

## Economic impact of natural gas flow disruptions

Topic: Input-Output analysis of disasters I

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In aiming to ensure a resilient energy system, the European Union (EU) has set forth an extensive energy policy package. Natural gas has been given an important role in meeting EU-wide future energy demand. It can be flexibly produced and stored and is therefore a good backup for intermittent renewable energy. Significant natural gas demand growth and demand variability is foreseen, especially for certain regions. Due to dwindling European gas reserves dependency on non-EU gas flows will increase even more. To support these developments, multiple far-reaching measures have been taken in order to arrive at one well-functioning internal gas market. The continuing integration of the gas market facilitates, and also contributes to, larger gas flows across all European countries.

However, this international dimension of the gas market also implies that any supply shock will be propagated extensively through the network. In this paper, we investigate the impact of disruptions in the supply of natural gas. We focus on the main natural gas extracting countries that supply to the EU gas market. A non-linear programming model is used to predict the short-run interregional and interindustry economic impacts of disruption scenarios. These short-run impacts are determined by the attempts of economic actors to continue their familiar activities and stay as close as possible to their established trade patterns. This behavioral response to a disruption is implemented by minimizing the difference between the pre- and the post-disruption pattern of economic transactions.

Several scenarios will be analyzed based on data from the EXIOPOL international input-output database. The database's detailed classification of sectors includes a separate natural gas extraction sector. One scenario is that the gas sector may cease to exist altogether in a specific country, due to exhaustion of the gas reserves. Alternatively, a country may decide to block exports of natural gas in order to use all domestically extracted gas for domestic production exclusively. In addition, we will investigate scenarios in which particular cross-border disruptions occur. Physical pipelines may be damaged, or politicians may decide to limit cross-border flows. These can be simulated by reducing or removing the trade flow of natural gas between two countries. Limited changes in gas supply can be accommodated by EU's gas infrastructure, because of the redundant capacity for security of supply reasons. However, constraints on the quantities that can be supplied, due to limited transport capacity, or limited possibilities to extract additional gas, will be imposed to exclude implausible adjustment predictions.

Our analysis of the economic impacts of gas flow disruptions will inform policy makers on critical gas supplier relations and critical cross-border pipeline connections. It also provides information regarding strains on the rest of the system following a gas supply disruption. This information can be used to further investigate mitigation strategies, for example, diversifying supply or investing in additional infrastructure.