Exploring the Potential of Downscaling Doughnut Economics to Achieve a Sustainable Vision of Cambridge

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Introduction

In light of the polycrisis of climate and environmental issues (Richardson et al., 2023) alongside rising inequality in many post-industrial societies (Crouch, 2019), the concept of Doughnut Economics is becoming increasingly popular as a potential policy framework for local governance. Doughnut Economics is a holistic framework for sustainable development, which aims to find a "safe and just space for humanity" by balancing a "social foundation" against an "ecological ceiling", as visualised in Figure one (Raworth, 2012). Crucially, Doughnut Economics rejects the hitherto incontrovertible assumption that economic growth is the best path to social prosperity (Raworth, 2017).

Driven by a desire to find this "safe and just space for humanity", many local authorities such as Amsterdam and Cornwall are actively exploring how the Doughnut can be downscaled for local

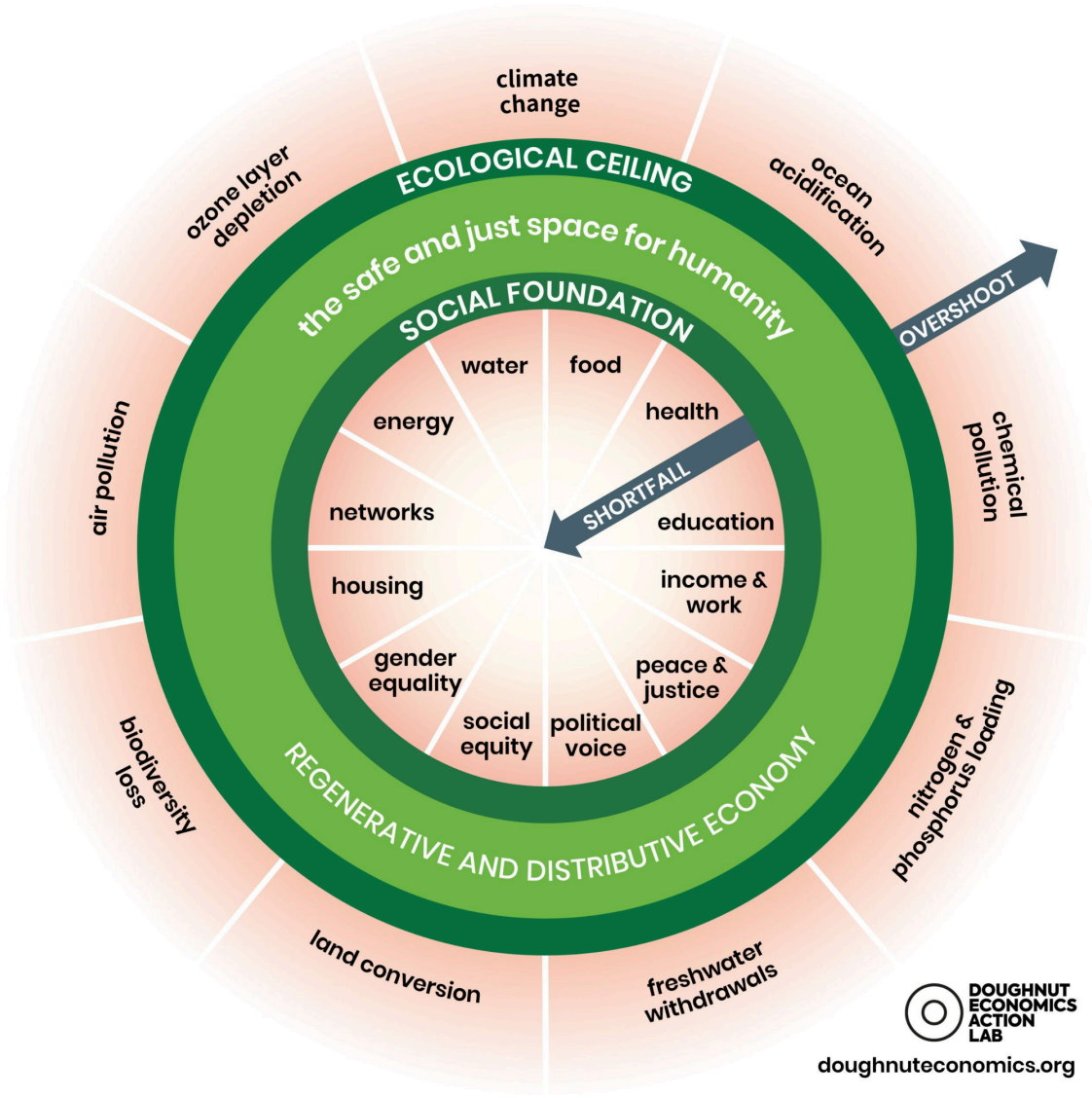

Figure one
A visualisation of the Doughnut framework.
Credit: Doughnut Economics Action Lab (DEAL)

governance (City of Amsterdam Voluntary Local Review, 2022; Turner et al., 2020). This research project will explore the possibility of downscaling Doughnut Economics to the city of Cambridge, by assessing where Cambridge is currently situated on the Doughnut and the feasibility of making the necessary changes to bring Cambridge within the Doughnut. Given the unusually high levels of inequality in Cambridge, alongside a high per-capita environmental footprint, this question is especially relevant.

Methodology

This research is grounded in the Doughnut Unrolled: Data Portrait of Place (2022) methodology for downscaling Doughnut Economics, produced by the Doughnut Economics Action Lab (DEAL). The Data Portrait of Place breaks the Doughnut framework into four overarching lenses: the local-ecological lens, the local-social lens, the global-ecological lens, and the global-social lens.

First, the local-social lens asks "how can all the people of this place thrive?" The dimensions of this lens are based on the Doughnut's social foundation - shown in Figure one - which are mostly drawn from the Sustainable Development Goals (SDGs). For this lens, I drew on a range of sources such as the Office for National Statistics (ONS) and local government reports (especially the 2023 State of the City Report).

