

Gutsch, Alexandra; Schult, Christoph

Working Paper

The German Energy Crisis: A TENK-based Fiscal Policy Analysis

IWH Discussion Papers, No. 1/2025

Provided in Cooperation with:

Halle Institute for Economic Research (IWH) – Member of the Leibniz Association

Suggested Citation: Gutsch, Alexandra; Schult, Christoph (2025) : The German Energy Crisis: A TENK-based Fiscal Policy Analysis, IWH Discussion Papers, No. 1/2025, Halle Institute for Economic Research (IWH), Halle (Saale),
<https://doi.org/10.18717/dpdtzw-4c15>

This Version is available at:

<https://hdl.handle.net/10419/309416.2>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Discussion Papers

No. 1

January 2025



The German Energy Crisis: A TENK-based Fiscal Policy Analysis

Alexandra Gutsch, Christoph Schult

<https://doi.org/10.18717/dpdtzw-4c15>

Authors

Alexandra Gutsch

Halle Institute for Economic Research (IWH) –
Member of the Leibniz Association,
Department of Macroeconomics, and Martin
Luther University Halle-Wittenberg
E-mail: alexandra.gutsch@iwh-halle.de
Tel +49 345 7753 863

Christoph Schult

Halle Institute for Economic Research (IWH) –
Member of the Leibniz Association,
Department of Macroeconomics
E-mail: christoph.schult@iwh-halle.de
Tel +49 345 7753 806

Editor

Halle Institute for Economic Research (IWH) –
Member of the Leibniz Association

Address: Kleine Maerkerstrasse 8
D-06108 Halle (Saale), Germany
Postal Address: P.O. Box 11 03 61
D-06017 Halle (Saale), Germany

Tel +49 345 7753 60

Fax +49 345 7753 820

www.iwh-halle.de

ISSN 2194-2188

The responsibility for discussion papers lies solely with the individual authors. The views expressed herein do not necessarily represent those of IWH. The papers represent preliminary work and are circulated to encourage discussion with the authors. Citation of the discussion papers should account for their provisional character; a revised version may be available directly from the authors.

Comments and suggestions on the methods and results presented are welcome.

IWH Discussion Papers are indexed in RePEc-EconPapers and in ECONIS.

The German Energy Crisis: A TENK-based Fiscal Policy Analysis

First version: 21.01.2025

This version: 27.10.2025

Abstract

We study the aggregate, distributional, and welfare effects of fiscal policy responses to Germany's energy crisis arising in 2022 using a novel ten-agent new Keynesian (TENK) model. The crisis, compounded by the COVID-19 pandemic, led to sharp price increases and significant consumption disparities. Our model, calibrated to Germany's income and consumption distribution, evaluates key policy interventions. We find that untargeted transfers had the largest short-term aggregate impact, while targeted transfers for lower-income households were most cost-effective. Other instruments yielded comparably limited welfare gains. The results highlight how targeted fiscal measures can address distributional effects and stabilize consumption during crises.

Keywords: DGE, energy crisis, fiscal policy, income distribution, TENK

JEL classification: E21, E62, Q43, Q48

1 Introduction

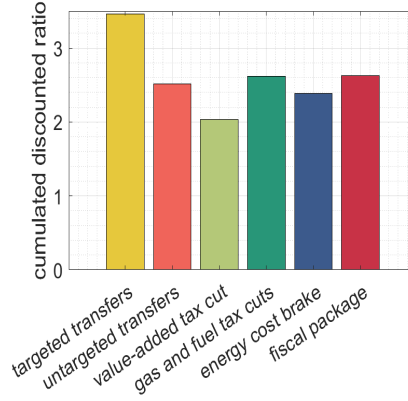
After the invasion of Ukraine by Russia in February 2022, inflation in Germany rose sharply due to concerns about energy supplies. Germany’s heavy reliance on Russian energy imports translated into substantial increases in energy and core inflation. By late 2022, the year-over-year change in the harmonized consumer price index for energy reached nearly 45 percent. While energy costs were not the only driver of overall consumer price inflation, their sharp increase significantly raised living and production expenses. Households with limited financial buffers were disproportionately affected, as higher consumption costs quickly reduced disposable income. At the same time, uncertainty about future price developments complicated decisions on consumption, savings, and investment, with direct implications for the purchasing power of household income. In response, the German government implemented a broad range of measures—including lump sum transfers, energy price caps, and tax reductions—designed to cushion households and firms and to reduce the risk of a deep recession. In this paper, we assess these interventions within a structural macroeconomic framework.

To this end, we develop—to our knowledge for the first time—a ten-agent new Keynesian (TENK) model that allows us to examine the aggregate, distributional, and welfare effects of negative energy supply shocks and fiscal policy responses in a small open economy that is highly dependent on energy imports. The model explicitly incorporates households in different financial positions, which makes it possible to capture how wealth groups react to shocks and reveal the channels through which these effects operate. We calibrate the model to German data, matching both aggregate macroeconomic indicators (GDP, consumption, inflation, energy use) and the distribution of income and consumption across deciles. First, we demonstrate that the model replicates key developments during the energy crisis. Then, we compare actual policy interventions with a counterfactual scenario without fiscal support, considering both individual instruments (transfers, tax cuts, energy cost brake) and the policy package as a whole. Finally, we conduct a welfare analysis across income groups.

We evaluate six fiscal responses against a no-policy baseline during the energy-price shock. In the *baseline*, the economy faces the realized energy shock with no fiscal intervention. We then consider: (i) *targeted transfers*—lump sum support directed to lower-income, hand-to-mouth households to stabilize essential consumption; (ii) *untargeted transfers*—a broad per-capita transfer that also reaches Ricardian households; (iii) a temporary *VAT cut for gastronomy*—modeled as a sector-specific VAT-rate reduction passed through to consumers; (iv) *gas and fuel tax cuts*—reductions in energy excise/sales taxes whose incidence scales with energy use; (v) the *energy cost brake (2023)*—a cap on the unit price paid by households up to a quota based on prior-year usage, with market pricing above the quota; and (vi) the *full package*, which combines all measures with their actual

implementation windows and magnitudes. For each scenario, we map official costs and timings into model shocks and simulate aggregate and decile-level outcomes. Figure 1.1 displays our core comparison—*fiscal effectiveness*, defined as the ratio of cumulated welfare gains to additional public debt—showing that targeted transfers deliver the highest welfare per euro of debt, untargeted transfers stabilize the most but are expensive, and price-based measures (VAT, fuel/gas cuts) and the cost brake perform less favorably on a welfare-per-debt basis.

Figure 1.1: Fiscal effectiveness: welfare to debt ratio



Note: Fiscal effectiveness measured by the ratio between welfare and debt deviations compared to baseline in case of targeted transfers (yellow), untargeted transfers (salmon red), value-added tax cut (light green), gas and fuel tax reductions (turquoise), energy cost brake (dark blue), and total fiscal package (dark red). For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

Our results show that policy trade-offs crucially depend on the fiscal cost and duration of the measures. Untargeted transfers yield the largest aggregate stabilization effects but are expensive. Targeted transfers, in contrast, deliver the highest welfare gains relative to cost, especially for low-income households. The energy cost brake, although directly addressing the main crisis variable, generates only modest welfare improvements, while temporary gas and fuel tax cuts perform better in terms of cost-effectiveness. Overall, German fiscal policy during the energy crisis stabilized consumption among lower-income households and addressed distributional concerns. Nevertheless, our analysis suggests that the greater targeting of support to vulnerable groups would have been more welfare-enhancing.

Germany represents a compelling case study of how a small open economy that relies heavily on imported energy can respond to a sudden energy crisis. Our model allows the results to extend beyond Germany and provide insights for countries facing similar vulnerabilities to external energy shocks. By calibrating our model to the German economy, we bridge theoretical analysis and empirical investigation.

The remainder of the paper is organized as follows. Section 2 reviews the related litera-

ture. Section 3 presents the model framework, while Section 4 describes the calibration strategy. Section 5 outlines the main findings, and Section 6 discusses their implications. Section 7 concludes.

2 Relevant Literature

From a more general perspective, our paper contributes to the broad branches of theoretical macroeconomic models with energy, often related to climate change issues,¹ heterogeneous agents models (HANK),² and fiscal policy analyses in general equilibrium models.³ Related to this particular energy crisis, a prominent study by [Bachmann et al. \(2024\)](#) calculates the expected loss in German GDP in the case of a Russian energy embargo. Their investigation suggests a drop in GDP of 0.5 to 3 percent for a 30 percent reduction in gas consumption in the short run, depending on the ability to substitute energy that is no longer imported from Russia. Furthermore, they prioritize the provision of aid to financially constrained households due to a higher share of energy expenditures, but without violating the energy-saving incentives. Second, they urge the adoption of renewable energy sources to substitute for fossil fuels. [Priftis and Schoenle \(2025\)](#) emphasize that potential increases in carbon emissions due to subsidizing fiscal policies during an energy crisis can be avoided by macroprudential instruments that promote the use of clean energy inputs.

Poorer households are disproportionately affected by this type of crisis, as highlighted in the report by the German Council of Economic Experts ([Grimm et al., 2022](#)). They document that personal inflation rates differ between income deciles, and poorer households experience higher consumer price index growth rates. This disparity is attributed to the larger share of energy and food expenditures in their total consumption relative to wealthier groups. Figure 2.1 illustrates this pattern, showing shares of energy and food expenditure ranging from below 4 percent for the highest income decile to nearly 9 percent for the lowest. [Grimm et al. \(2022\)](#) estimate that the maximum difference in inflation rates between deciles is 1.29 percentage points, with inflation burdens varying between 3.7 percent for the richest and 8.3 percent for the poorest decile.⁴ Poorer

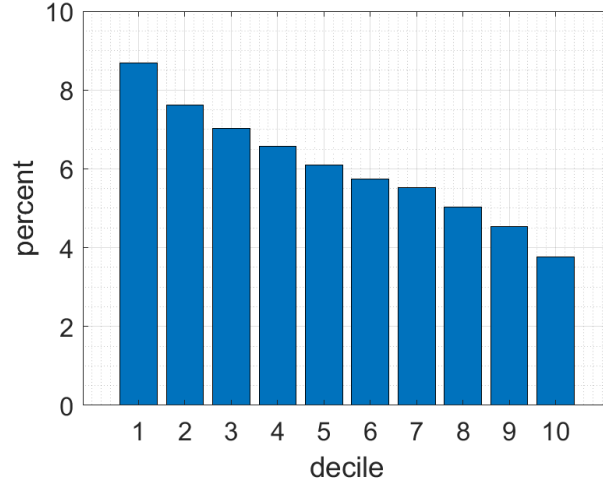
¹One example is from [Golosov et al. \(2014\)](#) about optimal fossil fuel taxes on a green transition path. [Hassler et al. \(2021\)](#) is a further paper with energy, in particular on the role of technological change under resource shortages.

²Different labor productivity risk of agents is assumed in [Aiyagari and McGrattan \(1998\)](#). For others, also related to fiscal policy, see, for example, [Bayer et al. \(2023\)](#) about the liquidity channel of fiscal policy.

³For instance, [Drygalla et al. \(2020\)](#) analyze the fiscal stimulus package during the Great Recession in Germany with a dynamic general equilibrium model. [Henkel et al. \(2021\)](#) look at the impact of fiscal transfers on spatial inequality in Germany.

