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Detecting Trade Clusters with TradeNetVis: A User Study

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Abstract:

International trade plays a crucial role in today's globalized society. Recent geopolitical crises and economic shocks have demonstrated how sensitive international trade networks are to such events. Therefore, it is important for both researchers and policymakers to better understand how the trade networks are structured and how they may respond to external disruptions. Of particular interest in this context are trade clusters (Jafari et al., 2023), defined as groups of countries that exhibit strong trade relationships within the group. Given the high density and complexity of international trade, often referred to as the Spaghetti Bowl effect (Bhagwati, 1995), identifying such clusters is a difficult task. To facilitate the exploration and understanding of trade, meaningful cartographic visualizations are required. These should enable users to examine both the position of individual trading partners within the global network and the structure of trade clusters that emerge from these relationships. Effective geovisualization can support users in identifying patterns, dependencies, and structural characteristics of international trade.

In previous work, we developed an interactive user interface (Küpper et al., 2025), which we refer to as TradeNetVis, for exploring the global food and agricultural trade network. The main component of the interface is the geovisualization component, which consists of two side-by-side geovisualizations enabling a comparison of two states of the network, for example, two different points in time. Each geovisualization is a node-link diagram (Beck et al., 2017) where countries are represented as discs and trade relationships as edges. The disc placement for the node-link diagram is computed using a force-directed algorithm (Küpper et al., 2025), which optimizes the layout with respect to spatial relationship, temporal consistency, and economic proximity between nodes. For an overview of the network, connections are displayed as straight lines, while a more detailed, country-focused view uses routed edges to avoid the loss of information without causing visual clutter. Beneath the visualization component, we have two infoboxes that provide additional information about the respective visualizations above. These infoboxes display data tables such as the five most important trading partners of a selected country or the total trading volume.

In this abstract, we want to sketch our user study that evaluates the effectiveness of TradeNetVis for detecting trade clusters. As detecting trade clusters is a very complex task, the user behavior and solution strategies can vary significantly. Hence, it is quite challenging to design a meaningful user study. Within our study, we want to focus on two research hypotheses.

(1) TradeNetVis supports users in identifying trade clusters within the data.

(2) The map view supports users more than the data tables for finding clusters.

We designed the user study as a within-subject study. As participants, we aim to recruit bachelor's and master's students from fields related to food and agricultural economics. Therefore, we expect participants to possess at least basic knowledge of trade networks. Our target sample size is at least 50 participants.

We prepared ten stimuli based on a comprehensive dataset on global food and agricultural trade (FAOSTAT Trade Matrix https://www.fao.org/faostat/en/#data/TM/metadata). Each stimulus is a version of TradeNetVis with a different underlying data subset, e.g., containing only data on vegetable-related commodities.

The experiments will be conducted online through a website that automatically guides the participant through the study. The structure of our study is illustrated in Figure 1. At the beginning, participants will complete a set of pre-questionnaires covering age, gender, highest educational qualification, professional experience with maps, professional experience with trade networks, and color vision deficiency. Then, participants will be introduced to TradeNetVis through an example stimulus that demonstrates all aspects of the interface. This introductory step is intended to reduce potential learning effects during the subsequent stimuli.

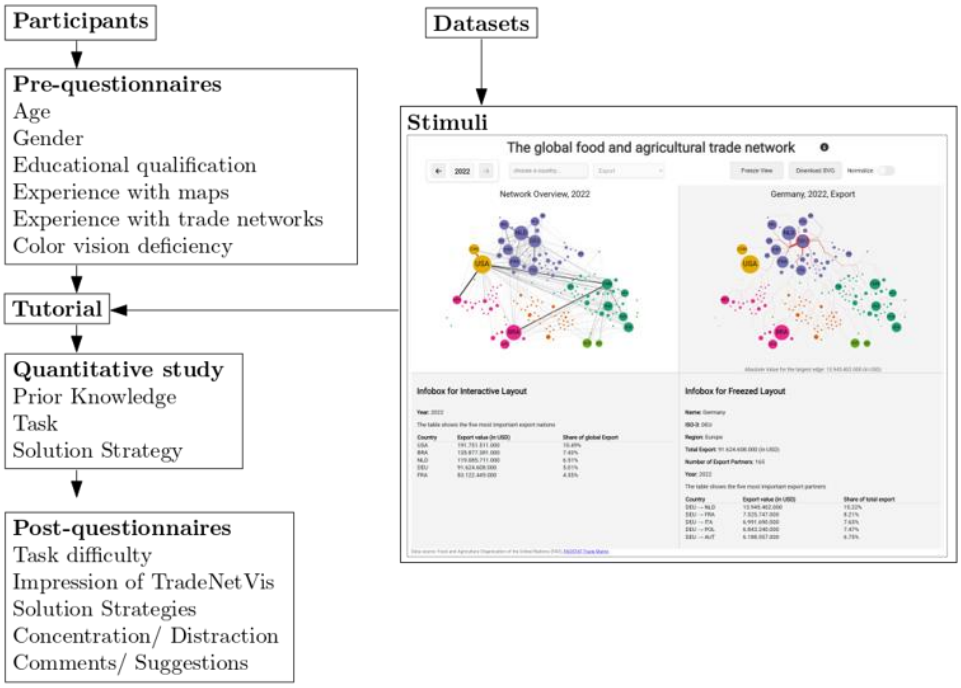

Figure 1. User study structure.

The quantitative part of the study will consist of the remaining nine datasets or stimuli. Each stimulus will be presented only once per participant. Before the respective stimulus will be presented, participants will have been informed about the commodity on which the upcoming stimulus is based. Then, they will be asked to select five countries they expect to belong to the most relevant trade cluster to measure their prior knowledge. Subsequently, participants will be given access to TradeNetVis for the respective commodity, and they will be asked again to select five countries that belong to the most relevant trade cluster. After completing the second question, participants will indicate which component of TradeNetVis has supported them most in solving the task: the visualization, the infoboxes, or both equally. In addition, we will measure the correctness of the answers, record the time required to complete each task, and log the sequence of interactions performed within the interface. For each stimulus, the participants will be asked to answer this sequence of questions on the prior knowledge, the task, and the solution strategy.

After completing all stimuli, participants will be asked to complete a final set of post-questionnaires. These questions address how easy they found the tasks, their overall impression of the interface, the strategies they used to solve the tasks, their level of concentration or distraction during the experiment, and any additional comments or suggestions for improvement. Responses will be collected using a combination of Likert-scale items and free-text fields.

We will evaluate the experimental results using statistical methods for quantitative data. The qualitative data, particularly the textual descriptions of the identified trade clusters, will be assessed by a domain expert in food and agricultural trade in order to evaluate the correctness and quality of the participants' responses.

This study aims to provide empirical insights into how geovisual analytics can support users in complex analysis tasks, such as identifying trade clusters within international trade networks. The findings will inform the design of future visual analytics tools for international trade data and similar spatial network datasets. We want to highlight that this study will fill a gap between the geovisualization and the trade analysis communities.

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