Comments and Discussion

COMMENT BY

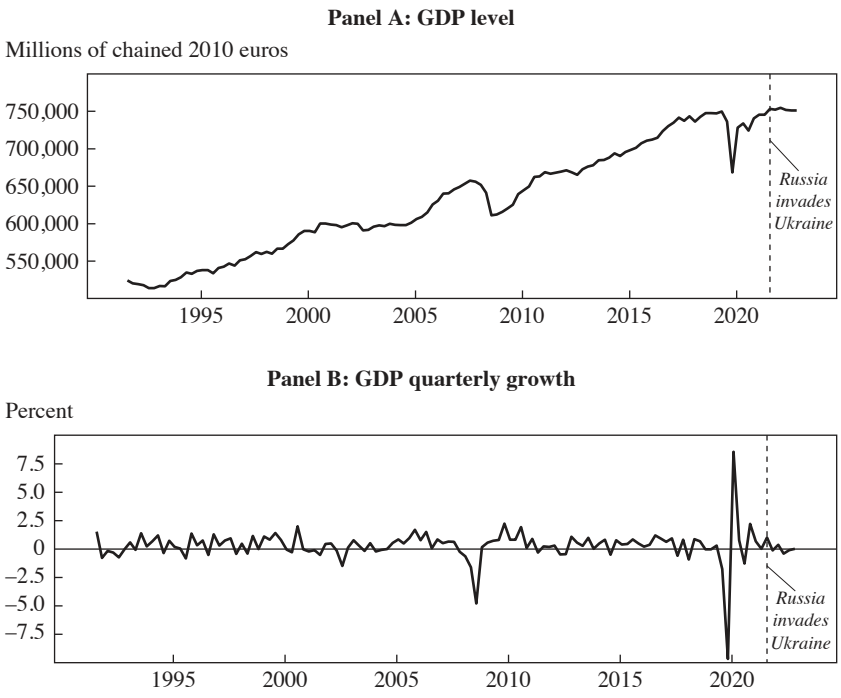
JAMES D. HAMILTON[1] Moll, Schularick, Zachmann, and their colleagues staked out a bold position in March 2022, predicting that loss of Russian natural gas would cause substantial but manageable challenges for the German economy (Bachmann and others 2022). They took a lot of flak for that conclusion from analysts who thought the economic consequences would be much more dire. But the subsequent events proved their prediction to have been largely correct. It's very appropriate at this point to provide a retrospective on how events unfolded a year and a half after Russia invaded Ukraine. I see my role as a discussant to be to highlight a number of the points made by Moll, Schularick, and Zachmann, perhaps with a slightly different emphasis from theirs.

ALL IS NOT WELL IN GERMANY The first point that bears repeating is that the German economy is currently struggling. Some in the financial press have started again referring to Germany as the "sick man of Europe" (*Economist* 2023). Panel A of figure 1 plots the level of German real GDP. Apart from the sharp drop and rebound associated with the COVID-19 pandemic, German output has essentially stagnated since 2019 and fell on average since the invasion.

Other measures corroborate that assessment. Panel A of figure 2 plots the Bundesbank's weekly index of the German real economic activity. This characterizes the German economy over the last year as experiencing a modest but clear decline. Panel B plots the ifo sentiment index based on a survey of German firms. Undeniably, many people in Germany have been very pessimistic about the economy since the invasion.

