C Review of other studies: no single study with deviation of yearly GDP from baseline larger than 5.3%, no recession with GDP drop larger than 2.5%

Any model-based quantitative assessment of the effects of a stop of Russian energy imports on the German macroeconomy is necessarily subject to considerable uncertainty, not only with respect to model parameterization but also with respect to model choice ("model uncertainty"). An assessment of these costs should therefore not be based on a single study like ours. Fortunately there exist a number of other studies providing alternative quantitative assessments of an import stop.

This appendix briefly reviews such studies published as of 23 April 2022, building on the careful reviews by Sachverständigenrat (2022) and Berger et al. (2022). In a nutshell, no single study has thus far provided quantitative model simulations with deviation of yearly GDP from baseline larger than 5.3%.[24] Similarly, taking into account GDP growth in a "do nothing" baseline (which various estimates predict to be substantially positive), no study has found a recession with a year-to-year GDP drop larger than 2.5%.

At the end of this appendix, we briefly discuss what this combined body of work suggests for the likely economic consequences of an import stop. In short, we believe that a year-to-year GDP drop of more than about 5% seems highly unlikely, and a recession with a GDP drop of 10 or 15% or even Great Depression-type scenarios are completely implausible.[25]

Summary table by German Council of Economic Experts. Table 4 summarizes the literature as of 9 April 2022. It is drawn from a very useful survey by the German Council of Economic Experts (Berger et al., 2022). We refer the reader to that paper for an in-depth discussion of several of these studies. The second-to-last column of Table 4 summarizes GDP deductions relative to baseline found by various studies. As can be seen from the Table, the highest number in the table is the 6% GDP deduction computed by IMK (2022). All other studies in the Table predict GDP deductions of less than or equal to 3%. The table lists a study by Goldman Sachs (2022) which finds a GDP deduction of 2.2% for the Euro area. The Goldman study, in fact, also reports a number for Germany alone which is not listed in the table and which is somewhat larger at around 3.5%. As discussed by Sachverständigenrat (2022) and Berger et al. (2022) some of the GDP deductions in the table are arguably additive because different studies quantify different mechanisms. Importantly, all these numbers are GDP deductions relative to a "do nothing" baseline which likely features substantial positive GDP growth, implying smaller effects on year-to-year GDP.

[24] One study by IMK (2022) argues for a single-year GDP drop of 6% or larger. As we discuss in more detail below, we view the computational experiment that generates this GDP drop as implausible. We therefore did not include it in the previous summary sentence.

[25] Words like "mass unemployment" and "poverty" (Minister of the Economy Robert Habeck) or "the loss of millions of jobs" (Chancellor Olaf Scholz) arguably suggest such scenarios.

