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RESEARCH ARTICLE

A consideration of the environmental externality of Turkey's integration into global value chains: evidence from dynamic ARDL simulation model

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Abstract
The phenomenal growth experienced by Turkey at the turn of the millennium is attributed in part to increased participation in global value chains. While participation in global value chains has been beneficial to the Turkish economy, it also poses unique environmental challenges. Consequently, this study focuses on shedding some light on the environmental externality of Turkey's participation in global value chains. This article examines the environmental effects of Turkey's participation in global value chains for the period 1990–2018, using a dynamic ARDL analysis. The study further compares the environmental effects of Turkey's backward and forward linkages into global value chains, so as to determine which contributes more to carbon emissions. The cointegration test results and dynamic ARDL simulations confirm the existence of a long-run relationship between the environment and global value chain participation. All measures of global value chain participation display a positive long-run impact on carbon emissions. The results also show that the polluting effect of backward and forward linkages into global value chains is not too different. The study finding suggests that Turkey is being assigned segments of the value chain that require dirtier production processes through incentives from global trade integration, thus making Turkey a pollution haven. It is concluded that this is because other countries continually source for inputs requiring dirty production processes from Turkey, as Turkey also exports final goods that are produced using eco-unfriendly techniques. Policymakers in Turkey therefore need to follow more environmentalist policies in the process of global value chain participation.

Keywords Turkey · Global value chains · Pollution · Dynamic ARDL

Introduction

Global economic integration has proven to be a powerful source of economic growth, as nations get to manufacture goods in ways that are comparatively advantageous (Koźluk and Timiliotis 2016). As countries concentrate on the production of goods that are consistent with their factor endowments, the production process continues to experience fragmentations into various stages of specialization (Baldwin and Yan 2014). The end result is a type of decentralized international industrial arrangement, called global value chains, in which production processes are fragmented across national borders (Delera 2021). İn global value chains, comparative advantage is reflected in terms of production stages instead of bundled goods (Koźluk and Timiliotis 2016). Under the global value chains arrangement, intermediate goods or inputs are sourced in a country, processed in another country, and sold for consumption in yet another country. Overall, global value chain participation permits cost minimization across the production stages.

Over the past three decades, integration into global value chains has increased significantly. This drastic growth is spurred by technological progress in transport and logistics, as well as increased trade openness (Delera 2021). According to the Organization for Economic Co-operation and Development (OECD 2020), as at 2020, approximately 70% of all international trade involved participation in global value

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chains. This rise in participation has caused an unprecedented economic convergence in which the developing nations have grown rapidly and are even beginning to catch up with the developed nations (World Development Report 2020). Developing countries participate in global value chains by focusing on the roles in which they excel based on their factor endowments; they also participate in value-adding services such as design, manufacturing, marketing, delivery, and after-sale service (Wang et al. 2021). Developing countries also reap indirect benefits such as skill/knowledge transfers and increased investments (Taglioni and Winkler 2014). Turkey is one of the emerging economies that have taken advantage of the global value chain expansion. Turkey's series of economic reforms at the turn of the millennium led to an expansion in global value chain participation, among other things. The phenomenal growth experienced by Turkey in the said period is attributed in part to increased participation in global value chains (World Bank 2022).

Participation in global value chains can however be both an opportunity and a challenge to developing nations such as Turkey. While the economic benefits of integration into global value chains are numerous, concerns are rising about the environmental effects of this cross-border fragmentation of production processes (Wiedmann and Lenzen 2018). Global value chains play a significant role in the export trade of nations (Görg and Greenaway 2004), and in the environment-growth literature, international trade is the second most important determinant of environmental performance after income (Can et al. 2021). International trade increases pollution by increasing economic activities (scale effect). It also causes variations in pollution intensity due to technological changes, comparative advantages, and factor price differences (technique effect), as well as through the relocation of dirty production process to countries with weaker environmental policies (composition effect) (Vale et al. 2018).

To deal with these concerns, regulations that compel producers to bear the cost of the negative externality generated by using the environment as a factor of production are being introduced (Koźluk and Timiliotis 2016). Compliance with such regulations generally raise the cost of production. Whether deliberately or due to weak enforcement capabilities, the level of environmental policy stringency varies across countries. These differences alter comparative advantages between nations. Countries with stringent environment regulations are likely to experience a shift towards less-polluting production processes. Such countries are thus likely to witness a decline in the number of firms engaged in the production of pollution-intensive goods, whereas countries with weak environmental regulations are likely to become a haven for firms adopting pollution-intensive production processes.