1. I thank Christiane Baumeister for assistance with obtaining the data for this discussion.

Figure 1. Level and Quarterly Growth Rate of German Real GDP

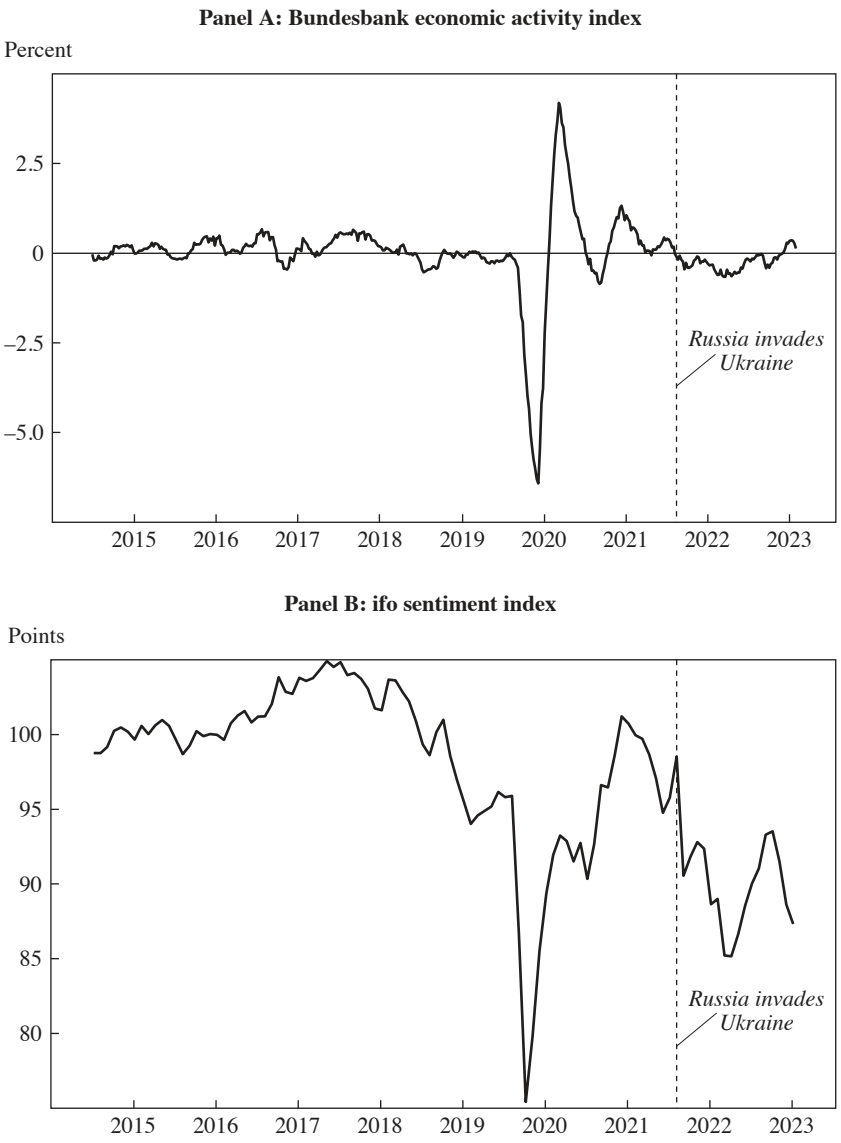


Source: Eurostat, series CLVMNACSCAB1GQDE, retrieved from FRED.
Note: Data are quarterly from 1992:Q2 to 2023:Q2.

To be sure, the challenges for the German economy began well before Russia invaded Ukraine. And the magnitude of the drop in output in 2022 is a far cry from the dire warnings of some prognosticators, and quite consistent with Bachmann and others (2022)'s original assessment of a substantial but manageable downturn. Still, I think we can agree that the German economy has faced some significant headwinds, and that disruptions in the supply of energy were part of those headwinds.

WHAT BROUGHT DEMAND DOWN? Figure 3 plots the wholesale price of natural gas in Germany. This exhibited a significant spike before the invasion, which Moll, Schularick, and Zachmann document was a result of prewar supply manipulations by Russia. The price went up spectacularly following the invasion. But natural gas prices began to fall dramatically after the summer of 2022 and are currently well below the levels even of 2021. Not only was the effect of the natural gas supply disruptions on German real

