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STRUCTURAL DECOMPOSITION OF GLOBAL CO2 EMISSIONS CHANGES AND CONTRIBUTIONS OF THE UNITED STATES, EUROPEAN UNION, BRIC AND REST OF THE WORLD

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ABSTRACT

The aim of this study was to estimate the structural decomposition of the variation of the world CO_2 emissions with the use of the world's input-output matrix in four effects: intensity, technology, final demand structure and volume of final demand. The main conclusions are that the intensity effect was the main mitigating factor of carbon dioxide emissions globally (-8202 $GtCO_2$). The main factor responsible for the increase in emissions was the volume effect of final demand (economic growth) with 9843 $GtCO_2$, followed by structural effect of the final demand with 7257 $GtCO_2$ and then the technology effect with 1152 $GtCO_2$. The United States and the European Union have reduced total emissions, the first mainly by technology effect and the second by intensity effect. The BRIC countries and Rest of the world made efforts to mitigate emissions by intensity and technology effects, however, the positive values of volume and structure effects of the final demand outweighed the negative values resulting in increased emissions. Therefore, targets and strategies for mitigating carbon dioxide emissions should consider the development stage of countries and the development of sustainable lifestyles and conscious consumption are important for new emission mitigation strategies.

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INTRODUCTION

The increase in concentration of carbon dioxide in the atmosphere is responsible for modifying hydrological cycles, destabilizing ecosystems and life cycles; in addition to being the cause of global habitat loss (Malik et al., 2016).The historical responsibility for climate change caused by the accumulation of carbon dioxide in the atmosphere lies with industrialized nations such as the United States and the European Union, while developing countries such as China, India and Brazil bear responsibility for the contemporary increase in emissions. The process of elaborating the solution to the problem of climate change in the form of international negotiations results in the elaboration of agreements that generate an initial commitment by the representatives of the countries within the Conferences of the Parties. The agreements must be ratified by the legislature in each country and will result in laws and public policies to achieve the proposed objectives (Gupta, 2012; Bodansky, 2016). The Kyoto Protocol of 2005 was based on the Principle of Historical Responsibilities (HRP) and on the Principle of Common but Differentiated Responsibility (PRDC). The initial proposal of the Kyoto Protocol corresponded to the fair attribution of responsibilities for the mitigation of emissions (Bueno Rubial, 2016). The contribution of Annex I countries (industrialized countries) to accumulated CO_2 emissions in the atmosphere in the period from 1850 to 1990 was 80.94%, in opposition to the 19.06% for all other countries. These countries have succeeded in their intensive development process in the burning of fossil fuels to obtain 82.45% of the world flux of wealth expressed by the Gross Domestic Product (GDP) as opposed to the 17.55% that belong to all countries in the rest of the world. in 1990,year from which the Kyoto Protocol initially predicted the need for reductions in global emissions (Souza and Corazza, 2017). The greatest responsibility of historic emitters (i.e. Annex I countries) has been assigned to industrialized countries under the Kyoto Protocol. However, the agreement left out too much of the emissions. Viola (2010) considered that only 20% of global GHG emissions would be covered and, therefore, these failures caused its destabilization in 2009, which generated the need to voluntarily set new targets by the Parties, which was consolidated in the Paris Agreement in 2015. The Paris Agreement can be interpreted as a "bottom-up" approach to climate negotiations, in which the Parties present their reduction targets for GHG (Greenhouse Gas) in a new arrangement in which Annex I and emerging countries must assume new responsibilities consolidated in the form of INDCs (Intended Nationally Determined Contributions) (Bueno Rubial, 2016; Okereke & Coventry, 2016; Afionis, 2017). The new agreement was signed only after the Parties had submitted their NDCs within two years and, throughout 2015, most had already submitted commitments (Afionis, 2017). The national contributions (NDCs) of countries must have the mitigation of climate change, the promotion of adaptation measures and the creation of economic opportunities (Bodansky, 2016). Considering the complexity of the climate change problem and the establishment of voluntary targets by countries in the Paris Agreement, it is important to measure the factors that drive the variations in emissions, which will help to improve the understanding of the problem and determination of targets and strategies for mitigating carbon dioxide emissions by countries to achieve the proposed goals.

