Effects of Energy Price Shocks on Germany's Economy and Private Households

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1 Introduction

The current sharp rise in energy prices has far-reaching consequences not only for the economy, but also for private end consumers. In addition to the overall high inflation, households are hit by high prices for energy for which they often have no possibility to substitute, e.g., tenants with regard to the heating system as landlords decide on the heating system and insulation measures. Furthermore, the energy costs per household do not increase proportionally with income, as energy is a basic good, but account for a higher share for lower income households, so that they are more burdened with energy expenses.

There are different approaches to measuring energy poverty (Halkos and Gkampoura 2021). In the expenditure approach, a household's spending on energy is put in relation to its income. Generally, a household is considered energy poor if this proportion is 10% or more. In Germany, the energy poverty rate had fallen by 2020 due to lower energy prices: while it was 18.3% in 2016, only 13.6% were affected by energy poverty in 2020. In 2021, energy prices increased more than incomes, partly because Germany introduced a national CO_2 price of 25 €/t CO_2 for transport and heating that year, which corresponds to a premium of about 7–8 €-cents at the petrol stations. Fueled by Russia's war against Ukraine, energy prices increased dramatically in 2022, so that in May 2022 the share of the population at risk of energy poverty had jumped to 25.2% (Henger and Stockhausen 2022). However, households are not equally burdened by income deciles: Bach and Knautz (2022) estimate that the burden of higher prices for electricity, heating, and fuels will increase by 6.7%

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of their net income for the lowest-income 10 percent of households in 2022, while the highest-income decile will only be burdened by an additional 2% of net income.

Across Europe, energy poverty decreased between 2013 and 2017 with lower energy import prices, but has been rising again since then (Rodriguez-Alvarez et al. 2021). Here, drastic differences can be seen between the 30 countries examined in the study: While Bulgaria or Greece, for example, have a relatively high energy poverty index that fluctuates strongly over the period analysed from 2005 to 2018, a low proportion of population suffers from energy poverty in the Scandinavian countries in particular. Energy poverty and the specific vulnerability of low-income groups are not new findings. Basic goods are known to have a regressive effect. A 2015 study by the European Commission (Pye et al. 2015) also shows comparable differences between countries. The effect of COVID-19 pandemic on energy poverty is estimated in a paper by Carfora et al. (2022) for EU member states. Data on demographic and social conditions, energy and environmental factors, and living conditions are used as explanatory variables for this. The results show that Bulgaria, Greece, Latvia, and Italy in particular are expected to suffer a strong increase in energy poverty as a result only of the pandemic. Steckel et al. (2022) analyse the effect of energy poverty on European households by expenditure deciles in the current price crisis. In the baseline scenario, price increases of 340% for gas, 83% for oil, and 150% for hard coal are assumed. For the gas price increase, the result is an uneven distribution, whereby the additional burden of higher costs is regressively distributed across expenditure deciles. This results in additional costs of about 13% of expenditure in the poorest 10%, compared to "only" 8% for the richest decile. In contrast, the additional cost burden for oil and hard coal is at a similar level across the deciles, between 2 and 4%.

A literature review shows that the change in demand for energy sources due to higher energy taxes and other changes in energy prices has been investigated in many studies—both in Germany and internationally. At the macroeconomic level, the price and income elasticities of energy demand are often estimated internationally. Gao et al. (2021) calculate income elasticities of energy demand in the range of 0.6 to 0.8 and price elasticities in the range of −0.1 to −0.3 based on extensive international panel data for the period 1960–2016. Held (2017) calculates German price elasticities of −0.19 to −0.44 for electricity, −0.35 to −0.94 for heating, and −0.08 to −0.67 for private transport. According to a meta-analysis by Bach et al. (2019) price elasticities in Germany range from −0.025 to −0.8. Held (2017) and Bach et al. (2019) also show that the demand for fossil heating fuels is more price elastic than that for electricity, and long-term price elasticities are larger than short-term ones. Most short-term price elasticity estimates are below −0.3. Edenhofer et al. (2019) assume higher price elasticities for the transport and heat sectors in Germany in the order of −0.5 to −1.1, in the base case of mostly −0.7. Pothen and Tovar Reaños (2018) empirically estimate energy price elasticities in a range of −0.34 to −0.67. Estimations for Austria from Köppl and Sommer (2016) for short-term elasticities are significantly lower in a range of −0.02 to −0.24.

This chapter analyses how the expected price shocks in 2022 and the following years will affect the overall economy, consumer prices for private households, and their burden of energy costs. Therefore, the model PANTA RHEI used for the calculation is first described and the assumptions in the development of import prices for fossil energies are described (Sect. 2). The resulting effects are presented as differences between a reference development and a scenario in which the higher import prices apply (Sect. 3). Finally, the results are discussed and evaluated against the background of the current developments and compared to climate mitigation efforts (Sect. 4).