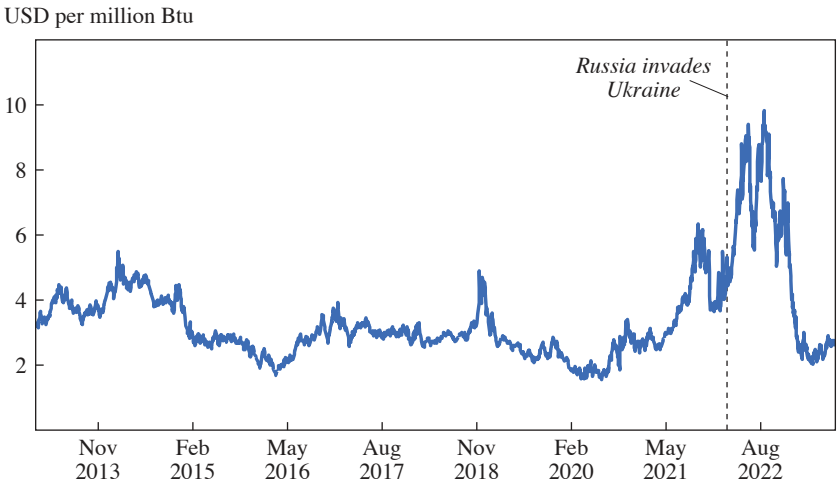
Figure 2. Other Measures of German Real Economic Activity



Source: Weekly Activity Index, Deutsche Bundesbank; and Business Climate Index for Germany, ifo Institute.

Note: Panel A data are weekly from January 5, 2015 to August 7, 2023. Panel B data are monthly from 2015:M1 to 2023:M7.

Figure 3. Wholesale Natural Gas Price in Germany



Source: Deutsche Börse Group.
Note: Wholesale price of natural gas in Germany, daily from January 2, 2013 to July 28, 2023.

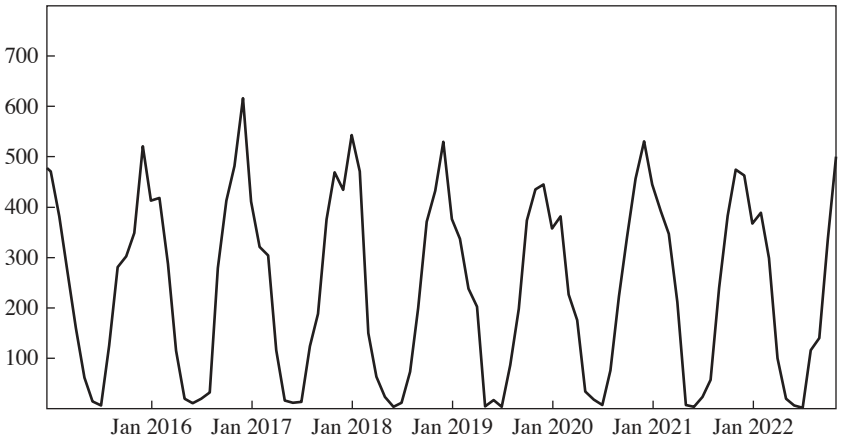
output more modest than many people had anticipated, so was the effect on the price of natural gas itself. One has to suspect that these two developments are related.

The first possibility many of us would consider is that there was some other factor shocking the demand, such as a milder than usual winter in 2023. But there's no real evidence that weather is the explanation (figure 4). The authors carefully investigate the contributions of weather to demand and conclude, correctly in my opinion, that weather is not the explanation for the mildness of the economic effects.

But why did the quantity demanded fall so much if the price actually fell? Part of the answer is the administered nature of the price paid by final users. This rose more slowly than the wholesale price, and the subsequent wholesale price declines were not immediately passed on to residential and business customers (Ruhnau and others 2023, fig. 1).

Another possible shift in the demand curve could arise from voluntary conservation efforts. The authors discount the importance of these, noting that the federal gas-saving campaign had a very limited budget. I would push back a little at the proposition that people only change their behavior if the government tells them to. I suspect that many German businesses and consumers felt a civic duty to conserve wherever they could. When the tanks

