The Power of Substitution
The Great German Gas Debate in Retrospect

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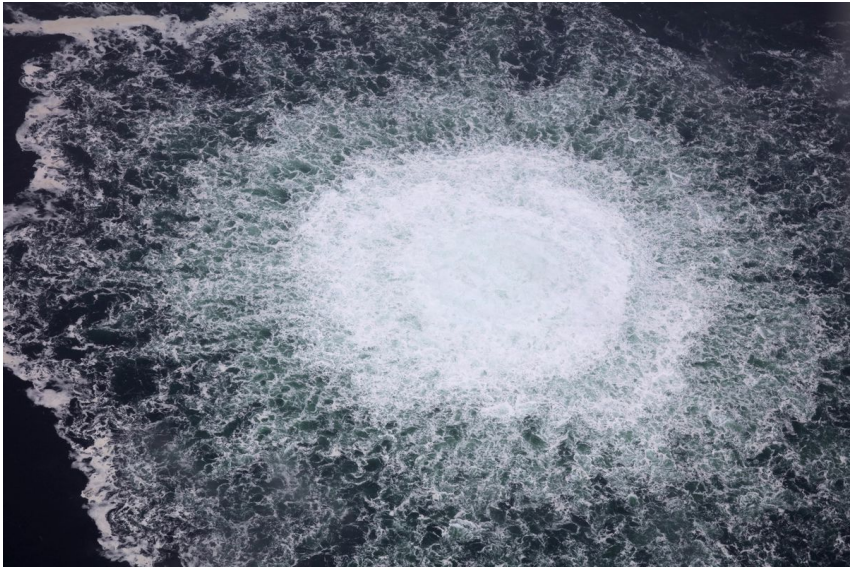
What this paper is about



Background: German primary energy consumption in 2021

	Oil	Gas	Coal	Nuclear	Renew.	Rest	Total
TWh	1077	905	606	209	545	45	3387
%	31.8	26.7	17.9	6.2	16.1	1.3	100
of which Russia	34%	55%	26%	0%	0%	0%	30%

Source: Bachmann et al. (2022a)

Embargo debate after Russian invasion of Ukraine

manager magazin

Money for Russian gas imports

660 million euros a day – this is how we finance Putin's war

Gas from Russia: For President Putin, gas exports are currently the most important source of foreign exchange Photo: Dmitry Lovetsky / dpa

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Putin is swimming in our money

embargo debate

BASF boss warns of destruction of the "entire economy"

Oil and gas are central to the chemical industry. Should their imports from Russia be stopped, BASF boss Martin Brudermüller predicts the "worst crisis since the end of the Second World War".

Our March 2022 “what if?” paper and the gas cut-off

Published 7 March 2022. Team: Rüdiger Bachmann, David Baqaee, Christian Bayer, Andreas Löschel, Moritz Kuhn, Ben Moll, Andreas Peichl, Karen Pittel,Moritz Schularick

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- Either embargo by Germany/EU
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Goal: rough magnitude of economic losses relative to “do nothing” baseline

1. Severe crisis like GFC ($\geq 5\%$) or even another Great Depression ($\geq 10\%$)?
2. Or more ordinary recession?

Our answer at the time: GDP decline up to 3% (“substantial but manageable”)

- Key mechanism: substitution of gas and gas-intensive inputs

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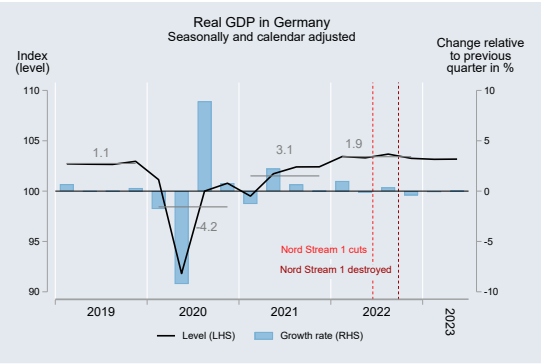
Soon after: cut-off happens because Russia weaponizes gas supplies