Second, the local-ecological lens is inspired by biomimicry, the idea that human systems and structures should be designed to mimic natural and biological processes (Ilieva et al., 2022). The Data Portrait of Place recommends eight dimensions of the local-ecological lens, which measure the extent to which beneficial natural processes are replicated in the city. These eight dimensions are: "cleanse the air, house biodiversity, store carbon, cycle water, harvest energy, regulate the temperature, build and protect soil, and enhance wellbeing" (DEAL, 2022). For this lens, I often considered the Cambridgeshire region, as many of the dimensions of the local-ecological lens are intrinsically connected to the wider area.

Third, the global-social lens measures the global impacts of local actions and policies, taking into account factors like global supply chains, cultural connections, carbon footprints, consumption patterns and so on. In a globalised world, exploring the city's impact beyond its territorial boundaries is crucial for gaining a holistic understanding of where that place is situated on the Doughnut.

Finally, the global-ecological lens asks "how can this place respect the health of the whole planet?" (DEAL, 2022). I chose the dimensions for this lens by considering both the planetary boundaries shown in Figure one and data availability. Ultimately, I used the seven boundaries identified by Fanning et al., (2022), shown in figure two. The availability of place-specific data varied for each planetary boundary. First, detailed Cambridge-specific data on carbon emissions was available from GOV.UK (2020) and Kuriakose et al., (2024). Next, there was sufficient data to approximate the material and ecological footprint of Cambridge, by adjusting the UK average footprints based on expenditure, using an adjustment

factor of 1.17, based on the fact that weekly expenditure in Cambridge is 117% of the national average (Office for National Statistics, 2022*).* This data should be treated as an approximation, as it relies on the assumption that there is a relationship between expenditure and material and ecological footprint (Ivanova et al., 2015; Pothen and Reaños, 2018; European Environment Agency, 2023; Oxfam, 2015; Kenner, 2015). However, this assumption cannot be made for biogeochemical flows, freshwater withdrawals and land-use change, so I used the per-capita UK footprint data as a proxy for these boundaries.