⁴The inflation burden measures the additional amount a household must pay to maintain the same consumption basket as in the previous year, assuming that nominal gross wages increased by 2.9 percent (from 2021-Q2 to 2022-Q2).

Figure 2.1: Share of Energy Expenditures on Total Expenditures per Income Decile



Note: Illustration of the different energy expenditure shares of households depending on their income group during the energy crisis.

Source: Statistical Office of Germany, own exhibition.

households face a more severe burden due to their higher consumption-to-income ratio. With minimal savings, they are less able to maintain their consumption levels during price increases. In addition, lower-income households have limited substitution possibilities, as they already purchase lower-cost products. These facts underscore the greater vulnerability of lower-income households, which is in line with previous findings for the United States ([Levinson and Silva, 2022](#)). Survey data from [Peersman and Wauters \(2024\)](#) further indicate heterogeneity in consumer responses to increases in energy prices, driven by differences in income and savings, highlighting the unequal impact of the crisis. Based on Italian survey data, [Jappelli and Pistaferri \(2014\)](#) find that households with a smaller liquidity have a higher marginal propensity to consume. [Misra and Surico \(2014\)](#) assess heterogeneity between households against the background of fiscal stimulus packages. The distribution effects of changes in oil price, such as between employees with different qualification levels, were examined by [Kehrig and Ziebarth \(2017\)](#). Given all this evidence, it is reasonable to assess fiscal policy in models with different consumer groups.

Concerns about potential distributional problems raise the question of targeted support for needy households. [Celasun et al. \(2022\)](#) analyze the impact of fossil fuel inflation on private households and highlight significant differences both within and between European countries. They state out that politicians should focus on easing the burden for the most vulnerable groups instead of distorting price signals. A similar argument is provided in a follow-up by [Arregui \(2022\)](#), who recommends independent rebates on energy bills or block tariffs coupled with taxes on wealthier households. Using a HANK model, [Pieroni](#)

(2023) reports that lower-income households in particular suffer from energy shortages. but fiscal and monetary interventions can address this issue. [Fetzer et al. \(2024\)](#) stress the need for targeted instruments in England and Wales, contrary to the energy price guarantee in the United Kingdom in 2022, which has lead to advantages, especially for wealthier households with higher energy shares, threatening incentives to save energy. [Auclert et al. \(2023\)](#) bring together the three branches of the macroeconomic literature, examining the effects of fiscal and monetary policy in the presence of energy price shocks on an open economy that imports energy. In addition to different dynamics in the representative agents (RANK) and HANK models, they indicate that fiscal policy can help single countries prevent inflationary pressure and economic downturn through losses in real wages. But when implemented by all importers, energy subsidies drive world market prices under a fixed supply, and countries with low purchasing power are worse off. An other HANK framework by [Kharroubi and Smets \(2024\)](#) shows that subsidies for firms and households with low income in combination with taxes for households in the higher income range is the best strategy of a social planner to react to energy shocks.

In a related study, [Clemens and Röger \(2024\)](#) develop a two-agent new Keynesian (TANK) model with liquidity-constrained and unconstrained households and compare the case of a fossil fuel embargo to a fossil fuel price markup shock. Testing various fiscal policy intervention scenarios, they find differences in effectiveness depending on the kind of shock, which is lower under an embargo. [Roeger and Welfens \(2022\)](#) analyze fiscal measures regarding stabilizing output and employment and distributional effects in a model based on [Clemens and Röger \(2024\)](#) with gas usage. They report that a temporary gas price subsidy for electricity firms can prevent losses in output and employment and partly reduce the distributional effects of a gas crisis because of less windfall profits in the context of the merit-order system. When used in conjunction with transfers for vulnerable groups, this instrument would address economic and distributional issues. [Bayer et al. \(2023\)](#) use a HANK model with an open economy representing a country operating in a currency union. They show that under welfare aspects, an energy subsidy benefits the home country but harms the rest of the currency union, while transfers are superior.

Investigating welfare effects during an energy crisis, [Gustafsson et al. \(2025\)](#) look at the Swedish case, using a dynamic stochastic general equilibrium (DSGE) model with a domestic energy producer and liquidity (un-)constrained households. They find that subsidizing investments in the energy sector is the most effective strategy. From a welfare perspective, it is better to support vulnerable households by supplying energy vouchers. Differentiating between energy subsidies and (un-)targeted transfers financed by debt or taxes, [Blanz et al. \(2023\)](#) find that the suitability of a policy depends on whether households should be protected from so-called energy poverty or if production should be stabilized. Their DSGE model also constitutes an economy with households that have no access to financial markets. Furthermore, [Levell et al. \(2024\)](#) analyze distributive

questions against the backdrop of the recent energy crisis in the United Kingdom and find that energy subsidies and bill rebates can reduce welfare losses.

[Turco et al. \(2023\)](#) use an agent-based model with households, firms, and banks to explore the economic impacts of fiscal policy on the wealth and income distribution in the case of a fossil fuel price shock. According to their analysis, a fuel price tariff reduction and an extra profit tax on energy firms would be the most effective strategy. Similarly, [Ciola et al. \(2023\)](#) concentrate on the distributional and overall economic implications of energy shocks: positive fossil fuel price shocks, negative productivity shocks, and negative fossil fuel supply shocks. It turns out that aggregate effects do not differ, but for distributional concerns, the nature of the disturbance plays a role.

Our project diverges from prior studies by taking a broader perspective on energy as a whole. Secondly, we put more emphasis on the demand side of energy, incorporating a wide range of heterogeneity among households by considering income deciles. Our paper offers a comprehensive analysis of these distinct groups, and our TENK model can be used for further distributive and energy-related analyses. Moreover, we contribute to the literature by providing a realistic and tractable analysis with an accurate calibration of the German economy during this crisis, closely replicating the actually observed development and policy measures, and not neglecting that the energy crisis followed a pandemic.

3 TENK Model

Our model represents an open economy in which energy endowments (E_t) are treated as exogenous.⁵ In this setting, the energy consumption of companies or households constitutes a net wealth loss, reflecting the dependence of Germany on energy imports, which represent 68 percent of the total energy demand. Figure 3.1 provides an illustrative overview of the structure of the model. A part $E_{Y,t}$ of the total energy supply, including domestic energy inputs $E_{D,t}$, is used as a complementary input factor to a capital-labor bundle in the firm sector, which produces a non-energy-consumption good. The other part, $C_{E,t}$, is consumed by the household sector in combination with non-energy consumption goods.

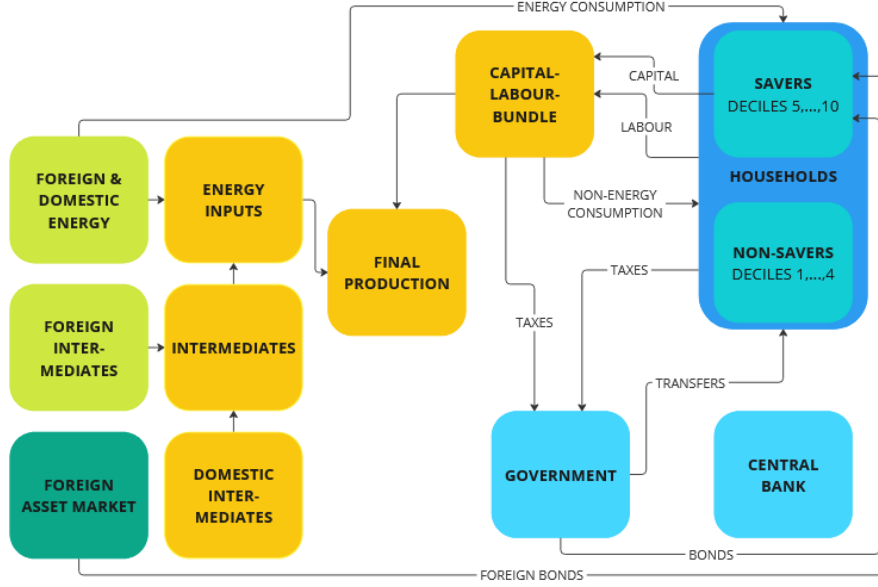
$$E_t = E_{Y,t} + C_{E,t} \quad (3.1)$$

Energy prices are set internationally and considered exogenous in our analysis. Therefore, the price $P_{E,t}$ evolves according to the following process:

$$P_{E,t} = (1 + \epsilon_{E,t})\bar{P}_E, \quad (3.2)$$

⁵Examples of other open economy models include [Christiano et al. \(2011\)](#), [Drygalla et al. \(2020\)](#), [Atkeson et al. \(2025\)](#), and [Eugeni \(2024\)](#).

Figure 3.1: Structure of the model.



Source: own exhibition.

where \bar{P}_E is the steady state energy price, and $\epsilon_{E,t}$ deviates from zero in case of a shock. Domestic energy is given as

$$E_{D,t} = \text{share}_{ED,t} \bar{E} (P_{E,t-1} / \bar{P}_E)^{\epsilon_{P_{E,t}}}, \quad (3.3)$$

with steady-state energy \bar{E} and $\epsilon_{P_{E,t}}$ as the elasticity of domestic energy inputs with respect to changes in the energy price in the last period relative to its steady-state value. All households supply labor and earn decile-specific wages. Capital, the other input factor, is owned by households that also have access to the domestic and foreign bond markets for investment opportunities. The population is divided into two groups: individuals in income deciles 5 through 10, comprising 60 percent of the population, are Ricardian agents who can save a portion of their income.⁶ Hand-to-mouth or rule-of-thumb households, on the other hand, consume their complete net labor income in each period without receiving or directing income to capital and bond investments. They react strongly to negative income shocks because of their inability to smooth consumption. Every income group pays taxes to the government: labor income taxes, consumption taxes on energy and non-energy (indirectly as value-added tax transferred by the domestic firm to the government). Savers pay a capital revenue tax and taxes on profit income. Additionally, households pay decile-specific lump sum taxes to the government or receive social transfers. The government finances expenditures through these taxes and debt, while the

⁶This fits to the value of 37.37 percent for the share of non-savers, which is estimated by Drygalla et al. (2020).

central bank reacts to fluctuations in inflation and output by setting the nominal interest rate on bonds.

