UCIL 20411 Creating a Sustainable World

Different approaches to measuring cities' carbon footprints.

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1. Acknowledgments

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2. Executive Summary:

Cities have undertaken efforts to reduce overall carbon emissions to the atmosphere as it is directly connected the climate change what is a threat to the sustainable development and future of humanity. The accounting of carbon emissions implemented by most of the cities around the world is the production-based responsibility. However, other methods of carbon emissions have been developed, namely consumption-based and. This applied project presents the outcomes of those different accountings and compares them with the production-based one. The results suggest that the consumption-based emissions, and in some cases income-based, are greater than production-based. The paper suggests that consumption-based emissions will surpass, or at least recompensate the decrease of, production-based emissions. Such findings uncover the unrecognized trends in overall emissions. Only a deep understanding of them will result in achieving the carbon-neutral world.

3. Introduction:

The applied project is set to provide a clear picture of how cities around the world measure their carbon footprint. Most of them count their footprints looking at a territorial-based perspective (directly released emissions and emissions consequent from electricity consumption). This is the standard set by the International Panel on Climate Change (IPCC). However, there are also other perspectives on what challenges to look at cities differently.

4. Context:

As rapid urbanization will continue, the number of people living in urban areas is forecasted to increase from nearly four billion to over six billion by 2050 (UN 2014). Having the majority of people living in urban areas leaves a great footprint on the environment. Cities are responsible for approximately 80% and 60% of the global consumption of energy and greenhouse gas emissions respectively (UN Habitat, 2016). Cities around the world have

pledged their carbon neutrality. They proudly show the decreasing rate of their territorial (production-based) carbon emissions and the way they will achieve it. However, cities are also responsible for carbon emissions that were not only produced on their territory. As so, other types of responsibility must be discussed, this includes consumption-based and income-based to show the true footprint that the city leaves on the environment.

5. Methodology:

1. Production-based emission accounting:

At first, I want to describe the base, on which I will later build my findings around, which is the territorial carbon emission of cities, a production-based (PB) approach. The PB approach accounts for carbon emissions produced within city boundaries directly, from sources located in city (scope 1), and indirectly, via electricity use (scope 2) (WRI, 2014). It excludes the emissions from for example the production of gases or its transport to the city (scope 3) because those emissions were produced outside the city's boundaries. The PB approach is criticized because it is not able to account emissions that were generated in trade between actors (in this case, cities) what creates the potential for carbon leakage (Peters, Edgar, 2008). The cities here take only the responsibility for the emissions generated directly within their boundaries.

I will present the trajectory of the PB carbon emissions per capita (how is and how is expected to be) from cities around the world. I will compere trajectories of international and local cities and show the differences/similarities, see if their PB emissions trajectory exhibits the same trends.

2. Consumption-based emission accounting:

The alternative to the PB responsibility is a consumption-based (CB) one. This measure sums the emissions generated from the production of goods and services consumed within city boundaries, not considering the location of production (BSI, 2013). The CB approach is, in fact, the indicator of a city's carbon trade balance as it measures its final demand for goods and services. Taking a particular good for example, the CB accounting measures the emissions "along its supply chain prior to the delivery to final demand" (Marques et. al, 2012). The CB method fulfills the gap and accounts for the emissions omitted in the PB accounting.

Taking, for example, China, where 20% of cities' emissions are generated in the process of production of goods that eventually will be exported (BBC, 2009). Those goods are not consumed by Chinese people but only produced because of the high demand from outside. Here we can see the unfairness that comes from PB accounting and why should cities take a different approach while summing their carbon emissions to show the true footprints they leave. The cities here are seen as main consumers and they should/ hold the responsibility for the goods they demanded and at the end consumed.

Presenting the data on CB emission I will look for not only the trends along the years but also the connection to PB accounts.

3. Income-base emission accounting:

The last one approach worth mentioning and comparing with others, especially the PB method, is the income-based (IB). The IB method shows the new profiles of cities emissions. Previous methods omitted so-called downstream carbon emissions (Lenzen et al., 2007) as the method counts the emission generated by main suppliers to the city, which generates the city's income by wages, profits and rents. Here, the responsibility rests on the suppliers because they benefit from the emissions as they receive the payment for the goods they supplied. The developed regions that invest in fossil fuels produce more emissions as they generate their income by doing so. Those emissions did not occur within their borders but enabled them to raise their income (Lenzen et al., 2010).

As the PB method is seen as simpler to understand and easy to measure because of the data transparency but is not as fair and comprehensive as the CB or the IB approach since it creates the carbon leakage and missing points when it comes to measuring carbon emissions. I will consider the trends in the IB accounting and compare them with the CB and PB ones.