Subsequently, I explored the targets set out by the Cambridge City Council to assess the extent to which there is a gap between current targets and the targets required to bring Cambridge within the Doughnut. Finally, from reviews of secondary literature supplemented with interviews of representatives from key organisations in Cambridge such as the Cambridge Doughnut Economics Action Group (CamDEAG) and the Cambridge City Council, I assessed the key barriers and challenges to downscaling Doughnut Economics in Cambridge.

There are limitations of the DEAL methodology for downscaling Doughnut Economics, especially for a small city like Cambridge. First, the local-social and global-social lenses are subjective, therefore the results will vary depending on the indicators and dimensions selected by the researcher. This is especially the case for the global-social lens because comprehensively mapping the global impacts of a city's consumption habitats, supply chains, attitudes to migrants and so on is extremely challenging.

Conversely, the global-ecological lens is quantitative and more objective yet it requires plentiful place-specific data. For a relatively small city like Cambridge, this data is not always readily available, therefore I either relied on approximations using an expenditure-adjusted approach, or used UK data as a proxy. Finally, the local-ecological lens requires a comparison of the city to the nearest 'thriving' habitat using the principles of biomimicry. Without a biomimicry specialist or ecologist this is not possible.

Results and discussion

Local-social lens

First, there are mixed results for the local-social lens, as Cambridge performs well on many of the headline indicators such as income, education and health, yet this masks underlying inequalities in these dimensions, driven by factors such as low social mobility and a housing affordability crisis. For a full breakdown of the indicators of the local-social lens, see this supplementary information.xlsx spreadsheet.

On the one hand, due to the plentiful high-skilled job opportunities in the so-called 'Silicon fen' - the cluster of high-tech businesses in Cambridge specialising in sectors such as biotechnology, pharmaceuticals, and AI - average incomes in Cambridge are substantially above the national average (Cambridge City Council, 2023a). Indeed, with nearly one quarter of jobs in Cambridge in the Silicon Fen as of 2011, it is difficult to overstate its importance to the Cambridge economy (SQW, 2011). Largely as a

result, Cambridge residents have the fifth highest disposable incomes in the country (Cambridge City Council, 2023a); the economic inactivity rate is lower than the national average (18.5% compared to 21.0%) (Office for National Statistics (ONS), 2024); and the proportion of the population receiving in-work Universal Credit is below the national benchmark and national city benchmark (Cambridge City Council, 2023a).

In addition, overall health outcomes are largely positive. For example, Cambridge residents enjoy the highest life expectancy of any city in the UK (84.5 years for females and 80.9 years for males) (ibid). Furthermore, Cambridge scored 101.9 on the overall ONS health index in 2021, which is marginally above the UK average of 100.8 (ONS, 2023). Across various other dimensions from mobility to connectivity and fuel poverty, the headline indicators are similarly strong.

Yet despite a strong overall performance on many of the local-social indicators, the benefits are poorly distributed. For example, in 2018, the Centre for Cities found that income is more unequally distributed in Cambridge than any of the other fifty-seven cities assessed in the UK, based on estimates of the Gini coefficient (Centre for Cities, 2018). In addition, low social mobility prevents a more equitable distribution of wealth in the city. Indeed, Cambridge is listed as a 'social mobility coldspot' as it ranks in the bottom 20% of UK local authorities in terms of social mobility (Social Mobility & Child Poverty Commission). This inequality is reflected in health outcomes, with the difference in life expectancy between the highest and lowest ranked neighbourhoods standing at twelve years, as of 2023 (ibid).