2 Material and Methods

2.1 Model Description

For the analysis of the effects resulting from a strong price increase for energy imports, the macroeconometric model PANTA RHEI is applied (Lutz et al. 2021b). It is the environmentally extended version of the INFORUM type simulation and forecasting model INFORGE (Almon 1991; Becker et al. 2022; Maier et al. 2015). In addition to the comprehensive economic core, energy and emissions are covered in detail. All model sections are consistently linked with each other.

The most important equations regarding private energy demand are presented below. For details of the complete model see Lutz et al. (2021b). Among others, it has been used for economic evaluation of different energy scenarios that have been the basis for the German energy concept in 2010 (Lindenberger et al. 2010). Applications include an evaluation of employment impacts of renewable energy promotion (Lehr et al. 2012), socio-economic impacts of the German energy transition (Lehr et al. 2019; Lutz et al. 2018, 2021b; Lutz and Lehr 2019) as well as of different energy system transformation pathways (Naegler et al. 2021; Ulrich et al. 2022), impacts of the transition to a green economy (Lutz et al. 2017), and economic effects of an e-mobility scenario (Ulrich and Lehr 2019). Rebound effects and policies to counter them have been explored by Ahmann et al. (2022) and Kern et al. (2022).

The entire model is solved simultaneously, i.e., the mutual impact of model variables is considered simultaneously. The model contains a large number of macroeconomic variables from national accounts and input–output tables and provides sectoral information according to 63 economic branches. The energy balances are fully integrated into the model.

The behavioural parameters are estimated econometrically using time series data, mainly from 2000 onwards. This basically assumes that behavioural patterns or reactions to price or quantity changes in the past will also prevail in the future. The use of econometrically estimated equations means that agents have only myopic expectations. They follow routines developed in the past. This implies, in contrast to optimization models, that markets will not necessarily be in an optimum and non-market (energy) policy interventions can have positive economic impacts. Adjustments can be implemented through exogenous specifications. For example, import prices are

Table 1 Elasticities for energy consumption purposes, own estimates

Consumption purpose	Income elasticity	Price elasticity	HDD elasticity	Trend
Electricity	0.52	−0.13	0.18	
Heating	0.12	−0.12	0.68	
Fuels	0.92	−0.07		

exogenously set in the model, based on scenarios from the World Energy Outlook (IEA 2021).

Private consumption patterns by 47 purposes of use[1] c_k are estimated as a function of real disposable income $\frac{YH}{PC}$ and relative prices $\frac{pc_k}{PC}$. PC denotes the consumer prices index. The consumption modelling is not a system estimation, but a single equation model, which explains total consumption bottom-up. Substitution between different consumption purposes is not directly modelled but can take place due to price changes and different income and price elasticities. This means that annual consumption and savings rates are variable, which is compatible with the drastic fluctuations in the German savings rate since 2019. Obviously, there is longer-term flexibility in consumption decisions through asset adjustments and debt.

For some consumption purposes, time trend t as a proxy for long-term change in consumption behaviour or the number of private households HH is used as an explanatory variable. Heating degree days (HDD) are important for energy consumption:

$$c_k = f\left(\frac{YH}{PC}, \frac{pc_k}{PC}, HDD, HH, t\right)$$

The following Table 1 shows the short-term elasticities of energy demand by private households. For electricity consumption the income elasticity is quite high. An increase in disposable of 1% income leads ceteris paribus to an increase in electricity consumption by 0.52%. The price elasticity is quite low. If the electricity price increases by 1%, consumption will fall by 0.13%. Heating degree days also have some influence on electricity consumption. Consumption for heating is dominated by temperatures in winter, i.e., the heating degree days. About 50% of private households use natural gas (AGEB 2022a). Changes in income, partly via larger living space and energy prices only have smaller impacts. Fuel demand is dominated by disposable income. The income elasticity is close to one, i.e., every increase in income translates into higher consumption, partly by buying higher-motorised cars (SUVs).

In the long term, investments in other technologies can reduce energy consumption. In the case of heat, heat pumps but also renewable energy sources such as solar thermal energy, biomass, and geothermal energy are currently ways to save

[1] The classification for purposes of use is based on the lowest level of the classification in Destatis (2021b), sheet 3.3.3.

fossil fuels. Building insulation measures also significantly reduce energy consumption per square metre of living space, which is increasing with household income. However, it will take a very long time before a larger proportion of the more than 43 million dwellings in Germany can consume less or other forms of energy. The refurbishment rate is well below 1% and craftsmen for refurbishment are scarce. The potential for additional measures is currently limited. As far as fuels are concerned, electric vehicles are currently an alternative that is subsidised by the state with a premium of up to 9.000 € plus tax reductions. Here, too, the additional potential is limited in the short term. Delivery times for new appliances and electric vehicles are currently many months. Heat pumps and electric vehicles will increase electricity consumption in Germany in the future, so overall energy consumption is not expected to change that much. Since these technical options are predominantly available to higher income households, we deliberately do not consider them in the following analysis. An analysis of the associated longer-term effects is provided by, e.g., Lutz et al. (2021b).

