Regional input-output tables for climate policy analysis: A brief data survey

Marius Braun* and Nils Keimes†

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Input-output tables are an important tool for model-based assessments of climate, trade or other economic policies (e.g., Pothen and Hübler 2018). While national input-output tables are widely available, within-country data on regional input-output tables (RIOTs) is unevenly distributed across regions and overall relatively scarce. However, RIOTs are necessary in order to reliably assess regional impacts of climate policy measures within countries and effectively implement future climate policies. This necessity stems from the differential economic impacts of climate policies across regions due to differences in the economic importance of active sectors and their contribution to the overall output of a region.

The aim of this article is to review the existing literature on RIOTs and identify priorities for future research efforts. This information can be relevant for modelers, data providers, funders and policy makers. While we choose to primarily focus on the federal states of Germany, the points raised in this article more generally apply to regional economic impacts of climate policies.

Availability of RIOTs across German federal states

At the time of writing, RIOTs are only available for eight of the 16 federal states (see Table 1). The state with the highest number is Baden-Wuerttemberg, for which we found three RIOTs since 2010 (Heindl and Voigt 2012; Haigner et al. 2015; Koch et al. 2019). The majority of RIOTs are not publicly available. Furthermore, the level of sectoral disaggregation of RIOTs varies considerably, ranging from 12 sectors (Prognos 2007; 2009) to 72 sectors (Heindl and Voigt 2012). Regarding regionalization methods, the literature generally relies on pure nonsurvey methods, with most recent contributions applying the Cross-Hauling Adjusted Regionalization Method (CHARM) developed by Kronenberg (2009), which accounts for cross-hauling (the

*Corresponding author, email: marius.braun-2@wirtschaft.uni-giessen.de, phone: +49-641-99-22112; Faculty of Economics and Business Studies, Justus Liebig University Giessen, Licher Strasse 66, 35394 Giessen, Germany.
†Faculty of Economics and Business Studies, Justus Liebig University Giessen, Germany.

simultaneous exporting and importing of the same type of product). However, some authors (e.g., Koch et al. 2019) adopt a hybrid approach that includes the use of original, state-specific data, which allows for a more precise accounting of regional economic activity. As shown in Table 2, data sources for this approach include the Household Budget Survey (EVS), the Working Group "Regional Accounts of the Federal States" (VGRdL) and labor market statistics, which are provided by the Federal Statistical Office (Destatis), the statistical offices of the federal states and the Federal Employment Agency (BA), respectively.

State	Author	Year	Number of sectors	Method	Publicly available
Baden-Wuerttemberg	Haigner et al. (2015)	2010	51	CHARM	No
Baden-Wuerttemberg	Heindl and Voigt (2012)	2006	72	CB/SDP	Yes
Baden-Wuerttemberg	Koch et al. (2019)	2014	38	CHARM	No
Hamburg	Prognos (2009)	2005	12	??	No
Hamburg	Kronenberg (2011)	2003	71	CHARM	No
Hessen	Penzkofer (2002)	1995	??	??	No
Hessen	Koschel et al. (2006)	2000	18	LQ	No
Lower Saxony	Schröder (2012)	2007	71	CHARM	Yes
Lower Saxony	Stöver (2018)	2013	20	CHARM	Yes
Mecklenburg-Western Pomerania	Kronenberg (2010)	2003	16	CHARM	Yes
North Rhine-Westphalia	Kronenberg and Többen (2011)	2007	59	CHARM	Yes
North Rhine-Westphalia	Prognos (2007)	2000	12	??	No
Saxony	Lehr et al. (2013)	2006	16	CHARM	No
Thuringia	Dettmer and Sauer (2014)	2010	73	FLQ	No

Table 1: Regional input-output tables for German federal states (based on Kronenberg and Wolter (2017) and own survey of the literature)

In addition, there are two notable recent contributions to the literature not included in Table 1. First, Schröder and Zimmermann (2014) describe the construction of a RIOT for the Baltic Sea region. However, they do not produce a complete RIOT and instead only provide regional output multipliers for different regionalization methods. Second, using shipment data, Krebs (2020) constructs an interregional input-output table (IRIOT) for 402 German counties and 26 foreign trading partners for 17 sectors. The IRIOT itself is not publicly available; however, the code necessary to construct the table is available upon request.

As illustrated in Figure 1, availability of RIOTs differs for the German federal states. While Baden-Wuerttemberg, Hamburg, Hessen, North Rhine-Westphalia and Lower Saxony provide multiple RIOTs, we found a discrepancy in availability, quality and quantity of RIOTs between the eastern and western federal states. Especially for climate policy analysis, this discrepancy demonstrates the need for a comprehensive and nationwide coverage of RIOTs in all federal states or, if possible, for all economic regions in Germany.

Priorities for future research

While the need for nationwide RIOTs is not adequately met at the state level, further disaggregation of RIOTs from state to individual regions would be necessary to narrow down climate policy effects. Evaluating such

