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REVIEW ARTICLE

The revised approaches to income inequality impact on production-based and consumption-based carbon dioxide emissions: literature review

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Abstract

In recent decades, many authors have investigated possibility of simultaneous reduction of income inequality and pollution related to climate change. However, none of the previous researches reviewed the empirical studies of relationship between inequality and CO_2 emissions. The authors of the selected papers, published from 2001 to 2019, found a diverse impact of income inequality on carbon dioxide (CO_2) emissions. It could depend on different trajectories of Kuznets curves. Furthermore, the majority of authors have provided theoretical analysis (even including human behaviour) of the influence of income inequality on CO_2 emissions, considering only territorial (or production-based) emissions. However, this paper recommends to distinguish between the production-based and consumption-based emissions and suggests the revised approaches to the impact of income inequality on CO_2 emissions with regard to the production-based and consumption-based emissions. Regarding the production-based emissions, the following approaches are proposed: (i) determination of environmental policies, which also could reveal and explain the leakage phenomenon, and the channels of EKC, i.e. (ii) scale, (iii) composition, (iv) technical and (v) globalization effects. The influence of income inequality on consumption-based emissions can be explained by applying two approaches, namely (i) inequality determined changes in working time (this approach is also related to "Veblen effect") and (ii) individual economic behaviours of households. Therefore, the present study provides a new insight into the subject of the relationship between income inequality and pollution related to climate change.

Keywords Climate change · CO_2 emissions · Inequality · Environmental Kuznets curve · Sustainable production and consumption · Economic growth

Introduction

Climate change and economic inequality are faced as the biggest challenges in recent decades (Jorgenson et al. 2016; Wolde-Rufael and Idowu 2017; Rao and Min 2018). The main consequences of climate change include polar ice shield melting, sea level rising and more frequent extreme weather events as heavy rains, heat waves and droughts. Thus, the reduction of carbon dioxide (CO_2) emissions is crucial for mitigation of climate change consequences (Matsumoto et al. 2018; Liu et al. 2019). Unequal societies badly affect sustainability and well-being as well (Khan et al. 2018). The authors have identified that inequality influences health and social problems (Wilkinson and Pickett 2009), impels poverty-driven migration (Hübler 2017), decreases economic growth due to changes in fiscal policies (Persson and Tabellini 1994; Ostry et al. 2014) and undermines human capital (McGee and Greiner 2018; Chancel et al. 2018). Therefore, a large number of authors have investigated whether these two problems, i.e. inequality and pollution related to climate change, could be solved simultaneously.

A discussion concerning the impact of income inequality on CO_2 emissions originated in the 1990s (Mader 2018; Baloch et al. 2018). A majority of studies theoretically and empirically analysed the relationship between inequality and environmental pollution (Torras and Boyce 1998; Liu et al.

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2019a). However, to the best of our knowledge, none of them has reviewed the empirical studies of relationship between inequality and CO_2 emissions. Thus, in this paper, by reviewing the selected papers published from 2001 to 2019, the impact of inequality on CO_2 emissions in developing and developed countries is presented.

Empirical studies on inequality and environmental impact offer diverse results (Borghesi 2006; Berthe and Elie 2015; Jorgenson et al. 2017; Grunewald et al. 2017; Chancel et al. 2018). Grunewald et al. (2012) has stated that different links between inequality and environmental impact vary with the level of inequality. Chow and Li (2014) together with Ibrahim and Law (2014) have argued that the links between economic development and pollution are moderated by the income inequality level. Moreover, the change in relationship between these variables is moderated by the level of economic development (Jorgenson et al. 2016; McGee and Greiner 2018). Therefore, in this paper, referring to Kuznets curve theory, which was applied to both inequality (Kuznets 1955) and environmental impact (Grossman and Krueger 1995), a particular attention was paid to revealing three possible alternatives: (i) the countries trace the same Kuznets curve trajectory (Jun et al. 2011; Zhang and Zhao 2014; Baloch et al. 2018); (ii) the turn points are different, and in the case of inequality reduction, the environmental pollution increases (or vice versa) and (iii) Kuznets trajectories are different; for income inequality, a U-shape is observed, although for environmental impact, it has an inverted U-shape (or vice versa). To my best knowledge, this aspect has still not been considered in scientific literature. Furthermore, this article presents the differences between the impact channels through which economic development affects inequality and CO_2 emissions.