Figure 4. Heating Degree Days in Germany



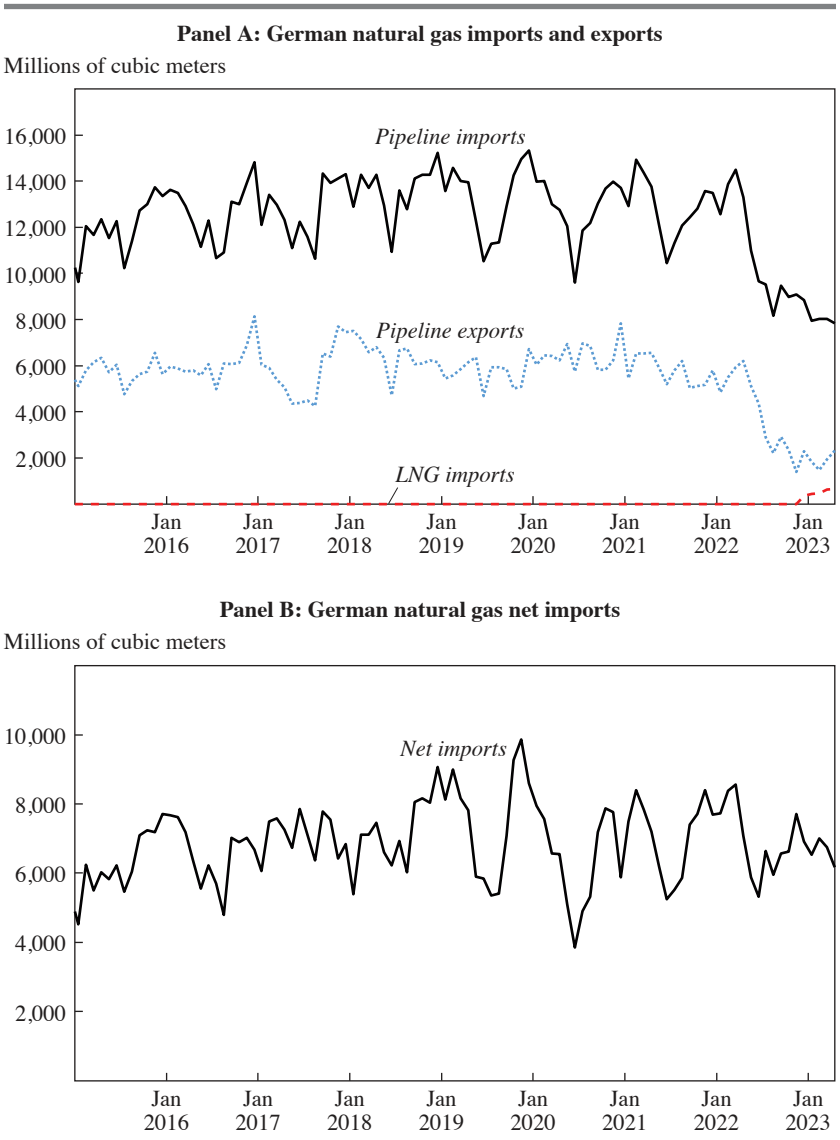
Source: Eurostat (data code nrg_chddr2_a).
Note: Heating degree days in Germany, monthly from 2015:M1 to 2022:M11.

are rolling into formerly peaceful villages, that may motivate some people to act in a way that government-sponsored advertising and slogans could not. I suspect that voluntary conservation may have played a role both in mitigating the price effects and, as I will elaborate below, in mitigating the real output effects as well.

Figure 5 highlights what I see as the single most important reason why reduced natural gas imports were less disruptive to the German economy than some had feared. The authors invested considerable effort into tracking flows of natural gas into and out of Germany. I have done something much simpler based on the gross flows reported in the Joint Organisations Data Initiative (JODI) database.[2] The top line in panel A shows that the monthly pipeline imports of natural gas into Germany fell by about 6 billion cubic meters, equivalent to 63 TWh per month and more than a 40 percent drop from preinvasion levels. Part of the initial worry came from people wondering: how in the world could Germany cut its use of natural gas by that much? The answer is, it didn't. As seen in the middle line in panel A of figure 5, most of the adjustment came in the form of reduced exports of natural gas from Germany. The loss of German net imports (panel B) is much more modest, around 2 billion cubic meters or

2. JodiGas, "The JODI Gas World Database," https://www.jodidata.org/gas/.

Figure 5. German Natural Gas Imports, Exports, and Net Imports



Source: JODI Gas World Database.

Note: Panel A presents data on German pipeline imports, LNG imports, and pipeline exports of natural gas. Data are monthly from January 2015 to May 2023. Panel B reflects total imports minus total exports.

