The ‘Baqaee-Farhi approach’ and a gas embargo

German Council of Economic Experts (GCEE) Workshop

François Geerolf

UCLA - OFCE-Sciences Po

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Section 1

Context

Review of the literature by the GCEE

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

Foreword: Bachmann et al. (2022) and Baqaee-Farhi

- 2 types of estimations in Bachmann et al. (2022):

  – some coming out of a **very crude** aggregate production function approach => upper bound estimates of **1.5%** and **2.3% of GDP**. (I'll come back to it)

  – some presented as coming out of an application of a "state-of-the-art" Baqaee-Farhi model. **0.2%-0.3% of GDP** even according to the most conservative parametrizations.

- The "Baqaee-Farhi estimates" are **an order of magnitude** lower compared to estimates of major German institutes, the Bundesbank (see previous slide), to simple "common sense", or to the paper's bottom-line. (which in the end seems to favor the simpler production function approach)

- That these estimates seem to be coming out of Emmanuel's joint work hurt me scientifically, but also (on a more personal note) emotionally, given how much respect I have for Emmanuel. (I'll come back to my relationship to Emmanuel Farhi in the next slide) Is it a problem with the Baqaee-Farhi approach in general ? Or is "science" (= state-of-the-art models) telling us that a 0.2-0.3% drop in GDP is the most likely outcome ?

A few words about Emmanuel Farhi

- Full disclosure: Emmanuel Farhi was my mentor. I was a visiting fellow at Harvard in 2012-13 thanks to Emmanuel. After Polytechnique and my Ph.D. in Economics in 2013 I was going to leave academia (in part, because I had strong doubts about mainstream academic macroeconomics), but Emmanuel encouraged me to continue and to try and convince the profession about my work, etc... Without his advice, his example, and his very strong support throughout, I would not have become an academic economist, or stayed "in the profession".
- Emmanuel was a hard scientist/an engineer by training: he went to prestigious "Corps des Mines", a specialized elite corps which (ironically) deals with mining and energy... I attended less prestigious "Corps des Ponts". (which deals with bridges and roads) We went to the same high school ("Lycée Louis Le Grand"), even to the same class ("TS1") we talked a lot about our former history teacher (P. Laduguie) each time we saw each other.
- David Baqaee had Emmanuel as an advisor, he became his main coauthor after his Ph.D. in 2015. I know David, who is one of my good colleagues at UCLA. Most of the comments here I have previously debated with David...

Economists vs. Engineers in France

From Brunnermeier, James, Landau (2018) "The Euro and the Battle of Ideas"

The Influence of Engineering

The new French tradition had its roots not so much in high thought, in the works of France's most prominent economists, but rather in the work of practical economists who were trained in institutions that had been conceived as oriented toward the service of the state. Allais in fact had begun as an engineer trained at the École Polytechnique. The strength of that engineering tradition is the basis of the conclusion of the sociologist Marion Fourcade that "French economists hold more favorable attitudes toward state intervention than practitioners in other advanced industrialized countries." Among French economic practitioners occurred a confluence of "a 'sociological' tradition, which affirmed the need for economists to look for the human act behind any economic phenomenon," with "a financial technocracy in the form of the Inspection des Finances, as well as various specialized elite corps (Mines, Ponts) in the interests of orchestrating the development of key industries."[82]

Summary of the main approaches

- **The aggregate production function approach.** This is where the main estimates - those which look more reasonable to everyone (including the authors apparently) - come from in the end. This is a paradox, because much of Baqaee-Farhi's work is precisely about how we should avoid using an exogenous aggregate production function approach. This approach is very simple but in the end rests on "the elasticity of substitution" which drives the results, and which we don't know much about especially in such a very extreme context.
- **The Baqaee and Farhi (2021) approach.** Stunningly small effects. Why is that ? In fact, both the model and the way it's taken to the data, are not well suited to that particular question of thinking about an energy embargo. This model improved upon previous elegant models but it does not have the level of detail of bigger computational models (especially, to model the energy and the manufacturing sectors).
- **The Baqaee and Farhi (2019a) approach.** An earlier paper of theirs which shows that in fact, Hulten's theorem is not at all a good approximation for thinking about shocks to energy prices, as shown during the 1970s oil embargo.

Section 2

The aggregate production function approach

Aggregate production function for energy

- The main results of the paper are obtained from a **very stylized** aggregate production function approach, with two factors of production Energy (E in the paper) and NonEnergy (X in the paper):

$$Y = \left(\alpha^{\frac{1}{\sigma}} \text{Energy}^{\frac{\sigma-1}{\sigma}} + (1-\alpha)^{\frac{1}{\sigma}} \text{NonEnergy}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$$

- Taking the first order derivative and the fact that the ratios of marginal productivities must equal the ratio of prices, it is easy to show that:

$$\frac{\text{Energy}}{\text{NonEnergy}} = \frac{\alpha}{1-\alpha}\left(\frac{p_{\text{Energy}}}{p_{\text{NonEnergy}}}\right)^{-\sigma}.$$

- Importance of the **elasticity of substitution** σ. When the price of energy relative to the rest goes up by 1%, the use of energy declines by σ%. If σ is (very) small, it implies its use declines (very) little when the price goes up.