Theoretical links of the relationship between environmental degradation (as air pollution level) and the inequality level are still required for complete understanding of the reasons (Chancel et al. 2018). Authors analysing the inequality impact on CO_2 emissions mostly used three approaches: (1) political economy explanation, (2) marginal propensity to emit (MPE) carbon dioxide and (3) individual economic behaviour (Liu et al. 2019a). However, these approaches are not suitable to explore the inequality impact on national CO_2 emissions, which is production-based. The argument that a different consumer behaviour (particularly consumption level) influences national emissions (which are production-based) (Hao et al. 2016; Jorgenson et al. 2015, 2016; Liu et al., 2019, a and etc.) might be a misconception considering that the major share of goods which people consume is imported or exported and thus related to the environmental impact in foreign countries. Therefore, analysing approaches to the relationship between inequality and pollution, the type of emissions (consumption or production-based) should be considered. Therefore, in this paper, the revised approaches to the impact of income inequality on production-based and consumption-based CO_2 emissions were suggested. These aspects, presumably, have not been analysed yet, and the present paper provides the new insights into the subject.

The impact of income inequality on CO_2 emissions with regard to economic development level

In order to thoroughly explore the influence of inequality on CO_2 emissions at different economic development levels, the databases ScienceDirect, Google Scholar and Web of Science were exploited by applying a query “inequality AND greenhouse gas emissions (carbon dioxide)”. All papers published from 2001 to 2019 were selected where authors empirically evaluated the links between inequality and CO_2 emissions. In the presentation of the results, countries were classified as low-, middle- and high-income countries, and a wide range of developed and developing countries. The relationship between income inequality and CO_2 emissions was also distinguished as positive, negative and neutral (or insignificant). Results in Table 1 revealed diverse results regarding the level of economic development. The impact of inequality on carbon emissions was different in developing and developed countries. These different results highlight the versatile role of inequality in CO_2 emissions.

Authors as Hao et al. (2016) show different effects of inequality on pollution related to different shapes of environmental Kuznets curve (inverted U-shape, U-shape, linearity). They proposed that when the EKC curve was depicted as an “inverted U”, the redistribution from the rich individuals to the poor contributes to the emission rise in connection with the decrease of the income inequality level. Conversely, in the case of a “U” shape, the enlargement of income inequality would contribute to the growth of emissions. When EKC relationship is linear, inequality has insignificant effect on environmental pollution. However, economic development is connected not only to environmental quality but also to income inequality level. Kuznets curve was applied for both variables (Kuznets 1955; Grossman and Krueger 1995). Hence, if countries trace the same trajectory of Kuznets curve, and the turn point is rather similar, then the positive relationship between inequality and CO_2 emissions is observed (Fig. 1a). In this case, pollution related to climate change is compatible with income inequality, and a process of economic development can resolve these issues (reduction of inequality and pollution) at the same time.

Yet, in the case of economic growth, the environmental impact can decrease or, put in other words, match the right side of the EKC. Alternatively, when the economic development level stays the same, income inequality does not reach the turn point and remains on the left side of Kuznets curve (and vice versa) (Fig. 1b). In these circumstances, according to

Table 1 Summary of studies on the impact of income inequality on CO_2 emissions according to economic development level

	Positive relationship	Negative relationship	Neutral (insignificant)
Low-income (developing) countries	Zhang and Zhao 2014; Jorgenson et al., 2015; Hao et al. 2016; Hubacek et al., 2017; Wolde-Rufael and Idowu 2017; Zoundi 2017; Rao and Min 2018; Baloch et al. 2018; Liu et al. 2019	Jun et al. 2011; Golley and Meng 2012; Ali et al. 2016; Grunewald et al. 2017; Khan et al. 2018	Wolde-Rufael and Idowu 2017; Khan et al. 2018
Middle-income (transition) countries		Grunewald et al. 2017	Policardo 2016
High-income (developed) countries	Baek and Gweisah 2013; Jorgenson et al. 2015, 2016; Knight et al. 2017; Grunewald et al. 2017	Ravallion et al. 2000; Heerink et al., 2001; Gangadharan and Valenzuela 2001; Kasuga and Takaya, 2017, Liu et al. 2019	Jorgenson et al., 2017; Mader 2018
Wide range of countries		Gangadharan and Valenzuela 2001; Bimonte 2002; Hübler, 2017	Borghesi 2006

the proposed model, the negative correlation between inequality level and CO_2 emissions is observed. The negative relationship between inequality and CO_2 emissions can occur when a U-shaped trajectory of one variable (income inequality level (Barro, 2000) or CO_2 emissions) is observed instead of the inverted U-shape (Fig. 1c). The relationship is insignificant when pollution or inequality level of the countries correspond to the turn point. Therefore, different correlations between the income inequality level and CO_2 emissions with regard to the economic development level could be observed due to the different Kuznets curve trajectories. In addition, when analysing links between income inequality and environmental impact, the channels through which economic development affects inequality and environmental pollution should be considered.