- June 2022: drastically cuts supplies, particularly via Nord Stream
- August 2022: completely halt Nord Stream flows (destroyed 4 weeks later)

This paper: adjustment of German economy after cut off

"Destruction of economy"? Instead: **mini recession** (last 3 Q's: $-.4\%, -.1\%, \pm 0\%$)



Other main results:

- Large movements in both gas demand and supply (imports from 3rd countries)
- Evidence for "cascading effects" along supply chains? No, instead "decoupling"
- In line with theory: a bit of substitutability goes a long way ($\sigma = 0.05$ vs $\sigma = 0$)

Plan

1. The core argument: the power of substitution
2. How the adjustment happened: adaptation and substitution
    - today: focus on industry
3. Could Germany have withstood an earlier gas cut-off?
4. Political economy of decision making in times of crisis

More in paper:

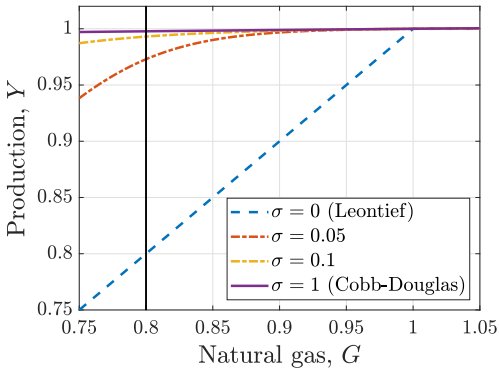
- Adaptation by households
- Keynesian demand amplification (= omission from “what if?” paper)
- Why was gas cut-off less costly than 1970s oil shocks?
- Did Germany simply get lucky due to a mild winter etc? No
- Online appendix: 36 concrete cases of substitution and demand reduction

The Core Argument:
The Power of Substitution

Illustration using aggregate production function: $\sigma = 0.05$ vs $\sigma = 0$

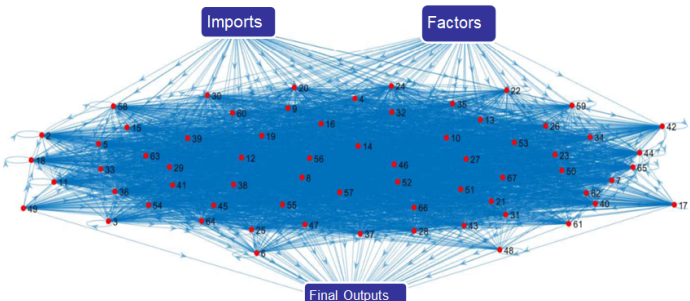
$$Y = \left[\alpha^{\frac{1}{\sigma}} \text{Gas}^{\frac{\sigma-1}{\sigma}} + (1-\alpha)^{\frac{1}{\sigma}} (\text{Other Inputs})^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \quad \text{and} \quad \text{Gas} \downarrow 20\%$$

- Output losses for different elasticities of substitution σ and $\alpha = 1\%$:



- Leontief $\sigma = 0 \Rightarrow$ production drops one-for-one with gas usage $= 20\%$
- Even with $\sigma = 0.05$, output losses much smaller $= 2.7\%$ (almost $10x$)

Modeling supply chains and international trade: “cascading effects” and substitution via imports



- We used model and sufficient statistics approach of Baqaee-Farhi
- Predictions from previous slide carry over (e.g. Leontief ⇒ 1-for-1 drop)
- Additional role for substitution of gas-intensive products via imports
- Noteworthy: DE manufacturing = “only” 23% of employment, 25% of VA