One of the raging debates in extant environmental literature is whether cross-country variations in environmental regulations are turning emerging economies such as Turkey into "pollution havens." It is argued that developing nations often deliberately relax environmental regulations in order to attract more investment (Dean et al. 2004). This has been termed as a "race to the bottom" in which countries seeking more investment keep relaxing environmental standards. More relaxed environmental standards generally encourage domestic firms using polluting production processes to increase their output. It will also encourage foreign firms operating in pollution-intensive sectors that are trying to avoid the high environmental compliance costs in their home countries to relocate their operations to such countries (Copeland and Taylor 2004; Zugravu-Soilita 2017).

As argued by Hua et al. (2021), division of labor within the global value chains restricts developing nations such as Turkey to performing pollution-intensive functions, while developed nations concentrate on less-polluting, high value-added functions. As a major developing economy, Turkey's economic growth has been attributed in part to increased international collaboration within global value chains (World Bank 2022). Studies conducted by researchers such as Terzi and Pata (2019), Karimov (2020), and Bulut et al. (2021) have also shown that Turkey has become a pollution haven, hosting numerous firms employing pollution-intensive production processes. In light of all of the above, this article seeks to provide new insights into the relationship between the trade and the environment in Turkey. The overall objective is to generate useful policy suggestions for sustainable trade and growth in Turkey. This article therefore specifically studies the trade-environment nexus in Turkey, by empirically assessing the environmental impact of Turkey's participation in global value chains.

This study expands the existing literature in several directions. To begin with, it is one of the first studies to consider the environmental externalities of the participation of a large developing nation such as Turkey in global value chains. Second, the study further provides insights into the nature of global value chain participation (forward integration and backward integration) that is most impactful on the environment. Third, this article is the first to employ the novel dynamic ARDL simulations of Jordan and Philips (2018) in investigating the environmental impact of global value chains in Turkey.

The article proceeds as follows. "Literature review" provides a review of relevant literature. "Material and methods" presents the materials and methods adopted for empirical analysis. "Empirical results" presents a summary of the empirical results. The final section contains the conclusion and recommendations.

Literature review

Theoretically, global value chain participation can induce environmental effects through a number of channels (López et al. 2011; Hua et al. 2021). The first channel is

through the increased production brought about by global value chain participation. As the outputs of participating firms increase, so does pollution. This is referred to as the scale effect. The second channel is referred to as the composition effect. İn this case, the reallocation of resources to suit a particular nation's position in the value chain has the tendency to induce changes in the extent to which dirty production techniques will be employed (Hua et al. 2022). The technique effect is the third channel. This refers to a situation where the pollution-output ratio varies over time within a country or between countries (Vale et al. 2018; Liobikienė and Butkus 2019).

A fourth channel is the income effect (Hua et al. 2022). This refers to changes in private income as a result of participation in global value chains. Richer residents are likely to demand more energy-intensive products. However, as they become even richer, environmental quality may improve due to better regulations, technology, and recomposition of the economic makeup (Coskuner et al. 2020). The cross-border trade in clean production technologies, which global value chain participation facilitates, is another important channel. As integration into global value chains deepens, sensitivity to environmental standards established by major players in the international trading system becomes more pronounced. Consequently, the use of eco-friendly techniques and production of eco-friendly goods might increase (OECD n.d; Wang and Lu 2020).

On the empirical front, there are a handful of studies examining the environmental consequences of global value chain participation. Sun et al. (2019) study how the global value chain position affects carbon efficiency in a sample of 60 countries, using both data envelopment analysis and panel remission. The findings from the study show that global value chain position and carbon efficiency are positively correlated. It is further concluded that the energy efficiency-promoting and emission-reducing impacts of global value chain participation are more pronounced in developing countries. Yang and Ji (2019), using panel regression analysis, examine the relationship between carbon emission intensity and the global value chain position of 38 selected Chinese industries. The authors find an inverse relationship between the two and thus argue that, as these industries integrate deeper into global value chains, carbon intensity reduces.

