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Online annex for Bulletin on "Energy markets: shock, economic fallout and policy response"

Estimating the macroeconomic impact of gas supply disruptions

This section of the annex illustrates the implications of a shutdown of Russian gas supply to Europe, discussing the differences in estimates based on different modelling approaches as well as their limitations.

Estimating the macroeconomic impact of the current disruptions is difficult because the shocks are much larger and more persistent than past ones. In addition, they propagate through the economy via several supply and demand channels and are amplified through financial and other channels, which are challenging to fully capture in standard models.

With these caveats in mind, a multi-industry general equilibrium model offers some insights. The model incorporates the standard nominal and real frictions (eg sticky prices and adjustment costs). It features a detailed set of industry relationships on the demand side (allowing for substitution between industries in consumption and investment) and on the supply side (allowing for spillovers through input-output linkages), covering 15 industries. There is no specific energy sector, but mining is a good proxy given its heavy input into electricity production. Hence, the gas supply shock is applied to this industry. Specifically, energy production is assumed to be cut by 13.5%, a figure which corresponds to the Russian share of total EU gas imports (45%) multiplied by the share of gas in European electricity generation and industry applications (roughly 30%).[1] Two scenarios are considered: a temporary shutdown lasting for two years, with gas supply fully restored afterwards, and a more pessimistic scenario where gas supply remains permanently lower. Both scenarios assume common knowledge, ie uncertainty about the nature, the length or the depth of the shutdown is ruled out. Because of this foresight, in the latter scenario agents adjust their spending patterns in response to the shock. However, when they know the shock will be temporary, they try to smooth consumption and make minimal adjustments to spending.

Simulation results indicate that GDP growth in this stylised economy falls by around 0.6 percentage points after two years following a temporary shutdown accompanied by consumption smoothing (0.8 percentage points over the same horizon after a permanent shutdown) (Graph A1, left-hand panel). Conversely, inflation increases by 0.8 percentage points after two years following a temporary shutdown (0.25 percentage points over the same horizon after a permanent shutdown) (right-hand panel). A temporary shutdown indeed leads to higher inflation because consumers and businesses, knowing the shutdown is temporary, are more reluctant to adjust the volume and composition of consumption and output. This leads to a smaller decrease in gas demand and, hence, a larger adjustment through prices.

These estimates sit at the lower end of the range of recent studies for the EU / euro area (ECB (2022), OECD (2022), Di Bella et al (2022) and the studies surveyed therein), ie between –0.2% and –2.8% for GDP and from +0.25 percentage points to +1.4 percentage points for inflation (Graph A2).[2] One reason is that these studies include other shocks. The ECB's scenario, for example, assumes that the gas supply disruption coincides with a repricing of assets and a deterioration in bank lending conditions. Furthermore, larger disruptions to trade and global value chains lead to lower euro area foreign demand. The overall impact then is a 1.4 percentage point reduction in GDP growth. Excluding the financial and trade spillovers would

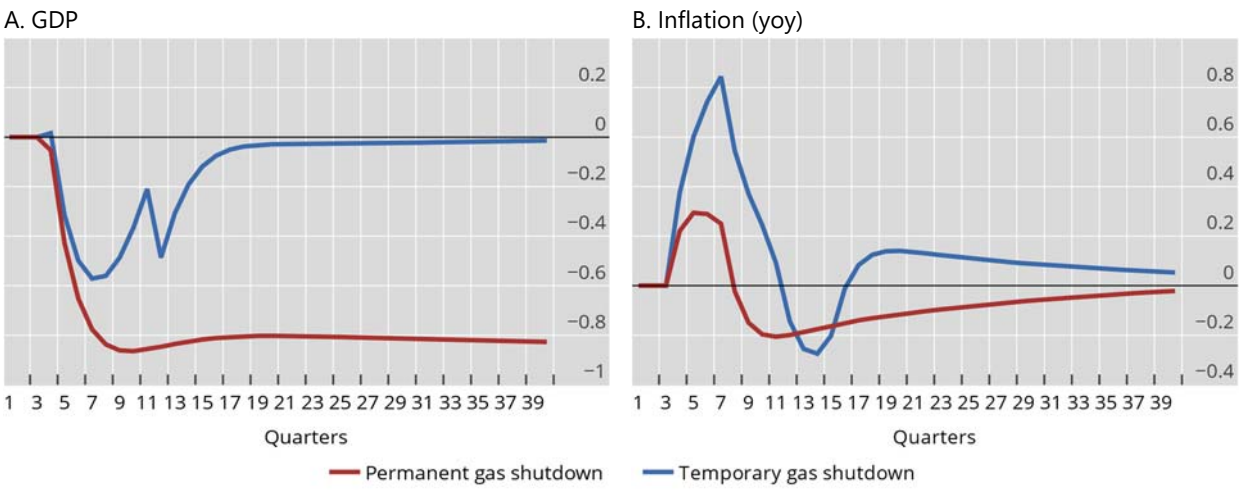
[1] This reduction is engineered as an industry-specific productivity shock since the model does not feature gas prices per se.