Furthermore, the abundance of high-skilled, high-income jobs has driven up house prices, worsening the cost of living crisis for those without access to the high-skilled jobs in the quaternary sector. This is reflected in the median rental costs which are 56% higher than the national average (Cambridge City Council, 2023a). This housing affordability crisis persists despite the fact that from 2013-2023 Cambridge has had the highest house building rates in the country (ibid).

Local-ecological lens

Likewise, there are mixed results for many of the local-ecological dimensions. Again, see the supplementary information.xlsx spreadsheet for a full breakdown of results. In summary, air quality is within the objective level of 40 $\mu g/m^3$ of nitrogen dioxide (Cambridge City Council, 2023b). However, levels of $PM_{2.5}$ (Particulate Matter with a diameter of 2.5 micrometres or less) were 10-12 $\mu g/m^3$ according to mapping of $PM_{2.5}$ levels across Europe by *the Guardian* using data from the Institute for Risk Assessment Sciences (Voce et al., 2023). This is over double the safe recommended concentrations set by the World Health Organisation (WHO, 2021).

Biodiversity in Cambridge and Cambridgeshire is generally very poor. For example, Cambridgeshire has some of the lowest proportions of Priority Habitats and land designated for nature conservation, including the second lowest proportion of woodland coverage in the UK (Cambridge City Council, 2022). Within the city itself, 60% of the areas surveyed by the 2021 Biodiversity Audit were in "poor" condition (Cambridge City Council, 2021b). Carbon storage in Cambridgeshire is also very poor, mostly because of the carbon released from wasted peatland, due to the drainage of peatland for agricultural purposes. As a

result, the county contains 70% of the wasted peatland in England, despite the fact it has 27% of England's total peatland (Cambridgeshire County Council, n.d.).

Additionally, there are systemic issues with water management in Cambridge. As a result of an expected deficit in the Supply Demand Balance (SDB) of freshwater, the Fens region is expected to run out of water in five to ten years at current rates (Cambridge Water, 2023; Centre for Landscape Regeneration, n.d.). Moreover, there is widespread soil degradation in Cambridgeshire and the Fens, with evidence of peatland degradation that has been occurring for centuries as a result of the drainage of peat for agricultural purposes (Holman, 2009; Fowler, 1933; Mahon et al., 2023).

Global-social lens

Arguably the most important global impacts of Cambridge arise from the Silicon fen companies which play important roles in the Global Value Chain (GVC) of products that are reshaping the world. For example, many Cambridge-based companies play an important role in semiconductor GVCs, such as Arm and Agile Analog Ltd. Whilst semiconductors are essential for powering modern devices and systems, the manufacturing process is associated with serious health risks for workers (Kim et al., 2013; Kim et al., 2018), the release of large volumes of highly polluting toxins and greenhouses gases (Lin et al., 2019), and is highly water and energy intensive (Frost and Hua, 2019). Therefore, with global sales of semiconductor chips rapidly increasing (from 2012 to 2022, global sales of semiconductor chips doubled to $602 billion for example) (Singh et al., 2023) the role of Cambridge-based companies in this industry should be acknowledged.

Another area where Cambridge-based companies are making significant global contributions is the super-linear growth of AI and machine learning (ML), such as Intellegens Ltd., IntelliSense.io, Kao data, and Spotta. This growth of AI is having socio-environmental implications, especially when the embodied carbon footprint of AI systems is taken into account, which includes the emissions of the manufacturing and training of AI. For instance, according to Patterson et al., (2021), the carbon footprint of training one large ML model is the same as driving 242,231 miles in an average passenger car. Of course, this technology also has the potential to accelerate progress towards the Doughnut but it is important to take into account the socio-environmental impacts of the industry (Wynsberghe, 2021).

Furthermore, the consumption habitats of Cambridge residents impact the wellbeing of people around the world. To give one example, in 2023 the UK ranked fourth in the world in terms of spending on clothing and footwear, despite only ranking as the twenty first most populous country (Statista, 2023). Within the UK, the South East region - including Cambridge - has a higher than average expenditure on clothing and footwear (ONS, 2022). The fast fashion industry is associated with child labour, prison labour, forced labour and bonded labour, and there is little economic incentive for the fashion companies to minimise the socio-environmental impacts of production (Environmental Audit Committee, 2019).