The channels through which the economic growth affects CO_2 emissions and income inequality

A large number of authors have analysed the EKC and identified that the relationship between air pollution (or other type environmental degradation) and economic level depends on three channels: (1) scale, (2) composition and (3) technique (Dinda 2004; Kaika and Zervas 2013; Farhani and Shahbaz, 2014; Liobikienė and Butkus 2018, 2019, etc.). Besides, the same channels pertain to the influence of economic development on income inequality level (Castells-Quintana et al. 2013; He and Feng 2019). However, the effects of these channels are different.

Factors that are assigned to the scale effect (as economic development level (GDP)) contribute to the increase of environmental impact. Neagu and Teodoru (2019) found that economic complexity (improved capabilities of a country in the production process) has a statistically significant impact on CO_2 emissions. Meanwhile, Barro (2000) argued that income inequality decreases due to economic growth in early stage of development level. Labour market is also related to the economic growth. Economic development can lessen inequality by allowing workers, who earn the least, to move from the informal employment sector to the formal. He and Feng (2019) pointed out that employment could improve income distribution. Castells-Quintana et al. (2013) also noted that in the European Union, inequality is higher in regions with higher unemployment.

Considering the composition effect or the changes in economic structure with regard to the EKC, the reduction of environmental impact is observed when sectors which are not very polluting (i.e. services sector) increase faster than the most polluting ones (i.e. manufacturing, industry) (Parith et al. 2009; Wang et al. 2013). Transfer from agriculture to manufacturing at first increases and then

