

# Towards a Regional Public Dashboard for Crisis and Resilience Management

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## Abstract

The paper presents ongoing work on a public dashboard that displays the trade relationships of a regional economy in Germany (Saxony) and uses semantic data integration techniques to connect it with localized information on global crisis events in supplying countries. Furthermore, it quantifies the impact of external supply shocks on (subregions of) the Saxon economy in quasi-real time and provides estimates of changes in macroeconomic determinants based on a regional input-output model. The dashboard will be a public resource to support decision makers from politics, business and administration in mitigating the effects of crises and improving regional resilience.

## Keywords

Resilience Management, Crisis Management, CoyPu Knowledge Graph, Regional Input Output Model

## 1. Introduction

The process of globalization has substantially reshaped global value chains since the 1980s. The onset of the global financial crisis in 2008/2009, though, and more so the Covid-19 pandemic and current geopolitical conflicts, such as the Russia-Ukraine war, have demonstrated risks of these highly cost-efficient but vulnerable extended international supply chains and the internationalization of production networks [1]. These events have shown that even minor disruptions to international supply chains can have a substantial impact on the production further up the value chain and lead to welfare losses, unemployment and inflation due to the interconnectedness of production networks [2]. Moreover, the dependency of global production on highly specialized and strategically important intermediate goods produced only in certain parts of the world has shifted the current debate to de-risking international supply chains via re-shoring, i.e. producing strategically important intermediates domestically or diversification, i.e. reducing the dependency on a single supplier or world region (e.g. [3] [4] [5]).


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This project develops a regional dashboard for crisis and resilience management. Our prime focus is the macroeconomic consequences of international supply chain shocks at the regional level in quasi-real time. While predictions regarding economic shocks are readily available at the national level, this does not apply to the sub-national level. This is of particular importance, since regional specialization in certain industries is prevalent across Germany and thus some regions will be more exposed to specific supply chain shocks than others. This will help regional policymakers to react to unemployment, losses in production and tax revenues in a timely fashion.

The project aims to integrate publicly available data and information relevant to crisis and resilience management on a more fine-grained regional level. We base our dashboard on the German state of Saxony. The dashboard serves as a (work-in-progress) prototype that proves feasibility while at the same time shedding more light on the specific challenges of the general endeavor.

## 2. Data and Methods

### 2.1. Data & CoyPu Knowledge Graph

We obtained data from the "Statistisches Bundesamt",<sup>1</sup> encompassing various economic indicators such as foreign trade statistics and the national accounting for both Saxony and Germany as a whole as well as the Input-Output-Calculation for Germany. The data were transformed into RDF format using custom scripts. The RDF schema employed allowed us to represent the complex relationships between different economic variables and regions.

For data retrieval in context of the dashboard, several SPARQL queries are sent to the SPARQL endpoint of the CoyPu triple storage.

We use SPARQL to gather the following data:

- Foreign Trade<sup>2</sup>
- Disaster events<sup>3</sup>
- Countries<sup>4</sup>
- Administrative Region<sup>5</sup>

One of the challenges that appeared during data integration and retrieval came from the fact that disaster events are, in many cases, not directly connected to country resources. There might be several reasons for this:

- the source data does not contain this information
- disasters (e.g. flood waves) happen on places like oceans so they can not set in relation to countries

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<sup>1</sup>[https://www.destatis.de/DE/Home/\\_inhalt.html](https://www.destatis.de/DE/Home/_inhalt.html)

<sup>2</sup>Data containing values and tonnage of tradings between Saxony and a country distinguished by trade group, year, month and trade direction. <https://www-genesis.destatis.de/>

<sup>3</sup>Disaster events like floods, earthquakes sourced from <https://public.emdat.be/> and <https://reliefweb.int/>

<sup>4</sup>Resources to identify countries and reuse them in the knowledge graph

<sup>5</sup>This entity is sourced from <https://www.geoboundaries.org/> and contains a hierarchical collection of administrative regions of the world.(e.g. District of Leipzig is part of Saxony and Saxony is part of Germany)

While disasters may have impact on several countries, we can not assume that all countries which are linked to a disaster event are actually affected. To tackle this linking issue an approach has been applied which makes use of geo-objects (e.g. polygons or multi-polygons) that country and disaster resources are usually linked to. To get a connection between disaster events and countries that are affected by disasters, we use the function *geof:sfIntersects*, defined in GeoSPARQL<sup>6</sup> standard, which finds intersections of geo-objects. GeoSPARQL features are enabled on the Apache Jena Triple Storage<sup>7</sup> which serves the CoyPu Knowledge Graph.