[2] The euro area constitutes 85% of EU GDP, so difference in coverage is not the primary reason for differences in estimates.

Impulse responses from a multi-sector model

In percentage points

Graph A1



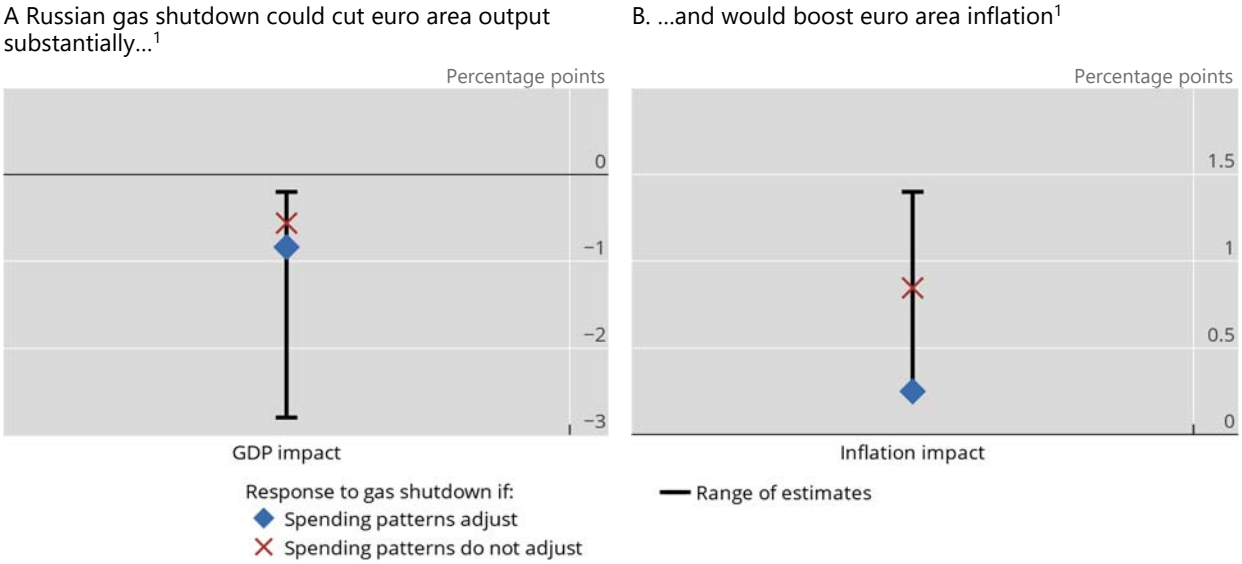
Sources: National data; BIS calculations.

generate a smaller impact of around –0.7 percentage points (ECB (2022), box 3), which is in line with the estimates in Graph A1.

On top of scenario assumptions, the model structure matters. NiGEM, which is utilised in OECD (2022), for instance, has an aggregate production function, which makes it unsuitable for examining large adjustments in specific industries such as energy. Conversely, Di Bella et al (2022) make use of two models featuring a rich set of disaggregated industries, in addition to domestic and international downstream linkages. The first of these allows no substitution of energy and other factors of production and is suitable for examining shortages in fragmented markets dominated by firms for which gas is an essential input and where there is incomplete pass-through to the end user. The second, based on Baqaee and Farhi (2019), allows for input substitution on the supply side. Yet the assumption of market clearing through prices means it is better suited for studying global markets (eg liquified natural gas (LNG) rather than gas) with

Estimated output cost and inflationary effects of gas supply shortages

Graph A2



[1] Estimates based on a suite of macroeconomic models.