Production function for gas / other ?

- Bachmann et al. (2022) also use an alternative version where instead of a Energy and non energy being imperfect substitutes, gas and non gas are imperfect substitutes. This is to allow for the fact that gas may not be easily be replaceable by other energy sources. So E sometimes stands for Gas in the paper, while X stands for NonGas.

$$Y = \left(\alpha^{\frac{1}{\sigma}} \text{Gas}^{\frac{\sigma-1}{\sigma}} + (1-\alpha)^{\frac{1}{\sigma}} \text{NonGas}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$$

- Of course, since gas in some location itself is not very substitutable with gas in another location in Germany, one can ask why we should stop there.
- In principle, if gas drops by 100% in some location and cannot be replaced, then one could get an arbitrarily large GDP drop. This is not necessarily realistic either, but this is simply to show that this approach is perhaps not that informative and may seem somewhat arbitrary.

How to get the 1.5% and the 2.3% of GDP ?

- Reduction in 10% of energy usage with elasticity = 0.04, reduction in 30% of gas usage with elasticity = 0.1. Computing the change in GDP obtained from this very simple production function is simply a matter of plugging the values in the production function. . .

Calibrations in Bachmann et al. (2022)

$\sigma = 0.04$; $\alpha = 0.04$; NonEnergy = 96%; Energy = 4% of GDP initially; -10%.

In[∘]:= $Y[\sigma\_, \alpha\_, Energy\_, NonEnergy\_] := \left(\alpha^{\frac{1}{\sigma}} Energy^{\frac{\sigma-1}{\sigma}} + (1-\alpha)^{\frac{1}{\sigma}} NonEnergy^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$

```
Y[0.04, 0.04, 0.04 * 0.9, 0.96] - Y[0.04, 0.04, 0.04 * 1, 0.96] // PercentForm
```

Out[∘]//PercentForm=

−1.569%

$\sigma = 0.1$; $\alpha = 0.01$; NonGas = 99%; Gas = 1% of GDP initially; -30%.

In[∘]:= $Y[\sigma\_, \alpha\_, Gas\_, NonGas\_] := \left(\alpha^{\frac{1}{\sigma}} Gas^{\frac{\sigma-1}{\sigma}} + (1-\alpha)^{\frac{1}{\sigma}} NonGas^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$

```
Y[0.1, 0.01, 0.01 * 0.7, 1 - 0.01] - Y[0.1, 0.01, 0.01, 1 - 0.01] // PercentForm
```

Out[∘]//PercentForm=

−2.343%

Very sensitive to the elasticity

- Of course, we can plug other numbers in them. Imagine that $\sigma = 0.01$ instead of $\sigma = 0.04$, and that natural gas is as substitutable as energy $\sigma = 0.04$ instead of $\sigma = 0.1$ then:

Robustness ? σ = 0.04 => 0.01 (nrg); 0.1 => 0.04 (gas)

$\sigma = 0.01$; $\alpha = 0.04$; NonEnergy = 96%; Energy = 4% of GDP initially; -10%.

In[∘]:= $Y[\sigma\_, \alpha\_, Energy\_, NonEnergy\_] := \left(\alpha^{\frac{1}{\sigma}} Energy^{\frac{\sigma-1}{\sigma}} + (1-\alpha)^{\frac{1}{\sigma}} NonEnergy^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$

```
Y[0.01, 0.04, 0.04 * 0.9, 0.96] - Y[0.01, 0.04, 0.04 * 1, 0.96] // PercentForm
```

Out[∘]//PercentForm=

-7.026%

$\sigma = 0.04$; $\alpha = 0.01$; NonGas = 99%; Gas = 1% of GDP initially; -30%.

In[∘]:= $Y[\sigma\_, \alpha\_, Gas\_, NonGas\_] := \left(\alpha^{\frac{1}{\sigma}} Gas^{\frac{\sigma-1}{\sigma}} + (1-\alpha)^{\frac{1}{\sigma}} NonGas^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$

```
Y[0.04, 0.01, 0.01 * 0.7, 1 - 0.01] - Y[0.04, 0.01, 0.01, 1 - 0.01] // PercentForm
```

Out[∘]//PercentForm=

-15.26%

What are these elasticities ?

- Metaanalyses such as Labandeira, Labeaga, and López-Otero (2017) are using changes in prices which **actually** took place (in normal times), but do not tell us anything about the elasticity conditional on a huge shock such as an embargo: you might have nonlinearities.
- Constant Elasticity of Substitution (CES) functions are only a local approximation. There are (engineering) reasons to believe that as the shock gets larger, you can potentially get to much smaller elasticities. . .
- I think we should agree that there is no way to know what these elasticities are, and they are subject to a considerable degree of uncertainty. (the authors repeatedly criticize the "engineering view", but who better than engineers can tell us what this elasticity of substitution really is ?)