3.1 Production Sector

We adopt the approach by [Atalay \(2017\)](#) and include materials in the production function. However, we only differentiate between energy and non-energy inputs. A representative firm i in the intermediate sector uses material inputs $M_{E,i,t}$ and a Cobb-Douglas bundle $CD_{i,t}$ of aggregate capital $K_{i,t}$ and total effective labor hours $N_{i,t}$.

$$CD_{i,t} = A_{i,t} K_{i,t}^\alpha N_{i,t}^{1-\alpha}, \quad (3.4)$$

where $A_{i,t}$ is the factor productivity of the bundle and α is the output elasticity of aggregate capital provided by the household sector.

$$Y_{i,t} = \left[\gamma_m^{\frac{1}{\sigma_m}} M_{E,i,t}^{\frac{\sigma_m-1}{\sigma_m}} + (1 - \gamma_m)^{\frac{1}{\sigma_m}} CD_{i,t}^{\frac{\sigma_m-1}{\sigma_m}} \right]^{\frac{\sigma_m}{\sigma_m-1}}, \quad (3.5)$$

$M_{E,i,t}$ consists of energy inputs $E_{Y,i,t}$ weighted by energy productivity $A_{E,i,t}$ and non-energy material inputs $M_{i,t}$:

$$M_{E,i,t} = \left[\gamma^{\frac{1}{\sigma}} (A_{E,i,t} E_{Y,i,t})^{\frac{\sigma-1}{\sigma}} + (1 - \gamma)^{\frac{1}{\sigma}} M_{i,t}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}. \quad (3.6)$$

These material inputs are either foreign or domestic input factors $M_{F,i,t}$ and $M_{D,i,t}$:

$$M_{i,t} = \left[\gamma_f^{\frac{1}{\sigma_f}} M_{F,i,t}^{\frac{\sigma_f-1}{\sigma_f}} + (1 - \gamma_f)^{\frac{1}{\sigma_f}} M_{D,i,t}^{\frac{\sigma_f-1}{\sigma_f}} \right]^{\frac{\sigma_f}{\sigma_f-1}}. \quad (3.7)$$

Equation (5) defines the production technology similar to [Hassler et al. \(2021\)](#) with a very small elasticity of substitution σ_m between the Cobb-Douglas-bundle and energy in the short-run, and γ_m as the energy intensity parameter. The other parameters can be understood in a similar way. Total costs are made up of interest payments for capital units to households, wage compensation for labor to workers, and the cost of energy, containing intermediate input usage:

$$\begin{aligned} Cost_{Y,i,t} &= (r_{K,t} + \delta) K_{i,t} + W_t N_{i,t} + P_{ME,t} M_{E,i,t} \\ &= (r_{K,t} + \delta) K_{i,t} + W_t N_{i,t} + (1 + \tau_{E,t}) P_{E,t} E_{Y,i,t} + P_{M,t} M_{i,t} \\ &= (r_{K,t} + \delta) K_{i,t} + W_t N_{i,t} + (1 + \tau_{E,t}) P_{E,t} E_{Y,i,t} + P_{F,t} M_{F,i,t} + P_{Y,t} M_{Y,i,t} \end{aligned}$$

W_t is the real wage expressed in relation to the gross price $P_{Y,t}$ of the numéraire good non-energy (including a value-added tax), $P_{E,t}$ the price of energy (other input prices

analogous), $r_{K,t}$ the rental rate of capital, and δ the depreciation rate. Firms pay taxes $\tau_{E,t}$ on energy inputs to the government.

Cost minimization leads to the following first-order conditions with symmetric firm i with respect to capital, labor, foreign materials, domestic materials, and energy:

$$\frac{r_{K,t}}{MC_t} = (1 - \gamma_m)^{\frac{1}{\sigma_m}} \alpha \left(\frac{Y_t}{CD_t} \right)^{\frac{1}{\sigma_m}} \frac{CD_t}{K_t} - \frac{\delta}{MC_t}, \quad (3.8)$$

$$\frac{W_t}{MC_t} = (1 - \gamma_m)^{\frac{1}{\sigma_m}} (1 - \alpha) \left(\frac{Y_t}{CD_t} \right)^{\frac{1}{\sigma_m}} \frac{CD_t}{N_t}, \quad (3.9)$$

$$\frac{P_{E,t}}{MC_t} = (1 + \tau_{E,t})^{-1} \gamma_m^{\frac{1}{\sigma_m}} \gamma^{\frac{1}{\sigma}} A_{E,t}^{\frac{\sigma-1}{\sigma}} \left(\frac{Y_t}{M_{E,t}} \right)^{\frac{1}{\sigma_m}} \left(\frac{M_{E,t}}{E_{Y,t}} \right)^{\frac{1}{\sigma}}, \quad (3.10)$$

$$\frac{P_{F,t}}{MC_t} = \gamma_m^{\frac{1}{\sigma_m}} (1 - \gamma)^{\frac{1}{\sigma}} \gamma_f^{\frac{1}{\sigma_f}} \left(\frac{Y_t}{M_{E,t}} \right)^{\frac{1}{\sigma_m}} \left(\frac{M_{E,t}}{M_t} \right)^{\frac{1}{\sigma}} \left(\frac{M_t}{M_{F,t}} \right)^{\frac{1}{\sigma_f}}, \quad (3.11)$$

$$\frac{P_{M,t}}{MC_t} = \gamma_m^{\frac{1}{\sigma_m}} (1 - \gamma)^{\frac{1}{\sigma}} \left(\frac{Y_t}{M_{E,t}} \right)^{\frac{1}{\sigma_m}} \left(\frac{M_t}{M_{E,t}} \right)^{\frac{1}{\sigma}}, \quad (3.12)$$

$$\frac{P_{ME,t}}{MC_t} = \gamma_m^{\frac{1}{\sigma_m}} \left(\frac{Y_t}{M_{E,t}} \right)^{\frac{1}{\sigma_m}}, \quad (3.13)$$

$$\frac{P_{Y,t}}{MC_t} = \gamma_m^{\frac{1}{\sigma_m}} (1 - \gamma)^{\frac{1}{\sigma}} (1 - \gamma_f)^{\frac{1}{\sigma_f}} \left(\frac{Y_t}{M_{E,t}} \right)^{\frac{1}{\sigma_m}} \left(\frac{M_{E,t}}{M_t} \right)^{\frac{1}{\sigma}} \left(\frac{M_t}{M_{D,t}} \right)^{\frac{1}{\sigma_f}}. \quad (3.14)$$

Aggregate labor hours are composed as a bundle of decile-specific labor inputs $N_{h,t}$, with substitution elasticity σ_N :

$$N_t = \left(\sum_{h=1}^{h=10} N_{h,t}^{1/\sigma_N} \right)^{\sigma_N}. \quad (3.15)$$

First-order conditions with respect to decile-specific labor input are then given as

$$W_{h,t} = \left(\frac{N_{h,t}}{N_t} \right)^{\frac{1-\sigma_N}{\sigma_N}} W_t. \quad (3.16)$$

As in [Calvo \(1983\)](#),⁷ a producer can set the individual gross price $P_{Y,i,t} = (1 + \tau_{VAT,t}) P_{Y,i,t,net}$ in our model, including a value-added tax (VAT) rate $\tau_{VAT,t}$, with a probability of $(1 - \theta_p)$ optimally. The other fraction θ_p of firms acts according to the pricing rule

$$P_{Y,i,t} = P_{Y,i,t-1}.$$

The demand for intermediate inputs is given as

$$Y_{i,t} = \left(\frac{P_{i,t}}{P_t} \right)^{-\frac{s_p}{s_p-1}} Y_t,$$

⁷We follow here [Christiano et al. \(2011\)](#).

with $\varsigma_p > 1$ capturing the market power of a firm that maximizes discounted profit

$$E_t \sum_{s=0}^{\infty} (\theta_p \beta)^s \nu_{t+s} D_{i,t+s},$$

where

$$D_{i,t+s} = 1/(1 + \tau_{VAT,t}) \tilde{P}_{Y,i,t} Y_{i,t+s} - \tilde{P}_{Y,i,t+s} m c_{t+s} Y_{i,t+s}$$

with respect to the optimal price $\tilde{P}_{Y,i,t}$. The real marginal costs $m c_{t+s}$ are the same for all producers, and $(\theta_p \beta)^s \nu_{t+s}$ is the stochastic discount factor of the firm owners. Staggered price setting causes price dispersion $p_{Y,t}^*$, such that the output under flexible prices Y_t and the actual output produced Y_t^* are related as follows:

$$Y_t = p_{Y,t}^* Y_t^*. \quad (3.17)$$

3.2 Household Sector

Domestically produced non-energy goods $C_{NE,t}$ are consumed together with energy $C_{E,t}$ by income groups $h = 1, \dots, 10$ of the same size. With decile-specific utility weight ψ_h for energy and an elasticity of substitution ϵ between non-energy and energy, the consumption basket is defined as

$$C_{h,t} = \left[(1 - \psi_h)^{\frac{1}{\epsilon}} C_{NE,h,t}^{\frac{\epsilon-1}{\epsilon}} + \psi_h^{\frac{1}{\epsilon}} C_{E,h,t}^{\frac{\epsilon-1}{\epsilon}} \right]^{\frac{\epsilon}{\epsilon-1}}. \quad (3.18)$$

The instantaneous utility function is given by

$$U_{h,t} = \log C_{h,t} - A_{h,t} \frac{N_{h,t}^{1+\varphi}}{1+\varphi},$$

where $N_{h,t}$ is the individual labor supply per representative household with disutility weight $A_{h,t}$ in a decile, and φ is the inverse Frisch elasticity. Depending on the type of household, there are different budget constraints.

Ricardian Households: We refer to households with savings possibilities as Ricardian—or savers. They receive capital and wage income from the firm as well as income from public and foreign bond holdings. Their capital stock evolves according to the law of motion

$$K_{h,t+1} AC_{K,h,t} = (1 - \delta) K_{h,t} + I_{h,t}. \quad (3.19)$$

and they can decide in every period on their investments $I_{h,t}$. Changes in capital cause adjustment cost $AC_{K,h,t}$. Ricardians maximize their utility with respect to the consumption of non-energy and energy goods, capital and domestic, as well as foreign bonds,

subject to the real budget constraint in terms of the non-energy good price

$$\begin{aligned}
& C_{NE,h,t} + (1 + \tau_{E,t} + \tau_{CE,h,t})P_{E,t}/P_{Y,t}C_{E,h,t} \\
& + K_{h,t+1}AC_{K,h,t} + AC_{B,h,t}B_{h,t+1} + AC_{B,F,h,t}B_{F,h,t+1}P_{F,t} + T_{h,t} \\
& = [1 + (1 - \tau_{K,t})r_{K,t}]K_{h,t} + (1 - \tau_{W,h,t})W_{h,t}N_{h,t} + \frac{1 + r_{B,t-1}}{1 + \pi_{Y,t}}B_{h,t} \\
& + \frac{1 + r_{F,t-1}}{1 + \pi_{Y,t}}B_{F,h,t}s_{F,t} + (1 - \tau_{D,h,t})D_{h,t}/P_{Y,t} + cost_{brake,h,t} + cost_{T,h,t},
\end{aligned}$$

where $\tau_{E,t}$ and $\tau_{CE,h,t}$ are general and individual energy consumption sales tax rates, $\tau_{W,h,t}$ are decile specific labor income tax rates, and $\tau_{K,t}$ is a capital revenue tax rate. $T_{h,t}$ are lump sum taxes or social transfers. Firm profits D_t are distributed according to the decile-specific share on aggregate capital $share_{K,h}$ and taxed by rate $\tau_{D,h,t}$. The term $cost_{brake,h,t} + cost_{T,h,t}$ concludes several fiscal policy instruments, see section 4.2 for details. Capital and bond adjustment costs are given as

$$\begin{aligned}
AC_{K,h,t} &= \exp^{\kappa_h(I_{h,t} - share_{K,h}I_{t-1})}, \\
AC_{B,h,t} &= \exp^{\kappa_{B,h}(B_{h,t} - \bar{B}_h)}, \\
AC_{B,F,h,t} &= \exp^{\kappa_{B,F,h}(B_{F,h,t} - \bar{B}_{F,h})}.
\end{aligned}$$