21 TWh per month. This quick estimate is consistent with the cumulative decline in German consumption of 157 TWh that the authors arrived at in table 2 in the paper, using much more careful methods.

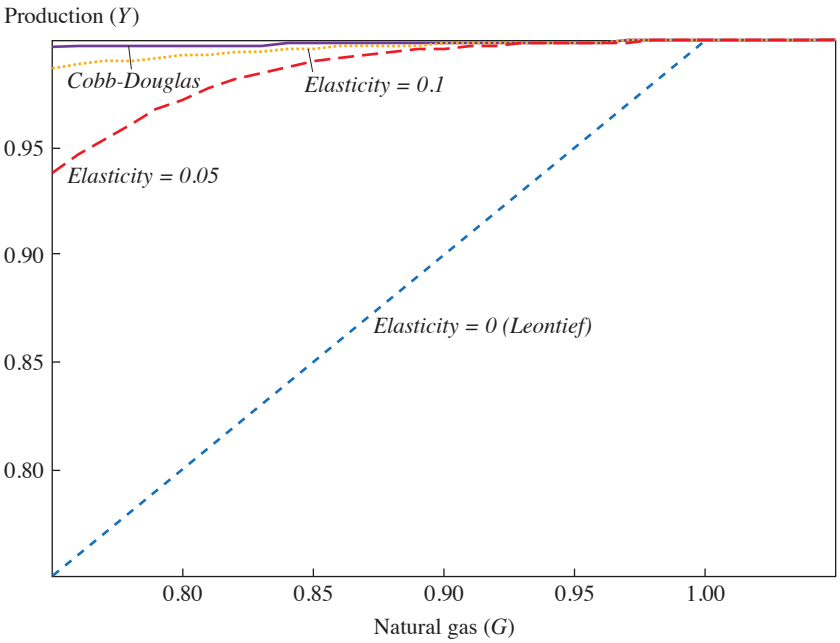
My conclusion is that the single biggest reason that the disruptions were less damaging to the German economy than some had feared is that Germany did not have to make the adjustments by itself. I see this very much as an illustration of the main point that the authors are making about the power of substitution. Markets find ways to adapt to challenges that policymakers and individual business planners can easily overlook. Their paper provides a wonderful demonstration of how this theme plays out in so many different ways.

DISCUSSION OF THE EFFECTS ON REAL GDP Let me now turn to the central question of the effects on overall real economic activity. Moll, Schularick, and Zachmann provide a simple illustration of the economy's ability to adapt using an aggregate CES production function:

$$Y = \left\{ \alpha^{1/\sigma} G^{(\sigma-1)/\sigma} + \left(1-\alpha\right)^{1/\sigma} \left[F\left(K, N\right) \right]^{(\sigma-1)/\sigma} \right\}^{\sigma/(\sigma-1)}.$$

Here Y is total real output, and G, K, and N are utilization of natural gas, capital, and labor, respectively, while σ is the elasticity of substitution and α determines the euro value of natural gas expenditures as a share of total nominal output. I take the initial expenditure share to be 1 percent for the calculations below. This corresponds to the authors' equation (1), where the only change I have made is to spell out explicitly the factors labeled as other inputs X in the authors' formulation. The question they ask is: what would happen to total output if utilization of natural gas were to change with utilization of capital and labor constant? The answer is plotted in figure 6, which reproduces the authors' figure 3. The graph shows how much Y would go down according to the above equation if natural gas consumption was cut by up to 25 percent while K and N did not change. If there is zero elasticity of substitution (corresponding to a Leontief production function), output would fall by the amount that natural gas was reduced. The authors' point is that the substitution elasticity can be very small, but as long as it is non-zero, effects are much more modest than would be predicted in the extreme Leontief case. For example, if $\sigma = 0.05$, output would only fall by 6 percent when consumption of natural gas is reduced by 25 percent. The authors' actual quantitative analysis is based on a detailed model of industry interactions

Figure 6. Effects of Changing Utilization of Natural Gas When Utilization of Capital and Labor Are Unchanged for Different Elasticities of Substitution



Source: Reproduced from figure 3 in the paper.
Note: Horizontal axis shows utilization of natural gas as a fraction of original level. Vertical axis shows total production as a fraction of original level.

as in Baqaee and Farhi (2019). But the simple summary in equation (1) gives some insight into what lies behind these calculations.