Uncertainty about σ does matter a lot !

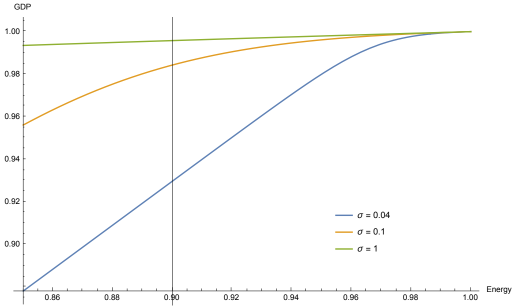
- The below graphs investigate the GDP drops for different values of the elasticity σ. Of course, the elasticity of substitution matters a lot for how much GDP drops.

10% reduction in Energy (4% of GDP)

In[16]:= $Y[\sigma\_, \alpha\_, Energy\_, NonEnergy\_] := \left(\alpha^{\frac{1}{\sigma}} Energy^{\frac{\sigma-1}{\sigma}} + (1-\alpha)^{\frac{1}{\sigma}} NonEnergy^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$

```
Plot[{Y[0.01, 0.04, Energy * 0.04, 0.96],
  Y[0.04, 0.04, Energy * 0.04, 0.96],
  Y[0.99999, 0.04, Energy * 0.04, 0.96]},
 {Energy, 0.85, 1}, AxesLabel → {"Energy", "GDP"}, ImageSize → Large,
 PlotLegends → Placed[{"σ = 0.04", "σ = 0.1", "σ = 1"}, {0.75, 0.25}],
 Epilog → {HalfLine[{0.9, 0}, {0, 1}]}]
```

Out[17]=

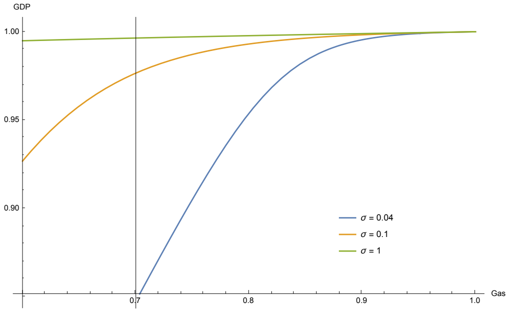


30% reduction in Gas (1% of GDP)

In[18]:= $Y[\sigma\_, \alpha\_, Gas\_, NonGas\_] := \left(\alpha^{\frac{1}{\sigma}} Gas^{\frac{\sigma-1}{\sigma}} + (1-\alpha)^{\frac{1}{\sigma}} NonGas^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$

```
Plot[{Y[0.04, 0.25 * 0.04, 0.25 * 0.04 * Gas, 1 - 0.25 * 0.04],
  Y[0.1, 0.25 * 0.04, 0.25 * 0.04 * Gas, 1 - 0.25 * 0.04],
  Y[0.99999, 0.25 * 0.04, 0.25 * 0.04 * Gas, 1 - 0.25 * 0.04]},
 {Gas, 0.6, 1}, AxesLabel → {"Gas", "GDP"}, ImageSize → Large,
 PlotLegends → Placed[{"σ = 0.04", "σ = 0.1", "σ = 1"}, {0.75, 0.25}],
 Epilog → {HalfLine[{0.7, 0}, {0, 1}]}]
```

Out[19]=



Using the production function is a contradiction ?

- What is paradoxical is that David Baqaee and Emmanuel Farhi's research agenda was precisely to move away from these extremely stylized production functions. In Baqaee and Farhi (2019b): "As micro data becomes more plentiful, parsimonious reduced-form aggregate production functions look more antiquated."
- This is a somewhat of a contradiction:

– On the one hand, the sophisticated estimation techniques in Bachmann et al. (2022) build upon state-of-the-art Baqaee-Farhi models. (but these seem to lead to embarrassingly small effects - 0.2-0.3% of GDP)

– On the other, the numbers they seem to believe in (and which they have put forward in the public debate) do not come from these sophisticated approach, but from an very stylized production function approach. As we've seen, this approach doesn't have a lot of scientific authority.

- So there's only one question left: why do Baqaee and Farhi (2021), lead to such small estimates ?

Section 3

Baqaee and Farhi (2021)

Main estimates

- The Baqaee and Farhi (2021) is presented in the Bachmann et al. (2022) paper as a "state-of-the-art multi-sector model with rich input-output linkages and in which energy is a critical input in production."
- Results of the model are extremely low except even with **very low elasticities**: 0.26% of GNE.