## 2.2. Input-output model

We are developing a regionalized input-output model to estimate the macroeconomic effects of crisis-induced supply chain shocks on (subregions of) the Saxon economy. Input-output models are a standard tool to display and analyze supply chain linkages between industries and central to the investigation of global value chains [6]. As input-output tables are published only for the national level, direct information on supply chain linkages on the sub-national level are missing. This is problematic since macroeconomic shocks can affect regions very differently [7] [8]. We use a non-survey approach to generate a regionalized input-output model for Saxony (cf. [9] [10]). Based on the regionalized data, we estimate the structural parameters of the model that determine the effects of changes in the supply of intermediate goods on total production and thus on employment, gross value added and tax revenues. Based on historical data on crisis events the effect of different types of crises on import flows in intermediates to Saxony can be estimated (cf. [11] [12]). Linked with our input-output model we can trace the effect of these supply chain disruptions from one sector to others and the entirety of the Saxon macroeconomy. To our knowledge, our project is the first to develop a dashboard that quantifies these effects in quasi-real time. The model is implemented in R. It is dockerized and integrated into the CoyPu Knowledge Graph.

## 2.3. Visualization

The choice of a suitable framework is essential for the efficient presentation and analysis of complicated datasets in the fields of data analytics and visualization. For the dashboard the HoloViz Panel framework has been chosen mainly due to its wide range of compatibility and adaptability. It is a flexible tool for developers since it can easily integrate different platforms and supports a wide range of visualization libraries, including as Plotly, Bokeh, and Matplotlib using Python [13].

To enhance performance and user experience, the filter widgets are used in the dashboard, that each is bound to specific SPARQL queries. This allows us reducing the server load for the data retrieval process, thus ensuring a responsive interface. Such optimization is crucial for facilitating user interaction with the dashboard, enabling focused and efficient data exploration.

The integration of the RDF Data Cube Vocabulary data within the dashboard enables the representation of multidimensional data as RDF in a Knowledge Graph. Although a performance

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<sup>6</sup>“GeoSPARQL defines a vocabulary for representing geospatial data in RDF, and it defines an extension to the SPARQL query language for processing geospatial data.” <https://www.ogc.org/standard/geosparql/>

<sup>7</sup><https://jena.apache.org/>

comparison has not yet been conducted, it provides a structured and standardized approach to handling complex datasets, which is an essential point for big data.

### 3. Results and Discussion

The dashboard offers a multidimensional perspective on the Saxon economy's foreign trade data, including metrics like exports/imports, trade groups, etc. The use of sidebar filter widgets simplifies exploration of big datasets, while sankey diagrams, line plots, and charts enable a rapid visual overview and comparison of trade flows.