Consumer prices for private households $TJPHH_e$ per fossil energy source e are modelled in PANTA RHEI as a function of the respective import prices of coal, oil, or gas IP_f:

$$TJPHH_e = f\left(IP_f\right)$$

Here, only the price component excluding taxes is estimated. For gas, the elasticity is 0.476, for coal products it is even lower between 0.237 and 0.241. Thus, the influence of import prices is well below 1, since long-term supply contracts with binding prices for end consumers buffer the price fluctuations on the international market. In the case of oil products, the import price has a stronger impact, with an elasticity of between 0.753 and 0.779: Both at petrol stations and in the supply of heating oil, changes in the oil price on the world market are passed on to end consumers.

For electricity, the price is first divided into its components, then only the price component for procurement and distribution is estimated, the other electricity price components are modelled separately of—if no change is foreseeable, as in the case of the electricity tax—left constant. As gas power plants currently dominate the price formation on the electricity market due to the merit order principle, the gas import price of both the current and the previous year is included as an explanatory variable in the regression. The reason for this is the merit order principle, according to which the most expensive power plants set the price, in this case the gas-fired power plants. Here it can be seen that the gas price of the previous year, with an elasticity of 0.691, has a greater influence on the electricity price than that of the current year, with an elasticity of 0.133. Subsequently, end-use price indices are estimated. These are set as a function of consumer prices, to which the energy tax and value-added tax (VAT) have previously been added. Here, the elasticities are close to 1.

Looking at the current development of the electricity price in Germany (Fig. 1), it can be seen that there is a strong change in the composition between 2021 and July 2022. Procurement and distribution costs have risen from just under 8 cents/

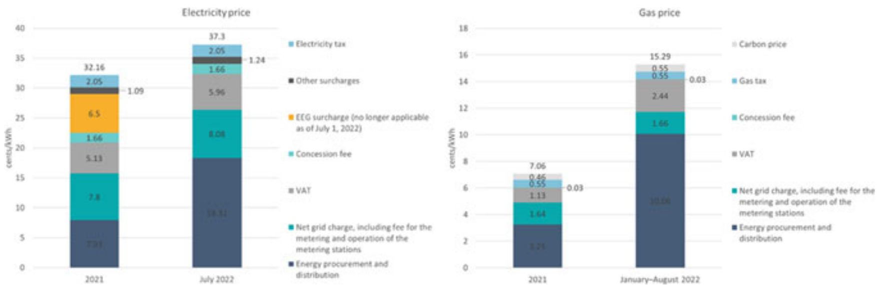

Fig. 1 Composition of prices for electricity and gas for German private households (reproduced from BDEW [2022a, 2022b])

kWh to over 18 cents/kWh. In contrast, the EEG[2] surcharge was initially halved at the end of 2021 and completely abolished on 1 July 2022. Since then, the renewable energy plants have been financed entirely through the federal budget, whereby due to the very high procurement prices, a high surplus has actually accumulated in 2022 (around €17 billion [50 Hz et al. 2022]) in autumn 2022, which is to be used to reduce grid costs in 2023. The gas price composition has also changed significantly in the period. Procurement costs have roughly tripled. As a result, the value-added tax that final consumers have to pay has also more than doubled. On 1 October 2022, the federal government temporarily reduced the VAT rate for gas from 19 to 7%. As the CO_2 price has risen to 30 €/t CO_2 as of 1 January 2022, the corresponding price component has also increased.

2.2 *Assumptions on Import Prices for Germany*

The assumptions for import prices are set against the background of current developments. Import prices for fossil fuels have already started to climb in the second half of 2021. As a consequence of Russia's invasion of Ukraine and Western sanctions, the import and domestic supply of natural gas in particular has become critical. According to the latest energy data for 2021 (AGEB 2022b), Germany produces only about 5% of its natural gas consumption domestically. Short-term production increases are not possible, even if an additional natural gas field in the North Sea close to the Dutch border is put into operation in the winter. There has been a high import dependency on Russia as one of the three supplier countries here (along with the Netherlands and Norway) (BMWK 2022). However, crude oil with 32% (2019) and hard coal with 45% (2020) import share of Russia have also become politically problematic energy sources given the current situation.

