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Vulnerability to fuel price increases: Socio-spatial patterns in Germany

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This work addresses the following topic(s) from the Call for Contributions:

- Placemaking to integrate urban spaces and mobility
- Promoting sustainable mobility choices in metropolitan regions
- Governing responsible mobility innovations
- Shaping the transition towards mobility justice
- System analysis, design, and evaluation
- other: _____

Extended Abstract

Problem statement

Measures such as CO₂ taxes and Emission Trading Systems are likely to be implemented over the next few years to ensure CO₂ emission reductions in all sectors, including road transport. These measures are likely to result in a substantial increase in fuel prices at the pump. This raises social justice issues, as some low-income households rely on cars for access to services and opportunities but struggle to afford related expenses. As such, vulnerability to fuel price increases is the object of heated public and political debates, in Germany and elsewhere.

In this context, it is often argued that the effects of fuel price increases are unevenly distributed across space. Empirical studies have shown this to be the case in e.g., Australia (Dodson & Sipe, 2007), the UK (Mattioli et al., 2019) and Italy (Mattioli et al., 2023). To date, however, there is little empirical evidence of this in Germany other than Büttner et al.'s study of the Munich metropolitan area (2013).

Research objectives

This extended abstract summarises the work conducted by the authors for a recent report commissioned by *Agora Verkehrswende* (Stark et al., 2023). The aim of the work was to put forward a spatial indicator of vulnerability to fuel price increases for German municipalities, using the best and most recent data available. The indicator could inform ongoing debates on how to transition towards sustainable, low-carbon transport systems while considering transport-related inequalities and injustices.

Methodological approach

Following an established approach (see e.g., Büttner et al., 2013; Mattioli et al., 2019), we define vulnerability to fuel price increases as a function of three factors: exposure (level of car ownership and/or use), sensitivity (level

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of income) and adaptive capacity (viability of modal alternatives to the car). The indicators used for each dimension are detailed in **Table 1**. The vulnerability index was calculated as the weighted sum of the four standardized indicators.

Table 1: Indicators for three dimensions of vulnerability to fuel price increases in Germany

Dimension	Indicator	Spatial unit	Data source	Year	Weight
Exposition	Motorisation rate	Municipality	KBA	2022	33.3%
Sensitivity	Disposable income of private households (per capita)	<i>Kreis</i>	Federal Statistical Office of Germany	2020	16.7%
	Median gross earnings for full-time employees	<i>Gemeindeverband</i>	Federal Employment Agency	2021	16.7%
Adaptive capacity	Public transport departures per day and per settlement area	Municipality	<i>Agora Verkehrswende</i>	2022	33.3%

Results

Figure 1 shows the spatial distribution of the three dimensions of vulnerability. The exposure map shows lower motorisation rates in urban areas and in East Germany, and higher rates in the South and West of the country. The sensitivity map shows higher income (and thus lower sensitivity) in the South of Germany, but also in parts of the West and the North, while most of East Germany is characterized by lower income levels (and thus higher sensitivity). The adaptive capacity map shows that public transport quality is better in the main urban areas, but there are also large differences between States that are otherwise quite similar (e.g., Bavaria vs. Baden-Württemberg, Thuringia vs. Saxony). These differences might reflect different policy approaches to public transport provision between States within the German federal system.