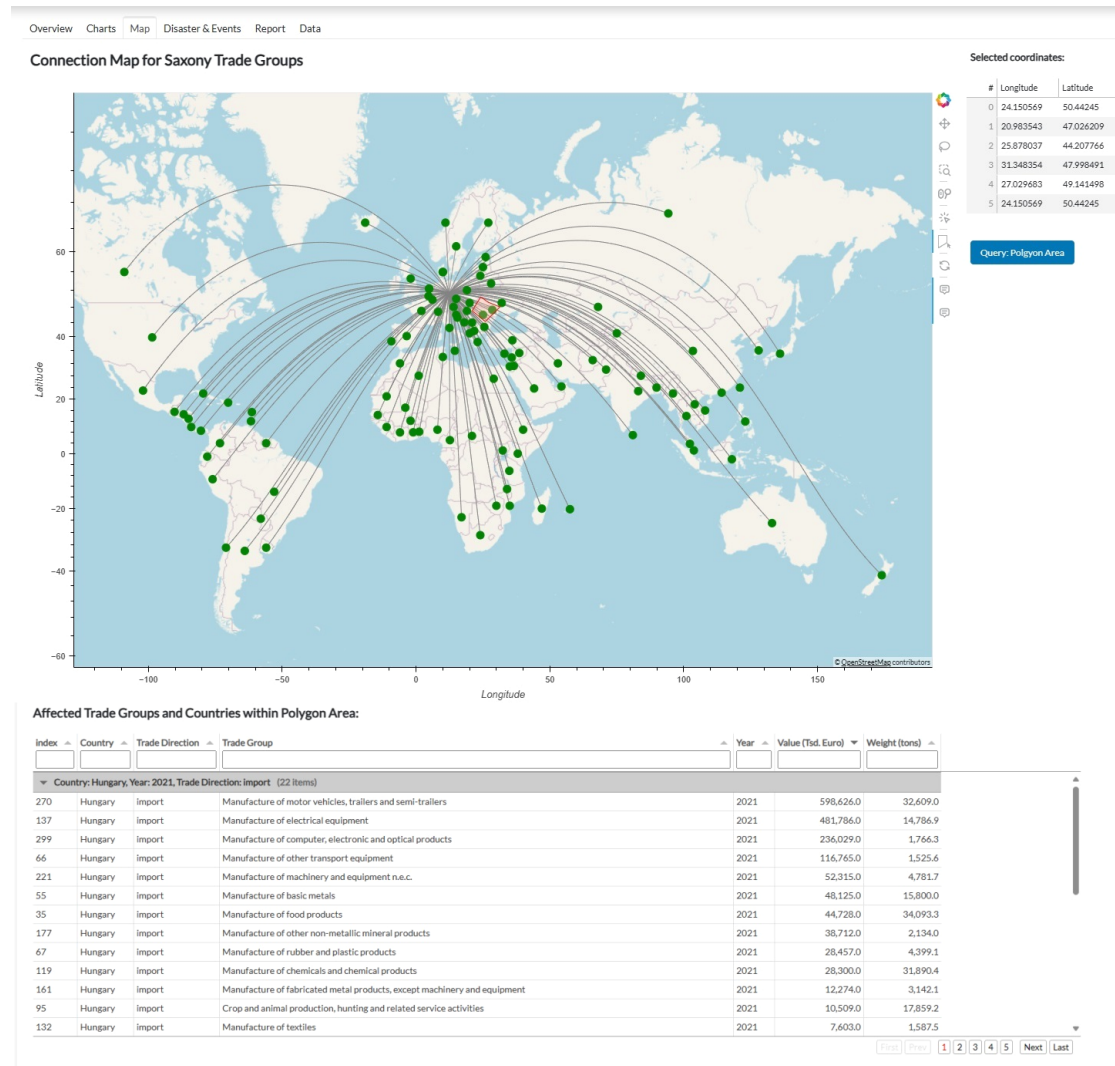
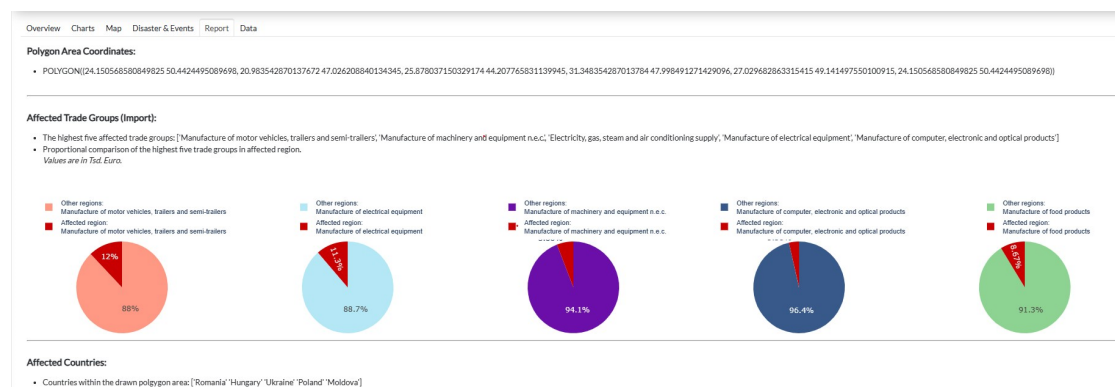


Figure 1: Connection Map for Saxony Trade Groups

The Map tab in Figure 1 offers a visualization of the Saxon economy's trade relationships on the world map using OpenStreetMap. It provides interactive tools like the Lasso Select and PolyDraw. The Lasso Select tool enables the selection of specific areas of connection points, which instantly displays the chosen connection points' relevant data such as trade groups, countries, and trade values in tables below the map. The PolyDraw tool allows us to draw custom polygon areas on the map. Using polygon area coordinates in SPARQL query, the data is traced in order to generate output data such as affected trade groups and countries in case of an event occurs in the marked polygon area. A report can be generated that displays the shares of the trade flows from/ to the selected area in total imports/ exports of Saxony for different trade groups as it can be seen partly in Figure 2. With its functionalities the dashboard enables users to zoom into Saxon trade data and rapidly generate customized descriptive statistics. The link with information on crisis events in supplying countries provides a first indication of a possible impact on the Saxon economy.



**Figure 2: Report Tab**

Furthermore, the dashboard focuses on quantifying the consequences of external supply shocks on (subregions of) the Saxon economy in quasi-real time. We develop a regionalized input-output model that is linked with import data and data on historical crisis events and provides estimates of changes in macroeconomic determinants, such as production, employment and gross value added, as a result of supply chain disruptions abroad. To our knowledge, our project is the first to develop a tool that provides these analyses for the regional level in quasi-real time. With the dashboard we aim to support decision makers from politics and business as well as administration in the event of a crisis to mitigate the economic effects of the shock and restore the continuity of production as quickly as possible. In addition, the dashboard can serve as a valuable point of reference for strategic considerations regarding the design of resilient economic areas in the medium and long run. Future work will focus on enhanced data integration to enrich the analysis further. On technical aspects, we focus on increasing the re-usability of the dashboard and its widgets. Therefore we will add a generic interpretation of datacube vocabulary. Additionally, the dashboard will be used as a blueprint to make available crisis-related economic information to regions other than Saxony.

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