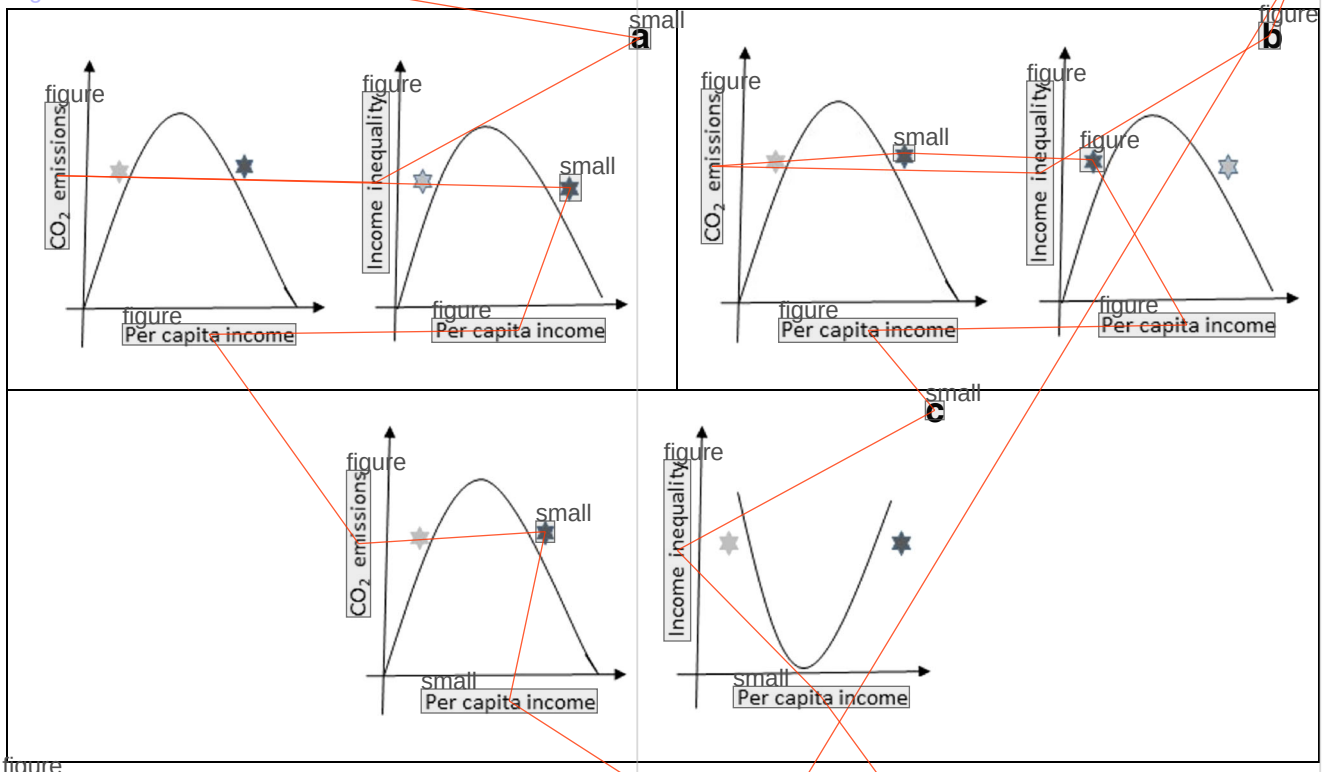

Fig. 1 Main alternatives with regard to Kuznets curve: **a** countries trace the same Kuznets curve trajectory; **b** turn points are different; **c** Kuznets trajectories are different

decreases income inequality. Moreover, Castells-Quintana et al. (2013) indicated that the inequality level is higher where the employment in agriculture or trade sectors is higher. A higher employment in the construction sector is also positively related to the higher-income inequality level. He and Feng (2019) revealed that industrialization could improve income distribution, which is not very favourable for the environment. However, the impact that a shift to the service sector makes on income inequality has still not been analysed. In this paper, it is suggested that a faster growth of the service sector can also contribute to the reduction of inequality level because the wage gap in this sector is not very big. Furthermore, the less qualified work can also be included in the service sector.

The technique channel is related to the development of technologies and innovations in the countries (Turner and Hanley 2011; Böhriger and Rutherfod, 2013). With regard to the EKC, the development of technologies has led to the reduction of environmental pollution (Dinda 2004; Turner and Hanley 2011; Kaika and Zervas 2013; Farhani and Shahbaz, 2014; Liobikienė and Butkus 2018, 2019, etc.). Meanwhile, regarding the income inequality, the development of the technologies may benefit the relatively richer population and contribute to the increase of income inequality. If technological development benefits the qualified labour (or richer individuals) more than the unqualified labour, the skill premium will increase, which should raise the income inequality level (Castells-Quintana et al. 2013).

Globalization, via trade and foreign direct investments (FDI), can also be attributed to an additional channel through which economic development affects environmental impact and income inequality (Zhuang et al. 2014). When discussing CO_2 emissions, the reviewed authors provide different results. Some authors found that FDI and trade contribute to economic growth and to the degradation of environment at the same time (Shahbaz et al. 2015; Kivyiro and Arminen 2015; Ertugrul et al., 2016; Azam and Khan 2016; Sarkodie and Strezov, 2019). Other authors showed that FDI and trade contribute to economic development due to technology development, productivity and efficiency gains, and promotion of new and more innovative processes and managerial skills (Shahbaz et al., 2015) resulting in the reduction of environmental impact in host countries (Sbia et al. 2014; Tang and Tan 2015; Zhang and Zhou 2016; Kang et al. 2016). As far as income inequality is concerned, the mechanisms of FDI and trade openness differ, and the results of the estimations are different as well (Dreher and Gaston 2008; Celik and Basdas 2010; Ines 2011; He and Feng 2019).

Therefore, the reviewed results display that, in the case of economic development, income inequality level and CO_2 emissions could change differently and separate channels affect these variables differently.

The approaches to the influence of income inequality on production- and consumption-based emissions

Almost all authors (listed in Table 1) have analysed the relationship between income inequality and territorial or production-based CO_2 emissions. However, only few of the studies have estimated the consumption-based emissions (see Golley and Meng 2012; Hübler 2017) or analysed the consumption-based emission inequality (see Wang and Zhou 2018; Xu et al. 2016). Baker (2018) and Jorgenson et al. (2019) emphasize that research should focus on international inequality impact on both consumption- and production-based CO_2 emissions. With respect to the production-based emissions, the leakage phenomenon should also be considered, which is defined as a process where the transfer of dirty industries to the emerging economies with weak regulatory systems rather than the increase in production efficiency and productivity accounts for the decrease of CO_2 emissions in the developed countries (Carvalho et al. 2013; Ertugrul et al. 2016; Bilgili et al. 2016).