Lifetime utility maximization leads to the following first-order conditions:

$$\Lambda_{h,t} = C_{h,t}^{-1}(1 - \psi_h)^{\frac{1}{\epsilon}} (C_{NE,h,t}/C_{h,t})^{-\frac{1}{\epsilon}}, \quad (3.20)$$

$$\Lambda_{h,t}P_{E,t}/P_{Y,t}(1 + \tau_{E,t} + \tau_{CE,h,t}) = C_{h,t}^{-1}\psi_h^{\frac{1}{\epsilon}} (C_{E,h,t}/C_{h,t})^{-\frac{1}{\epsilon}}, \quad (3.21)$$

$$\Lambda_{h,t}AC_{K,h,t} = \beta\mathbb{E}_t\Lambda_{h,t+1} [1 + (1 - \tau_{K,t})r_{K,t+1}], \quad (3.22)$$

$$\Lambda_{h,t}AC_{B,h,t} = \beta\mathbb{E}_t\Lambda_{h,t+1} \frac{1 + r_{B,t}}{1 + \pi_{Y,t+1}}, \quad (3.23)$$

$$\Lambda_{h,t}AC_{B,F,h,t} = \beta\mathbb{E}_t\Lambda_{h,t+1} \frac{1 + r_{F,t}}{1 + \pi_{Y,t+1}} s_{F,t+1}. \quad (3.24)$$

Euler Equations (3.22) to (3.24) show the consumption smoothing possibility of Ricardians because they can freely choose their amount of savings and decide between investment alternatives. Note that $s_{F,t}$ is the exchange rate.⁸ $r_{F,t}$ and $r_{B,t}$ are interest rates for

⁸Assume that a domestic investor buys bonds worth of 100 US dollars today. The value is then given in euros per dollar, the exchange rate then is $s_{F,t} = 1 \frac{EUR}{USD}$. After one year we get a return of $100USD \times (1 + r_{F,t})s_{F,t+1}/s_{F,t}$, because the investment is denominated in the foreign currency which has to be changed back into domestic currency at exchange rate $s_{F,t+1}$. This amount has to be changed back into euros given the exchange rate $s_{F,t+1} = 2EUR/USD$. That's an appreciation of the foreign currency

foreign and domestic bonds $B_{F,h,t}$ and $B_{h,t}$ and are equal for all households.

Non-Ricardian Households: Missing investment possibilities are the difference from the other group of households, so-called non-Ricardians, hand-to-mouth, or rule-of-thumb households, as in Bilbiie (2008) and Galí et al. (2007). They account for 40 percent of the total population. Given their budget constraint

$$\begin{aligned} C_{NE,h,t} + (1 + \tau_{E,t} + \tau_{C,E,h,t})P_{E,t}/P_{Y,t}C_{E,h,t} + T_{h,t} \\ = (1 - \tau_{W,h,t})W_{h,t}N_{h,t} + cost_{brake,h,t} + cost_{T,h,t}, \end{aligned}$$

they get similar first-order conditions as the savers, but no Euler equations. That implies different responses to shocks, since these households cannot use savings in the case of a crisis and spend all of their net income on consumption.

Wage Setting: As in Christiano et al. (2011), all various households j per decile group have wage-setting power, but only a fraction $1 - \theta_w$ can reset their wage optimally in the current period. Other households follow the rule

$$W_{h,j,t+1} = \tilde{\Pi}_{W,h,t+1} W_{h,j,t},$$

where

$$\tilde{\Pi}_{W,h,t+1} = (1 + \pi_{h,t})^{\kappa_w} (1 + \pi_h)^{1-\kappa_w}, \quad \kappa_w \in (0, 1),$$

when setting their wage. $\tilde{\Pi}_{W,h,t+1}$ is the underlying decile-specific expected optimal wage growth, and κ_w is an indexation parameter that determines the degree to which this inflation factor depends on current or steady-state price inflation. The demand for labor varieties is given as

$$h_{h,j,t} = \left(\frac{W_{h,t}}{W_{h,j,t}} \right)^{-\frac{\varsigma_w}{\varsigma_w - 1}} N_{h,t}, \quad (3.25)$$

and households optimize their expected lifetime disutility from labor, subject to their net compensation for hours worked. Due to the staggered wage adjustment, there will be wage dispersion $w_{h,t}^*$, which will determine the link between labor hours under flexible prices $N_{h,t}^*$ and effective labor hours $N_{h,t}$:

$$N_{h,t}^* = w_{h,t}^* N_{h,t}. \quad (3.26)$$

and a depreciation of the domestic currency which results in an effective return of $200EUR \times (1 + r_{F,t})$.

3.3 Public Sector

In the public sector, real government consumption of non-energy G_t and potential transfers to households are financed by collected real tax revenues TR_t (in terms of $P_{Y,t}$), lump sum taxes, and debt:⁹

$$G_t = TR_t + T_t + B_t - \frac{1 + r_{B,t-1}}{1 + \pi_{Y,t}} B_t - cost_{brake,t} - cost_{T,t}, \quad (3.27)$$

where

$$TR_t = \sum_{h=1}^{h=10} \left(\frac{(\tau_{E,t} + \tau_{CE,h,t}) P_{E,t}}{P_{Y,t}} C_{E,h,t} + \tau_{W,h,t} W_t N_{h,t} \right) + \frac{\tau_{E,t} P_{E,t}}{P_{Y,t}} E_{Y,t} \\ + \frac{\tau_{VAT,t}}{1 + \tau_{VAT,t}} Y_t^* - \frac{\tau_{VAT,t} P_{M,t}}{P_{Y,t}} M_t + \sum_{h=1}^{h=6} \left(\tau_{K,t} r_{K,t} K_{h,t} + \frac{\tau_{D,h,t}}{P_{Y,t}} D_{h,t} \right).$$

In the case of an energy cost brake, the government has to pay $cost_{brake,t}$; in the case of transfer policies, it pays $cost_{T,t}$. Lump sum taxes react according to the fiscal rule

$$\frac{T_t}{Y} - \frac{T}{Y} = \phi_b \left(\frac{B_{t-1}}{Y} - \frac{B}{Y} \right) + \phi_g \left(\frac{G_t}{Y} - \frac{G}{Y} \right), \quad (3.28)$$

which implies that they react to deviations in the public debt-to-GDP share and the government spending-to-GDP ratio as in [Galí et al. \(2007\)](#).

3.4 Monetary Policy

The central bank reacts to deviations of inflation from steady-state $\bar{\pi}$ and changes in output. Parameters ϕ_π and ϕ_y capture the intensity of this reaction. η_r is an interest rate smoothing parameter, since the European Central Bank operated for a long time at the zero lower bound and gradually increased the nominal interest rate during the energy crisis. $\epsilon_{r,t}$ is a term for possible monetary policy shocks.¹⁰

$$\frac{1 + r_{B,t}}{1 + \rho} = \left(\frac{1 + r_{B,t-1}}{1 + \rho} \right)^{\eta_r} \left[\left(\frac{1 + \pi_t}{1 + \bar{\pi}} \right)^{\phi_\pi} \left(\frac{Y_t}{Y_{t-1}} \right)^{\phi_y} \right]^{1 - \eta_r} \exp(\epsilon_{r,t}) \quad (3.29)$$

⁹The VAT rate is levied on the net price $P_{Y,t,net} = 1/(1 + \tau_{VAT,t}) P_{Y,t}$, so the firms pay $\tau_{VAT,t} P_{Y,t,net} = \tau_{VAT,t}/(1 + \tau_{VAT,t}) P_{Y,t}$ per sold unit to the public sector. VAT payments for intermediates must be paid back to the firms, otherwise there would be double taxation.

¹⁰This rule is quite similar to the linear rule of [Christiano et al. \(2011\)](#).

3.5 Rest of the World

As small open economy, Germany conducts trade with the rest of the world. Nominal net exports NX_t are given as

$$NX_t = P_{Y,t}X_t - P_{F,t}M_{F,t} + P_{E,t}(E_{D,t} - E_t), \quad (3.30)$$

where X_t are exports to the rest of the world. Since there is also domestic energy production, domestic energy consumption is corrected by domestic energy supply, which is part of energy production inputs.

3.6 Market Clearing

We assume that all markets are cleared in equilibrium. The gross domestic product in nominal terms consists of private consumption expenditures, investments, government spending, and nominal net exports:

$$GDP_t = P_{Y,t}C_t + P_{Y,t}I_t + P_{Y,t}G_t + NX_t$$

4 Data and Calibration

We use our TENK model to analyze actual implemented fiscal policy measures to mitigate the impacts of the energy crisis in Germany. To approximate data for consumption, GDP, (non-)energy inflation, and energy use for the total time period, we set several shock series. Time series data start in 2004-Q1, where net foreign asset positions have been approximately equal to zero, so that we declare this period the steady-state in our open economy model.¹¹ Our last observation is from 2025-Q1. The distributional key variables are matched to data at the decile level.

4.1 Calibration of Key Structural Parameters

Our calibration reflects a quarterly capital depreciation rate of 1.5 percent, as in [Drygalla et al. \(2020\)](#), and a time preference rate of 0.1 percent. The energy share of total production is set to 2.59 percent. This value is calculated given OECD input-output tables for Germany in 2018. For capital, it is set to the usual value of 30 percent, resulting in a labor share of around 67 percent. We choose a low elasticity of substitution between energy and non-energy in the production and household sectors. This decision reflects the limited

¹¹For determining the steady-state period, we consulted data from the [Bundesbank](#) on balance sheets from 1999 to 2022. We subtracted liabilities to foreign countries from claims on foreign countries relative to GDP.

Table 4.1: Calibration of parameters.

Parameter		Value (Source)
$share_E$	energy share on GDP	0.0259 (OECD)
δ	depreciation rate of capital	0.015 (DHK)
ρ	time preference rate	0.001 (calibrated)
φ	inverse Frisch elasticity of labor supply	1 (calibrated)
ϵ	substitution elasticity (non-)energy consumption	0.12 (calibrated)
σ_M	elasticity of substitution capital-labor and energy	0.1 (calibrated)
θ_p	degree of price rigidity	≈ 0 (calibrated)
θ_w	degree of wage rigidity	0.8 (calibrated)
κ_w	wage inflation indexation parameter	1 (CWT)
ς_p	mark-up parameter production sector	1.2 (CWT)
ς_w	mark-up parameter labor markets	1.8 (calibrated)
ϕ_π	monetary policy inflation reaction parameter	1.5 (calibrated)
ϕ_y	monetary policy output reaction parameter	0.25 (calibrated)
ρ_ν	monetary policy shock persistency	0.5 (calibrated)
η_r	interest rate smoothing parameter	0.87 (CWT)
η_g	government deficit reaction	0.86 (calibrated)

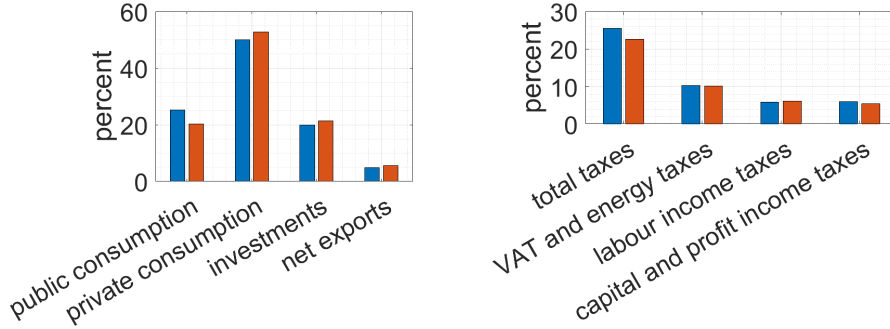
Sources: [Christiano et al. \(2011\)](#) (CWT), [Drygalla et al. \(2020\)](#) (DHK) and OECD input-output-tables. Other parameters are calibrated based on a common range of values in the literature.

ability to react by using different inputs or consumption goods in case of rising energy prices in the short run. The Frisch elasticity of labor supply is equal to 1 for households. We set the degree of wage rigidity to 0.75 and the markup parameters determined by the substitution elasticity between production and labor input to 1.2 as in [Christiano et al. \(2011\)](#). The monetary policy parameters are equal to $\phi_\pi = 1.5$, $\phi_y = 0.25$, and $\eta_r = 0.87$ for the smoothing parameter as in [Christiano et al. \(2011\)](#). We assume a zero inflation steady-state. The values of the parameters are documented in Table 4.1; for a complete overview, please consult the Appendix.