How the Adjustment Happened

Large adjustments on both demand- and supply side

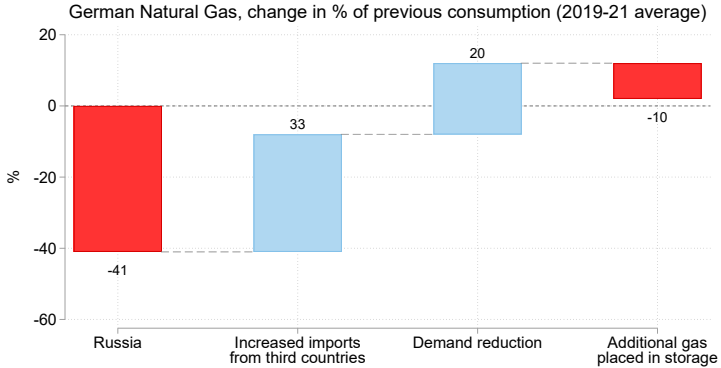


Figure 4: Germany's changing gas balance

Notes: The figure compares German natural gas imports, consumption, and storage change for the period July 2022 - March 2023, to the corresponding average from 2019 to 2021 using data from Eurostat (database code nrg_ti_gasm), McWilliams and Zachmann (2023), and AGSI. On the supply side, we take into account not only direct imports to Germany but also indirect imports via third countries as well as re-exports within Europe. More details, including on sources, are in appendix B.

Large demand reduction by industry and households

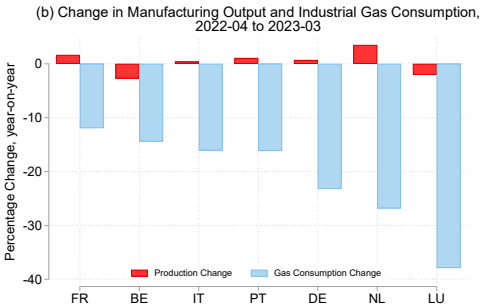
	2022/23 consumption	Baseline consumption	Reduction rel. to baseline	Percentage reduction	Bachmann et al. (August 2022)
Total	642 TWh	799 TWh	157 TWh	20%	25%
Industry	276 TWh	373 TWh	98 TWh	26%	26%
Households	281 TWh	339 TWh	58 TWh	17%	16%
Power	85 TWh	87 TWh	1 TWh	2%	45%

Table 2: Large demand reduction by industry and households

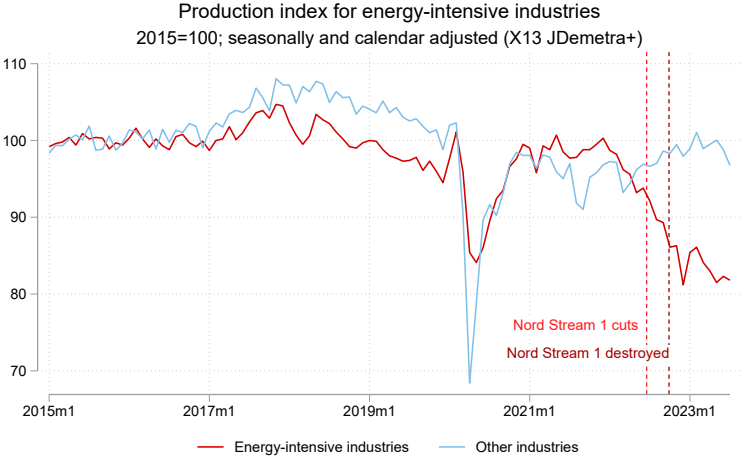
Notes: The table summarizes gas consumption over the period July 2022 to March 2023 ("2022/23 consumption") and compares it to average consumption in the same months in the years 2019 to 2021 ("baseline consumption").