Three theories have been proposed by the authors that theoretically analyse the approaches of relationship between income inequality and environmental impact: (i) political economy explanation (in this paper, it is renamed as determination of environmental policies), which was suggested by Boyce (1994); (ii) economic behaviours of households (the latter theory overlaps with the MPE theory), suggested by Ravallion et al. (2000), and "Veblen effect" (Schor 1998; Veblen 2009); (iii) inequality determined changes in working time, which could also be attributed to "Veblen effect", discussed by Bowles and Park (2005). These theories were widely discussed by other authors (Table 2). However, the authors who presented these theories usually referred to the production-based emissions. Meanwhile, in this paper, it is assumed that all the abovementioned approaches do not adequately explain the relationship between inequality and territorial (or production-based) CO_2 emissions. Thus, it is emphasized that the approaches should be separated when analysing the production and consumption-based CO_2 emissions. The following sections propose the separate approaches to the influence of income inequality on the production-based and consumption-based emissions.

The approaches to income inequality impact on production-based CO_2 emissions

Regarding the production-based CO_2 emissions, only two of the abovementioned approaches are appropriate: determination of environmental policies and inequality determined changes in working time. Determination of environmental policies operates mainly via political influence due to the changes in income inequality (Boyce 1994). Boyce hypothesized that the increasing demand for "the environment" is related to the increase in income. Therefore, in the countries where the inequality level is usually low, the prevailing higher environmental standards condition lower levels of emissions. Other authors state that the reduction of environmental impact might request a higher political and economic equality at first (Roberts and Parks 2006; Downey 2015). Meanwhile, according to Franzen and Vogl (2013) and Berthe and Elie (2015), a higher level of income inequality causes the material and social problems to take priority over the environmental aspects. Thus, inequality renders the agreement on environmental policies and implementation of these policies more difficult (Hourcade 2013; Laurent 2014; Chancel et al. 2018). In developing countries, where the level of income inequality is usually high, the environmental standards are low. Grunewald et al. (2017) suggested that the growth of income inequality impedes environmental policy solutions to emerging issues, which subsequently conditions that the growth of inequality can contribute to the increase of air pollutions.

Table 2 The main theories analysing the relationship between income inequality and environmental impact

Theories	References
Political economy explanation	Boyce (2007); Gassebner et al. (2008); Baek and Gweisah (2013); Prell et al. (2015); Downey (2015); Berthe and Elie (2015); Hao et al. (2016); Grunewald et al. (2017); Jorgenson et al. (2017); Kasuga and Takaya (2017); Wolde-Rufael and Idowu (2017); Knight et al. (2017); Mader (2018); Chancel et al. (2018); McGee and Greiner (2018); Liu et al. (2019, 2019a) and Jorgenson et al. (2019).
Economic behaviours of households	Borghesi (2006); Golley and Meng (2012); Grunewald et al. (2012); Zhang and Zhao (2014); Berthe and Elie (2015); Hao et al. (2016); Jorgenson et al. (2017); Hübler (2017); Charfeddine and Mrabet (2017); Knight et al. (2017); Kasuga and Takaya (2017); Wolde-Rufael and Idowu (2017); Jorgenson et al. (2017); Grunewald et al. (2017); Rao and Min (2018); Mader (2018); Baloch et al. (2018); Jorgenson et al. (2019); Liu et al. (2019a); Liu et al. (2019).
Inequality determined changes in working time	Knight et al. (2013); Fitzgerald et al. (2015, 2018); Grunewald et al. (2017); Wolde-Rufael and Idowu (2017); Chancel et al. (2018); Jorgenson et al. (2017, 2019).

Besides, expensive environmental protection in wealthy countries generates the transfer of dirty production to poor countries, where the environmental standards are low. Consequently, due to the leakage phenomenon, the CO_2 emissions increase in developing (or of higher inequality) countries, while in developed (or of lesser inequality) countries, the pollution level decreases. Furthermore, within countries, rich communities reap disproportionate benefits from dirty activities and avoid the negative consequences (as air pollution) of their production by moving polluting industrial activities into less rich areas (Boyce 2007; Martinez-Alier and Muradian 2015; Jorgenson et al. 2017; Chancel et al. 2018). This reveals that income inequality promotes and enhances the implementation of environment-polluting projects, which strengthens the power of the rich society to impose environmental fine on the poor (Wolde-Rufael and Idowu 2017). Hence, for the less developed countries, inequality is as an obstacle for the mobilization of the collective effort essential for confronting environmental pollution and carbon dioxide emissions (Islam 2015; Wolde-Rufael and Idowu 2017). Moreover, Gassebner et al. (2008) and Grunewald et al. (2017) stated that rising income inequality in less rich countries is related to industrial reduction and a decrease of producers' political power, thereby reducing their ability to decrease environmental impact.