Hand-to-mouth consumers are 40 percent of the population, according to [Drygalla et al. \(2020\)](#). Our model replicates the observed income and consumption distribution. For this purpose, we use data from the income and consumption survey provided by the German Statistical Office, as well as income data from the socio-economic panel by DIW. Figure 4.2 compares the steady-state distribution between the model and the data. This excellent fit to the data is done using different instruments, such as tax rates and shares, in our model. For further information, please check the Appendix.

At the aggregate level, we use data from the Eurostat and OECD input-output tables to calculate shares related to the gross domestic product. Furthermore, based on tax revenue data from the German Statistical Office, we check if our model can also predict the steady-state shares of collected taxes in relation to gross domestic product. Figure

Figure 4.1: Aggregate shares on GDP.
expenditure shares on GDP tax revenue shares on GDP



Note: steady-state shares of public spending, private consumption expenditures, investments and net exports on GDP (left); steady-state shares of aggregate tax revenues on GDP (right). Comparison between model (blue) and data (orange). Sources: Eurostat and Statistical Office of Germany.

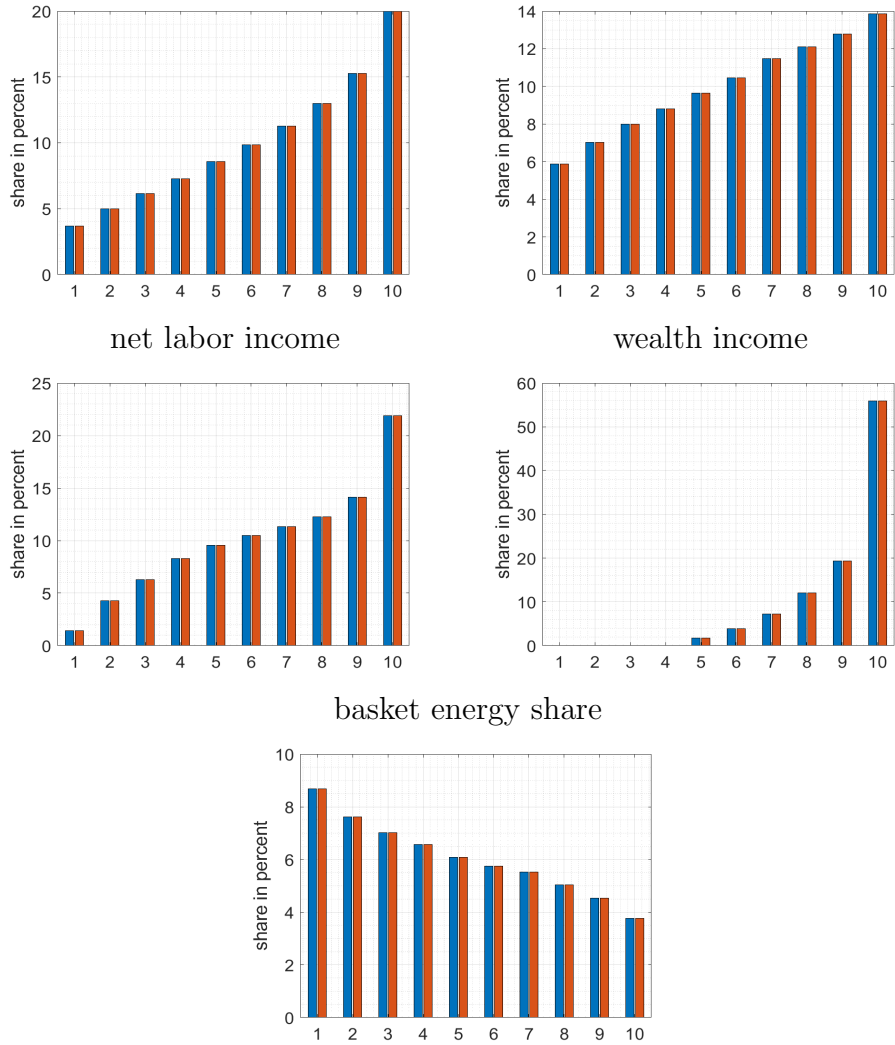
4.1 shows the comparison between the data and the model.

4.2 Fiscal Intervention

In response to the energy shock, the German government implemented a broad swathe of fiscal policy measures. Our instruments can directly affect all households or company owners. In addition, our model explicitly considers instruments targeting different deciles. There have been three relief packages and a so-called *Abwehrschirm* (German for defense shield), where only the defense shield has a volume of around 200 billion euros. Hence, together with the measures during the COVID-19 crisis, the 2020s have been characterized by significant fiscal interventions. In part, there has been an overlap of instruments related to COVID-19 and the energy crisis. Our main source is Table 1 of [Bayer et al. \(2025\)](#), where all support measures are presented with cost estimates for each year. We calculate the specific amount in euros per quarter, given the respective periods of implementation (as budget effectiveness can differ).

After that, we allocate them to different policy instruments in the model. There are three groups of transfer instruments: transfers to all deciles (for example, one-off child benefit bonus and long-distance commuter allowance), transfers to Ricardians (for example, business aid), and transfers targeted to poorer deciles like the non-Ricardians (for example, one-off payments to social transfer recipients and a heating subsidy for housing benefit recipients). Furthermore, we model the energy cost brake as described in Section 5. Another energy-related measure has been the reduction of the sales tax on gas from 19 percent to 7 percent. In addition, the energy tax on fuel has been reduced. Furthermore, we will also look at the isolated effect of the temporary reduction in the VAT rate for the gastronomy sector, which was instituted during the COVID-19 recession. Section 5 provides information on the respective simulated policy measures.

Figure 4.2: Distribution of income and consumption.
consumption expenditures energy expenditures



Note: steady-state consumption and income shares in percent per decile: share of individual on aggregate consumption expenditures, share of individual on aggregate energy expenditures, share of individual energy expenditures on individual total consumption expenditures, share of individual on aggregate net labor income, share of individual on aggregate wealth income. Comparison between model (blue) and data (orange).

Sources: Statistical Office of Germany and Socio Economic Panel, DIW Berlin.

4.3 Aggregate Dynamics and the Energy Crisis

Following the COVID-19 crisis, it has become clear that the economy was far from a long-term equilibrium when the energy crisis occurred. Our open economy set-up requires a balanced long-run foreign net wealth position and therefore an external trade balance equal to zero. Consequently, we start in 2004-Q1, the last time the net foreign asset position was zero in Germany. We replicate the actual deviations from the trend of GDP, consumption, (non-)energy inflation, and energy use, given the implemented mix of fiscal policy measures in our period of interest, the energy crisis.

Our model captures the development of these aggregate variables, considering all actual policies implemented using productivity shocks on the supply side to match production, capital accumulation shocks on the demand side to replicate consumption, inflation shocks to capture price development, and energy efficiency shocks to determine the total energy use (see Figure 4.3). Note that the data report the actual situation in Germany given the fiscal response; consequently, we use the case with all instruments for the matching scenario. The Appendix provides explanations for the aggregate data and the matching procedure.

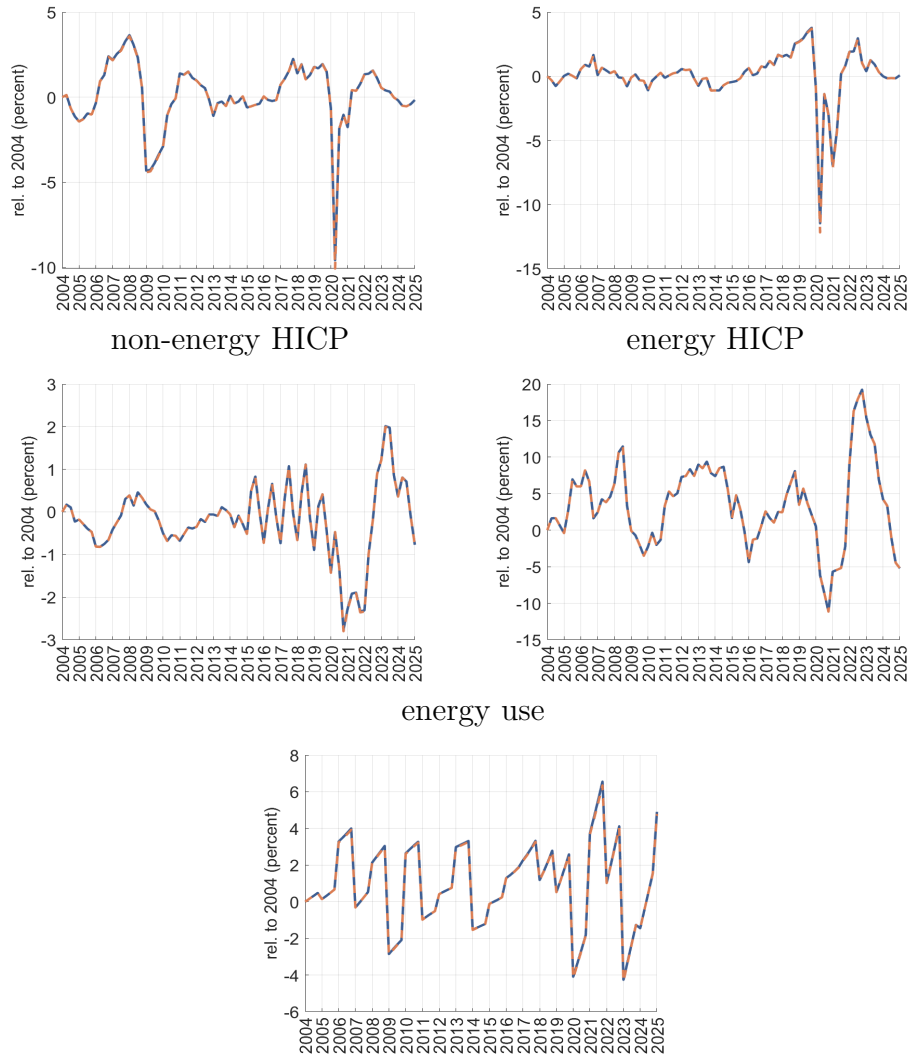
5 Effectiveness of Policy Measures

The analysis begins by examining the economic effects of the energy crisis under a baseline scenario without a fiscal reaction. Therefore, the scenario represents a counterfactual world without any policy interventions. We then assess the impact of targeted transfers, focusing on low-income deciles. Next, we compare them to untargeted transfers that address all income groups. Additionally, we evaluate the implications of a value-added tax adjustment in the hospitality and restaurant sector, as well as instruments such as reductions in gas and fuel taxes. The analysis also considers the role of an energy cost brake designed to limit energy bills. Finally, we examine the combined effect of all measures, providing a comprehensive overview of possible policy responses to the energy crisis.