Also, Yasmeen et al. (2019) investigate the effects of value-added trade from the perspective of global value chains on 8 different air pollutants in a panel of 39 countries. The panel generalized method of moment regression outcomes shows that an inverted U relationship exists between the variables. The authors submit that while pollution increases at the early stages of value-added trade, it reduces beyond a threshold. Guedidi and Baghdadi (2020) conduct a panel gravity model study on the link between carbon emissions and global value chains in the Middle East and North Africa. It is found that the global value chain participation of the sampled countries increases the pollution caused in the primary sector, upstream low-tech manufacturing sector, and downstream high-tech manufacturing sector. Wu et al. (2020), using both panel vector autoregressive model and system generalized method of moments, study the causal relations between global value chain participation and carbon emissions in a panel of 172 countries and conclude that integration into global value chains aggravates pollution in the Asia–Pacific region.

Material and methods

Data

In this article, annual time series data for the period 1990–2018 is used to empirically investigate the environmental externality of Turkey's integration into global value chains (GVCs), while controlling for the effects of gross domestic product, fossil fuel consumption, foreign direct investment, and urbanization. To measure GVC participation, the GVC participation index representing overall GVC participation is used. Two components of the GVC index—forward GVC participation (DVX) and backward GVC participation (FVA)—are also used to observe the impacts of forward and backward integration into GVCs on the environment. GVC, DVX, and FVA data series are obtained from the UNCTAD-Eora Global Value Chain Database constructed by Casella et al. (2019) (https://worldmrio.com/unctadgvc/). Per capita carbon dioxide (CO_2) emission is used as a proxy indicator for environmental degradation (Danish and Ulucak 2022) and fossil fuel energy consumption (FFEC) as a percentage of total energy consumption. CO_2 and FFEC data series are obtained from the database of Our World in Data (https://ourworldindata.org). Finally, for gross domestic product (GDP), foreign direct investment (FDI), and urbanization (URB), data series of GDP per capita (constant 2015 USD), FDI net inflows (BoP, current USD), and urban population (% of total population), respectively, are used. GDP, FDI, and URB data series are retrieved from the World Development Indicators of the World Bank (https://databank.worldbank.org/source/world-development-indicators).

Following the papers by Olasehinde-Williams and Oshodi (2021) and Xu et al. (2022), all data series are transformed into logarithmic form to avoid possible non-normality, non-linearity, and heteroscedasticity issues. The descriptive statistics of the variables are presented in Table 1. Jarque–Bera values indicate that all variables are normally distributed.

Model specification

To empirically investigate the impact of GVC participation on the environment in Turkey, three econometric models are proposed as follows:

$$CO_{2t} = \beta_0 + \beta_1 GVC_t + \beta_2 GDP_t + \beta_3 FFEC_t + \beta_4 FDI_t + \beta_5 URB_t + e_t, \quad (1)$$

$$CO_{2t} = \beta_0 + \beta_1 DVX_t + \beta_2 GDP_t + \beta_3 FFEC_t + \beta_4 FDI_t + \beta_5 URB_t + e_t, \quad (2)$$

$$CO_{2t} = \beta_0 + \beta_1 FVA_t + \beta_2 GDP_t + \beta_3 FFEC_t + \beta_4 FDI_t + \beta_5 URB_t + e_t, \quad (3)$$

where $t = 1, \ldots, T$. In Eqs. (1)–(3), CO_2 is carbon dioxide emissions, *GVC* is global value chain participation index, *DVX* is indirect value added, *FVA* is foreign value added in exports, *GDP* is gross domestic product, *FFEC* is fossil fuel energy consumption, *FDI* is foreign direct investment, *URB* is urbanization, β_0 is constant term, β_1 is the coefficient of independent variable, β_2 to β_5 are the coefficients of control variables, and e_t is the stochastic error term.

Estimation technique

In this paper, the dynamic ARDL model developed by Jordan and Philips (2018) is employed. The dynamic ARDL model was proposed to deal with the shortcoming in the traditional ARDL model developed by Pesaran et al. (2001). According to Jordan and Philips (2018), the dynamic ARDL model simplifies the evaluation of the short- and long-run association among variables. Using stochastic simulation techniques, the dynamic ARDL simulation model estimates, simulates, and visualizes the spurious changes in the dependent variable that are due to a counterfactual change in an independent variable, while taking other independent variables constant (Danish and Ulucak 2020).

