Patterns of unequal exchange in urban food trade networks: towards a spatial theory of food geographies.

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Objective and contribution of the paper

The urbanization megatrend implies an intensification in food supply from fewer farms and agricultural workers in rural areas to growing populations in urban and peri-urban areas worldwide. Historically, increasing farm labour productivity and decreasing food prices have provided the necessary conditions for industrialization, economic prosperity and food security in cities (Evenson and Gollin, 2003; Moore, 2010). As a result, cities around the globe can now be characterised as settlements with greater densities of population, commercial activities and related income, among others, without the burden of a substantive primary sector, i.e. agricultural and mining activities (Glaeser, 2016; Daviron et al. 2019). Instead, contemporary cities depend on dense and long-range trade networks that connect them with agricultural production and related resources elsewhere (Steel, 2013; Friis, 2019). Vice versa, farmers and agricultural workers in rural areas are "tele-coupled" to urban markets through global value chains that shape the flows of people, services, money, information and waste among spatial scales in the global resource system (Cumming, 2014, Tacioli and Agergaard, 2017, Garrett and Rueda, 2019; Barrett et al. 2022). Urban food consumption thus increasingly depends on productive ecosystems in peri-urban and rural areas elsewhere, as well as on fossil fuels and minerals to accommodate primary production, processing, packaging and trade activities in the globalized food system (Li et al. 2022; Roux et al. 2021). In fact, the uneven distribution of land and other natural resources among geographical entities means that efforts towards local and global food security requires trade among cities and regions (based on: Friis, 2019). In this context, FAO (2023) estimates that high income countries rely for 60% of their food consumption on imports, of which the majority share is consumed in urban areas (Grewal and Grewal, 2012; Goldstein, 2017). However, despite empirical evidence that a better integration in world markets supports environmental efficiency (Liao et al. 2023) and swift responses to supply shocks and disruptions in trade relations (Gomez

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et al. 2021; de Schutter et al. 2023), there is growing evidence that unsustainable resource use, social disparities and (related) vulnerabilities in the global resource system correlate with urbanisation and related changes in food consumption.

Cities increasingly recognize their critical position in global food trade networks, both as drivers of environmental pressures and as recipients of cascading risks in global food networks, as witnessed during covid and the global rise in food and energy prices. In this context, urban food strategies are becoming more common and tend to focus on developing alternative food networks and new forms of connectivity and sustainable practices at the local level (Sonnino et al. 2016; Blay-Palmer et al. 2021). However, despite the notion of centrality of relations among urban and peri-urban agents as potential intervention point, there is still limited insights in the scope of urban agency in shaping their food networks towards sustainability and equity in the global resource system (Battersby and Haysom, 2018). Knowledge gaps persist in understanding food (in)security as the outcome of multi-scalar mechanisms among spatial levels in urban food networks (Ericksen, 2008; Sonnino, 2016; Battersby and Haysom, 2018). This paper addresses this knowledge gap from a spatial perspective, both with an empirical and a theoretical framework. First, by employing a multiregional input-output framework, we analyze the spatial structure of resource, labour and environmental pollution footprints associated with urban food consumption in high income countries. Building on theories of unequal spatial development, we develop the concept of “food geographies” and explain their spatial constellation and related impacts from an urban agglomeration perspective. Finally, in the discussion, we elaborate on the potential agency of cities and peri-urban regions in steering urban food networks towards (more) sustainability and equity.

Empirical framework (Methods and data used)

We construct urban food consumption accounts for four cities in the EU, i.e. Vienna, Hamburg, Madrid, and Amsterdam based on household budget surveys (monetary value) and available surveys of physical volumes of at-home and out-of-home food consumption. We calculate resource, labour and environmental pollution footprints with the multiregional input-output database of EXIOBASEv3.8, with an extended food product resolution (de Schutter et al. 2024).

Theoretical framework

Three spatial theories have been selected to develop a framework that can support urban food system analysis from a spatial perspective: unequal development theory from the field of spatial economics (Krugman, 1990), productivity theory from the field of ecological economics (Georgescu-Roegen, 1968, 1971) and Ecologically Unequal Exchange from the perspective of political ecology and environmental inequality (a.o. Hornborg, 1998). We describe and integrate these theories into a coherent theoretical framework of "food geographies" as spatial conjunctions of place-based communities and functional economic agents in urban food systems.