5.1 Energy Crisis Without Policy Response

The effects on the aggregate level without policy interventions highlight the differences between the COVID-19 recession and the subsequent energy crisis (see Figure 5.1 and the Appendix). During COVID-19, GDP dropped by almost 10 percent compared to 2004-Q1, while during the energy crisis, it remained relatively stable. In a counterfactual world, consumption declines without any policy interventions during the energy crisis, while quarterly energy inflation matches the observed development until 2025-Q1. Compared to the unprecedented impact of COVID-19, the energy crisis appears insignificant, but

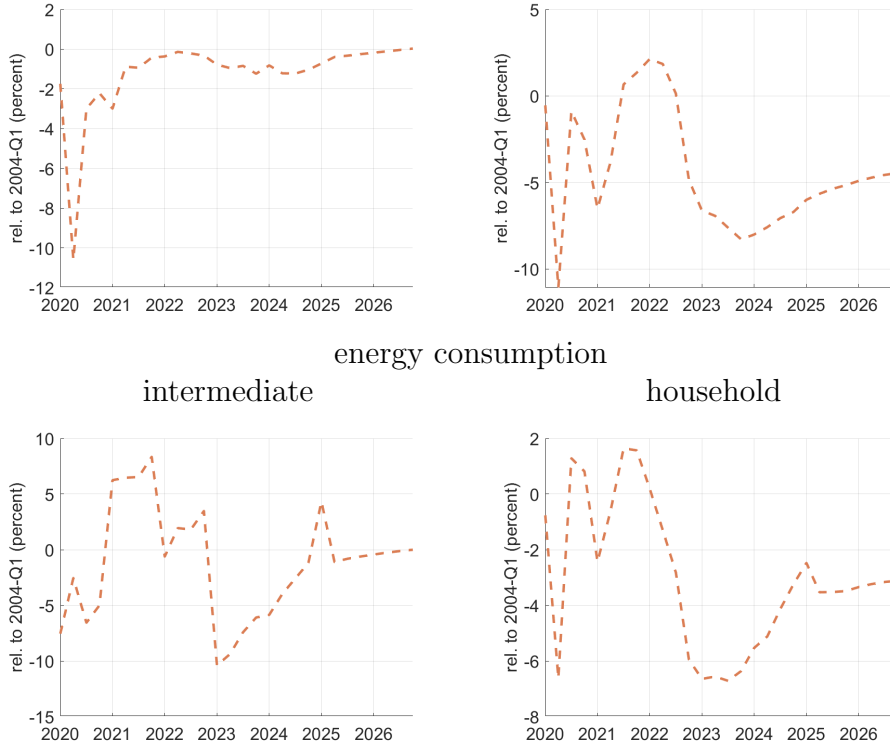
Figure 4.3: Development of aggregate key variables over time.
real GDP consumption



Note: Data from the model (solid blue) are results from simulations with the actually implemented fiscal policy mix in Germany during the energy crisis and show the deviation from 2004-Q1. Actual quarterly data (orange dashed) are HP-filtered and represent the deviation from long-term trend with 2004-Q1 as reference period.

Sources: Eurostat, AGEBA and own computation. For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

Figure 5.1: Dynamics on aggregate level without policy intervention.
GDP aggregate consumption

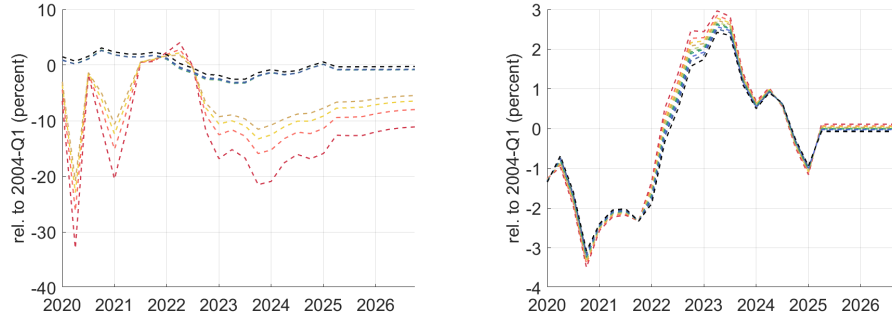


Note: Development of gross domestic product (GDP), consumption expenditures (CONS), energy input (EY), and energy consumption (CE) in the baseline scenario without any fiscal intervention. For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

there are certain mechanisms at work. More specifically, it shows that GDP has not returned to pre-COVID-19 levels, revealing a long-term downward trend since 2004-Q1. Higher energy costs will not only reduce energy inputs by 26 percent at the peak but also the use of capital-labor compared to 2004-Q1. That leads to a drop in wages and the rental rate for capital. This loss of income and the higher cost for energy consumption, which is complementary to non-energy consumption, will reduce energy and total consumption by around 7 percent at the peak. In total, GDP will shrink by around 1.5 percent at maximum, and total energy use matches the fall of 6 percent in 2022, 9 percent in 2023, and 1 percent in 2024, relative to the respective previous year on average. Investments exhibit significant volatility in response to changes in the interest rate. Government debt rises in both crises. During the early deflationary period of the COVID-19 pandemic, interest rates for bonds decreased. In contrast, in the subsequent quarters marked by expected inflation, these interest rates increased.

There are differences at the household level in the reactions of income deciles and individual changes in the consumer price index (see Figure 5.2). Deciles at the bottom of the income distribution react sensitively to the increase in energy prices in comparison to

Figure 5.2: Dynamics on decile level without policy intervention.
consumption price index



Note: Development of decile-specific consumption and price index in the baseline scenario without any fiscal intervention for decile 1 (dark red), decile 2 (salmon red), decile 3 (yellow), decile 4 (ocher yellow), decile 5 (light green), decile 6 (green), decile 7 (turquoise), decile 8 (blue), decile 9 (dark blue), and decile 10 (black). For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

unconstrained households and have a more volatile response over time. In contrast to the enormous impact on poorer households, the consumption decline of the wealthy is almost negligible. One reason is that their consumption directly follows the loss of income. Second, their share of energy in the consumption basket is higher, so that the decile-specific inflation rate depends more on the development of energy prices. In general, the energy crisis leads to a recession and has distributional implications. Lower-income deciles suffer more from rising energy prices than Ricardians. Our findings from this simulation raise the question of how policy interventions change the effects of the energy crisis. Therefore, the following scenarios will discuss instruments that have been implemented by the German government.

5.2 Targeted Transfers

One measure that addresses these distributional concerns is targeted lump sum transfers to constrained households. We understand these overall as targeted measure because they directly affect vulnerable groups during this crisis. They can potentially allow balancing consumption expenditures in times of losses in purchasing power of income. The German government decided on a wide range of supportive measures, listed in Table 5.1.

In total, these interventions account for approximately 0.25 percent of the German nominal GDP between 2022 and 2026. Hence, we calibrate the size of transfers to the respective share of GDP, distributed equally among deciles 1 to 4. In the model, we use quarterly values depending on when a single measure has been implemented and the extent of the fiscal costs in the respective year.

Solid lines represent the effects of the policy in Figures 5.3 and 5.4 compared to the dotted baseline without policy (see the Appendix for additional figures). An increase

Table 5.1: Targeted measures to liquidity constrained households in Germany.

Lump Transfer Policy Measure	Cost (Bill. Euros)
Payment for recipients of unemployment benefit and social transfers 100/200 euros	1.2
Bonus for children in poverty	3.6
Heating cost subvention for low-income households and housing benefit recipients	1.0
Increase in minimum wage and changes for marginal employment	-0.7
Pensioner's bonus (300 euros)	6.4
Student bonus (200 euros)	0.7
Housing benefit reform	11.6
Introduction citizens money	21.2
Increase in midi-job limits	3.2
Elimination of double taxation of pension contributions	5.0
Total sum	53.2
Approximate share on nominal GDP 2022-2026	0.25%

Source: Bayer et al. (2023b), Table 1. Own choice of allocation to targeted transfers. GDP data are from AMECO6.

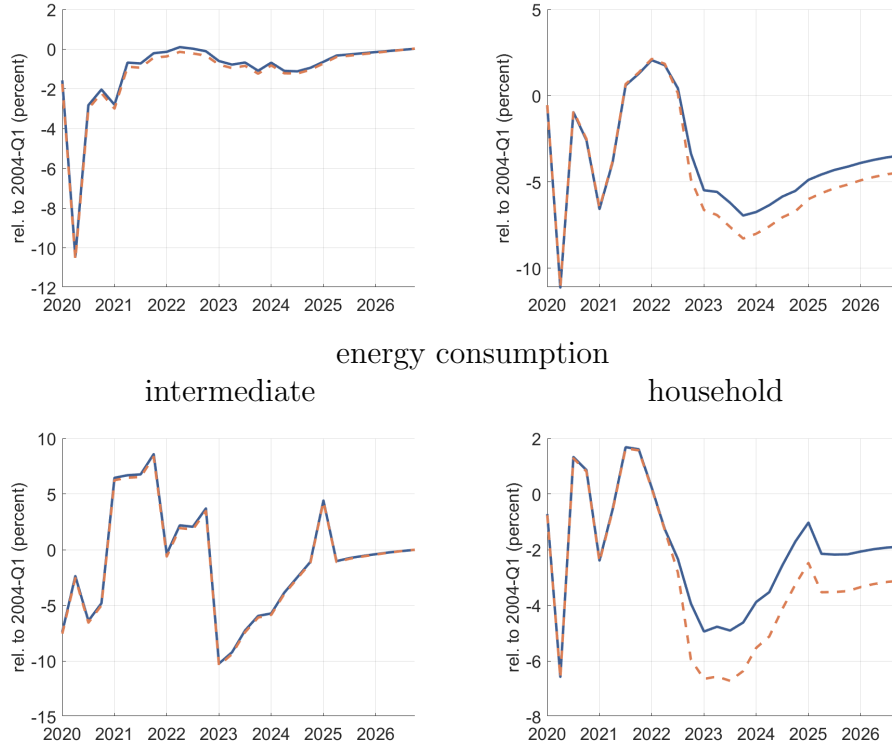
in aggregate total and energy consumption, as well as GDP, appears compared to the baseline. Energy inputs for production do not react significantly, nor do decile-specific consumer price indices. Labor income increases relative to the baseline, and there is a larger stock of capital with a slightly lower rental rate; furthermore, public debt reacts significantly, but the interest rate remains stable. Targeted households are better off than they would be with no intervention in terms of consumption, while a very small negative spillover effect can be observed on Ricardian households that have investment possibilities and are aware of potential future tax increases after costly interventions.

5.3 Untargeted Transfers

Differently, some measures affected all households or only the richer deciles in a direct way. As a next step, we simulate a scenario with those bundled as two instruments, again modeled as transfers and matching the quarterly cost as a share of GDP in our model. Table 5.2 provides an overview of the single items in this basket, which represent around 1.21 percent of GDP.