Institution	Publication date	Scenario	Assumptions	GDP-deduction[1]	Additional inflation[1]	Region
Effects relative to a baseline scenario incorporating the state of the conflict and sanctions at time of publication						
Deutsche Bank Research[2]	09.03.2022	Negative scenario with a temporary import stop of natural gas and oil from Russia	Sharply higher energy prices (oil 140 US-$/barrel; natural gas 150 €/MWh)	1.5	1–1.5	Germany
ifo[2] (Wollmershäuser et al.)	23.03.2022	Alternative scenario	Sharper and longer increase of natural gas and oil prices (oil 140 US-$/barrel in May; natural gas 200 €/MWh in May); longer lasting uncertainty and supply chain shortages	0.9	1.0	Germany
IMK[2] (Behringer et al.)	29.03.2022	Risk scenario	Sharper and longer increase of natural gas and oil prices (annual average of oil 141 US-$/barrel; natural gas 200 €/MWh in Q2); longer lasting uncertainty	2.4	2.0	Germany
IMK[2] (Behringer et al.)	29.03.2022	Partial stop of Russian natural gas imports	Increase of natural gas price to 900 €/MWh	6.0	–	Germany
Oxford Economics[2]	02.03.2022	Stop of Russian natural gas imports for 6 months	Oil price between 100 and 115 US-$/barrel, natural gas price at 190 €/MWh	1.5	2.6	Euro area
Goldman Sachs[2]	06.03.2022	Stop of russian natural gas imports		2.2	–	Euro area
ECB[2]	10.03.2022	Adverse scenario	Sharp temporary increase of natural gas prices and increase of oil prices	1.2	0.8	Euro area
ECB[2]	10.03.2022	Severe scenario	Sharper and longer increase of natural gas and oil prices; strong second round effects	1.4	2.0	Euro area
IMK[2]	29.03.2022	Risk scenario	Sharper and longer increase of natural gas and oil prices (annual average of oil 141 US-$/barrel; natural gas 200 €/MWh during Q2); longer lasting uncertainty	2.2	2.1	Euro area
Effects relative to a baseline scenario not incorporating the state of the conflict and sanctions at time of publication						
NIESR[2] (Liadze et al.)	02.03.2022		Oil price at 140 US-$/barrel higher public spending	0.8	2.5	Euro area
EcoAustria[2] (Köppl-Turyna et al.)	08.03.2022	Increase of natural gas prices and stop of exports to Russia	Natural gas price of 172 €/MWh and no exports to Russia and to Ukraine	1.3	–	Austria
OECD[2]	17.03.2022		Shocks of the commodity and financial sectors observed during the first weeks of the war extend to one year	1.4	2.0	Euro area
Estimates of Felbermayr et al. (2022), Bachmann et al. (2022), Bayer et al. (2022) and Baqaee et al. (2022)						
Felbermayr et al.	03.03.2022	Decoupling between Russia and the US and its allies (Scenario 3C)	Doubling of non-tariff barriers in the Kiel Institute Trade Policy Evaluation Model, which lead to a drop of bilateral trade between Russia and the US and its allies by more than 95 %	0.4 [a]	–	Germany
Bachmann et al.[3]	07.03.2022	Cessation of trade between Russia and the EU	Introduction of trade barriers in the model of Baqaee and Farhi (2021), which lead to a stop of all imports from Russia to the EU	0.2–0.3	–	Germany
Bachmann et al.[4]	07.03.2022	Stop of Russian natural gas imports	30 % decline of natural gas imports; elasticity of substitution between natural gas and other inputs of 0.1	2.2	–	Germany
Bachmann et al.[5]	07.03.2022	Stop of Russian energy imports	30 % decline of energy imports; change of the cost share of energy imports in the GNE by 5 percentage points to 7.5 %	1.4	–	Germany
Bayer et al.[6]	29.03.2022	Stop of Russian energy imports	Stop of Russian energy imports decreases productivity (–2.2 %) temporarily and eliminates part of capital stock (–3 %) in a DSGE model	3.0	2.3	Germany
Baqaee et al.	04.04.2022	Stop of Russian energy imports	Introduction of trade barriers in the model of Baqaee and Farhi (2021), which lead to a stop of all imports from Russia to the EU	0.2	–	France
Baqaee et al.	04.04.2022	Stop of Russian energy imports	15 % decline of natual gas imports	0.3	–	France

Table 4: Review of Literature by German Council of Economic Experts (Berger et al., 2022)

Important studies not covered in Table 4. Two important studies, Gemeinschaftsdiagnose (2022) and Bundesbank (2022), have appeared after Berger et al. (2022) produced Table 4. Gemeinschaftsdiagnose (2022) conducts a full-blown macro analysis including a detailed modelling of the energy sector, for example they model the fill level of German gas stores. One interesting aspect is that their model features a production network or supply chain with Leontief production in much of this chain.[26] Gemeinschaftsdiagnose (2022) predicts that a full cold-turkey import stop in April 2022 would result in GDP deductions relative to a "do nothing" baseline of 0.8% in 2022 and 5.3% in 2023 and so an average deduction of 3.05% across the two years. Given substantially positive baseline growth, this results in year-to-year GDP changes of +1.9% in 2022 and -2.2% in 2023 (strikingly, their model predicts positive growth in 2022).

Bundesbank (2022) conduct two separate model simulations, one capturing the effects of higher energy prices (both because of the ongoing war and because of an embargo) and resulting in GDP deductions of 1.85% in 2022, 3.5% in 2023 and 3.4% in 2024, the other one capturing rationing and supply chain effects of an import stop and resulting in a GDP deduction up to 3.25%.[27] Adding the results from the two model simulations, Bundesbank (2022) argue for GDP deductions of 5.1% in 2022, 3.5% in 2023 and 3.4% in 2024.[28] Given substantial positive estimated baseline growth of 3.1%, the 5.1% deduction in 2022 implies a recession with a year-on-year GDP drop of 2% in 2022 (the implied year-to-year GDP changes in 2023 and 2024 do not seem to be reported).