Table 1: German GNE losses predicted by Baqaee-Farhi multi-sector model

	Parameterization 1 (as in Baqaee-Farhi paper)	**Parameterization 2 (low elasticities)**	**Parameterization 3 (very low elasticities)**
		A. Parameter Values	
θ	0.5	0.1	0.05
ε	0.2	0.2	0.05
		B. German GNE Loss	
DEU	0.19%	0.22%	0.26%

Problems with the model / the calibration

- **Only 30 sectors** (the table they use has 35 sectors, but they want to get rid of 0s): for example, water supply is mixed with electricity and gas in the "Electricity, Gas and Water Supply" sector; the chemical industry is mixed with rubber and plastics. Within a sector, there is perfect substitution. 2016 release of the world input-output table has more sectors.
- **Only 4 factors**: high-skilled, medium-skilled, low-skilled labor, and capital. This implicitely assumes that a high-skilled person (say, an engineer) can easily switch across any of the 30 sectors. As shown in Baqaee and Farhi (2019a), the number of factors is hugely important.
- **No space**: as discussed in Baqaee and Farhi (2019a), there might even be one factor per location, if people can't freely move in the short run (note: gas also cannot easily be moved around).
- **Few parameters**: there are 4 key elasticities of substitution. (e.g. only one for all consumption goods) This is better than the production function approach, but still very stylized. And no way to know what these elasticities are in this particular example. (never been seen before) Overall, this model closer to a "toy model" than to a "quantitative model".

Only 30 sectors

- Particular application at hand is perhaps not that well suited to study this particular question. Use of the 2013 release of the WIOD database, with only 35 sectors (which they assemble into 30). 2016 release breaks energy into two pieces. (Contrast this with Baqaee, Farhi (2019): 88 sector US KLEMS.)

D Data Appendix

To conduct the counterfactual exercises in Section 8, we use the World Input-Output Database (Timmer et al., 2015). We use the 2013 release of the data for the final year which has no-missing data — that is 2008. We use the 2013 release because it has more detailed information on the factor usage by industry. We aggregate the 35 industries in the database to get 30 industries to eliminate missing values, and zero domestic production shares, from the data. In Table 5, we list our aggregation scheme, as well as the elasticity of substitution, based on Caliendo and Parro (2015) and taken from Costinot and Rodriguez-Clare (2014) associated with each industry. We calibrate the model to match the input-output tables and the socio-economic accounts tables in terms of expenditure shares in steady-state (before the shock).

Only 30 sectors

	WIOD Sector	Aggregated sector	Trade Elasticity
1	Agriculture, Hunting, Forestry and Fishing	1	8.11
2	Mining and Quarrying	2	15.72
3	Food, Beverages and Tobacco	3	2.55
4	Textiles and Textile Products	4	5.56
5	Leather, Leather and Footwear	4	5.56
6	Wood and Products of Wood and Cork	5	10.83
7	Pulp, Paper, Paper , Printing and Publishing	6	9.07
8	Coke, Refined Petroleum and Nuclear Fuel	7	51.08
9	Chemicals and Chemical Products	8	4.75
10	Rubber and Plastics	8	4.75
11	Other Non-Metallic Mineral	9	2.76
12	Basic Metals and Fabricated Metal	10	7.99
13	Machinery, Enc	11	1.52
14	Electrical and Optical Equipment	12	10.6
15	Transport Equipment	13	0.37
16	Manufacturing, Enc; Recycling	14	5
17	Electricity, Gas and Water Supply	15	5
18	Construction	16	5
19	Sale, Maintenance and Repair of Motor Vehicles...	17	5
20	Wholesale Trade and Commission Trade, ...	17	5
21	Retail Trade, Except of Motor Vehicles and...	18	5
22	Hotels and Restaurants	19	5
23	Inland Transport	20	5
24	Water Transport	21	5
25	Air Transport	22	5
26	Other Supporting and Auxiliary Transport....	23	5
27	Post and Telecommunications	24	5
28	Financial Intermediation	25	5
29	Real Estate Activities	26	5
30	Renting of M&Req and Other Business Activities	27	5
31	Public Admin/Defence; Compulsory Social Security	28	5
32	Education	29	5
33	Health and Social Work	30	5
34	Other Community, Social and Personal Services	30	5
35	Private Households with Employed Persons	30	5

Table 5: The sectors in the 2013 release of the WIOD data, and the aggregated sectors in our data.

Only 4 factors

- There are only 4 factors in the Baqaee and Farhi (2021) model, for all industries: high-skilled, medium-skilled, low-skilled labor, and capital.

> **Calibration.** The benchmark model has 40 countries as well as a "rest-of-the-world" composite country, each with four factors of production: high-skilled, medium-skilled, low-skilled labor, and capital. Each country has 30 industries each of which produces a single industry good. The model has a nested-CES structure. Each industry produces output by combining its value-added (consisting of the four domestic factors) with intermediate goods (consisting of the 30 goods). The elasticity of substitution across intermediates is θ_1, between factors and intermediate inputs is θ_2, across different primary factors is θ_3, and the elasticity of substitution of household consumption across industries is θ_0. When a producer or the household in country c purchases inputs from industry j, it consumes a CES aggregate of goods from this industry sourced from various countries with elasticity of substitution $\varepsilon_j + 1$. We use data from the World Input-Output Database (WIOD) (see Timmer et al., 2015) to calibrate the CES share parameters to match expenditure shares in the year 2008.[33]

No space

- Not only too few industries, too few factors, there also are too few locations. (there's just one) In theory, adding space could be done, by simply adding more factors, one that is more specific to each factor.
- The more factors you have that are not substitutable, the less possibility of substitution you get.
- So in fact, it's not a problem with "mathematical models" which do not work, it's more a problem about the assumptions we choose to use in these mathematical models.
- I don't see any reason why we should simply assume these problems away. In general, the issue with this model is perhaps that it is too stylized (or rather, too simplified in key respects, such as the modelling of the energy sector) compared to what you'd ideally like to have for such an exercise.