Global-ecological lens

Finally, Cambridge exceeds many of the planetary boundaries of the global-ecological lens. For example, the per-capita carbon emissions of Cambridge were above the threshold calculated by O'Neill et al., (2018): 3.7tCO_2e in 2022 (GOV.UK, 2020) compared to the planetary boundary of 1.6tCO_2e. In addition, for Cambridge to make a 'fair' contribution to achieving the planetary boundaries based on the equity principles of the UN Paris Agreement, Kuriakose et al., (2024) calculate that Cambridge should reach zero or near zero carbon emissions no later than 2043.

It is also possible to approximate the per capita material footprint of the South East of England, including Cambridge as 26.13 tonnes per capita, using an expenditure-adjusted approach. (Fanning et al., 2022; ONS, 2022). This far exceeds the threshold of 6.8 tonnes per capita set by Fanning et al., (2022). Using the same approach, the ecological footprint of the South East, including Cambridge, can be approximated at 5.51 global hectares per capita (Fanning et al., 2022; ONS, 2022). Fanning et al., (2022) do not set a threshold for the ecological footprint in global hectares per capita.

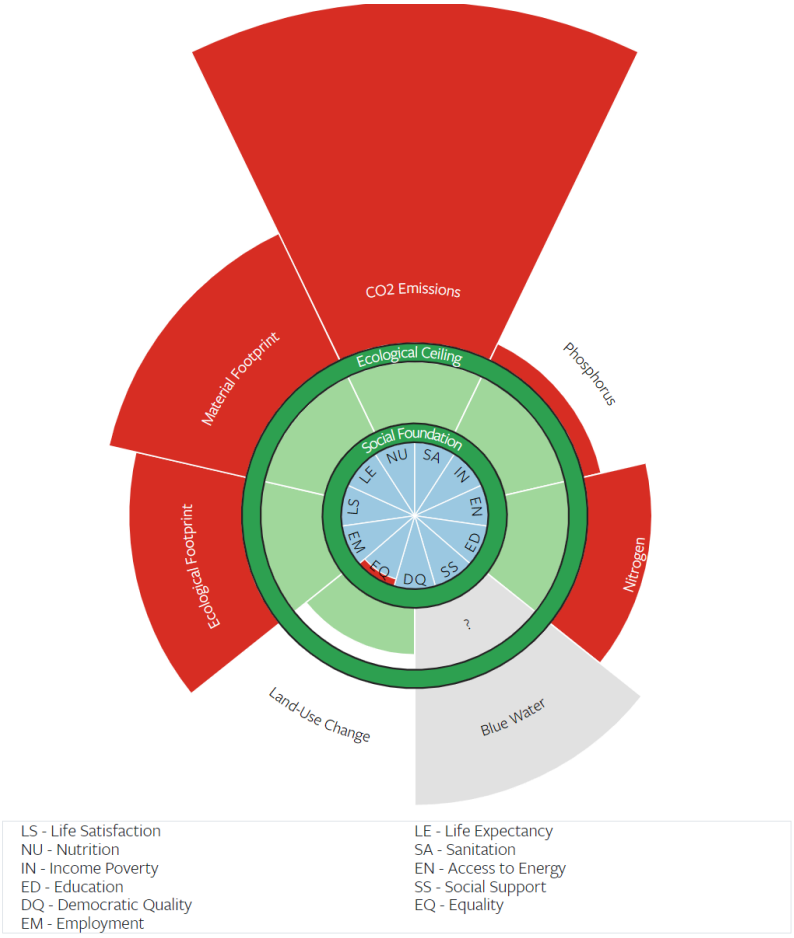

Figure two
A visualisation of where the UK is situated on the Doughnut model.
Credit: Fanning et al., (2022).