The dynamic ARDL simulations of the econometric models specified in Eqs. (1)–(3) in the error correction form are derived as follows:

$$\begin{aligned}\Delta CO_{2t} = {} & \beta_0 + \beta_1 CO_{2t-i} + \beta_2 \Delta GVC_t + \beta_3 GVC_{t-i} \\ & + \beta_4 \Delta GDP_t + \beta_5 GDP_{t-i} + \beta_6 \Delta FFEC_t \\ & + \beta_7 FFEC_{t-i} + \beta_8 \Delta FDI_t + \beta_9 FDI_{t-i} \\ & + \beta_{10} \Delta URB_t + \beta_{11} URB_{t-i} + e_t,\end{aligned} \quad (4)$$

$$\begin{aligned}\Delta CO_{2t} = {} & \beta_0 + \beta_1 CO_{2t-i} + \beta_2 \Delta DVX_t + \beta_3 DVX_{t-i} \\ & + \beta_4 \Delta GDP_t + \beta_5 GDP_{t-i} + \beta_6 \Delta FFEC_t \\ & + \beta_7 FFEC_{t-i} + \beta_8 \Delta FDI_t + \beta_9 FDI_{t-i} \\ & + \beta_{10} \Delta URB_t + \beta_{11} URB_{t-i} + e_t,\end{aligned} \quad (5)$$

$$\begin{aligned}\Delta CO_{2t} = {} & \beta_0 + \beta_1 CO_{2t-i} + \beta_2 \Delta FVA_t + \beta_3 FVA_{t-i} \\ & + \beta_4 \Delta GDP_t + \beta_5 GDP_{t-i} + \beta_6 \Delta FFEC_t \\ & + \beta_7 FFEC_{t-i} + \beta_8 \Delta FDI_t + \beta_9 FDI_{t-i} \\ & + \beta_{10} \Delta URB_t + \beta_{11} URB_{t-i} + e_t.\end{aligned} \quad (6)$$

Empirical results

In order to apply the dynamic ARDL simulation model, the dependent variable must be integrated at *I*(1), and none of the independent variables must be integrated at higher than

Table 2 Unit root test results

Variables	ADF	ΔADF	PP	ΔPP
CO_2	−0.789	−5.901***	−0.679	−6.186***
GVC	−1.277	−4.470***	−1.258	−4.476***
DVX	−1.168	−4.727***	−1.169	−4.759***
FVA	−1.543	−4.278***	−1.543	−4.280***
GDP	0.405	−5.421***	1.378	−5.421***
FFEC	−1.364	−4.508***	−1.364	−4.515***
FDI	−1.081	−5.283***	−0.997	−5.291***
URB	−2.139	−5.156***	−3.366**	−4.508***

*, **, ***Statistical significance at 10%, 5%, and 1%, respectively

Table 1 Descriptive statistics

Variables	Mean	Max	Min	Std. Dev	Skew	Kurt	J-B
CO_2	1.345	1.657	1.033	0.195	−0.021	1.663	0.339
GVC	30.968	31.865	29.731	0.736	−0.108	1.474	0.238
DVX	30.322	31.066	29.289	0.635	−0.097	1.420	0.216
FVA	30.212	31.270	28.705	0.856	−0.159	1.572	0.274
GDP	8.929	9.393	8.576	0.261	0.344	1.823	0.325
FFEC	4.455	4.506	4.399	0.037	−0.212	1.628	0.327
FDI	22.005	23.816	20.226	1.394	−0.025	1.211	0.144
URB	4.206	4.319	4.081	0.073	−0.068	1.758	0.389

Max. maximum value, *Min.* minimum value, *Std. Dev.* standard deviation, *Skew.* skewness, *Kurt.* kurtosis, *J-B* probability of Jarque–Bera normality test

$I(1)$; that is, independent variables can be integrated either at $I(0)$ or $I(1)$ or a combination of $I(0)$ and $I(1)$. To analyze whether the data series in this study meet these conditions, the augmented Dickey and Fuller (1979) and Phillips and Perron (1988) unit root tests are implemented and the results presented in Table 2. According to both unit root test results, the null hypothesis of a unit root is rejected for all the study data series at first difference at 1% level of significance. This result indicates that all the data series are stationary at first difference, i.e., integrated at $I(1)$.