No space: Olaf Scholz is correct

Will: But, as you know, quite a few economists, see this …

Scholz: But they get it wrong! And it's honestly irresponsible to calculate around with some mathematical models that then don't really work. I don't know absolutely anyone in business who doesn't know for sure that these would be the consequences. That's why we've prepared so well and that's why we're now working at the fastest possible pace to make ourselves independent of these imports.

Will: Mr. Scholz, you are saying that all the others, all economists who for all purposes have expertise, have a scientific reputation, some of whom belong to the Council of Economic Experts, that they have all not understood the situation?

Scholz: It is a different matter whether you calculate how much gas, how much oil you need, how much coal you need to import, and how much coal, oil and gas there is on the world markets, or if you deal with the question – which is what the Economics Minister has done, what many business associations and companies have done, by the way – where is the gas actually supposed to run through, where are the pipelines, what is the regasification capacity, where are the terminals, and if everyone else is doing it, is there enough capacity to achieve that. Believe me the question "What happens when it suddenly stops?" has been on my mind for a long time and we have prepared very carefully for this situation, and that is why we are now moving so quickly on these things that I have spoken about here. But you can't just simply say this and then it's done. We will try to get away from Russian coal and oil imports this year, and we want to create the technical prerequisites for becoming independent of gas imports as quickly as possible.

Closer to a “simple stylized model”

- More generally: few parameters, quite a few simplifying assumptions. This computational experiment ends up being closer to a simple stylized model than to a large-scale computational GE model.
- “Can lead to unreliable quantitative predictions when compared to the large-scale models”.

1 Introduction

Trade economists increasingly recognize the importance of using large-scale computational general equilibrium models for studying trade policy questions. One of the major downsides of relying on purely computational methods is their opacity: computational models can be black boxes, and it may be hard to know which forces in the model drive specific results. On the other hand, simple stylized models, while transparent and parsimonious, can lead to unreliable quantitative predictions when compared to the large-scale models.

How does Baqaee and Farhi (2021) fit into their research agenda ?

The Baqaee and Farhi (2021) paper is very related to an earlier paper of theirs, released in Econometrica:

- Baqaee and Farhi (2021): open economy model. Questions that they look at: gains from trade, impact of tariffs, etc.
- Baqaee and Farhi (2019a): Breaking from Hulten's "theorem"

But the second paper appears to me like a much more relevant paper, and I'll explain why:

- Assumes that factors are much less substitutable (one factor for each industry), which is more relevant for the short run, as the authors themselves point out.
- One of the experiments is precisely about energy, and the authors conclude that there does not seem to be much substitution.

Section 4

Baqaee and Farhi (2019a): Breaking from "Hulten's theorem"

Hulten: Key reason why model-implied losses are small

- Extract from the paper:

The key reasons why the model-implied economic losses are relatively small are the following: (i) the share of fossil energy imports (gas, oil and coal) in German production is small to begin with at about 2-2.5% of GDP, and (ii) the model predicts that, while this share rises considerably, it will not rise by an unreasonably large amount. In the model, the change in the share of energy imports in GNE summarizes in a succinct fashion the substitutability implied by model choices about elasticities and changes in the input-output structure. Beliefs about substitutability boil down to beliefs about changes in the energy import share in GNE.

- This is some version of Hulten's theorem: the effects of a shock on a sector has something to do with the importance of that sector in GDP.

Summers dismisses "Hulten's theorem" for energy

- In his Secular Stagnation Speech at the 2013 IMF Fourteenth Jacques Polak Annual Research Conference (Emmanuel was in the front row), Larry Summers compared the 2007-2009 financial crisis to a power failure. He was precisely explaining that key sectors such as the financial sector, or the energy sector, were so central to the working of the economy, that clearly using such sectors would be far more important than suggested through their importance in GDP. In other words, he was dismissive of Hulten's theorem.
- The quote (at 54'24' ') is: "You know, I always like to think of these crises as analogous to a power failure. Or analogous to what would happen if all the telephones were shut off for a time. The network would collapse, the connections would go away and output would of course drop very rapidly."