The monthly data for natural gas in Fig. 2 show that the import price has increased sharply during 2022, but it already rebounded to 2019 levels after the lockdowns due

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[2] EEG = Renewable Energy Sources Act ("Erneuerbare-Energien-Gesetz").

to the pandemic in 2021: A first rise happened with the start of the Russian war in February 2022. Deliveries from Russia through the Nord Stream 1 and Jamal pipelines were sharply reduced in July and then suspended altogether, causing a further sharp rise in prices. It should also be borne in mind that Germany at the same time increased the requirements for the storage of natural gas to 85% by 1 September and around 95% by 1 November, which made additional imports necessary. In the meantime, natural gas is flowing into Germany from Norway, the Netherlands, and Belgium, with increasing flows of liquefied natural gas (LNG). From winter 2022/2023, Germany is planning four LNG ports in the North and Baltic Sea of its own, which will significantly increase import opportunities. In July 2022, the gas import price was 103.72 euros/MWh, a 387% price increase compared to July 2021 (BAFA 2022).

Looking at end-user prices also shows a sharp increase in 2022. The gas price analysis by components (BDEW 2022a) (see Fig. 1) reveals that the higher import prices are reflected in the procurement and distribution component which accounts for 66% of the total price in 2022 (considered up to August). In the previous year, procurement and distribution made up only 46% of the price. In absolute terms, the component has roughly tripled from 3.25 cents/kWh to 10.06 cents/kWh (for single-family houses).

The percentage gas price surcharges for German industry are much more severe. For large customers, distribution costs (network fees) and taxes have so far been significantly lower than for private households (Bundesnetzagentur and Bundeskartellamt 2022). This is because large customers also incur lower transmission costs. In terms of gas tax, very energy-intensive companies are largely exempt, and VAT does not apply to any company. The higher costs for companies mean that

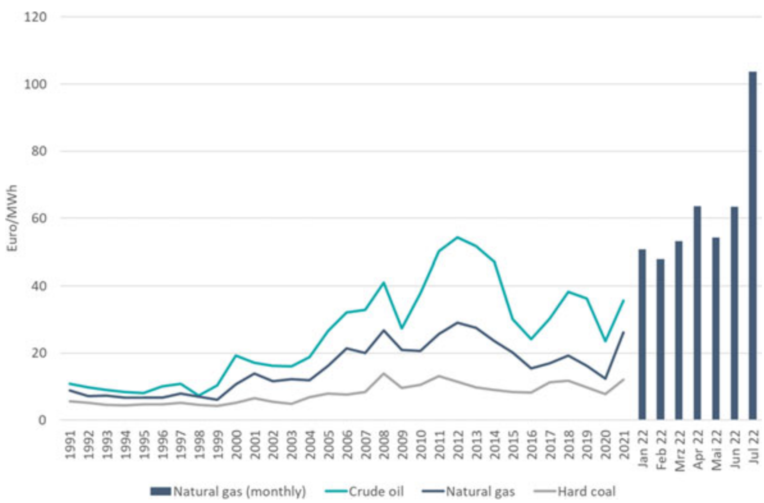

Fig. 2 Development of import prices for crude oil, gas, and hard coal since 1991 (reproduced from BMWK [2022] and BAFA [2022])

they have to pass on a large part of the cost increase to prices. Their substitution and energy efficiency opportunities are small in the short term, without investment in improved facilities. Studies have so far assumed short-term price elasticities of demand in the range of −0.1 to −0.4 (Köppl and Schratzenstaller 2021; Li et al. 2022; Lutz et al. 2021a; Prognos 2013; Zarnikau et al. 2021). Only low cross-price elasticities are also reported (Stern 2012). Reducing production is another possible reaction in this context. The cost increases then also lead to price increases at further production stages downstream. In the macroeconomic outcome, the German inflation rate has risen to 10% in September 2022 (Destatis 2022), the highest value in 70 years. However, this is also due to the sharp rise in food prices, internationally increased transport costs, and general problems in the international supply chains, which are not considered in this chapter. So, the energy price increase alone is likely to have a much smaller effect on inflation.

The reference scenario already includes an accelerated energy transition, based on the German government's "Easter Package" and aims for faster expansion of renewable electricity generation capacity although the targets for PV and offshore wind energy cannot be achieved due to bottlenecks in the construction sector (see also Zika et al. 2022). In addition, the consequences of Russia's war against Ukraine are partly considered, through increased import prices, especially for food, sanctions against Russia, as well as an increase in defence spending and in net immigration. Due to the current political situation and the pandemic, supply chains are interrupted, negatively affecting the economic activity in most sectors. Import prices for fossil energies develop as in the Announced Pledges Scenario from IEA (2021) which assumes an increase of between 32% (coal) and 60% (crude oil) by 2030 compared to 2020. In contrast, for the price shock scenario, the import price in 2022 is assumed to be four times as high for natural gas as in the reference scenario and twice as high for oil and coal. After 2022, it is assumed that prices will return linearly to the level of the reference case by 2030 (see Fig. 3). This assumption may seem too low in view of the extreme increase in European gas price futures in the summer and autumn of 2022. On the other hand, these are annual averages that also include significantly lower prices at the beginning of the year. Furthermore, price increases for other commodities are not taken into account.