Another condition for the dynamic ARDL simulation model to be applicable is that there must be a cointegration among the variables under consideration. To see whether the data series in this study fulfill this requirement, the modified Pesaran et al. (2001) bounds test with Kripfganz and Schneider (2020) lower and upper bound critical values is applied. These critical values are chosen because they are more reliable and robust for a small finite sample size, such as in this paper (Danish and Ulucak 2020). The cointegration test results for the estimated models in Eqs. (1)–(3) are presented in Table 3. Since the F-test value of all three models is greater than the upper bound critical value of the 1% level, the null hypothesis of no cointegration is rejected at 1% level of significance for all the estimated models. This demonstrates the existence of cointegration among the data series included in the models. The results of both the unit root and cointegration tests indicate that the data series used in the study are suitable for the dynamic ARDL simulation model.

Since all the required preconditions are met, the dynamic ARDL simulation model is employed to determine the short- and long-run effects of GVC participation on the environment. The results for each of the models are reported in Table 4. Based on the results, it is observed that all of the measures of GVC participation (overall, forward, and backward) have positive long-run influences on CO_2 emissions in Turkey. In the long run, a 1% increase in GVC, DVX, and FVA results in 0.166%, 0.150%, and 0.148% increases, respectively, in CO_2 emissions in Turkey. These findings

Table 3 Bounds test results

Estimated models	F-test	10%		5%		1%	
		$I(0)$	$I(1)$	$I(0)$	$I(1)$	$I(0)$	$I(1)$
(1) $CO_2 = f(gvc, gdp, ffec, fdi, urb)$	8.78***	2.45	3.50	2.86	3.99	3.74	5.01
(2) $CO_2 = f(dvx, gdp, ffec, fdi, urb)$	8.77***	2.45	3.50	2.86	3.99	3.74	5.01
(3) $CO_2 = f(fva, gdp, ffec, fdi, urb)$	6.99***	2.45	3.50	2.86	3.99	3.74	5.01

$I(0)$ is the lower bound and $I(1)$ is the upper bound critical values of Kripfganz and Schneider (2020)

*Statistical significance at 1%

Table 4 Dynamic ARDL simulation results

	Model 1		Model 2		Model 3	
	Coeff	Prob	Coeff	Prob	Coeff	Prob
CO_{2t-1}	−1.641***	0.000	−1.647***	0.000	−1.532***	0.000
ΔGVC_t	0.038	0.346				
GVC_{t-1}	0.166***	0.003				
ΔDVX_t			0.041	0.264		
DVX_{t-1}			0.150***	0.004		
ΔFVA_t					0.024	0.591
FVA_{t-1}					0.148**	0.011
ΔGDP_t	0.554***	0.001	0.567***	0.001	0.593***	0.001
GDP_{t-1}	0.879***	0.000	0.898***	0.000	0.888***	0.001
$\Delta FFEC_t$	1.135**	0.015	1.090**	0.020	1.214**	0.015
$FFEC_{t-1}$	4.324***	0.000	4.268***	0.000	4.215***	0.000
ΔFDI_t	−0.023**	0.034	−0.025**	0.025	−0.022*	0.073
FDI_{t-1}	−0.040**	0.011	−0.040**	0.010	−0.036**	0.034
ΔURB_t	−14.312**	0.046	−14.708**	0.043	−13.177*	0.076
URB_{t-1}	−2.119***	0.002	−1.733***	0.009	−2.540***	0.001
Constant	−20.147***	0.000	−21.103***	0.000	−17.577***	0.000
Adj. R^2	0.854		0.852		0.830	
F-stat	13.84***	0.00	13.56***	0.000	11.62***	0.000

*, **, ***Statistical significance at 10%, 5%, and 1%, respectively

imply that the environment in Turkey is adversely affected as the GVC participation increases. The implication of these findings is that all kinds of global value chain participation adversely affect the environment in Turkey. Also, the negative environmental externality generated from Turkey's forward integration into global value chains is not too different from that produced from backward integration into global value chains. This suggests that Turkey is being assigned segments of the value chain that require dirtier production processes and therefore serves as a pollution haven. This is an indication that other countries continually source for inputs requiring dirty production processes from Turkey, as Turkey also exports final goods that are produced using eco-unfriendly techniques. Policymakers in Turkey therefore need to follow more environmentalist policies in the process of GVC participation.