"There'd be a set of economists who would sit around explaining that **electricity was only 4% of the economy** and so if you lost 80% of electricity you couldn't possibly have lost more than 3% of the economy. And there would be, you know, there'd be people in Minnesota and Chicago and stuff would be writing that paper... but it would be stupid ! It would be stupid ! And we'd understand that, somehow, even if we didn't exactly understand in the model, that when there wasn't any electricity there wasn't really going to be much economy."

“Secular stagnation” speech from Larry Summers

- Link to the YouTube Video: https://www.youtube.com/embed/qAsW6UnATAY?start=3265.

This argument is influential

- One of the arguments for why the effects found in Bachmann et al. (2022) are so low is that the share of energy is only about 4% of GDP, and the share of gas is only about 1% of GDP.
- It's very paradoxical because Baqaee and Farhi (2019a)'s work was a way to precisely break Hulten's theorem.
- Since Hulten's theorem is such an important tenet of growth accounting, this was presented however only as a second-order approximation, though in fact it was first order.

Importance of factor reallocation

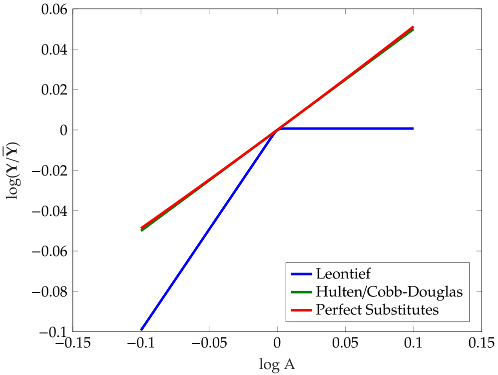
- Baqaee and Farhi (2019a) show that with complementarities, a negative shock can cause a large downturn when labor cannot be freely re-allocated, but the **ability to re-allocate labor** largely mitigates these effects.
- There are reasons to suspect in such circumstances of a Russian gas embargo, that labor could not be easily reallocated. (probably in the 2021 trade paper the authors assume more reallocation is possible because they look at longer-term effects of trade) "In light of increasing evidence (see for example Acemoglu et al., 2016; Autor et al., 2016; Notowidigdo, 2011) that labor is not easily reallocated across industries or regions after shocks in the short run, we view the no-reallocation case as more realistic for modeling the short-run impact of shocks, and the full-reallocation case as better suited to study the medium to long-run impact shocks."

Reallocation is difficult

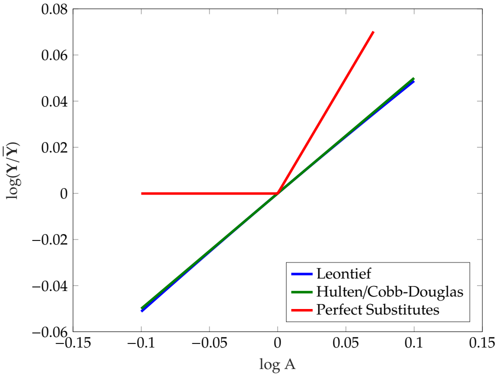
Empirical exercise shows reallocation is difficult at business cycle frequencies:

- Overall, given our elasticities of substitution, the model with full reallocation is **unable to replicate** the volatility of the Domar weights at either annual or quadrennial frequency, suggesting that this model is not nonlinear enough to match the movements in the Domar weights as arising from sectoral productivity shocks.
- We also consider the response of aggregate output to shocks to specific industries, using our benchmark calibration. It turns out that for a large negative shock, **the "oil and gas" industry** produces the **largest negative response in aggregate output**, despite the fact it is not the largest industry in the economy.
- In our baseline calibrations, we assume that intermediate inputs can be freely reallocated across producers even in the short run. This is sensible since intermediate goods are probably easier to reallocate than labor.

The importance of factor reallocation



(a) log aggregate output with no reallocation/extreme decreasing returns. Perfect substitutes and Hulten's approximation overlap almost perfectly.



(b) log aggregate output with full reallocation/constant returns. Leontief and Hulten's approximation overlap almost perfectly.

Example of the 1970s oil shock

- Share of oil went up and went down not mostly through substitution, but through a change in prices. (moreover: the household sector did some of the effort at the time. . .)