However, for biogeochemical flows, land conversion, and freshwater withdrawals, there was insufficient data to approximate the per-capita contributions of Cambridge. Instead, the UK data - illustrated in figure two - can be used as a proxy. In this regard, the UK exceeds its ecological boundary for biogeochemical flows (which measures the use of phosphorus and nitrogen). This is because the average per capita UK release of phosphorus between 2010 and 2015 was 1.1 kg P/yr compared to the per capita boundary of 0.88 kg P/yr and the average per capita release of nitrogen for this period was 17.2 kg N/yr, compared to a per capita boundary of 8.65 kg N/yr (Fanning et al., 2022).

On the other hand, the UK is within the per capita boundary in terms of land use change, at least when using Effective Human Appropriation of Net Primary Productivity (eHANPP) as an indicator. The UK has a per capita eHANPP of 2.4 tonnes of carbon yr^{-1}, which is within the per capita boundary of 2.6 tonnes of carbon yr^{-1} (O'Neill et al., 2018).

Finally, as of data published in 2014 the UK is within the per-capita boundary of freshwater withdrawals because the per capita water use is 393 m^3 (Tukker et al., 2014), whereas Nykvist et al., (2013) identify the 'safe operating space' as 585 m^3yr^{-1} per capita and Hoff et al., (2014) identify it as 570 m^3yr^{-1} per capita.

Future targets and challenges

Under current policies, it is unlikely that Cambridge will be brought within the Doughnut in the foreseeable future. Although Cambridge is mostly above the social foundation, current targets will not bring the city within the ecological ceiling. For example, as already stated, the net zero targets of Cambridge would have to be moved forward from 2050 to 2043 (Kuriakose et al., 2024). In addition, the extensive house building plans (see Greater Cambridge Shared Planning, 2024; Cambridge City Council, 2018) may put increased pressure on certain dimensions of the local-ecological lens, such as freshwater withdrawals and biodiversity.

Through interviews with stakeholders and a review of relevant literature, it is possible to identify two overarching barriers which may prevent Cambridge moving into the Doughnut. First, as is common with local governance institutions, the economic growth paradigm is deeply embedded within institutional practices and discourse (Turner and Wills, 2022) which feeds into local planning strategies, such as housing (Cambridge City Council, 2023a; Cambridge City Council, 2018). Second, a lack of devolved powers and funding means that even if there was a desire to adopt Doughnut Economics in Cambridge, the council would be unlikely to be able to implement the necessary policies without transformative change at the national government level. Indeed, the Cambridge City Council (2021d) argue that to meet "fair" net zero targets "would require a very significant step change in [national] Government policy, investment and regulation". Instead, the national government is pushing for more development in Cambridge, with the objective of "supercharging" it into an engine of economic growth, for instance by building up to 150,000 new homes (GOV.UK, 2024b).

Conclusion

Currently, Cambridge achieves many of the dimensions of the social foundation, although substantial improvements to social equity are required for Cambridge to fully achieve the social foundation. Additionally, Cambridge exceeds many of the dimensions of the ecological ceiling. Bringing Cambridge back within the ecological ceiling would require transformative change at the local and national level to rapidly curb consumption, restore biodiversity, and transition to a circular economy. This would be extremely challenging because of the deeply entrenched institutional belief that further economic growth

is the best way to achieve social prosperity, as well as the lack of devolved powers and funding from the national government, who are instead pushing for Cambridge to become an engine for GDP growth.

Nevertheless, doughnut economics is a useful framework for sustainable development at local, national and regional scales, including in Cambridge. In particular, it is appealing because it addresses both social and environmental needs, thus seeking to avoid trade-offs between the two spheres. With the Earth beyond six of the nine planetary boundaries (Richardson et al., 2023) and large proportions of the global population remaining below the social foundation (Fanning et al., 2022), finding a way to resolve ecological breakdown whilst increasing wellbeing and quality of life is becoming increasingly urgent.

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