6. Findings:

1. Production-based accounting:

In the fig.1 we can see the comparison of the territorial carbon emissions in cities like Copenhagen and Milan. The measure was made in three categories: base year, presenting current carbon emissions, business as usual (BAU) which measures the tendencies of carbon emissions based on trends in applying mitigating policies, and post-carbon world emissions (PC2050) that predicts the emissions after 2050, based on cities' ability to meet 2050 targets (Economics, 2015). We can see that cities will experience the decrease (with single exceptions like Istanbul) in the per capita carbon emissions, compared to the base year. Taking as a great example Copenhagen which is expected to decrease its carbon emissions per capita over five times under BAU and to almost complete fadeaway under PC2050. Even though some cities like Milan or Zagreb are not expected to completely eliminate their carbon emissions under PC2050, the tendency of the decrease in overall emissions is similar.

The trajectory is simple and expected, as cities around the world implement policies that are ought to offset their carbon emissions. They introduced decarbonization of their electricity use, invest in carbon and cost-saving public transport and infrastructure. They introduce and invest in new technology that is environmentally friendly and helps to reduce carbon emissions on their territory (Hopkins et al., 2017). They are banning private ways of transporting from entering the city territories as they have a greater negative environmental impact than public transport, taking, for example, London or Manchester which are creating the Clean Air Zones from their cities' territory.

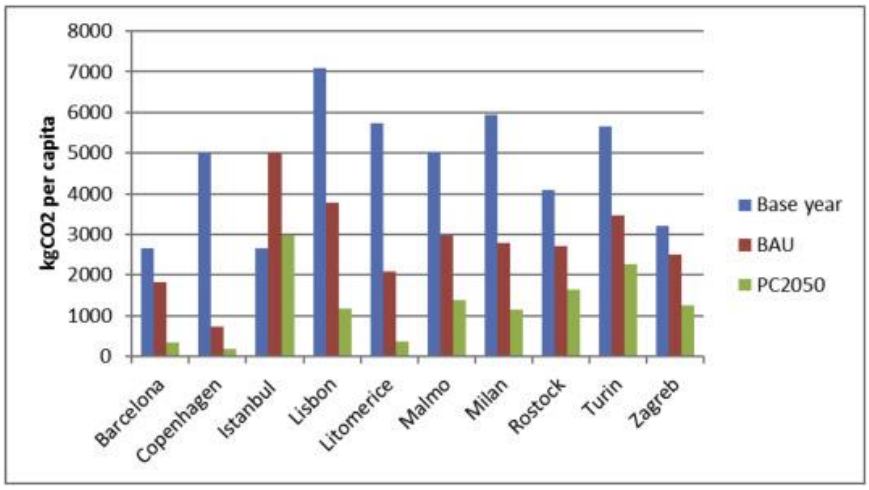

Fig.1 (Harris et al., 2019)

2. Consumption-based accounting:

Fig. 2 presents the overall emission accounting with the specification on what part of the whole emissions accounting the consumption and production approaches are responsible. Now it is visible what is the level of CB emissions after the decreasing trends described earlier. We can see that when measuring the PB emission we could present a city Barcelona as an example to follow because of its steady and clear decline in carbon emissions per capita, but now we see the increase in overall carbon emissions caused by the sharp increases in CB accountings. Between a base year and under PC2050 we can see over two times an increase in CB emissions alone and over three times increase in carbon emissions overall despite the impressive decreases in PB accountings.

Compering all the cities included below we can see two main tendencies. First, the overall carbon emissions will stay the same between the base year and under PC2050, despite the decrease in PB emissions, because of the visible and clear increase in the CB emissions. Describing Lisbon's overall emissions, we can notice that the decrease in PB emissions will be

'recompensated' by the increase in CB emissions, keeping overall effect on considerably at the same level of carbon emissions. The considerably similar results can be observed describing cities like Milan, Litomerice, Malmo, Rostock or Turin. as well. Second, the increase in overall carbon emissions. As described earlier Barcelona is one of the examples but compering the emission under PC2050 with the base year, the clear increase in overall emissions is noticeable in cities like Copenhagen, which proudly presents its fading out of PB emissions, Istanbul or Zagreb. The increase in overall emissions comes along with the decrease in PB emissions as the CB emissions rise greatly.

One more thing to notice is that some cities, for example, Copenhagen or even more explicitly Zagreb, have the CB emissions in the base year a few times greater, two and three respectively, than PB emissions at the same time. The divergence of those two accounts increases.

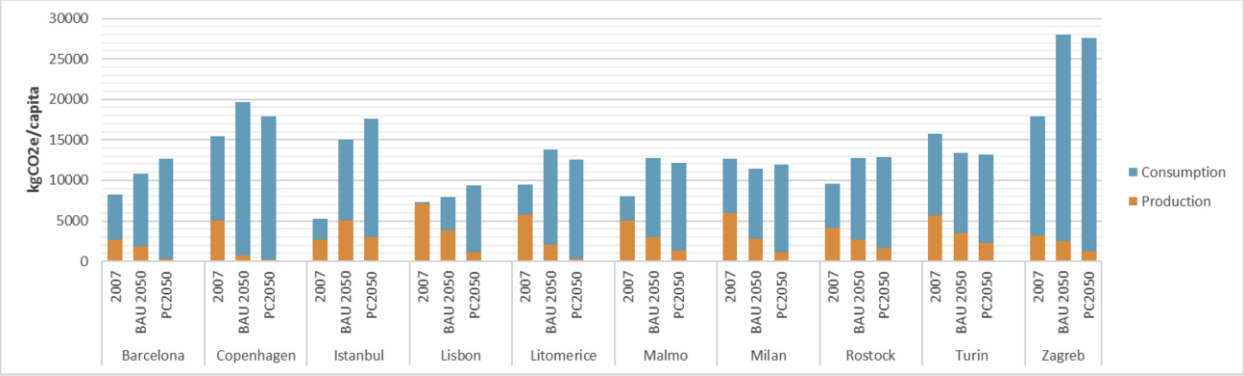

Fig. 2 (Harris et al., 2019)