I have reproduced here the calculation in their figure 3 in order to highlight the implicit assumption that the drop in natural gas consumption does not lead to any change in utilization of capital or labor. I would argue that the defining characteristic of an economic recession is a dramatic decline in the utilization of capital and labor. From this perspective, one might say that analysis like that in their figure 3 rules out the possibility of an economic recession by assumption.

Is there a reason to think that a disruption in energy supplies could result in underemployed labor and capital? I've argued that, historically, underemployed labor and capital were very important in understanding why some historical oil price shocks were followed by economic recessions in the United States. We often observe in those episodes that the oil price

increases were followed by substantial declines in spending on new cars and other items. Quantitatively, the decline in car production made a significant contribution to the total observed decline in GDP in these historical downturns (Hamilton 2009). One can make a case that this correlation is causal. For example, the decline is the biggest for the least fuel-efficient vehicles, with production of more fuel-efficient cars sometimes even rising.

The original analysis by Bachmann and others (2022) recognized the potential importance of this issue. But they argued that it need not overturn their analysis, to the extent that "fiscal and monetary policies cushion potential demand-side Keynesian effects" (Bachmann and others 2022, 3). As long as we are taking this opportunity to praise the many ways in which their original analysis got so many things right, we should perhaps acknowledge that this particular policy prescription was not among them. I think we would all agree today that more fiscal and monetary stimulus was not an option for Europe in 2022. Indeed, the consensus view of many today is that excessive stimulus in 2021–2022 in Europe, the United States, and much of the rest of the world was a key factor in the resurgence of inflation. I would further argue that additional stimulus was also not an option in responding to the oil shocks of 1974 or 1979, for the same reason.

The authors were correct that mainstream macroeconomic models assume that demand effects could be mitigated using appropriate Keynesian-type stimulus. But that is not my view. I maintain that recessions do not result from a mismatch between aggregate demand and an aggregate production function, but instead from a mismatch between the composition of demand and the specific goods to which specialized resources are dedicated in advance to produce. Workers and factories may be capable of producing a huge number of gas-guzzling sports utility vehicles. But if people no longer want to buy those, the result is inevitably going to be underutilized capital and labor, for which added monetary stimulus is not the solution. I show how demand spillovers operating through these factors can play out in a dynamic general-equilibrium setting in Hamilton (2023).

In the present paper, Moll, Schularick, and Zachmann investigate possible demand spillovers in more detail than in the original study. They conclude that in the case of Germany in 2022, the observed magnitude of demand spillovers was limited. I agree with their analysis, and I think it is related to the authors' broader theme of the power of substitution. When gasoline prices double, the short-run options for most consumers are limited. They go ahead and fill up the gas tank, whatever it costs, and cut spending someplace else. In my view, it was those other cuts in spending that were the main cause of the economic disruption associated with historical oil price

shocks. The authors do a wonderful job of documenting the rich variety of ways that firms can (and did) reduce their use of natural gas without significant disruptions in other spending. And individual consumers can (and did) reduce their use of natural gas by lowering the thermostat, perhaps spurred in part by civic conscientiousness, and again without disrupting other economic spending. I believe that the authors are also correct that another reason why natural gas disruptions may be less disruptive than some historical oil shocks is the fact that the expenditure share of natural gas is on the order of 1 percent, in contrast with a number like 4 percent for the economic value of refined petroleum products. In my opinion, these were the primary reasons why the significant disruptions in GDP that some analysts had feared never came to pass.

SUMMARY There is much to like about this paper. I hope it will end up becoming a classic case study in the theme posed by the paper's title—the power of substitution.

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COMMENT BY

TAREK A. HASSAN The paper studies the adjustment of the German economy after Russia cut Germany off from gas supplies in the summer of 2022. The authors highlight three main findings. First, despite Germany's