Figures 5.5 and 5.6 present the results (see the Appendix for additional figures). These untargeted transfers have a comparable qualitative impact on the economy, but note that the government spent a much larger amount of money on them, and the effects are significantly stronger. In this case, hand-to-mouth households also benefit from the political intervention, while wealthier deciles slightly reduce their consumption, smoothed over time. They shift additional available income toward capital. Given the large share of total capital stock, the richest decile prioritizes it and has a clear negative response to consumption. Again, there is no difference in individual price indices. Given the huge size of the shock, in this scenario, lower-income deciles benefit so much from the intervention

Figure 5.3: Dynamics on aggregate level with targeted transfers.
GDP aggregate consumption



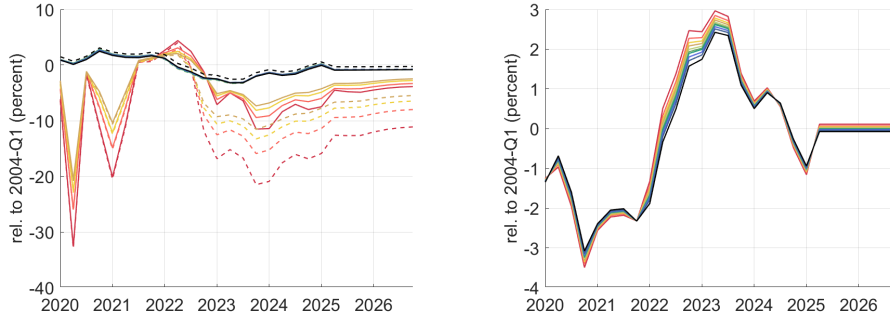
Note: Development of gross domestic product (GDP), consumption expenditures (CONS), energy input (EY), and energy consumption (CE) in the fiscal policy scenario (solid line) compared to the baseline scenario without any fiscal intervention (dashed line). For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

that they are even better off than in their pre-crisis state or long-run equilibrium.

5.4 Value-Added Tax Reduction

A further instrument that affected all consumers has been the temporary 19 to 7 percent reduction in the value-added tax rate for restaurants and catering services, which was prolonged after the pandemic. During the double crisis, it was active from the third quarter of 2020 to the last quarter of 2023. According to [Bayer et al. \(2025\)](#), the total cost of this measure has been around 3.3 billion euros, equal to 0.016 percent of GDP in the respective time span, where we again take the values as well as projections from the AMECO6 database. Instead of matching the cost, we take the average share of monthly expenditures for restaurants and catering services on total private consumption purchases from the German Statistical Office income and consumption survey 2018 and calculate, respectively, the decrease in the VAT rate. Quantitatively, the responses are comparable, but the effects are much smaller, as can be expected given the much larger volume of the transfer measures (see Figure 5.7 and the Appendix). Figure 5.8 presents

Figure 5.4: Dynamics on decile level with targeted transfers.
consumption price index



Note: Development of decile-specific consumption and price index for decile 1 (dark red), decile 2 (salmon red), decile 3 (yellow), decile 4 (ocher yellow), decile 5 (light green), decile 6 (green), decile 7 (turquoise), decile 8 (blue), decile 9 (dark blue), and decile 10 (black) in the fiscal policy scenario (solid lines) compared to the baseline scenario without any fiscal intervention (dashed lines). For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

the distributional impact of the tax reduction. Again, we do not see any difference in the decile-specific consumer price index, and lower-income deciles benefit from the cut in terms of consumption, while the wealthy are almost unaffected.

5.5 Gas and Fuel Tax Reduction

In the next step, we look at the gas and fuel tax reductions. Given different shares of energy expenditures in the consumption basket depending on the financial situation of households, we can also expect a distributive impact. The gas tax reduction cost about 13.4 billion euros, and the fuel tax cut amounted to around 3.2 billion euros, which makes 0.063 percent and 0.016 percent of nominal GDP, respectively. As for the other instruments, we use here [Bayer et al. \(2025\)](#) and AMECO as sources. Similarly to the last scenario, we do not match the cost, but calculate the decrease in the energy tax rate based on the share of gas on total energy use, as well as the usage of different mineral oils and natural gas from the AGEB Annual Reports 2022. This leads to a decrease of 2.8 percentage points in the gas sales tax and a decrease of 5.4 percentage points in the fuel tax (on mineral oils and natural gas).

The observed effects are smaller than in the last scenario with the value-added tax cut, see Figure 5.9 and the Appendix. The fiscal shock hits the economy in 2022-Q2 for four quarters (the tax on fuels was reduced in 2022-Q1 and the tax on gas in 2022-Q2 to 2022-Q4). In this scenario, we can see effects on the personal consumer price indices of deciles, which decrease slightly with this reduction in the gross price for energy, since the tax directly affects this index. The positive effects on consumption are again observable for constrained households and are smaller than in the case of direct transfers or the

Table 5.2: Untargeted instruments and measures to all households and transfers to saving households in Germany.

Lump Transfer Policy Measure	Cost (Bill. Euros)
General Transfers	
Increase employee flat rate	6.6
Increase basic allowance	15.2
Long-distance commuter allowance	0.7
Short-time working benefits	0.5
Fourth Corona tax aid act	10.9
Child bonus 100 euros	1.4
Nine euros ticket	2.5
Energy price flat rate	10.4
Inflation compensation act	119.7
Successor nine euros ticket	12.0
Prolongation short-time working benefit	0.1
Adjustments home-office flat rate	3.9
Further measures	28.3
Tax exemption for payments to employees	1.2
Financial transaction	41.0
Total sum	254.4
Approximate share on nominal GDP 2022-2026	1.19%
Transfers to Ricardians	
Tax exemption for additional payments from companies to employees	1.2
Business aids	4.0
Peak compensation for energy-intensive companies	1.7
Total sum	6.9
Approximate share on nominal GDP 2022-2026	0.032%
Total sum	260.1
Approximate share on nominal GDP 2022-2026	1.21%

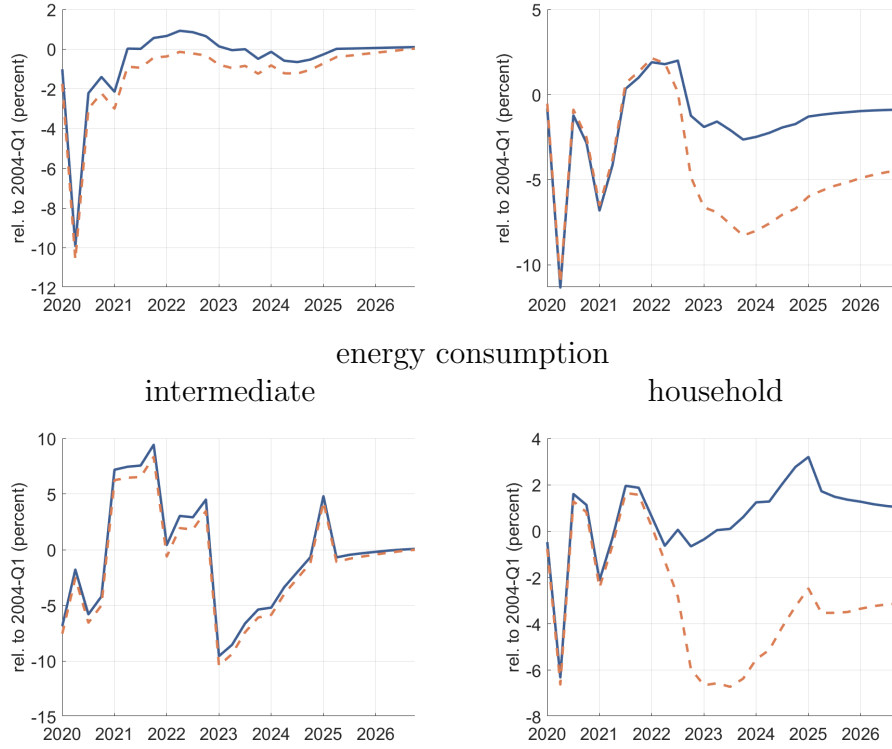
Source: Bayer et al. (2023b), Table 1. Own choice of allocation to targeted transfers. GDP data are from AMECO6.

value-added tax cut, as Figure 5.10 demonstrates.

5.6 Energy Cost Brake

A further scenario is the energy cost brake, instituted by Germany in 2023. For energy consumers, there have been maximum prices for electricity, gas, and district heating, setting payments below the market price. To maintain energy-saving incentives, subsidies applied only to 80 percent of the use in the previous year. Table 5.3 lists the conditions for private households.

Figure 5.5: Dynamics on aggregate level with untargeted transfers.
GDP aggregate consumption



Note: Development of gross domestic product (GDP), consumption expenditures (CONS), energy input (EY), and energy consumption (CE) in the fiscal policy scenario (solid line) compared to the baseline scenario without any fiscal intervention (dashed line). For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

Table 5.3: Energy cost brake in Germany.

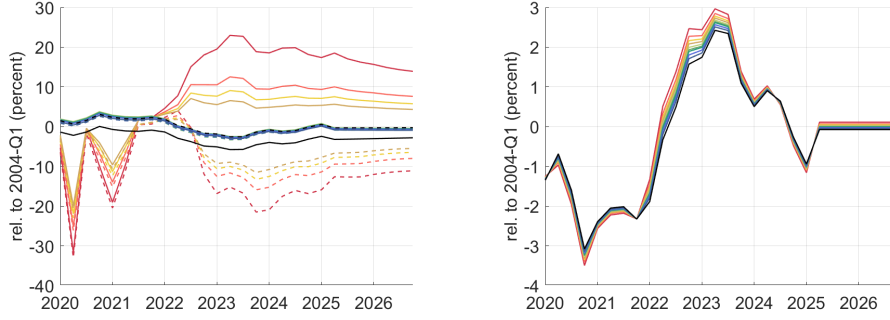
Energy Source	Maximum Price	Maximum Amount	Market Price
Electricity	40 ct/kWh	80% of 2022	ca. 42 ct/kWh
Gas	12 ct/kWh	80% of 2022	ca. 14 ct/kWh
District heating	9.5 ct/kWh	80% of 2022	ca. 25 ct/kWh

Source: Bundesregierung, Eurostat, FairEnergy

With average prices above the guaranteed maximum price, the cost brake has been (slightly) binding.