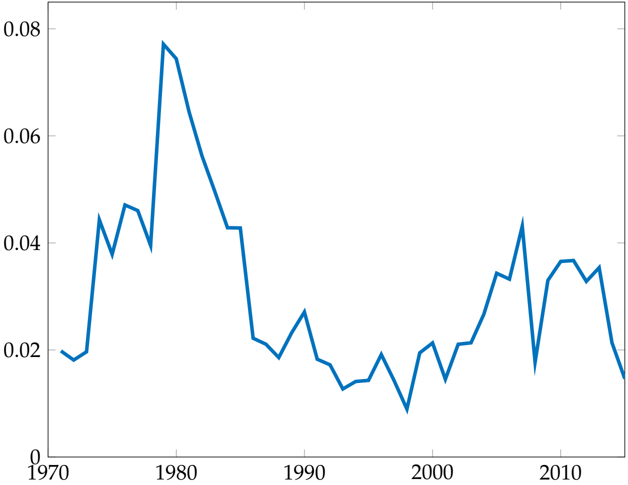
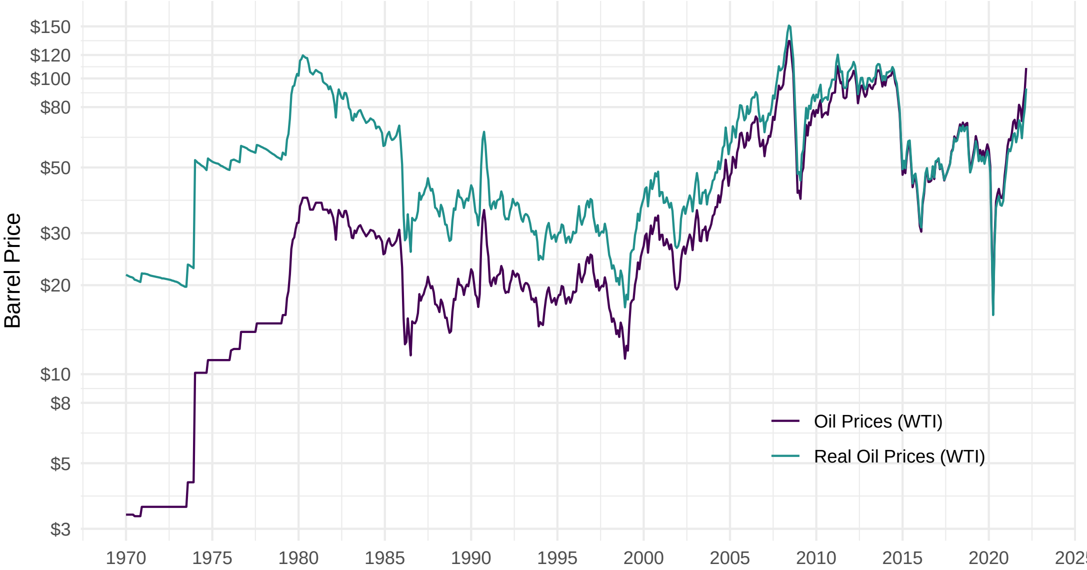


Figure 7: Global expenditures on crude oil as a fraction of world GDP.

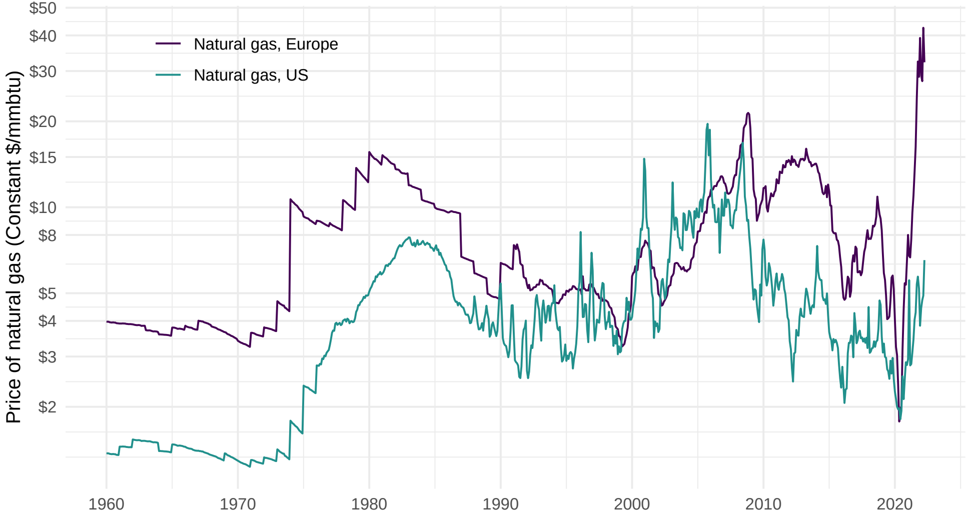
Changes in oil prices



Circular reasoning

- Back to the initial quote, the authors refer to the energy import share in GNE a lot, arguing that it cannot rise too much. The argument: if the price of energy goes up too much (in some estimations, it goes up by a factor of 10) without there being a substantial reduction in the quantity of energy bought, then the energy import share will rise too much.
- This is circular reasoning. If substitution is low, then yes the share of energy in consumption will rise a lot. Yet this is precisely what we experienced during the two oil shocks.
- There are reasons to think that in fact, cutting Russian gas now would be much worse for Germany than the two oil shocks: the change in natural gas prices is already larger; and would be an order of magnitude larger if there was an embargo. (see next slide)
- Moreover, because of low substitution, I don't think indeed the price system would suffice, and there would be rationing. (i'll come back to it) But this is precisely evidence in favor of limited substitution (to an extent that the price system would not be able to do its job), not against !