Therefore, the objective of the study was to estimate the structural decomposition of the variation of CO_2 emissions in the world using the world input-output matrix. Specifically, it wasintendedto:

a) Decompose variations in carbon dioxide emissions into four effects: Intensity (emissions per unit of production), Technology (changes in the composition of use of inputs), Structure of final demand (structure of purchases of final goods and services) and Volume of final demand (economic growth).
b) Group the results into: European Union, United States, the group of countries called BRIC (Brazil, Russia, India and China) and Rest of the World and estimate the contribution of the groupings to the global effects,
c) Estimate efforts to mitigate CO_2 emissions for each group of countries and identify the main drivers of variations.

The methodology used to measure variations in countries' carbon dioxide emissions is based on the global input-output matrix. The multi-regional input-output system has intersectoralrelationships within each country and flows of goods and services in international trade. Therefore, the methodology considers a general economic equilibrium model for the regions, capturing the effects of structural changes in the world economic system in the period 2000-2014 on countries' emissions. The results show the evolution of variations in carbon dioxide emissions and the main effects. In addition, the estimates can be used to indicate strategies for mitigating the CO_2 emissions of the countries that are mainly responsible for their variations.

METHODOLOGY

Structural Decomposition Analysis (SDA): The model thatmet the proposal of the article is based on De Haan (2001) which can be applied to sectoral data on the labor market, emissions and energy. The works that use Structural Decomposition Analysis use the input-output model as a basis for decomposition, as it allows a better approximation of reality. Changes in CO_2 emissions in Gigatons per sector (Δc) can be described as a function of changes in factors related to the structure of the economy presented in the input-output matrix. Changes in emissions in terms of monetary units of production are determined by (Δn), which shows changes in the intensity of emissions. Variations in the technical coefficients of the economy, changes in the composition of the final demand structure and the increase in volume in the final demand are denoted respectively by (Δs), (Δys) and (Δyv). Thus, the generic formula for calculating the factor decomposition can be characterized by:

$$\Delta c = \Delta n + \Delta s + \Delta y^s + \Delta y^v \tag{1}$$

The structural decomposition analysis of CO_2 emissions can be derived by assuming that c_{1j} of C represents the value of emissions from activity j. In this way, the total of the variable generated by all productive activities can be determined as a function of the total product:

$$c = NX \tag{2}$$

The element$c$ indicates the total value of CO_2 emissions generated in all production activities. The column vector X has the values of the total sectoral product and$N = C(\hat{X})^{-1}$, in which the elementsn_{1j} of N indicate the emission coefficients, that is, the amount of emissions generated by a monetary unit of production of activity j. $\hat{X}$represents the diagonalized matrix of X. The equation$X = (I - A)^{-1}y$ shows the value of total sectoral production X as a function of final demand y, where $S = (I - A)^{-1}$represents the inverse Leontief matrix and A represents the matrix of technical coefficients (De Haan, 2001 and Miller and Blair, 2009). The matrix with the final demand values,y ,with (nxm) as dimensions contains the final demand elements which are household consumption, government, investment and exports. The total in the row of this matrix is the row vector y^v, which is the final demand volume with (mx1) as dimensions. The composition of the final demand, y^s, is a matrix of coefficients obtained by dividing each element of the matrix by the vector y^vin its inverse and diagonalized form:

$$y^s = y\hat{y}^{v-1} \tag{3}$$

The values of CO_2 emissions generated by all sectors can be determined by the following equation:

$$c = NX = NSy^s y^v \tag{4}$$

For the present study, we have:

$N$is the vector (1xn) of carbon dioxide coefficients;
S is the inverse Leontief (nxn) matrix;
$y^s$is the matrix (nxm) of final demand coefficients; and
$y^v$is the vector (mx1) with the total final demand by category.

