (2007), Korhonen and Juurikkala (2009), Hasanov (2010), and Hasanov et al. (2017) reached a positive effect of relative productivity on real effective exchange rate in different oil exporting countries.

Conclusions

The link between carbon pricing policies (implicit) and international competitiveness is investigated in this study. The different cointegration tests (ARDLBT, CCR, DOLS, and FMOLS) are utilized to assess the long-term relationship between the variables for this goal. Our findings show that there is a cointegration relationship between the variables for Azerbaijan. The estimation results indicate that the domestic crude oil price and relative productivity have a statistically significant and positive influence on real effective exchange rate as a proxy of international competitiveness.

The obtained positive impact of carbon pricing, measured by the domestic crude oil price means that the implicit measures of carbon pricing policies (increase the prices of energy products) can boost production costs and increase real effective exchange rate. A rise in real effective exchange rate (apreciation of national currency) hinders the competitiveness of Azerbaijan. According to the results of this study, Azerbaijan should apply a slow energy price reform (removing incentives for fossil fuel energy or raising the prices of energy products) to reduce CO_2 emmision. A steady increase in domestic energy prices to bring them up to worldwide benchmark levels, so increasing government budget revenues and making the economy and society more energy efficient. Also, the results of this study and many previous empirical studies stated that there is a trade-off between carbon pricing and competitiveness for oil-rich developing economies (such as Azerbaijan). Therefore, an effective trade-off is needed. For this reason, policy makers should apply the best trade-off policy option considering characteristics of Azerbaijan. Such means will reduce CO_2 emissions while the competitiveness of Azerbaijan will not be negatively influenced. In addition, the revenues getting from carbon pricing policies (raising the prices of energy products) should be returned to sectors to help them move smoothly to energy-efficient technologies and renewable energy sources. As a result, the industries cut carbon emissions without lowering production levels and harming their competitiveness. This idea may largely be executed by encouraging industries to invest in energy-efficient technologies and easing the transition to renewable energy sources. Moreover, Azerbaijani policy makers should ensure support packages to industries and household for minimizing the negative consequences of price rises as well as retaining international competitiveness of Azerbaijan. This would also raise the public acceptability of carbon pricing in Azerbaijan.

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