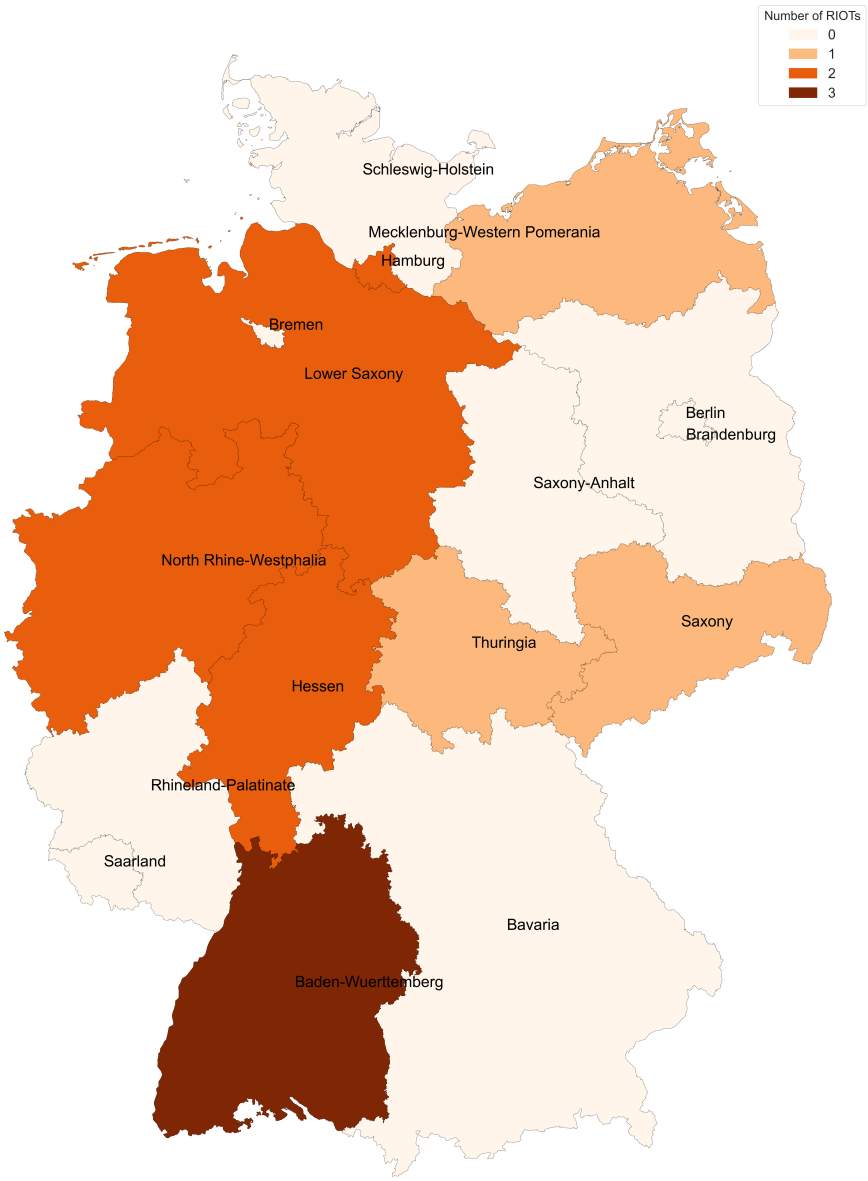

Figure 1: Regional input-output tables across the German federal states

Variable	Data source	Producer(s)	Publication frequency	Publicly available
Intermediate demand	NIOT	Destatis	Annually	Yes
Private consumption	Scientific use files of the EVS	Destatis	Every five years	No
Government final consumption expenditure	VGRdL	State statistical offices	Annually	Yes
Gross fixed capital formation	VGRdL	State statistical offices	Annually	Yes
Change in inventories	NIOT	Destatis	Annually	Yes
Exports and imports	CHARM method using NIOT	-	-	-
Compensation of employees	VGRdL	State statistical offices	Annually	Yes
Employment by sectors	Labor market statistics	BA	Monthly	Yes

Table 2: Data sources for the construction of regional input-output tables (based on Stöver (2018) and Koch et al. (2019))

effects at a more granular level may be crucial for climate-relevant regions likely to be affected by climate policy measures due to the sectors active there. This includes regions whose production shows a clear dependence on climate-damaging production chains, regions that would strongly benefit in the case of a subsidization of climate-friendly alternatives, or regions that would benefit from a restriction of climate-damaging industries. One example of a region that fits the former definition of climate relevance can be observed in the region of Lusatia in the east of the federal state of Brandenburg (Seibert et al. 2018). Despite the relatively low population density, Lusatia is home to the second-largest lignite mining region in Germany. Considering the relevance of lignite in power generation, the mining sector is of particular importance for the local industry. While in the short run, lignite will continue to be used for power generation, Germany's climate policy goals prepare for a complete phase-out of lignite for power generation until 2038 (Stürmlinger and Fuchs 2021).

Whereas regions with a strong dependency on climate-damaging industries like Lusatia are potentially negatively affected by stricter climate policy settings, other regions may be more robust to such policy settings or even benefit from them. A case could be made that Schleswig-Holstein is one of these beneficiaries (Burmeister and Sudheimer 2016). Although wind energy power plants are common across Germany, the northern federal states including Schleswig-Holstein show a much higher economic dependency on the wind energy industry compared to the rest of Germany. Thus, climate policy striving for a increasing share of renewable energies, e.g., an increase in subsidies for renewable energy production, may result in positive welfare effects for Schleswig-Holstein.

In conclusion, a number of priorities for future research emerge from this report. First, we have identified a lack of availability of RIOTs for some of the German federal states. This dearth of data is particularly prevailing in the eastern federal states. Considering the large differences in the economic importance of certain industries across federal states or even across smaller regions (e.g., mining in Lusatia and wind energy in Schleswig-Holstein), this discrepancy should be addressed by future research in order to accurately quantify the regional impacts of climate policy measures. Second, of the 14 RIOTs identified in our review of the literature, at the time of writing only five were publicly available. While this issue appears to be particularly prevalent in older publications, even in the most recent contribution included in our survey (Krebs 2020), the constructed RIOT is not openly accessible. Thus, future research should ensure public availability of RIOTs to achieve a openly accessible database for all researchers. The third priority should be the use of a standardized method for the construction of RIOTs. The most promising method to harmonize the construction of RIOTs across literature is the CHARM approach by Kronenberg (2009). If these issues are adequately addressed, future research could provide a harmonized foundation for the analysis of regional effects of climate policy measures.

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