Krugman (1990) built on Von Thünen's land rent model and developed it into a non-competitive *spatial economics theory of unequal development*, by showing how increasing returns (market expansion by qualitative change), transport costs and factor mobility can explain emergent patterns of spatial agglomeration and rural dispersion (Fujita, Krugman and Venables, 2001; Fujita, 2010). This so-called "new economic geography" (NEG) conceptualises a core-periphery structure that explains agglomeration effects in manufacturing by centrifugal forces (labour supply and product demand) in urban markets ("core") and dissipative effects (decreasing land rent, factor immobility, reduced transportation costs) in agriculture ("periphery"), as well as agglomeration spillovers in urban trade networks. As such, NEG theory provides an economic explanation for patterns of unequal spatial development.

In the EU, polycentric agglomeration patterns have been found, and can be explained by NEG theory, in location behavior of farms and firms in towns and hinterlands in rural regions (Van Leeuwen et al., 2010). In addition, although port cities provide trade spillovers to food manufacturing, among other industries, Jacobs et al. (2010) find that manufacturing tends to move away from the city center to the peri-urban level due to a lack of available land and environmental constraints. Overall, by combining NEG theory and (limited) empirical evidence, it can be argued that food manufacturing in high income countries tends to concentrate at the peri-urban level of urban economies and that (towns in) rural areas can also provide for agglomeration economies in food and agricultural processing.

A second theoretical argument for unequal spatial development in urban food networks can be found in *productivity theory* from an ecological economics perspective (Georgescu-Roegen, 1968). Based on geo-climatical limitations, Georgescu-Roegen provides an ecological explanation for the structural disadvantage of productivity in agriculture as compared to industrial manufacturing. Dictated by growing and harvesting seasons, operations in [arable] farming are generally organized in parallel, i.e. all beginning and ending at the appropriate phase of the annual climatic cycle. As a result, idleness of (partly indivisible) production factors in arable farming (land, labour and machines) is unavoidable during a significant part of the year. Due to limited control over geo-climatic conditions, Georgescu-Roegen argues that the global farming process suffers from structural overcapitalization and, as a result, from structurally lower productivity levels as compared to the industrial manufacturing process in a production year (Georgescu-Roegen 1986; 1971). G.R.'s "theory of unequal productivity" thereby provides an ecological argument for the emergence of the agricultural periphery in NEG's model of unequal spatial development.

Finally, based on world systems theory (Wallerstein, 2020), the theory of *ecologically unequal exchange* (EUE) posits that the structure of international trade contributes to environmental degradation in countries that are largely dependent on agriculture (Frey et al. 2019; McKinney 2019). EUE analysis demonstrates how unequal transfers in the global resource system allow "the core" to accumulate value added, infrastructures and economic growth, while distributing environmental and related social impacts to primary sectors in the periphery (Hornborg, 2018; Dorninger et al. 2021; Althouse et al. 2023). For example, empirical evidence for patterns of EUE has been found for value added per tonne of embodied raw materials, embodied labour and, with the exception of China, for embodied land, with every region not classified as high-income serving as net provider of raw materials between 1990 and 2015 (Dorninger et al., 2021). The authors highlight that, when embodied resource flows are considered, net flows of money and resources both flow from periphery to core (instead of opposite directions in standard trade flow accounting). Building on Dorninger's analysis, Althouse et al. (2023) linked country level patterns of EUE to the integration of core countries in global value chains (GVCs), thereby providing a political economy argument for the displacement of environmental impacts to the periphery.