The structural decomposition of the change in emission values and their total value between the periods of$t$and $t-1$ can be determined as follows:

$$\begin{aligned}
\Delta c &= c_{(t)} - c_{(t-1)} \\
\Delta c &= N_{(t)}S_{(t)}y^s_{(t)}y^v_{(t)} - N_{(t-1)}S_{(t-1)}y^s_{(t-1)}y^v_{(t-1)} \\
\Delta c &= (\Delta N)S_{(t)}y^s_{(t)}y^v_{(t)} + N_{(t-1)}S_{(t)}y^s_{(t)}y^v_{(t)} \\
&\quad - N_{(t-1)}S_{(t-1)}y^s_{(t-1)}y^v_{(t-1)} \\
\Delta c &= (\Delta N)S_{(t)}y^s_{(t)}y^v_{(t)} + N_{(t-1)}(\Delta S)y^s_{(t)}y^v_{(t)} + N_{(t-1)}S_{(t-1)}y^s_{(t)}y^v_{(t)} \\
&\quad - N_{(t-1)}S_{(t-1)}y^s_{(t-1)}y^v_{(t-1)} \\
\Delta c &= (\Delta N)S_{(t)}y^s_{(t)}y^v_{(t)} + N_{(t-1)}(\Delta S)y^s_{(t)}y^v_{(t)} + N_{(t-1)}S_{(t-1)}(\Delta y^s)y^v_{(t)} \\
&\quad + N_{(t-1)}S_{(t-1)}y^s_{(t-1)}y^v_{(t)} \\
&\quad - N_{(t-1)}S_{(t-1)}y^s_{(t-1)}y^v_{(t-1)} \\
\Delta c &= (\Delta N)S_{(t)}y^s_{(t)}y^v_{(t)} + N_{(t-1)}(\Delta S)y^s_{(t)}y^v_{(t)} + \\
&\quad N_{(t-1)}S_{(t-1)}(\Delta y^s)y^v_{(t)} + N_{(t-1)}S_{(t-1)}y^s_{(t-1)}(\Delta y^v)
\end{aligned} \tag{5}$$

According to Dietzenbacher and Los (2000), the formulation made in equation (5) describes just one situation among several possible ones. Therefore, with n factors, $n!$ forms of structural decompositions that follow a structure like the one described can happen. Jacobsen (2000) and Hoen and Mulder (2003) proposed using the average of the two existing polar forms. Equation (22) is one of the polar forms. The other is given by:

$$\Delta c = (\Delta N)S_{(t-1)}y^s_{(t-1)}y^v_{(t-1)} + N_{(t)}(\Delta S)y^s_{(t-1)}y^v_{(t-1)} + N_{(t)}S_{(t)}(\Delta y^s)y^v_{(t-1)} + N_{(t)}S_{(t)}y^s_{(t)}(\Delta y^v) \tag{6}$$

Here, the suggestion of Jacobsen (2000) is also used and the average of the two polar forms is given by:

$$\Delta c = \tfrac{1}{2}\left((\Delta N)S_{(t)}y^s_{(t)}y^v_{(t)} + (\Delta N)S_{(t-1)}y^s_{(t-1)}y^v_{(t-1)}\right) \quad \text{(Intensity Effect)}$$
$$+ \tfrac{1}{2}\left(N_{(t-1)}(\Delta S)y^s_{(t)}y^v_{(t)} + N_{(t)}(\Delta S)y^s_{(t-1)}y^v_{(t-1)}\right) \quad \text{(Technology Effect)}$$
$$+ \tfrac{1}{2}\left(N_{(t-1)}S_{(t-1)}(\Delta y^s)y^v_{(t)} + N_{(t)}S_{(t)}(\Delta y^s)y^v_{(t-1)}\right) \quad \text{(Final Demand Structure Effect)}$$
$$+ \tfrac{1}{2}\left(N_{(t-1)}S_{(t-1)}y^s_{(t-1)}(\Delta y^v) + N_{(t)}S_{(t)}y^s_{(t)}(\Delta y^v)\right) \quad \text{(Final Demand Volume Effecty)}$$

To obtain the results disaggregated by sector, simply take$N$in its diagonalized form in equation (6),$C = (\hat{N})X = (\hat{N})Sy^{s}_{(t)}y^{v}_{(t)}$. The model has already been used by Pergião et al. (2017) and Pompermayer Sesso et al. (2020) for CO_2 emissions and Esteves (2017) for renewable and non-renewable energy variations of countries.