The results of the control variables for all three models indicate that GDP and FFEC have significant and positive short- and long-run impacts on CO_2 emissions. This indicates that increased economic activities, captured through GDP, still damages the environment. This finding is in consonance with the conclusions reached in recent studies conducted by Saint Akadiri et al. (2019), Alhassan et al. (2020), Saint Akadiri et al. (2020), Iorember et al. (2021), Adebayo et al. (2022), and Lee and Olasehinde-Williams (2022). It may however be inferred from the result that Turkey is still a developing country that is yet to reach the turning point beyond which GDP and pollution become inversely related, as stated by the environmental Kuznets curve hypothesis. The negative environmental impact of fossil fuel energy consumption is also in alignment with a priori expectation. There is a consensus that fossil fuel is a crucial input for economic growth. In the process of increasing economic growth, huge amounts of fossil fuel are burnt, leading to rising carbon emissions. Fossil fuel remains the most widely used energy form in Turkey. Recent studies with similar findings include Olanipekun et al. (2019), Coskuner et al. (2020), and Iorember et al. (2022).

FDI and URB, on the other hand, have significant and negative short- and long-run impacts on CO_2 emissions in Turkey. The fact that the impact of foreign direct investment, while controlling for the impact of global value chain participation, is negative is quite interesting. This finding lends credence to the pollution halo hypothesis and agrees with the positions of Huang et al. (2018), Hao et al. (2020), and Horobet et al. (2021) that polluting countries generally prefer to attract foreign investment inflows that lower pollution. It suggests that the Turkish government is doing a good job of preventing the country from becoming a pollution haven through direct investment inflows. The study findings however reveal that Turkey's status as a pollution haven occurs mainly through global value chain participation and related incentives, rather than through investment inflows. The pollution-reducing effect of urbanization confirms its role as an important demographic factor capable of altering energy consumption and pollution patterns of households. This finding supports the compact city theory in Turkey. The theory posits that economies of scale in public infrastructure is achieved as urban population increases, and this lowers pollution (Burton 2000; Capello and Camagni 2000).

The results of the diagnostic tests performed to determine whether the outputs obtained from the dynamic ARDL simulation model are reliable are shown in Table 5. The results demonstrate that there are no serial correlation, heteroscedasticity, model specification, and non-normality issues for all three estimated models, which implies that the dynamic ARDL simulation model results are reliable.

As a final step, the predicted effects of one standard deviation counterfactual shocks to the measures of GVC participation (GVC, DVX, and FVA) on CO_2 emissions are simulated and plotted as presented in Figs. 1, 2, and 3. The graphics on the left side in Figs. 1, 2, and 3 show that a positive one standard deviation shock to GVC, DVX, and FVA will stimulate a significant increase in CO_2 emissions in the short run that eventually reaches sustained long-run values of about 1.476, 1.463, and 1.484, respectively. The graphics on the right side in Figs. 1, 2, and 3 show that a negative one standard deviation shock to GVC, DVX, and FVA will cause a significant decline in CO_2 emissions in the short run, to sustained long-run values of about 1.328, 1.348, and 1.317, respectively. These results demonstrate that positive shocks to Turkey's GVC participation will cause an increase in CO_2 emissions, while negative shocks will cause a decrease in CO_2 emissions. Overall, it can be concluded that GVC participation is a significant factor for the environment in Turkey.

Table 5 Diagnostic test results

Diagnostic tests	Model 1	Model 2	Model 3	Conclusions
Breusch Godfrey LM	0.812	0.829	0.816	No serial correlation issue
Breusch Pagan Godfrey	0.508	0.803	0.219	No heteroscedasticity issue
ARCH test	0.854	0.501	0.894	No heteroscedasticity issue
Ramsey RESET test	0.625	0.569	0.393	No model specification issue
Jarque–Bera test	0.563	0.563	0.776	No non-normality issue