With regard to the second approach, Bowles and Park (2005) reveal that income inequality increases working hours and consequently contributes to the growth of energy consumption and CO_2 emissions (Knight et al. 2013; Fitzgerald et al. 2015, 2018; Jorgenson et al. 2017, 2019). Furthermore, the latter approach in this paper contributed to the explication of the theories on the impact of income inequality on production-based CO_2 emissions. In addition, it separated the effects of scale, composition, technique and globalization. Therefore, the abovementioned channels of EKC, by the means of which economic growth affects environmental quality, could be applied when analysing the relationship between inequality and CO_2 emissions. Thus, the inequality determined changes in working time could be attributed to the scale effect, when income inequality contributes to an increase in working hours and, analogically, to economic growth.

Inequality, via contribution to economic growth, influences the growth of environmental pollution (Grunewald et al. 2017; Jorgenson et al. 2017; Rao and Min 2018; McGee and Greiner 2018).

Referring to the composition effect, Gassebner et al. (2008) declared that in developed countries the increasing level of inequality is related to the industrial decline, which in turn reduces pollution. Meanwhile, in poorer countries, the rising industrial sector leads to the reduction of environmental regulations, when richer segments of population are related to the growing industrial sector. Consequently, these arguments reveal that in both poor and rich countries, different links between income inequality and CO_2 pollution could be observed (Grunewald et al. 2017).

In terms of the technique effect, the reviewed authors revealed that a high level of inequality negatively affects the diffusion of environmental technologies and innovations (Vona and Patriarca 2011; Zhang and Zhao 2014). Thus, a high level of inequality can influence the reduction of technologies, which determines the increase of carbon emissions.

Inequality level also influences trade and FDI transfers. With the high level of inequality investors are not inclined to invest, and in such countries, it is hard to develop international trade. Therefore, inequality via the globalization effect can contribute to either reduction or growth of CO_2 pollution. It depends on whether trade and FDI enhance or reduce environmental impact.

imageDescription: These approaches to the influence of income inequality on production-based CO_2 emissions are summarized in Fig. 2.

Headline
heading
The approaches to the influence of income inequality on consumption-based CO_2 emissions

The influence of income inequality on consumption-based carbon emissions can be explained referring to the following two approaches: (i) inequality determined changes in working time (which is also suitable in the case of production-based emissions and is related to "Veblen effect") and (ii) individual economic behaviours of households (or individual

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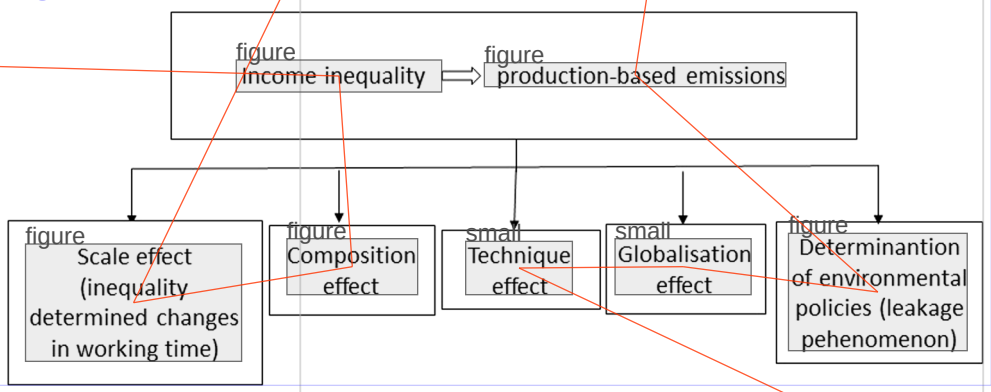

imageDescription
Fig. 2 Theoretical model analysing the influence of income inequality on production-based CO2 emissions

consumption level), which combines the MPE theory and "Veblen effect". These approaches are summarized in Fig. 3.

With regard to the changes in working hours, authors have stated that people work more in order to copy the lifestyle of individuals who have higher status (Bowles and Park 2005; Chancel et al. 2018). Thus, at the same time, the increase in working time contributes to economic growth and to the consumption increase as well, influencing the growth of pollution (Jorgenson et al. 2017). In consumer society, people usually work more in order to buy more and to consequently support the self-image. It is particularly typical in unequal countries due to "Veblen effect". Veblen (1934) hypothesized that people from different social classes are more inclined to compare their lifestyle with other individuals from a higher social class and to mimic their consumption style. Particularly, it is observed in more unequal societies. Consequently, due to the Veblen status, consumption or, put in other words, the consumption competition (Schor 1998), wealthier or higher-income groups are more inclined to consume large amounts of goods and services (Veblen 1934; Jorgenson et al. 2017, 2019; Grunewald et al. 2017) and thus determine the environmental pollution (Ravallion et al. 2000; Wolde-Rufael and Idowu 2017).