3 Results

3.1 Effects on Consumer Prices

The rise in import prices for energy means that consumer prices also increase. As a result, the price for gas is almost 6 cents/kWh higher than in the reference in 2022, and heating oil rise by almost 35 cents/litre (see Fig. 4). In the following years, the difference is assumed to decrease again. Electricity is also becoming more expensive compared to the reference in 2022, although there is a time lag before

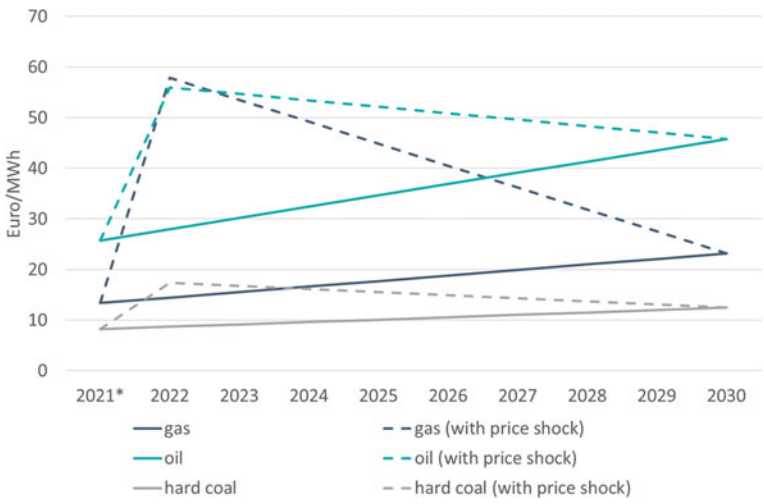

Fig. 3 Assumed development of import prices in the reference (solid lines) and price shock scenario (dotted lines). *The data for 2021 are calculated model figures and not historical ones, so the values differ from those in Fig. 2.

the cost increases reach final customers. In many cases, the suppliers have already bought the electricity months and years in advance. In 2022, the increase is still very small at 2 cents/kWh (comment: but then it is much lower than in reality). In 2023, the electricity price then rises by 20 cents from 37.3 cents/kWh in 2022 to 57.7 cents/kWh.

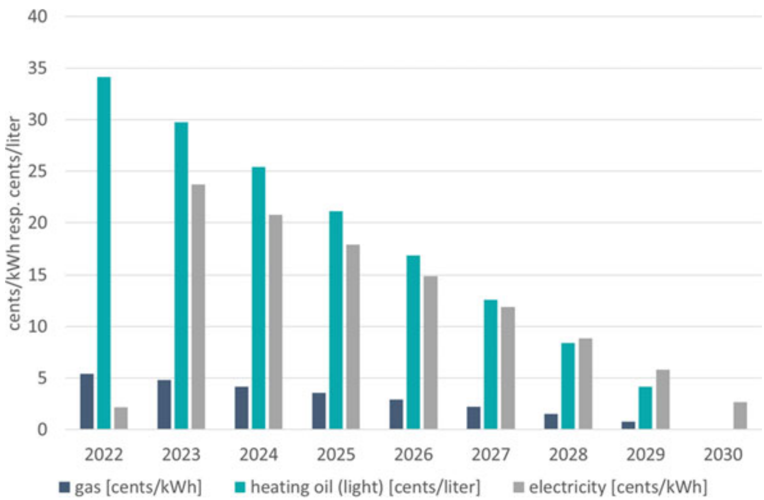

Fig. 4 Absolute deviations of private household energy prices for gas, fuel oil, and electricity in the price shock scenario compared to the reference

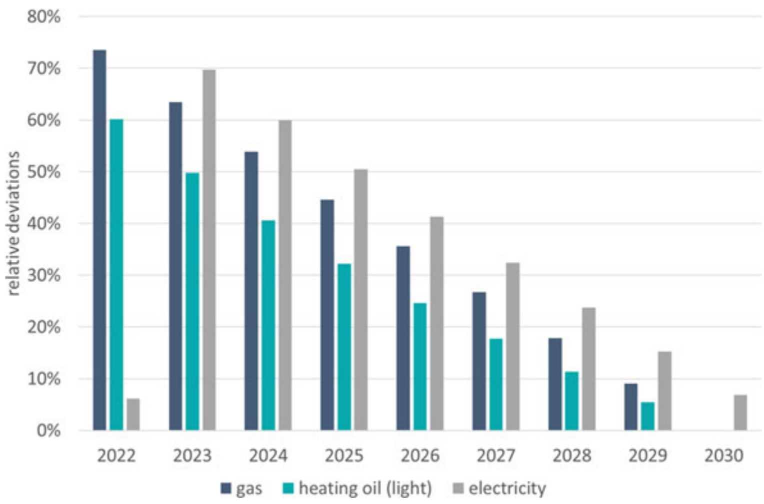

Fig. 5 Relative deviations of private household energy prices for gas, liquid fuels, and electricity in the price shock scenario compared to the reference