This table includes chi-square *p* values

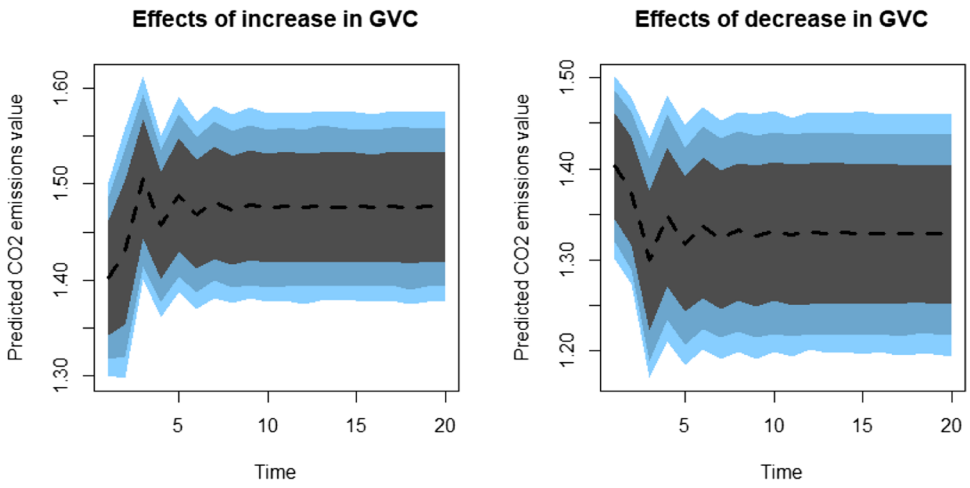


Fig. 1 ± 1 standard deviation change in the GVC and its effect on carbon dioxide emissions. The predicted values are presented by dashed lines. The 75%, 90%, and 95% confidence intervals are shown in graphs from darkest to lightest areas, respectively. Following Abbasi et al. (2021) and Amin and Dogan (2021), the number of simulations is set as 5000

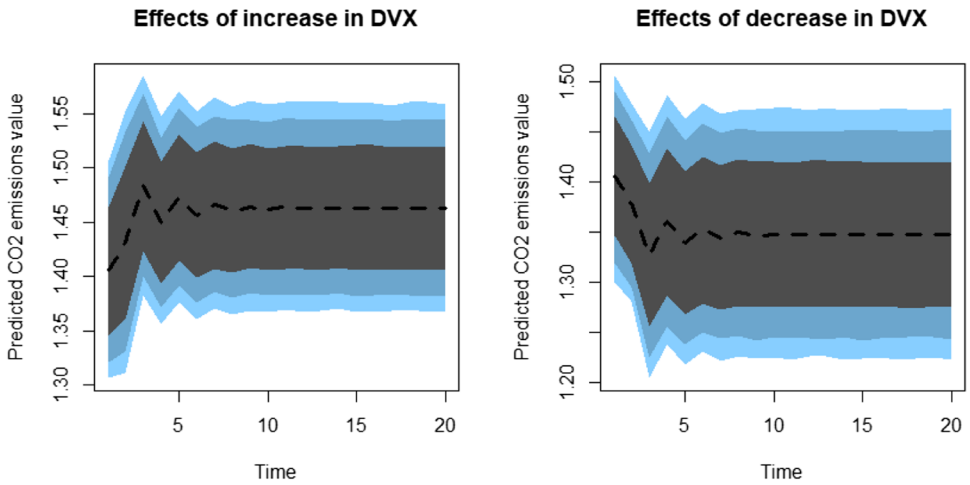


Fig. 2 ± 1 standard deviation change in the DVX and its effect on carbon dioxide emissions. The predicted values are presented by dashed lines. The 75%, 90%, and 95% confidence intervals are shown in graphs from darkest to lightest areas, respectively. Following Abbasi et al. (2021) and Amin and Dogan (2021), the number of simulations is set as 5000