With regard to the individual consumption level, the MPE indicates that at various levels of income and inequality distribution, individuals' propensities to consume more polluting goods differ due to the change in the patterns of consumption level (Ravallion et al. 2000; Borghesi 2006; Grunewald et al. 2012; Jorgenson et al. 2017). Hence, Jorgenson et al. (2017) declared that consumption level was the key factor influencing the MPE. However, there is not a single hypothesis analysing the inequality influence on consumption-based CO_2 emissions. The main condition of the changes in income inequality affecting the consumption-based carbon emissions depends on the MPE ratio between materially wealthy and poor people. If poor people's MPE is bigger than that of the wealthy, an increase in inequality reduces CO_2 emissions (Ravallion et al. 2000; Liu et al. 2019a; Heerink et al. 2001; Hübler 2017). Authors as Baloch et al. (2018), Hao et al. (2016), and Magnani (2000) assumed that due to higher prices resulting from environmentally friendly production, the poorest people cannot afford to buy any of these products. Furthermore, these people are not inclined to choose to use renewable electricity. Moreover, larger income distribution would decrease individuals' environmental concern (Baloch et al. 2018), and vice versa, the environmental quality is more important for rich people and they have higher environmental concern (Scruggs 1998; Heerink et al. 2001; Zhang and Zhao. 2014; Kashwan 2017; Wolde-Rufael and Idowu 2017). The assumption that the MPE is bigger if compared with richer countries corresponds to the Keynesian model when lower-income individuals, rather than higher income, have a higher marginal tendency to consume, so the growth of inequality reduces the income of the poor and decreases the emissions (Jorgenson et al. 2017). A large number of authors identified that the MPE falls with the level of income (Grunewald et al. 2012, 2017; Jakob et al. 2014; Serino and Klasen 2015; Grunewald et al. 2017). Meanwhile, if low-income individuals have a lower level of MPE than the high income, the growth of income inequality raises CO_2 emissions (Mader 2018). Islam (2015), Kasuga and Takaya (2017), Baloch et al. (2018) and Jorgenson et al. (2019) declared that due to different consumption levels, the rich people more negatively influence environmental impact than the poor individuals. Furthermore, according to Berthe and Elie (2015), the rich people are not necessarily pro-environmentally friendly, and they are not willing to assume the responsibility and the costs of environmental issues (Wolde-Rufael and Idowu 2017). Therefore, the reduction of income inequality is shown to reduce consumption-based carbon pollution, which suggests that the reduction of income inequality and CO_2 emissions can be achieved simultaneously (Golley and Meng 2012). In other case, when the income inequality is more balanced, the consumption of more polluting goods increases due to the shift of poor people to the middle class (e.g. Heerink et al. 2001; Borghesi 2006; Grunewald et al. 2017; Charfeddine and Mrabet 2017; Liu et al. 2019). Hence, inequality can raise the middle social groups' willingness to achieve the superior (wealthy) social group's patterns of consumption ("Veblen effect"), causing greater environmental impact by increasing the consumption level (Berthe and Elie 2015).

Insignificant relationship between inequality and pollution reveals that when income becomes more equally distributed, the individuals from the poor class will increase their consumption of energy and other polluting products as they transfer to the middle class. Thus, when the three classes of individuals (poor, middle and rich) are considered, the relationship

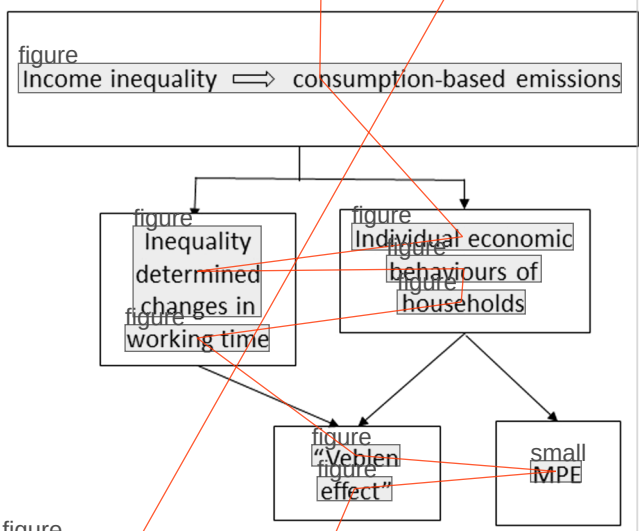

Fig. 3 Theoretical model analysing the influence of income inequality on consumption-based CO_2 emissions

between inequality and environmental pollution may not be linear. The propensity to emit may rise and then descend, which causes the curvilinear link between inequality and environmental pollution (Jorgenson et al. 2017). Furthermore, constant emission intensity across the income classes would reveal that any income redistribution would have an insignificant or no impact on consumption-based emissions (Golley and Meng 2012). In conclusion, the possible influence of inequality on environmental pollution via individual behaviours depends on MPE and changes in the social norms (Berthe and Elie 2015).