(Tentative) results: Food geography constellations as a spatial food system lens (work in progress)

From a spatial perspective, urban food networks can be defined as an urban node ("the core"), connected to a dispersed structure of unevenly distributed social and ecological resources among different types of human settlements and regions in the global resource system (Friis, 2019; Oberlack et al., 2018; Cumming, 2014). Settlements in urban food networks can thus be understood as spatial conjunctions of functional economic agents in global supply chains and place-based communities engaged with the regeneration of local (social and ecological) resources. With support of the empirical analysis and the theoretical framework (previous section), which all point at emergent patterns of unequal spatial development, we propose the concept of "food geographies" as a hierarchical spatial structure in urban food trade networks. Three distinct food geographies can de conceptualised:

(1) *Urban food geographies* with food retail and food service activities (fast food chains, business canteens and other restaurants) agglomerating in large consumer and labour markets, where workers are relatively young and educated (e.g. Pinho et al. 2020);

(2) *Peri-urban food geographies* where proximity to urban labour and/or primary products, trade services and urban consumer markets (including second tier cities) attracts (i) global retail chains, wholesalers and their distribution centers, (ii) food manufacturers oriented at high value products for urban consumers with sedentary lifestyles and a high willingness to pay (Guiné et al. 2020) and (iii) primary production of high value crops and livestock products.

(3) *Rural food geographies* where the majority of agricultural production is located in regions with low population densities and land prices (see Figure 1). Rural food geographies include settlement structures of smaller villages and scattered farming activities connected to the immobile production factor land, as well as towns as agglomeration economies of agricultural processing and other industrial activities. In the rural economy, towns fulfil an important community function for farmers and rural households, both as regional markets for basic goods and services, as well as for employment and public services (van Leeuwen, 2010; Johansson and Norman, 2010).

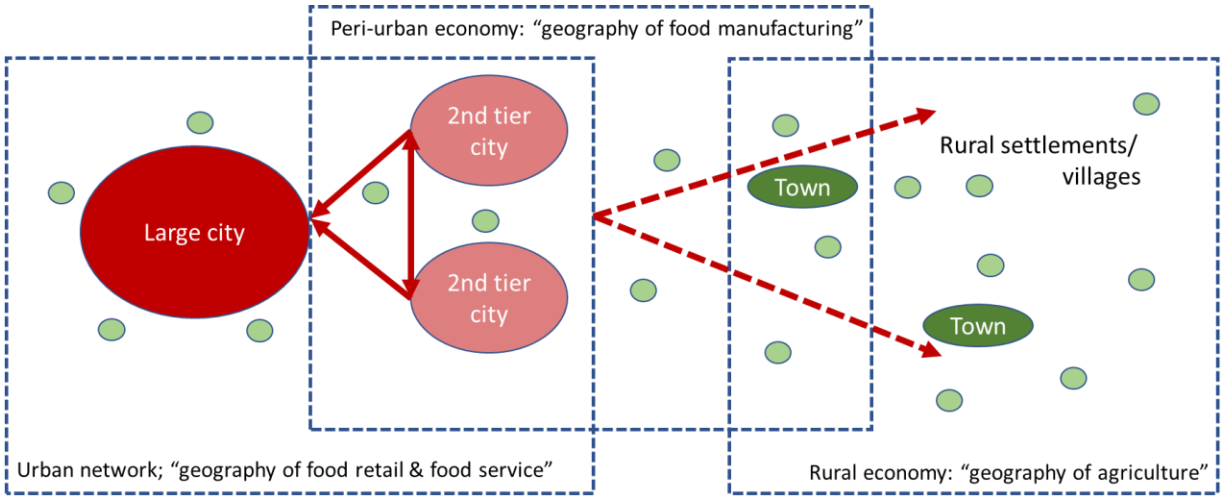

Figure 1: Conceptualisation of "food geographies" as spatial conjunctions of place-based communities and functional economic agents in the urban food network. Solid red arrows indicate urban agglomeration forces, dashed red arrows indicate urban dispersion forces

Conclusions

Based on empirical analysis and spatial theories, we conceptualize three distinct food geographies, i.e. the urban core as a " geography of food retail and food service", The peri-urban economy as the " geography of (high value) food manufacturing and trade, and the "rural periphery" as the geography of arable agriculture and industrial processing". Moreover, with a spatial lense, we explain how urban agglomeration shapes emergent patterns of inequality among food geographies in the global resource system. Finally, we argue that agency in food system transformation towards sustainability requires a multi-level governance approach.