Natural gas price increases already greater (Source: World Bank)



Section 5

Other thoughts

Elasticity optimism in neoclassical macro

- One which macroeconomists are usually particularly interested in is the elasticity of substitution between capital and labor.
- Harrod-Domar: Keynesian growth models had Leontief at the macroeconomic level So economists did not always believe that Leontief was "nonsensical", even at the macroeconomic level.
- Solow (1956) made substitution substantial => neoclassical growth model. The Cobb-Douglas production function was then used, which has an elasticity of substitution of 1.
- Baqaee and Farhi (2019a): "a mixture of analytical tractability, as well as balanced-growth considerations, have made Cobb-Douglas the canonical production function for networks, multisector RBC models, and growth theory."

Leontief is not nonsensical according to Samuelson

Samuelson, Economics textbook in 1948

> One catch to this theory was the fact that often product seems to depend upon a joint combination of labor and capital in such a way that increasing one without increasing the other results in *no extra product*; whereas decreasing the one without changing the other often results in a loss of product equal to the *whole productivity* of the combined "dose." The marginal product theory then would set limits on the separate shares of labor and capital which varied between 0 and 100 per cent. Of course, such limits would be quite useless and would make a mockery of the proposed theory of distribution.

Is the comparison with Covid-19 valid ?

Facts II: Hardest Hit Industries

	2022 Crisis (Import Stop)			2020 Crisis (Covid-19)		
	Chemicals	Food+	Metal	Air Trans.	Hosp.	Entert.
Employees (in 1,000)	352	941	271	66	1894	693
Employees (% of total)	0.78	2.08	0.60	0.15	4.18	1.53
GVA (in €bln)	46	47	21	7	51	43
Gross Output (in €bln)	137	195	104	25	104	69
Share males (in %)	74	52	88	46	47	49
Share gas (%)	37	12	10			

Source: Volkswirtschaftliche Gesamtrechnungen (2019)

3 hardest hit sectors:

- Make up 59% of industrial gas usage
- In terms of GVA, wages, and employees comparable to hardest hit sectors in 2020
- Big difference in gender to sectors shut down in 2020

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Manufacturing: increasing returns to scale

- I think that the comparison to Covid-19 is not valid. Drop in GDP during Covid-19 is largely replaced by home production (food at home vs. food away from home) **industry** / manufacturing is characterized by increasing returns to scale.
- Baqaee-Farhi (2019): “Our formulas can also in principle be applied with increasing-returns to scale under the joint assumption of marginal-cost pricing and **impossibility of shutting down production**, by simply adding producer-specific fixed factors with negative marginal products and negative payments (these factors are “bads” that cannot be freely disposed of).” Of course, industries are worried about shutting down production, and going bankrupt. There are **dynamic aspects** to this as well. Macroeconomic elasticities are greater because some firms which are intensive in natural gas might actually exit the market. Industry requires long-term know-how, skills. Lots of fixed costs in industry => large irreversibilities. There are dynamic effects that the industry is rightly worried about.
- Measuring the economic damage in € does not make much sense here. If you spend 100€ every month on heating, and the same on restaurants, the 100€ on heating is “worth much more” (brings you more utility). The elasticity of substitution is much lower for energy, so the consumer surplus is much larger.

Section 6

Concluding thoughts

Many other issues I did not touch on

- Focused on the issues that were not emphasized as much in the debate thus far; and in particular on the role of Baqaee-Farhi. But of course there are other issues that others have raised before.
- The production function approach with a 2.3% GDP drop implies a tenfold increase in the price of natural gas. At the same time, the authors (and most economists) advocate in favor of letting the price-signal act to reduce natural gas consumption efficiently. To me, it's clear there would need to be rationing since most residential consumers could not cope. (and people are sometimes on long-term contracts anyways)
- There would be huge transfers involved: this tenfold increase in price would lead to a very important transfer from gas importing countries to gas exporting countries.
- Appendix says that monetary policy needs to be at the same time expansionary (because an increase in energy prices is a drag on disposable income) and contractionary (in order to reduce inflation).

Conclusion

- I am very sad that Emmanuel Farhi is not here today to settle the debate; he was a true intellectual, deeply committed to the power of ideas and research. In any case, I find that the current debate about the macroeconomic effects of a Russian gas embargo isn't like Emmanuel. Emmanuel was a thoughtful, modest, and careful scholar. Based on his previous research, I don't think he would have handled this controversy in this way, or be comfortable using such strong statements (e.g. "Leontief is nonsensical").
- I am very glad that some academic economists have tried to assess the consequences of a Russian gas embargo using his tools. Emmanuel was deeply concerned about the real-world applications of his models. Yet I am not comfortable with the way this was done in Bachmann et al. (2022). I think David's and Emmanuel's work here may have been misused in this particular example.
- Based on the above elements, I am in fact very confident that Emmanuel Farhi would **not** have claimed that his research was showing that the effects would be limited to 0.2-0.3% of GDP. In fact, I hope to have shown that if anything, his previous joint work with David Baqaee suggests a much more nuanced view of what the effects of a Russian gas embargo would be.

Section 7

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