Data base: For the present study, we have the interregional input-output system with 44 regions (43 countries and the rest of the world) each with 56 sectors (Timmer et al., 2014 and Timmer et al., 2015). The data is made available by the World Input-output Database (WIOD, 2021). The results obtained refer to values of carbon dioxide emissions in Gigatons per year (Corsatea et al., 2019) obtained in EU Science Hub (2021).

RESULTS AND DISCUSSION

Table 1 presents the results of the estimates of the structural decomposition of the variation of global emissions in $GtCO_2$ (Gigatons) in the period 2000-2014. The values were used for the elaboration of Figure 1, which illustrates the participation of each effect of the structural decomposition of the variation of global emissions of carbon dioxide in percentage values in relation to the absolute value of each period. The results of the variation in emissions (Totals for the period) in Table 1 indicate the increase in emissions in the period 2000-2007 from 262 $GtCO_2$ to about 1229 $GtCO_2$ per year, this was mainly caused by the Effects of final demand (structure and volume). In the periods 2007-2008 and 2008-2009 there were decreases in emissions of -22 and -317 $GtCO_2$ respectively due to the slowdown in the world economy and, after that, a new growth in emissions in 2009-2010 and 2010-2011 with an increase in the rate of growth. World emissions entered a period of reduction between 2011 and 2014 with greater commitment by countries to mitigation by Effect Intensity. In Figure 1, the Intensity Effect of global CO_2 emissions is the main mitigation factor, followed by the Technology Effect. On the other hand, the final demand volume effect, or economic growth, is the main factor for the increase in emissions, followed by the final demand structure effect. In the periods of lower economic growth, 2007-2008 and 2008-2009, there is a change in the behavior of variables with negative effects related to final demand.

The result of the impact of economic growth on emissions was estimated as the effect of the variation in deflated sectoral final demand values, indicated as the main reason for the increase in CO_2 emissions. The final demand structure effect concerns the modification of the demand structure for final goods and services; therefore, the modification of the final demand structure is the second most important factor at the global level in emissions generation and directly related to the increase in *per capita* income, changes in the population's consumption habits, changes in the export agenda and other factors that alter its composition. The intensity effect shows the variation in emissions because of the modification of the emissions per unit of production ratio, this factor is directly related to energy sources. The total values of the effects (Table 1) showed that the intensity effect is the main mitigation factor of carbon dioxide emissions in global terms with -8202 $GtCO_2$ and negative values occur in 12 of the 14 periods. The highest positive value obtained in total values was the economic growth with 9843 $GtCO_2$, presented as an effect of the volume of final demand. Secondly, the final demand structure effect with 7257 $GtCO_2$ and, third, the technology effect responsible for 1152 $GtCO_2$. Looking at Figure 1, a pattern of behavior can be noted in the periods with positive technology, structure and volume of final demand effects and a negative intensity effect, with the exception of three periods: 2001-2002, 2007-2008 and 2008-2009. Jiang and Guan (2016) and Xia et. al (2020) found similar results to the present study for variations in global CO_2 emissions, however, the technology effect would be negative for the authors' results. It should be considered that the Intensity Effect estimated in this study is a technological effect, since it is about the modification of the amount of CO_2 emissions per unit produced related to the energy matrix and, thus, adding the intensity and technology effects, we have a negativevalue, consistent with the results of previous surveys.

Table 1. Results of the structural decomposition of the variation of global carbon dioxide emissions in the period 2000-2014. Values in Gigatons

Period	Effects				Period totals
	Intensity	Technology	Final demand structure	Final demand volume	
2000-2001	-262	56	149	319	262
2001-2002	488	-662	181	324	332
2002-2003	-446	535	303	722	1114
2003-2004	-1078	611	532	1080	1146
2004-2005	-1501	1074	588	992	1153
2005-2006	-1051	140	712	1163	964
2006-2007	-1215	412	900	1131	1229
2007-2008	-71	-1077	635	491	-22
2008-2009	1164	-1069	370	-781	-317
2009-2010	-411	141	956	1113	1799
2010-2011	-643	268	542	864	1031
2011-2012	-1181	75	590	907	391
2012-2013	-634	56	401	705	528
2013-2014	-1363	592	398	813	440
Effecttotals	-8202	1152	7257	9843	10050