Study with largest GDP deduction by IMK. As shown in Table 4, the study with the largest predicted GDP deduction of 6% is IMK (2022).[29] In fact, the paper suggests that this 6% number may be an underestimate because more appropriate model simulations "run into stability problems." We view the computational experiment that generates this GDP deduction as implausible and therefore do not include it in this section's headline summary. The reason for this assessment is that IMK (2022) feed into the model they use (the National Institute of Economic and Social Research's NiGEM model) an extreme gas price increase by a factor of about 45 (i.e. 4500%) from around €20 per MWh to around €900 per MWh.[30] At the same time, this extreme price movement induces only a relatively small quantity response of less than 15% (i.e. less than half the 30% gas shortfall we argued for). The combination of these two model features implies that the share of gas expenditure in GDP likely shoots up to extreme values around 25 or 30%.[31] The extreme gas price movement in combination with the small quantity response

[26] See the appendix at https://gemeinschaftsdiagnose.de/wp-content/uploads/2022/04/GD22F_Hintergrund-Alternativszenario_final.pdf, in particular p.5.

[27] The rationing effects are almost entirely due to gas rather than oil and coal, consistent with our analysis.

[28] The paper features a useful discussion whether and to what extent one can add up the two numbers.

[29] The IMK or "Institut für Makroökonomie und Konjunkturforschung" is a German union-funded think tank. It is funded by the Hans-Böckler Stiftung, the foundation of the German Trade Union Confederation DGB.

[30] This 45-fold increase is partly due to the import stop and partly due to heightened energy prices even in the absence of an import stop. Without the import stop, the gas price increases from about €20/MWh to €160, so an 8-fold increase. The import stop then increases this price by an *additional* factor of around 5.5 to €900 per MWh. See https://twitter.com/ben_moll/status/1512911428629446658?s=20&t=N5I2FSL9YTNmvM04qsdzrg.

[31] See https://twitter.com/ngarnadt/status/1514907211159556099?s=20&t=vQyWdLwtNjJAlSmVn56vbQ. IMK (2022) justify this strategy as follows: the goal is to increase the gas price until the NiGEM model generates a 30% gas reduction. However, even with a gas price of €900 per MWh it only closes less than half of this 30% gap; for

leads us to view the IMK's computational experiment as implausible.

Summary and takeaways for the likely economic consequences of an import stop. In summary, no single study has thus far predicted a deviation of yearly GDP from baseline larger than 5.3% or a recession with a year-to-year GDP drop larger than 2.5%. Put differently, all studies find GDP deviations from baseline in the low single digits and strongly bounded away from -10%. Similarly, no single study argues for a recession with a year-to-year GDP decline larger than the 4.5% observed in 2020 during the Covid-19 pandemic. We think that this is unsurprising given the facts about the German economy presented in Appendix A.1 (e.g. that industry accounts for about a quarter of economic activity).

As emphasized above, any model-based quantitative assessment of the effects of a stop of Russian energy imports on the German macroeconomy is necessarily subject to considerable uncertainty. This uncertainty comes in various forms, in particular both in the form of uncertainty with respect to parameter values and functional form assumptions and in the form of uncertainty about model choice ("model uncertainty").

Despite these large uncertainties, in particular those surrounding the estimates of any one single study, we believe that the combined body of work reviewed above suggests the following takeaways for the likely economic consequences of an import stop:

- A recession with a year-to-year GDP drop of more than about 5% seems highly unlikely.
- A recession with a GDP drop of 10 or 15% or even a Great Depression-type scenario is completely implausible.

These assessments are conservative. For example, a 5% year-to-year GDP drop is more than twice as large as the recession predicted by any one single study (which all predict year-to-year GDP drops of less than 2.5%) and would require a GDP deduction from baseline of 7% or more. Despite the smaller estimates of individual studies, we postulate the pessimistic scenarios above to acknowledge the aforementioned large degree of uncertainty, and because we agree with Sachverständigenrat (2022) and Berger et al. (2022) that some of the effects in different studies may be additive because they quantify different mechanisms.

larger gas price increases the model becomes unstable. Our view is instead that a 45-fold gas price increase without a sizable quantity reduction indicates that the NiGEM model – or more precisely the parameterization used by IMK (2022) – is not suitable for conducting the attempted import-stop experiment. This is perhaps not surprising given that the NiGEM model was originally developed and parameterized for simulating counterfactuals with respect to much smaller shocks or policies.

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