Industrial production in Germany and Europe looks nothing like Leontief

Recall: Leontief ⇒ should have seen 20-30% drop in industrial production

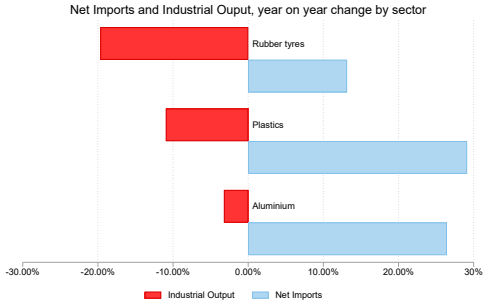


Decoupling: large cuts in energy-intensive sectors but not rest = polar opposite of “cascading effects”



Source: Destatis

Substitution of gas-intensive products via imports



BASF's ammonia production (= very gas-intensive): when gas prices ↑

- drastically cut ammonia production in Luwigshafen, Germany
- But BASF has plant in U.S. ⇒ produce ammonia there, ship it to Germany

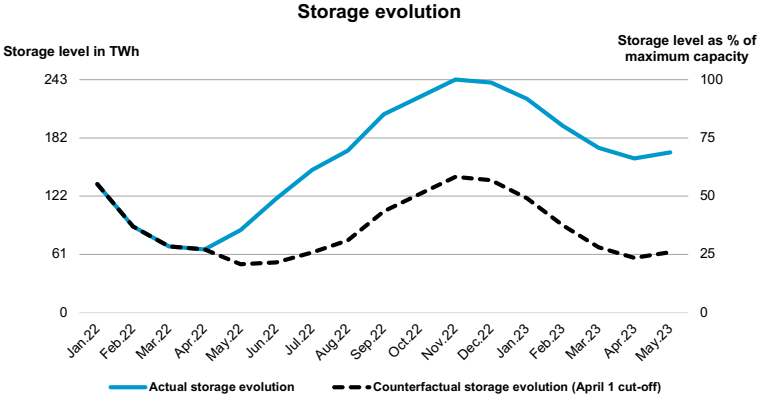
Substitution via imports can happen even within same company

Bad for German ammonia production but kills cascading effects

Could Germany have withstood an earlier cut-off as well?

Yes, Germany could have withstood cut-off at end of March

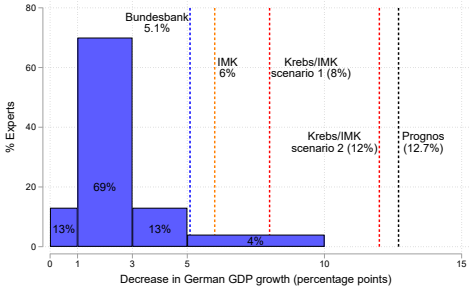
- Gas in storages at end of heating period = 160 TWh (65% of capacity)
- Gas imported from Russia Apr-Aug 2022 = 100 TWh (10% of yearly cons.)
- Assuming identical consumption, would still have had 60 TWh (25%) left



Political economy of decision making in times of crisis

Two political problems with lessons for future crises

1. Policymakers turned to business leaders & their associations for advice
   - "expertise on the ground" but also clear incentive to talk up dependence
   - striking divergence: claimed dependence vs observed substitution (BASF)
2. Strategic use of special-interest-financed think-tanks to increase uncertainty



Source: The April 2022 CfM survey

Head of Chancellery Econ Division: "We will never ever be able to determine whether this has a 2% or 10% GDP impact. We are simply trying to take the pragmatic middle course."

Key Takeaways

Germany blunted Putin's energy weapon using two margins of adjustment:

- Supply side: gas imports from 3rd countries ↑ (insurance through trade)
- Demand side: demand ↓ 20% driven by industry (26%), households (17%)

Key lesson: the power of substitution

- A bit of substitution goes a long way: $\sigma = 0.05$ very different from $\sigma = 0$
- Large number of examples how this works in practice – see appendix

Decoupling from energy-intensive industries rather than cascading effects

In retrospect, even immediate gas import stop (embargo) was feasible

Not implementing sanctions against Russia sooner and more decisively
= major missed opportunity to help avert enormous human suffering in Ukraine

Thank you!