3. Income-based accounting:

There is unfortunately still a small number of literature and researches that consider this method of accounting. Also, a small number of cities have considered this way of measurement when it comes to their carbon emissions. So, because of that, I have to implement a different approach in the last section. According to Hopkins et al. (2017), there is some clear connection to conclude that the emissions of nations and their cities exhibit similar trends. Based on that, fig.3 presents the number of tons of carbon emissions in different countries using three different accounting approaches: consumption, income and production. We can see that in countries, for example, Singapore and Switzerland, the levels CB and IB emissions are higher than PB. Furthermore, we can notice that in countries like Norway, Russia or Venezuela have the IB emissions measure greater than CB and PB ones. Those states are the suppliers of fossil fuels that generate their income but are not consumed all on their territory and are exported abroad. It is expected that cities around the world, which are the primary suppliers of fossil fuels, which invest in fossil fuels, being 'green' at the same time, hold the high responsibility of carbon emissions.

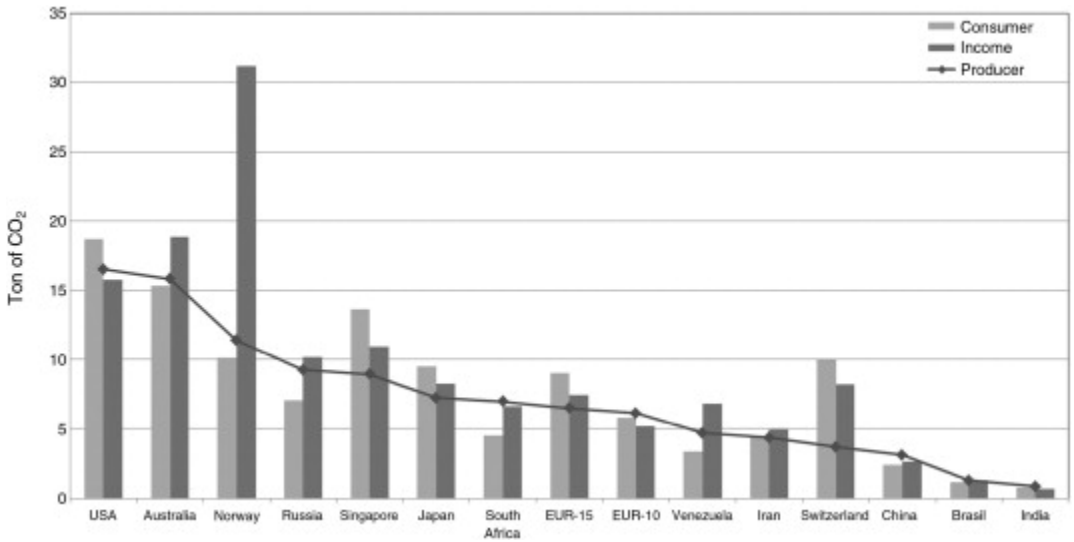

Fig.3 (Marques et al. 2012)

7. Conclusion:

The aim of this project was to illustrate different approaches to carbon footprint measurement. We find that different methods yield different responsibility values and the responsibility is respective of the methods chosen. Surprisingly, cities considered to be one the 'cleanest' and the 'greenest' in the world, such as Copenhagen, have greater CB emissions with growing trends, not decreasing compering to PB emissions. We can also conclude that IB responsibility is able to qualify the situations where enabling carbon emissions generate income by fossil fuel export. Focusing only on the PB emissions, as most cities do, does not show the true picture of carbon emissions and limits the options of how to offset them. Actions taken in the future should also address the CB and IB emissions. Cities' councils should develop new, strong policies that could be applied to CB and IB emissions as making only one of the indicators to fall is not the way sustainable development should be carried. The focus only on zero PB emissions will not significantly impact future carbon emissions. The difference between a near-zero carbon vision set for 2050 in different responsible emissions accountings is substantial. Under all scenarios, the PB emissions are expected to decrease what is not the case with CB and would clearly not be the case with IB emissions. The increase in other than PB emission should be a warning sign to cities' governors that increase in consumption and spending, what from the economic point of view is linked to rising GDP, is not an efficient way to look at how (sustainable) developed is the city. We can also conclude that expanding technological efficiency in production is not able to compensate for the rise in consumption expenditure. On the contrary, reducing CB emissions creates the opportunity for a bigger reduction in global carbon emissions.

This report does not undermine the importance of PB emissions mitigation, the action is needed in all forms.

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