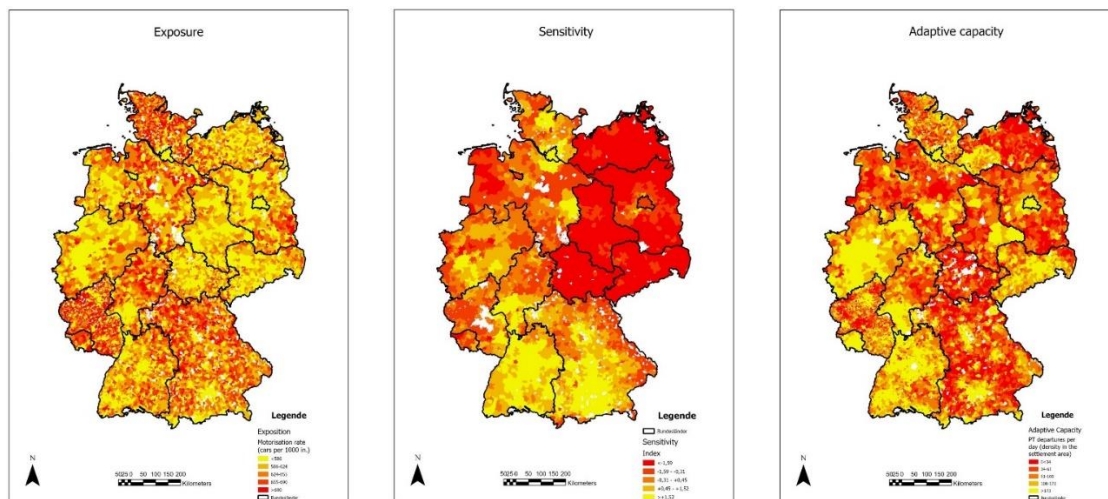


Figure 1: Spatial distribution of the three dimensions of vulnerability to fuel price increases in Germany

The composite indicator of vulnerability combines the three vulnerability dimensions into a single metric (**Figure 2**). The resulting spatial pattern is complex but tends to show higher levels of vulnerability in East Germany and in less densely populated areas in the West, along with important differences between States. Overall, we estimate that about 1.9 million people (ca. 2.3% of the population) live in the municipalities with the highest vulnerability to fuel price increases (top quintile of the distribution).

Overall, the findings suggest that the spatial distribution of vulnerability to fuel price increases in Germany is more complex than usually assumed in the public debate. As expected, vulnerability is higher in rural and periurban areas (mainly because of greater car dependence) and in East Germany (mainly because of lower income levels). There are, however, important differences between regions that are otherwise relatively similar, which seems to be the result of different policy approaches to public transport provision within the German

federal systems. This stands in contrast with the results of similar analyses conducted in other European countries (Mattioli et al., 2019; 2023), which did not bring to light such a pattern of ‘regionalisation’.

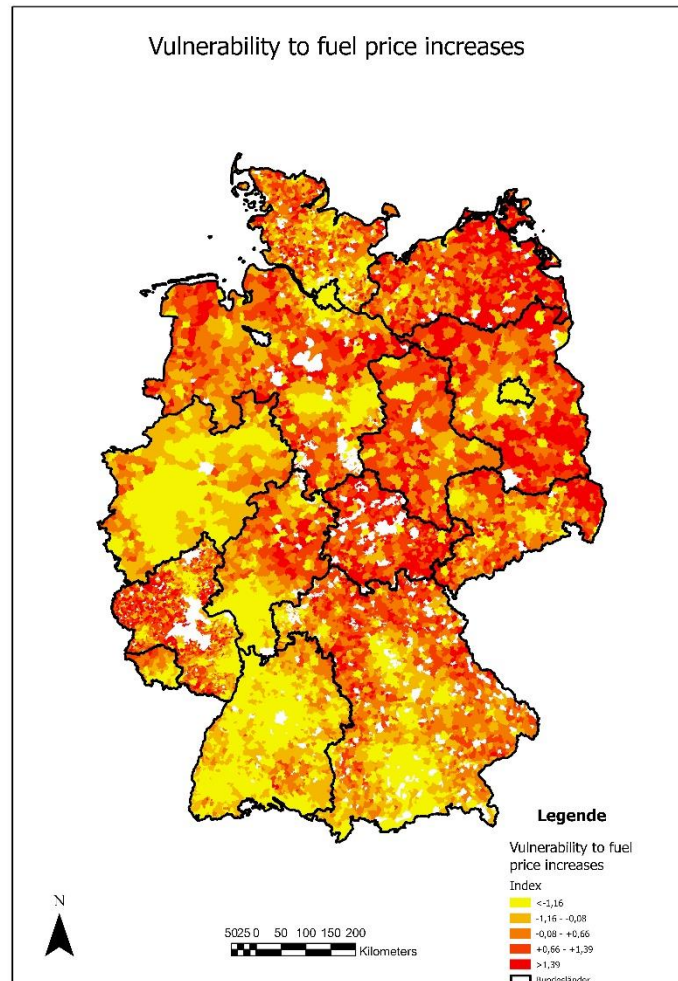


Figure 2: Spatial distribution of the composite indicator of vulnerability to fuel price increases in Germany

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