Conclusions

In recent decades, the environmental research has paid much attention to the analysis whether the reduction of income inequality and pollution related to climate change could be achieved simultaneously. By reviewing the selected papers published from 2001 to 2019, where these experts empirically evaluated the impact of inequality on carbon emissions, the author of the present article identified that the links between inequality and CO_2 emissions were different in developing and developed countries. The different results reveal that the role of inequality on CO_2 pollution is quite versatile. Referring to Kuznets curve, which was applied for both income inequality and environmental quality, it was assumed that the aforementioned different results could derive from the different trajectories of Kuznets curve. Therefore, if countries trace the same trajectory of Kuznets curve, a positive impact of inequality on environmental impact is observed. If environmental impact matches the right side of the EKC but income inequality has not reached the turn point at the same economic development level and stays on the left side of Kuznets curve, a negative relationship between the level of inequality and pollution is recognized. The negative relationship between inequality and CO_2 emissions is observed when the U-shaped trajectory of one variable occurs instead of the inverted U-shape. An insignificant relationship could be observed when the country's pollution or inequality level matches the turn point. These Kuznets curve trajectory differences depend on the differences of impact channels through which economic development affects inequality and environmental pollution. This paper presented the following four channels: (1) scale, (2) composition, (3) technique and (4) globalization, through which economic development affects both CO_2 emissions and inequality level.

The majority of authors have analysed theoretical links of inequality impact on CO_2 emissions with regard to territorial (or production-based) emissions. This paper suggested to consider the production-based and consumption-based emissions separately when analysing the approaches to relationship between inequality and pollution. Therefore, the proposed theories according to the origin of emissions were distinguished and new approaches which could explain the influence of income inequality on CO_2 emissions were provided.

With respect to the production-based emissions, the following approaches were proposed: determination of environmental policies, which could also reveal and explain the leakage phenomenon, and the channels by the means of which the income inequality affects CO_2 emissions: the scale, composition, technique and globalization effects. Therefore, the income inequality determined changes in working time could be attributed to the scale effect, when income inequality contributes to the increase in working hours and analogically to economic growth and CO_2 pollution. The composition effect, conditioned by the growth of income inequality, is related to the industrial decline, which in turn reduces pollution in rich countries. In terms of the technique effect, the high level of inequality negatively affects the spread of innovations, consequently harming the environmental technologies' development. Taking into account the globalization effect, inequality also influences trade and FDI transfers; besides, inequality can contribute to the decrease or growth of CO_2 emissions. It depends on whether the trade and FDI enhance or reduce the environmental impact.

The following two approaches, namely (i) inequality determined changes in working time (which is related to "Veblen effect") and (ii) individual economic behaviours of households (or individual consumption level), which combine the MPE theory and "Veblen effect", contribute to the explanation of the influence of income inequality on consumption-based emissions. Furthermore, the working time increase does not only contribute to economic growth, but to the consumption increase as well, simultaneously influencing the increase of CO_2 emissions. This approach is related to "Veblen effect" when in an unequal society, people from different social classes are more inclined to compare themselves with individuals from a superior social class and mimic their consumption level. With regard to the individual consumption level, it should be noted that the consumption demand is a key factor influencing the MPE. The main condition for the changes in income inequality to affect the consumption-based CO_2 emissions depends on the MPE ratio of the poor and the wealthy, and changes in social norms. Furthermore, inequality can contribute to the growth of middle social groups' willingness to achieve the superior social group's consumption level ("Veblen effect") and, correspondingly, CO_2 emissions.

Therefore, this paper provides new (revised) approaches explaining the impact of inequality level on separate production-based and consumption-based CO_2 emissions. Big hopes are held that in the nearest future, our theoretical considerations regarding these theories will be confirmed or corrected by other experts in the field. This study can also provide new insights for the policy makers concerned to seek the reduction of income inequality and pollution related to climate change.

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