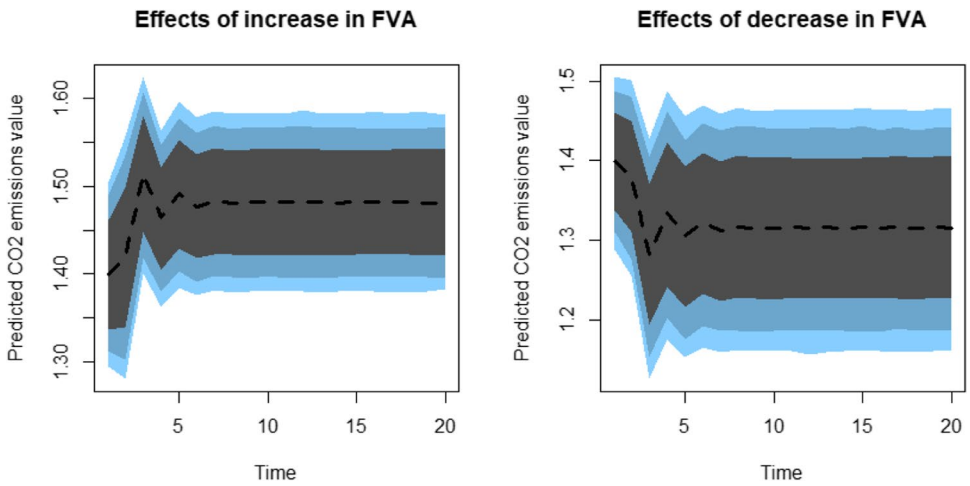


Fig. 3 ± 1 standard deviation change in the FVA and its effect on carbon dioxide emissions. The predicted values are presented by dashed lines. The 75%, 90%, and 95% confidence intervals are shown in graphs from darkest to lightest areas, respectively. Following Abbasi et al. (2021) and Amin and Dogan (2021), the number of simulations is set as 5000

Conclusion

The phenomenal growth experienced by Turkey at the turn of the millennium is attributed in part to increased participation in global value chains. While participation in global value chains has been beneficial to the Turkish economy, it also poses unique environmental challenges. Consequently, this study focuses on shedding some light on the environmental externality of Turkey's participation in global value chains. This article empirically examines

the environmental effects of Turkey's global value chain participation for the period 1990–2018, using a dynamic ARDL analysis. The study further compares the environmental effects of Turkey's backward and forward linkages into global value chains, so as to determine which contributes more to carbon emissions.

A dynamic framework incorporating the overall global value chain participation index, the indirect value added, foreign value added in exports, GDP, fossil fuel energy consumption, foreign direct investment, and urbanization is analyzed via a dynamic ARDL simulation approach. The approach provides a large degree of flexibility and is able to identify the short- and long-term effects of counterfactual shocks in exogenous variables. From the empirical analysis, the modified Pesaran et al. (2001) bounds test with Kripfganz and Schneider (2020) critical values confirms that there is a significant long-run relationship between all measures of global value chain participation and carbon emissions. All three measures of global value chain participation display a positive long-run impact on carbon emissions. The results also show that the polluting effect of backward and forward linkages into global value chains is not too different, indicating that their impacts are quite similar.

The finding suggests that Turkey is being assigned segments of the value chain that require dirtier production processes through incentives from global trade integration, thus making Turkey a pollution haven. It is concluded that this is because other countries continually source for inputs requiring dirty production processes from Turkey, as Turkey also exports final goods that are produced using eco-unfriendly techniques. Policymakers in Turkey therefore need to follow more environmentalist policies in the process of the global value chain participation.

On the empirical front, the finding reveals that in the face of increasing globalization, not controlling for the effect of global value chain participation while examining the pollution haven/halo hypotheses might lead to misleading inference. While controlling for the impact of global value chain participation, it is found that direct investment inflows lower pollution in Turkey. This finding lends credence to the pollution halo hypothesis. It suggests that the Turkish government is doing a good job of preventing the country from becoming a pollution haven through direct investment inflows. The study findings however reveal that Turkey's status as a pollution haven occurs mainly through global value chain participation and related incentives, rather than through investment inflows.

It is recommended that Turkey should not develop its economy through global value chains in a way that is detrimental to the quality of the environment. Turkey needs to carefully position itself in the global value chain so as not to become a pollution haven for the advanced economies. An inclusive green trade strategy aimed at achieving a synergistic connection between the environment and the economy should be pursued. Turkey should therefore strengthen its research and development so that both trade-induced growth and environmental protection can occur simultaneously. Moreover, Turkey has an added advantage, since more developed nations have already advanced the frontiers of technology. By aggressively adopting cleaner technologies earlier in the development process through green-technology trade, Turkey can lower pollution. Inefficient competition for a larger share of the global value chain through the lowering of environmental standards should be avoided. Policymakers should set environmental regulations as close to the Pareto optimal level as possible. Turkey must avoid being caught either in the "race to the bottom" or the "not-in-my-backyard" phenomena.

Author contribution Godwin Olasehinde-Williams wrote the introduction, literature review, and conclusion. Oktay Özkan collected data, analyzed the data, and also worked on the methodology.

Data availability The corresponding author can provide data used in the study on appropriate request.

Declarations

Ethics approval and consent to participate NA.

Consent for publication NA.

Competing interests The authors declare no competing interests.

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