Sources: National data; BIS calculations.

diversified sectors where costs pass through to end users. Neither model can capture policy channels, confidence effects and wage-price rigidities that could propagate shocks. Analytical approaches fully modelling demand side effects and assuming rigid economic structures deliver larger estimates of output losses.

Some financial aspects of the energy crisis

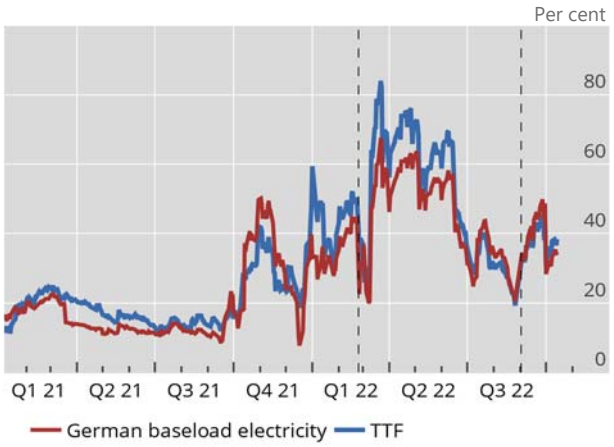
This section briefly surveys some vulnerabilities in key EU electricity-related future markets that could amplify the macroeconomic impact of supply shortages.

As prices and volatility in European gas and electricity spot markets rose, so did hedging costs in their future markets. Initial margins had begun to increase in the fall of 2021 and jumped again in early March and September (Graph A3, left-hand panel). As margins spiked across several commodity future markets, open interest collapsed in gas future exchanges, and somewhat less sharply in electricity futures (right-hand panel).[3] This led to a brief period of stress in global money markets during the first quarter, as companies scrambled to gather cash to cover the resulting margin calls.

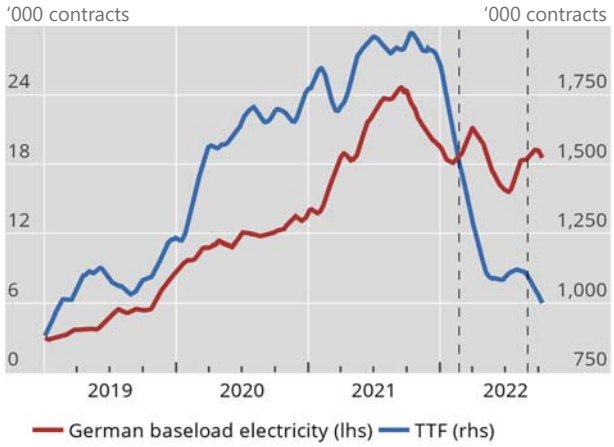
The shallowing of energy futures markets can eventually put at risk the orderly functioning of physical markets, particularly in electricity. As electricity cannot be stored as easily as physical goods, the smoothing role played by inventories in goods markets must be replaced by careful planning, and forward contracts linking generators and users play a key role in that process.

Hedging cost surged in EU electricity-related markets, and open interest fell — Graph A3

A. Relative initial margin in futures markets



B. Open interest[1]



The dashed vertical lines indicate 24 February 2022 (start of war in Ukraine) and 2 September 2022 (Gazprom announces indefinite shutdown of Nord Stream 1). TTF = Title Transfer Facility (virtual marketplace managed by Gasunie, the Netherlands' gas transport system operator – its daily fixing is the spot benchmark for European natural gas).

[1] Monthly moving averages of open interest on ICE.

Sources: Bloomberg; ICE; BIS calculations.

Initially, stress has been concentrated in the forward markets, on the side of electricity generators locked in long-term contracts to sell electricity at relatively low fixed prices. Some of them used to generate electricity with Russian gas that they had also locked in long-term contracts. Gazprom – the Russian majority state-owned gas producer – has effectively defaulted on those contracts.[4] As a result, some EU electricity generators are experiencing a financial double whammy: they need to buy on the expensive

[3] Open interest is the number of future contracts being traded in any given exchange (futures market) at any given moment of time. The higher the open interest, the higher the amount of future energy demand/supply being hedged.

[4] The company has alleged that force majeure, resulting from sanctions and countersanctions between the relevant jurisdictions, has prevented it from servicing its contractual obligations.