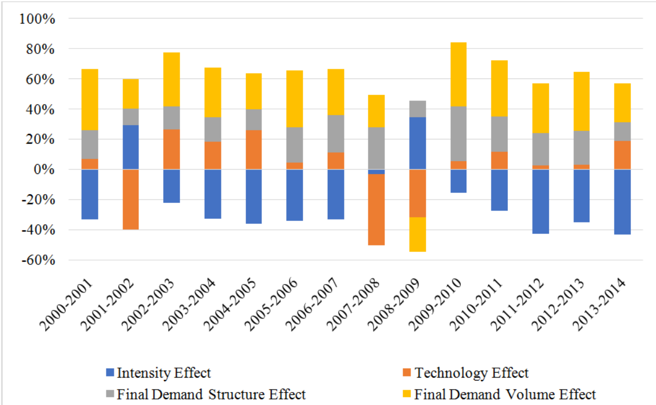

Figure 1. Results of the structural decomposition of the variation of global carbon dioxide emissions in the period 2000-2014. Effect values in percentage values in relation to the total absolute variation of each period

Figure 2 shows the values disaggregated byregions (European Union, United States, BRIC countries and Rest of the world) of the estimates of the structural decomposition of variations in global carbon dioxide emissions in the period 2000-2014. The percentage values indicate the participation of regions in the global total variations. During the period of analysis there was a total increase of 10050 $GtCO_2$. The intensity effect was the main reason for mitigating emissions with -8202 $GtCO_2$. China had the largest participation in this global mitigation process with around -50%, followed by the Rest of the World with -26%, followed then by the European Union with the value of -17%. Other countries showed less expressive values such as India (-2%), Russia (-3%) and the United States (-2%) and Brazil (+1%). The technology effect on global carbon dioxide emissions was +1152 $GtCO_2$ between 2000 and 2014. China's main share of the increase was +159%, followed by Rest of the World (+77%). On the other hand, Russia (-30%) and the United States (-112%) were successful in mitigating emissions due to technology. India (+3%) and the European Union (+4%) showed insignificant positive values and Brazil had a share of -2%. The final demand structure effect on global emissions was positive in the period 2000-2014 with +7257 $GtCO_2$. China had the largest share of global value with 89%, followed by Rest of the World with 29%. Less significant positive values were obtained for India and Russia with 2%.