The following Fig. 5 shows that the percentage deviations are highest for gas at 70%, while heating oil will become more expensive by just under 45% compared to the reference development in 2022. For electricity, the increase in 2023 is particularly drastic at over 70%, after the effect in 2022 is relatively moderate at just over 6% due to the lagged impact mechanism. This is also the reason why the electricity price in 2030 is still higher in the price shock scenario, although import prices are again assumed to be the same in both scenarios.

This raises the question of how to proceed in an annual model with certain time lags in the cost pass-through during the year. Usually this is not a problem because the price changes are limited. In 2022 it is a different story, given the huge changes in procurement prices. We have assumed that the import price increases for gas will be passed on immediately, but that there will be a time lag for electricity and that the strong price increase will not occur until 2023.

3.2 Macroeconomic Effects

The strong energy price increases and the associated inflation negatively affect the gross domestic product (GDP) (see Fig. 6). As a result, the GDP in 2022 is more than 2% lower than in the reference, in which high growth was still expected at the end of the Corona pandemic. At −2.8%, private consumption is even hit worse than GDP. Exports also decline at an above-average rate due to higher prices. However, since energy imports have risen sharply in price, the overall economic import in constant

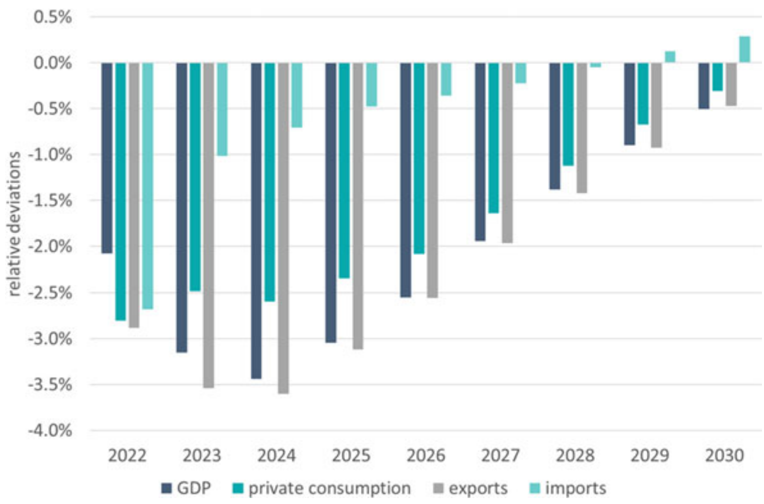

Fig. 6 Relative deviations of selected GDP components (in real terms) in the price shock scenario compared to the reference

prices reacts below average. With the assumed end of the higher prices at the end of the decade, the negative effects on the economy will also be significantly reduced.

On the German labour market (see Fig. 7), it should be noted that in previous crises such as the financial crisis or the pandemic, declines in production had only a below-average effect on employment. In 2022, a 2.5% reduction in production leads to employment losses of 0.3% against the reference, in which employment would have increased. This has to do with the delayed wage formation on the German labour market—hourly wages increase only slightly in nominal terms (0.6% in 2023), while production prices increase strongly (4.4% in 2023)—state support such as short-time working allowance and the shortage of skilled workers. Due to the strong price increase, there is a temporary significant decline in real wages in 2022, which is also partly maintained in 2023. Companies that cut back their production can continue to pay their employees through the short-time allowance. In addition, due to the shortage of labour and the low unemployment rate in Germany, they lay off as few workers and employees as possible. For private households, too, this means that wage payments only decline to a limited extent, which somewhat dampens the decline in the compensation of employees and final consumption.