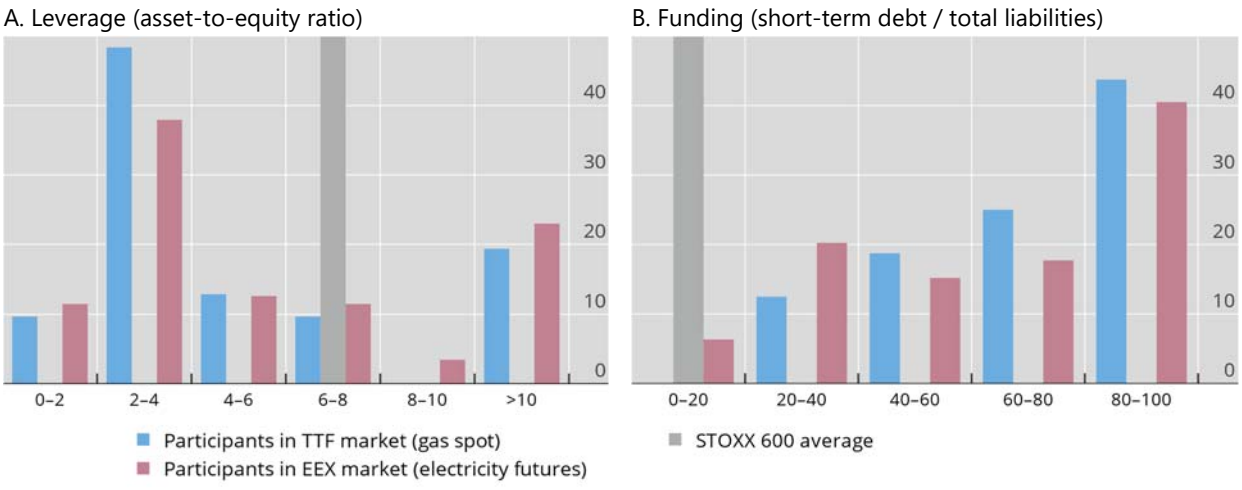
spot electricity or gas markets to deliver on their forward sales as they become due, and at the same time they are suffering from the liquidity squeeze of sizeable margin calls in future markets. In some key energy future exchanges such as Leipzig's, posted initial margins rose from €7 billion before the war, to about €100 billion by early September. Without the planned access to Russian gas, the maturity of electricity future contracts could cement the financial losses of the margin calls, potentially compromising the solvency of some firms within the segment of electricity generators. Uniper, the large German electricity utility which was recently nationalised, has been a high-profile example of this situation.

In general, firms in this space tend to have little leverage, but rely heavily on short-term funding. About 60% of a sample of firms in the EU gas market and in electricity markets have asset-to-equity ratios of 4–6 times or lower,[5] significantly below the average of the firms in the STOXX 600 equity index (Graph A4, left-hand panel). That said, the same firms tend to rely much more on short-term debt (right-hand panel). This implies high rollover needs and makes them more vulnerable to monetary policy tightening. Strains on liquidity may eventually turn into solvency problems. While less likely to trigger systemic stress in financial markets, failure of these firms could very well lead to electricity supply disruptions and possibly calls for fiscal resources to shore them up.

Fiscal support for the sector has been large in Europe, where natural gas scarcity and energy price increases have been most acute. Liquidity support, equity injections and state-guaranteed loans for energy firms have played a big role. Germany and France have made equity injections that eventually turned into full-blown nationalisation of key utilities. Several other countries, particularly in northern Europe (United Kingdom, Scandinavia, Germany) set up liquidity facilities to support energy firms facing large margin calls. They are intended as a backstop, in case banks were reluctant to provide financing given the volatile conditions. Support tends to be targeted, priced at market-based fees, and usually comes with conditionalities, both before (eg financial health requirements for access) and after receiving it (eg restrictions on dividends and bonuses).

Limited leverage in EU energy firms, but high reliance on short-term debt

In per cent — Graph A4



Sources: Bloomberg; EEX; Gasunie; BIS calculations.

References

Baqaee, D and E Farhi (2019): "Networks, barriers, and trade", *NBER Working Paper* 26108.

[5] A *lower* asset-to-equity ratio implies that a *larger* fraction of the firm's assets has been funded with equity instead of debt.

Di Bella, G, M Flanagan, K Foda, S Maslova, A Pienkowski, M Stuermer and F Toscani (2022): "Natural gas in Europe: the potential impact of disruptions to supply", *IMF Working Papers*, WP/22/145.

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