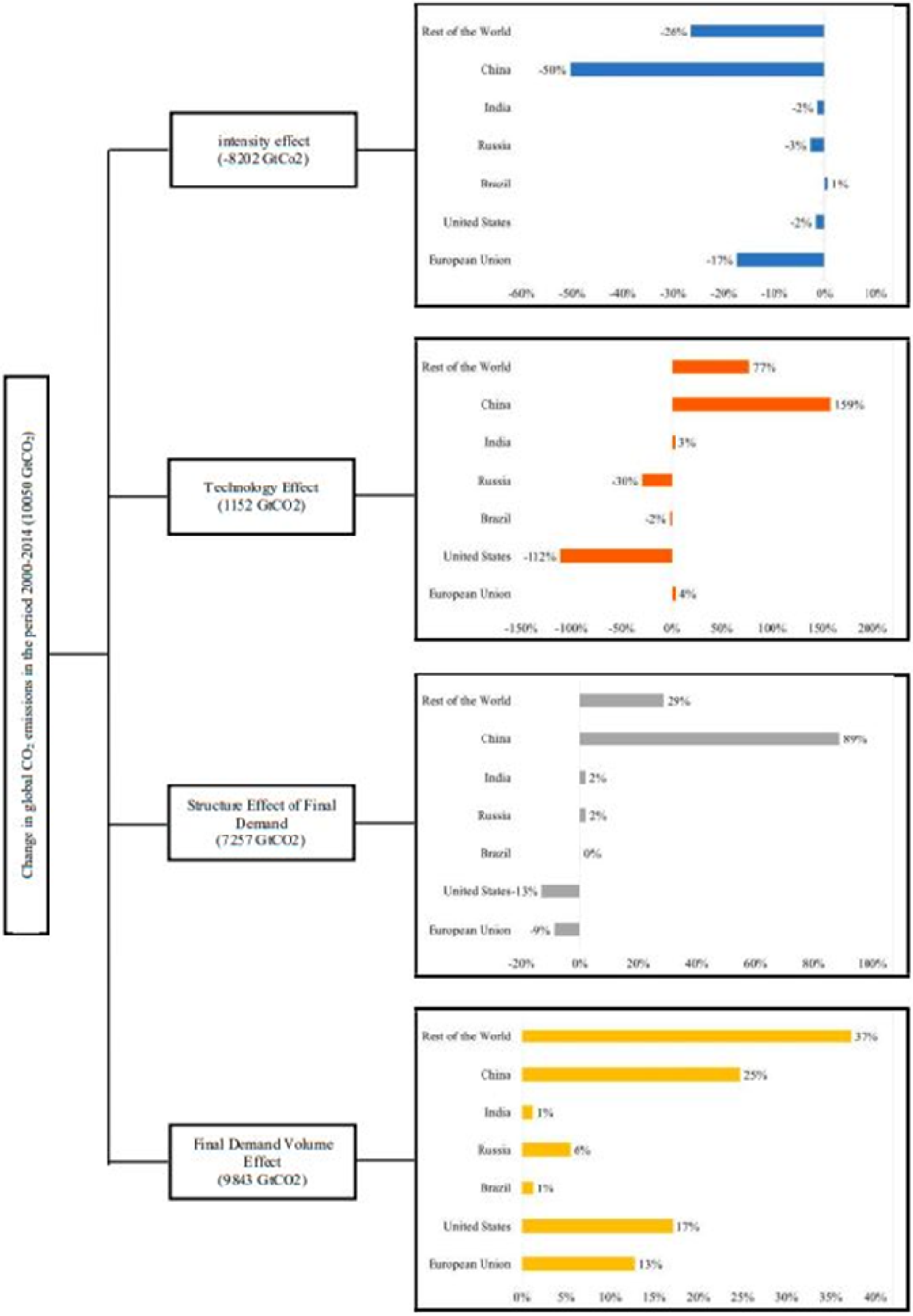

Figure 2. Disaggregation of global structural decomposition effects of carbon dioxide emissions in the period 2000-2014. The percentage values indicate the participation of regions in the global total variations

Brazil presented a value close to 0%. United States and European Union showed negative values, respectively, of -13% and -9%. The final demand volume effect (economic growth) was the main factor responsible for the increase in carbon dioxide emissions between 2000 and 2014, with about 9843 $GtCO_2$. The region with the highest participation was the Rest of the World (+37%), followed by China (+25%), the United States (+17%), the European Union (+13%), Russia (+6%) and India and Brazil obtained 1% each. Estimates showed that the main causes of the increase in global emissions are economic growth (volume effect on final demand) and the structure of final demand, which is composed of Household Consumption, Investment, Government and Exports. China, the United States and the European Union have important contribution percentages both in the mitigation process and in the increase in emissions, given the size of their economies. However, the total results of their emissions are different due to different stages of development of countries. Brazil, India and Russia have an impact on the variations in global emissions in percentage values lower than those regions and, like China, showed an increase in values. The results indicate that the results obtained show different stages of development of the countries. Furthermore, considering that the effects related to final demand are the most important for increasing emissions, the development of a sustainable way of life and conscious consumption must be present in both industrialized and developing nations (Malik et al., 2016). Additional concerns are the effects of international trade (exports as an end-demand item) on emissions, such as transfer impacts between the final demand of developed countries generating CO_2 emissions in developing countries (emissions outsourcing). These considerations agree with previous studies such asArto and Dietzenbacher, 2014, Wang et al., 2017and Raupach et al., 2007.