Energy demand is largely inelastic according to Table 1. This means that despite a strong price increase in 2022 and 2023, the effects on energy demand remain limited. Private households respond to higher energy prices with lower energy consumption of 4.1% in 2022 and 4.9% in 2023 compared to the reference development. The deviation between the scenarios is 4.6% for heating oil consumption in 2022, while it is 8.4% for gas given the higher assumed price shock. Due to the lower energy consumption, CO_2 emissions are 4.9% lower than in the reference scenario. The

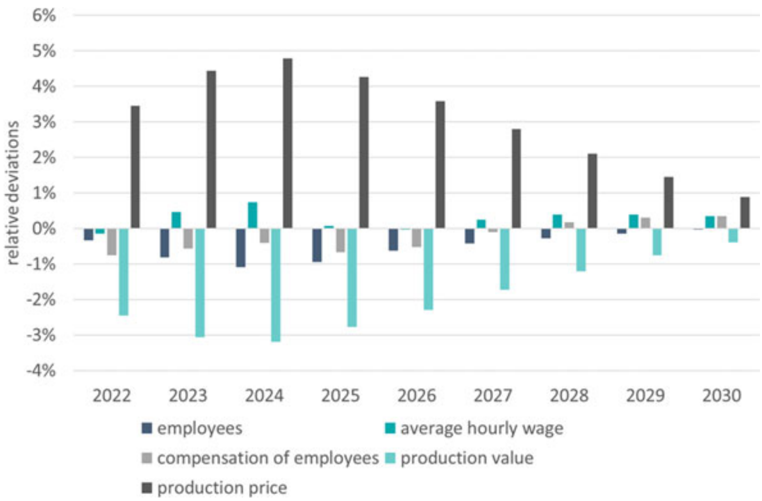

Fig. 7 Relative deviations of selected labour market variables in the price shock scenario compared to the reference

effect on emissions is stronger than the reference scenario since households also use less electricity and therefore less fossil energy is consumed in the transformation.

3.3 Distributional Effects

For the assessment of distributional effects, energy expenditures are considered by income class (see Table 2). Overall households, 4.2% of net household income was spent on energy in 2020. Across the income classes, there is a regressive development: The higher the income, the lower the share spent on energy. Thus, in the lowest income class (<1300 euros/month), 10.7% of net income is spent on energy, compared with only 2.8% in the highest (Destatis 2021a). The data source used employs a comparatively comprehensive concept of net household income,[3] so that the percentage expenditure on household energy and fuel is slightly lower than in sources referring to the socio-economic panel or the sample survey on income and consumption.

In the reference scenario, the shares for energy expenditure for the years 2022 and 2023 increase hardly or only slightly compared to the historical figure of 2020. For households with a monthly net income of less than 1300 euros, the share increases from 10.7% in 2020 to 10.9% in 2022. In the upper income classes, the share in 2023 is back at the level of 2020. Although energy prices also rise in the reference scenario, the concurrent increase in incomes evens this. In the price shock scenario, higher

[3] Net household income describes a household's disposable income minus earnings derived from the sale of goods and other earnings, which account for about 2% of disposable income.

Table 2 Share of private household consumption expenditure on energy by net income class (reproduced from Destatis [2021a] [2020] and own calculations [2022, 2023])

		2020 (%)	Reference scenario (%)		Price shock scenario (%)	
			2022 (%)	2023 (%)	2022 (%)	2023 (%)
Monthly net household income	Lower than 1300 euros	10.7	10.9	10.8	19.0	17.7
	1300 to 1700 euros	7.6	7.8	7.7	13.6	12.6
	1700 to 2600 euros	6.0	6.1	6.0	10.6	9.9
	2600 to 3600 euros	5.1	5.2	5.1	9.1	8.4
	3600 to 5000 euros	4.1	4.2	4.1	7.3	6.8
	5000 euros and higher	2.8	2.9	2.8	5.0	4.6
All households		4.2	4.3	4.3	7.5	7.0

prices lead to significantly higher shares of energy costs. Compared with 2020, the shares almost doubled in 2022. In the lowest income group, this results in almost one-fifth of net household income being spent on energy.

For transport fuels (see Table 3), expenditures in 2020 account for a similarly high share of net household income across income classes. The lowest share for fuels, at 1.6%, occurs in the group with incomes of less than 1300 euros per month, while the highest share of 2.2% is spent by households with monthly net incomes between 1700 and 2600 euros. In the reference scenario, the shares do not change in 2022 and 2023, i.e., the prices for transport fuels and incomes increase in a similar way. The higher prices for oil products in the price shock scenario lead to higher shares in fuel expenditures, but both the increase and the unequal distribution of the higher burden are less pronounced than for residential energy expenditures.

4 Discussion and Conclusions

The results show that the sharp price increases for natural gas, coal, and petroleum products due to the Russian war in Ukraine, the Western sanctions that have been adopted, and the supply stop for natural gas will lead to sharply rising prices and clearly negative macroeconomic effects, at least for Germany. German GDP is up to 3.4% lower in 2024 than in the reference development. The largest negative effects compared to the previous year occur in 2022 and 2023. In the labour market, the effects are only transferred to the number of employees to a limited extent because there is a decline in real wages and other processes also slow down the transfer. But of course, the reduced incomes of private households have a negative impact on GDP.