Table 2 presents the results of the structural decomposition of the variation in carbon dioxide emissions from the European Union, United States,BRIC countries and Rest of the World between the years 2000 and 2014. The values in Table 2 were used in percentage values in relation to the total to prepare Figure 3.According to the values in Table 2 in relation to the total variation of the regions under analysis, the United States and the European Union reduced emissions while the other regions showed an increase in total emissions. Considering the different factors that cause these variations, the volume effect of final demand was positive for all regions and the main factor in the increase in emissions for the United States, the European Union, Brazil, Russia and Rest of the World. The Structure Effect of Final Demand was negative for the United States and the European Union and positive for the other regions, notably for China and India, being the main factor for the increase in emissions in these countries.

The Intensity Effect was positive only for Brazil, being an important emission mitigation factor for China, the European Union and Rest of the World.In the United States and Russia, the Technology Effect was the most important for mitigation. The European Union presented a reduction in total emissions (-748 $GtCO_2$) by Effects intensity (main mitigation factor) and negative final demand structure with values of -1423 $GtCO_2$ and -634$GtCO_2$, respectively. On the other hand, the final demand volume effect was the main positive value (economic growth) with 1262 $GtCO_2$ and Technology with 47 $GtCO_2$ in the period 2000-2014. The United States achieved the reduction in total emissions mainly due to Technology Effects (-1288 $GtCO_2$), in second place Final Demand Structure Effect (-945 $GtCO_2$) followed by a less expressive Intensity Effect (-154 $GtCO_2$). Economic growth positively impacted emissions with 1680 $GtCO_2$. The technology effect is caused by the variation in the combinations of inputs of the sectors of the economy. Among the BRIC countries, all showed an increase in total emissions. The highest absolute value was from China with 6570 $GtCO_2$ due to positive Technology and Final Demand Effects (structure and volume). The negative intensity effect of -4135 $GtCO_2$ shows the Chinese economy's effort to modify the emissions per unit of production ratio. It is observed that the Structure of Final Demand effect is positive and greater than the Volume Effect, this indicates that changes in consumption habits, exports, government spending and investment are more important than economic growth itself. This leads us to consider the great importance of the change in Chinese consumption habits due to the increase in per capita income and the development of conscious consumption, in addition to the effects of international trade (exports) on CO_2 emissions. India showed a similar behavior to China for the effects of the structural decomposition of the variation of CO_2 emissions. The increase in total emissions of 184 $GtCO_2$ was the result of a negative intensity effect (-130 $GtCO_2$) and positive Technology, Structure and Final Demand Volume Effects of 39 $GtCO_2$, 145 $GtCO_2$ and 130 $GtCO_2$ respectively. The impact on emissions of the variation in the composition of final demand was more important than its growth. For Brazil and Russia, the main positive effect was the volume of final demand, respectively of 132$GtCO_2$ and 543$GtCO_2$. The main difference between countries was that the Intensity Effect was positive for Brazil (51 $GtCO_2$) and negative for Russia (-239 $GtCO_2$). However, we must remember that Brazil's emissions are relatively lower than those of Russia,because the former has a cleaner energy matrix (Baumann et al., 2012 and Souza et al., 2015).

Table 2. Results of the structural decomposition of the variation of carbon dioxide emissions in the European Union, United States, BRIC countries and Rest of the World in the period 2000/2014. Values in $GtCO_2$

Regions	Effects				Total variation
	Intensity	Technology	Final demand Structure	Final demand volume	
European Union	-1423	47	-634	1262	-748
United States	-154	-1288	-945	1680	-706
Brazil	51	-24	18	132	177
Russia	-239	-341	153	543	116
India	-130	39	145	130	184
China	-4135	1828	6447	2430	6570
Restofthe World	-2171	890	2073	3666	4457
Totals	-8202	1152	7257	9843	10050

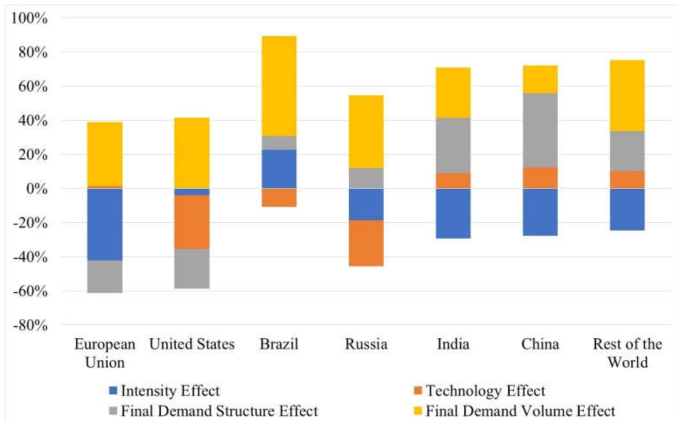

Figure 3. Results of the structural decomposition of the variation in carbon dioxide emissions from the European Union, United States, BRIC and Rest of the world in the period 2000/2014. Values of the effects in percentages in relation to the absolute total variation of each region

The results show different strategies for mitigating carbon dioxide emissions. The most successful cases are from the United States and the European Union, which managed to reduce total emissions, the first mainly due to the technology effect and the second due to the intensity effect. The modification of the energy matrix is at the base of this process, according to Malik et al. (2016), with the United States and the European Union making efforts to obtain new energy sources and sectors adopting cleaner technologies (França, Zapparoli and Sesso Filho, 2018 and Esteves, 2017). The BRIC countries and the Rest of the World made efforts to mitigate emissions in accordance with the values obtained in the present study. However, economic growth led to an increase in the demand for final goods and services (Volume Effect) and in the Structure Effect (Composition) and, consequently, these effects exceeded the negative values of the Intensity and Technology Effects. The conclusions agree withPompermayer Sesso et al. (2020) and Perdigão et al. (2017), who found negative effects for intensity and technology with higher values for the effects of final demand leading to increased emissions from BRIC countries. Strategies to reduce emissions must consider the different stages of development of countries, as stated by Xia et al. (2020), and each of them must establish its mitigation goals and internal policies (Bueno Rubial, 2016; Okereke & Coventry, 2016; Afionis, 2017; Bodansky, 2016). In this sense, the Paris Agreement is more likely to adhere to countries and succeed in the mitigation process than the Kyoto Protocol. The main strategies are based on reducing the ratio of emissions per unit of production (Intensity Effect) and the combination of inputs (Technology Effect), which imply the modification of the energy matrix with the introduction of renewable and less polluting sources and the production chain of the sectors. On the other hand, the main factors for the increase in emissions are the growth of the economy (volume effect of final demand) and the composition of final demand (Structure effect). Therefore, the reduction of CO_2 emissions implies changes in people's awareness of consumption and flows in international trade, strategies that should be intensified in the pursuit of global reductions in CO_2 emissions, especially in developing countries.

CONCLUSIONS

The main factor driving global carbon dioxide emissions is economic growth (volume effect of final demand) and modification of demand behavior (structure effect). Final demand is made up of household consumption, government, exports and investment aggregates. Therefore, the impacts of international trade on CO_2 emissions, conscious consumption and sustainable lifestyles are important in the search for emissions mitigation. The results show different strategies for mitigating carbon dioxide emissions. The United States and the European Union have managed to reduce total emissions; the first mainly for the Technology Effect and the second for the Intensity Effect, this shows that they presented technological changes in their production chains to mitigate emissions and effort to modify the energy matrix. The structural decomposition estimates showed that the results depend on the different stages of development in which the countries find themselves, therefore, the goals and strategies for mitigating CO_2 emissions depend on the context that each region/country has in terms of the structure of the economy, rate per capita income growth, rural migration and incorporation of new consumers into the market. The BRIC countries and the Rest of the world have made efforts to mitigate emissions. However, the growth of the economy led to an increase in the demand for final goods and services (Volume Effect) and their composition (Structure Effect) and, consequently, these effects surpassed the negative values of the Intensity and Technology Effects. New studies can be developed to estimate the effects of international trade on the transfer (outsourcing) of CO_2 emissions between industrialized and developing countries. The culture of conscious consumption will be important in developing countries to reduce the advance of CO_2 emissions and studies on consumer behavior can improve the understanding on the subject. Changes in countries' energy matrices are the basis of the Intensity Effect analyzed in this research and are the subject of further studies, as well as the intensity of energy use within global production chains.

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