Table 3 Share of private household consumption expenditure on fuels by net income class (reproduced from Destatis [2021a] [2020] and own calculations [2022, 2023])

		2020 (%)	Reference scenario		Price shock scenario	
			2022 (%)	2023 (%)	2022 (%)	2023 (%)
Monthly net household income	Lower than 1300 euros	1.6	1.6	1.6	2.0	1.9
	1300 to 1700 euros	2.0	2.0	2.0	2.6	2.4
	1700 to 2600 euros	2.2	2.2	2.2	2.8	2.7
	2600 to 3600 euros	2.1	2.1	2.1	2.7	2.5
	3600 to 5000 euros	2.0	2.0	2.0	2.6	2.4
	5000 euros and higher	1.7	1.7	1.7	2.1	2.0
All households		1.9	1.9	1.9	2.4	2.3

The price shock affects private households differently according to their consumption structure. Especially in the case of heating energy, the share of disposable income that has to be spent on energy increases drastically for lower income groups, almost doubling, reaching 19% in 2022 in the lowest income group. In contrast, high-income earners are relatively much less affected. In the highest income group, the share “only” rises from 2.8% to 5%. The distribution effects are much less pronounced for fuels. Middle-income earners spend the largest percentage of their income on fuel, but the differences are limited. Low-income earners, in particular, can usually not afford car ownership, so they often do not need fuel. Moreover, the tax share for fuels is significantly higher than for gas, heating oil, and electricity, so that the relative burden remains limited. For some income groups, fuel expenses increase by 0.6 percentage points. In a study by Bach et al. (2018), a regressive distribution of the higher burden across income classes is, however, also found for the increase in fuel prices.

When interpreting the results, it must be taken into account that these are average values. There are enormous differences in heating requirements depending on the age and renovation status of a building. The difference between a subsidised new building, which achieves 40 kWh/sqm and year, and a poorly insulated old building from the 1960s can quickly be a factor of 5–10. Conversely, zero-energy and plus-energy houses are already being built that are not affected by the energy price crisis. For the income groups particularly affected, however, this means that individual households will probably have to pay twice or even three times as much for energy as the average household. It quickly becomes clear that this can no longer be managed by low- and even middle-income households without drastic cuts in heating, food, and other expenditures. The federal government has already acted and put together the first relief packages. However, so far, they are not targeted enough. The significant reduction of the energy tax for gasoline and diesel for three months in the summer of 2022 was also not targeted in terms of protecting the particularly vulnerable household groups. The same is true for the reduction of the VAT on gas starting from October. It helps every household according to its gas consumption, but the reduction from 19 to 7% will be far from enough.

The federal government must provide much greater relief for the lower income groups that rely primarily on gas, electricity, and mineral oil for heating and appliances. A per capita bonus is seen by many economists as better than general gas and electricity price caps, which the government currently favours. Firstly, the savings incentive of high prices must be maintained because gas and electricity are indeed scarce. And secondly, because consumers with low consumption—that is predominantly those on low incomes—are relieved relatively more than consumers with high consumption. Even more effective would be a relief based on individual last year's income and consumption, but such a measure is currently not administratively feasible in Germany.

The negative macroeconomic effects of high energy import prices are in significant contrast to other scenarios in which the prices of fossil fuels are raised by high CO_2 prices. In this case, the overall economic effects depend crucially on the recycling of the revenues. If the national CO_2 price in Germany is raised to 180 €/t CO_2 by 2030 and further measures such as an increased expansion of renewable energies and more building renovation are financed by the income, there will even be positive GDP effects in the order of 1.4 to 1.7% in 2030 (Lutz et al. 2021b). The main reason is that the money is spent domestically, and also induces indirect effects and additional expenditure there. In such a scenario, the distributional effects could be improved by per capita bonuses for private households. Then private households could significantly reduce their energy expenditures by 2030 not only compared to the reference, but also compared to the expenditure shares in 2015. The analysis of an environmental tax reform from 2011 came to similar conclusions (Blobel et al. 2011).

The government must also organise the decarbonization of the homes of low-income households so that they no longer depend on fossil fuel imports and their possible price fluctuations in the long term. Implementation is of course not easy. Indeed, low-income households usually have neither their own apartments nor the financial means for energy efficiency measures or the use of new technologies such as heat pumps or solar thermal energy for heating. Their landlords/landladies, in turn, will not want to take these measures if they cannot recover the costs from higher rents. State funding programs and regulatory laws will have to contribute to this change.

The comparison of the results with the calculations in Lutz et al. (2021b) makes it clear that ambitious climate mitigation, which comes with a significant reduction in the use of coal, oil, and gas, would significantly increase the resilience of the German economy to changing world market prices for fossil fuels. This could also reduce the associated regressive distribution effects. Climate policy is thus increasingly becoming a central part of environmental and social policy.

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