In our theoretical model, we define this maximum price P_E^{Max} for a certain amount of consumption $C_{E,h}^{Max}$, where $C_{E,h,t}^{Max} = \mu \bar{C}_{E,h}$ is the maximum amount of consumption for which the guaranteed maximum price holds. We set $\mu = 0.8$ and $\bar{C}_{E,h}$ as steady-state energy consumption prior to the crisis per household. There are three possible cases of

Figure 5.6: Dynamics on decile level with untargeted transfers.
consumption price index



Note: Development of decile-specific consumption and price index for decile 1 (dark red), decile 2 (salmon red), decile 3 (yellow), decile 4 (ocher yellow), decile 5 (light green), decile 6 (green), decile 7 (turquoise), decile 8 (blue), decile 9 (dark blue), and decile 10 (black) in the fiscal policy scenario (solid lines) compared to the baseline scenario without any fiscal intervention (dashed lines).

consumption expenditures:

1. The brake does not bind and $P_{E,t} \leq P_E^{Max}$: In this case, consumption expenditures for energy per household can be defined in the usual way as

$$(1 + \tau_{E,t} + \tau_{CE,h,t})P_{E,t}C_{E,h,t}.$$

2. The brake is binding and a household purchases less than the maximum consumption amount, i. e., $P_{E,t} > P_E^{Max}$ and $C_{E,h,t} \leq C_{E,h}^{Max}$: This implies consumption expenditures defined as

$$(1 + \tau_{E,t} + \tau_{CE,h,t})P_E^{Max}C_{E,h,t}.$$

3. The brake is binding and a household purchases more than the maximum consumption amount, i. e., $P_{E,t} > P_E^{Max}$ and $C_{E,h,t} > C_{E,h}^{Max}$:

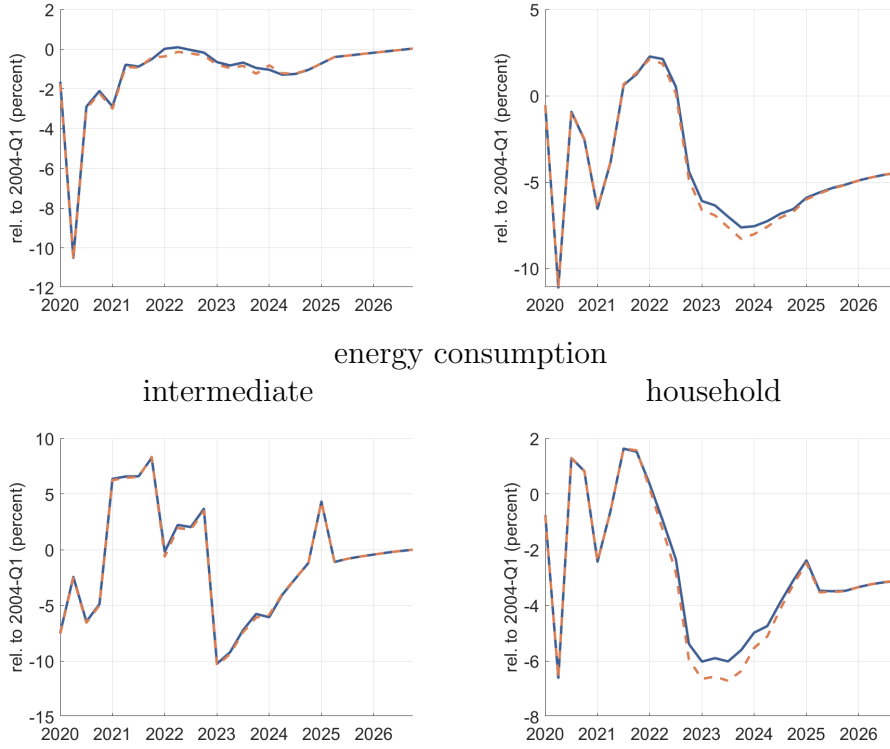
Energy consumption expenditures are then equal to

$$(1 + \tau_{E,t} + \tau_{CE,h,t}) \left[P_E^{Max}C_{E,h}^{Max} + P_{E,t} (C_{E,h,t} - C_{E,h}^{Max}) \right].$$

Bayer et al. (2023) report the cost of the energy price brake at around 106 billion euros, which is about 0.5 percent of the projected GDP of AMECO between 2022 and 2026.

The solid lines in Figure 5.11 (and figures in the Appendix) show the effects with such a brake, while the dashed line again represents the baseline scenario without intervention. At the aggregate level, one can observe a slightly smaller loss in consumption relative to the steady-state, but no difference in GDP. All households benefit from lower consumption expenditures with a binding-cost brake, but they react differently. Although liquidity-

Figure 5.7: Dynamics on aggregate level with value-added tax cut.
GDP aggregate consumption



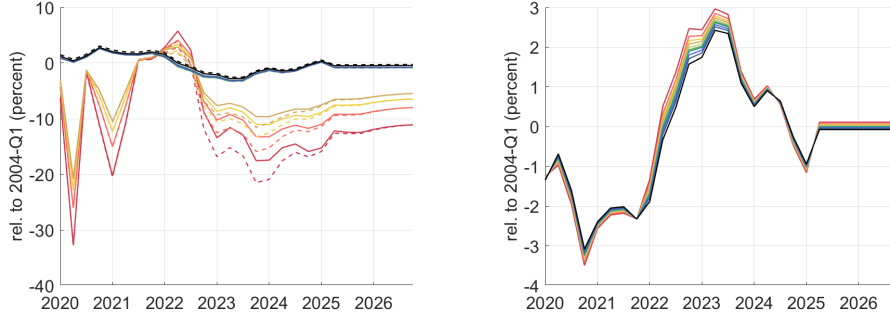
Note: Development of gross domestic product (GDP), consumption expenditures (CONS), energy input (EY), and energy consumption (CE) in the fiscal policy scenario (solid line) compared to the baseline scenario without any fiscal intervention (dashed line). For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

constrained households react straightforwardly by consuming more than in the baseline, households with saving possibilities do not react significantly during the brake periods. Figure 5.12 documents this process. Decile-specific prices are not affected since this is not a price brake with a direct price effect but a cost cap.

5.7 Fiscal Package

Lastly, we want to present in Figures 5.13 and 5.14 (and figures in the Appendix) the overall effect of the fiscal package in Germany by implementing all shocks from policy scenarios in our model. The package did well in stabilizing GDP, as can be seen in the positive deviation from the steady-state. Aggregate consumption could be stimulated significantly, with similar results for energy use. At the household level, there has not been a significant positive consumption effect on Ricardians, while lower-income deciles have a strong consumption boost. The fiscal package overcompensates for losses from the energy crisis. Individual prices are slightly smaller than in the baseline, which results from the reductions in fuel and gas taxes. We see that all measures have quantitatively

Figure 5.8: Dynamics on decile level with value-added tax cut.
consumption price index



Note: Development of decile-specific consumption and price index for decile 1 (dark red), decile 2 (salmon red), decile 3 (yellow), decile 4 (ocher yellow), decile 5 (light green), decile 6 (green), decile 7 (turquoise), decile 8 (blue), decile 9 (dark blue), and decile 10 (black) in the fiscal policy scenario (solid lines) compared to the baseline scenario without any fiscal intervention (dashed lines). For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

similar effects, with a different size and fiscal cost. In order to make them comparable, we will analyze welfare effects in the following section and will also take a look at the cost measured by public debt compared to the baseline.

5.8 Welfare Analysis

In order to better compare the policy interventions, we set up a welfare measure. We specify aggregate welfare as the sum of logarithmic functions of decile-specific utilities. This functional form is chosen because it considers the distribution among households:

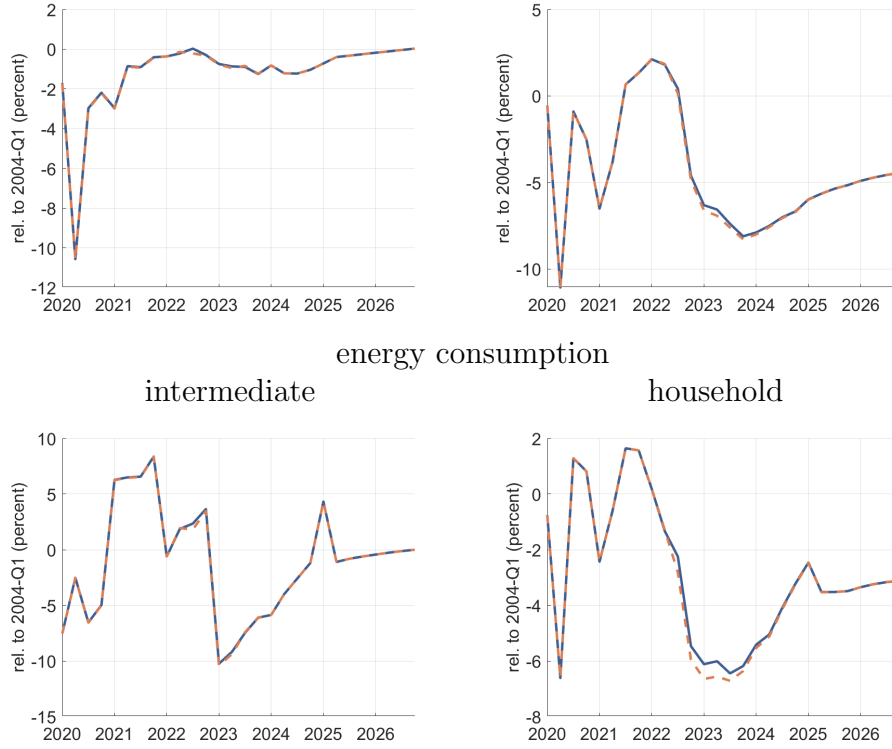
$$U_t = \sum_{h=1}^{h=10} \ln(U_{h,t}) .$$

Aggregate discounted welfare is calculated for the first period of the energy crisis and the following years with fiscal cost:

$$W = \sum_{t=2022.00}^{2026.75} \beta^t U_t .$$

To compare several scenarios, we calculate the percentage deviations of the cumulated discounted welfare with the respective policy intervention from the cumulated discounted welfare without any measures. Figure 5.15 shows the welfare effects. Unsurprisingly, the fiscal package has the largest welfare effects. Looking at the single measures, it turns out that the energy cost brake and fuel and energy tax reductions contribute the least in terms of welfare, while transfers are the most welfare-increasing measures. The welfare effects depend on the costs of the respective measures and the duration of implementation. The

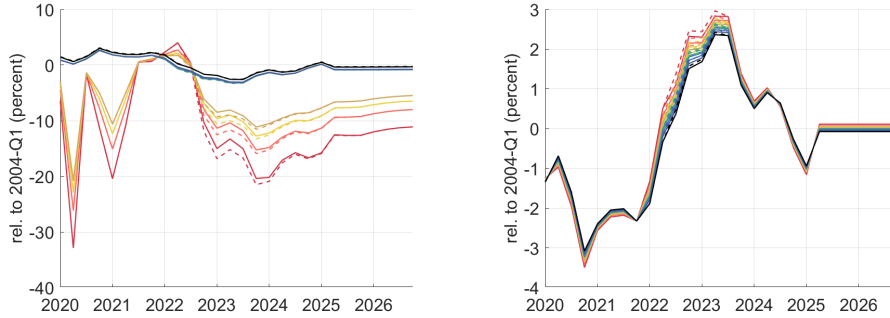
Figure 5.9: Dynamics on aggregate level with gas and fuel tax reduction.
GDP aggregate consumption



Note: Development of gross domestic product (GDP), consumption expenditures (CONS), energy input (EY), and energy consumption (CE) in the fiscal policy scenario (solid line) compared to the baseline scenario without any fiscal intervention (dashed line). For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

cost of each policy measure will increase public debt (see Figure 5.16). Concerning the fiscal burden of these instruments, the smallest debt-driving effect is caused by the energy-targeted instruments, which also had the smallest welfare gains. Untargeted transfers are the instrument with the highest fiscal impact, in line with the significant welfare benefit. To take a look at the cost-effectiveness of the instruments and the willingness to pay given the overall impact, we compare the cumulated welfare effects with the cumulated discounted public debt in Figure 1.1 (see Section 1) by calculating the ratio of deviations from the baseline, reporting the cumulated value over the periods until 2026-Q4. The analysis reveals that targeted transfers and reductions in gas and fuel taxes are the most cost-effective measures, while the value-added tax reduction has proven to be the most expensive instrument relative to its implied welfare benefits. Also, the energy cost brake and untargeted transfers show limited welfare gains compared to transfers targeted solely and directly at lower-income deciles.

Figure 5.10: Dynamics on decile level with gas and fuel tax reduction.
consumption price index



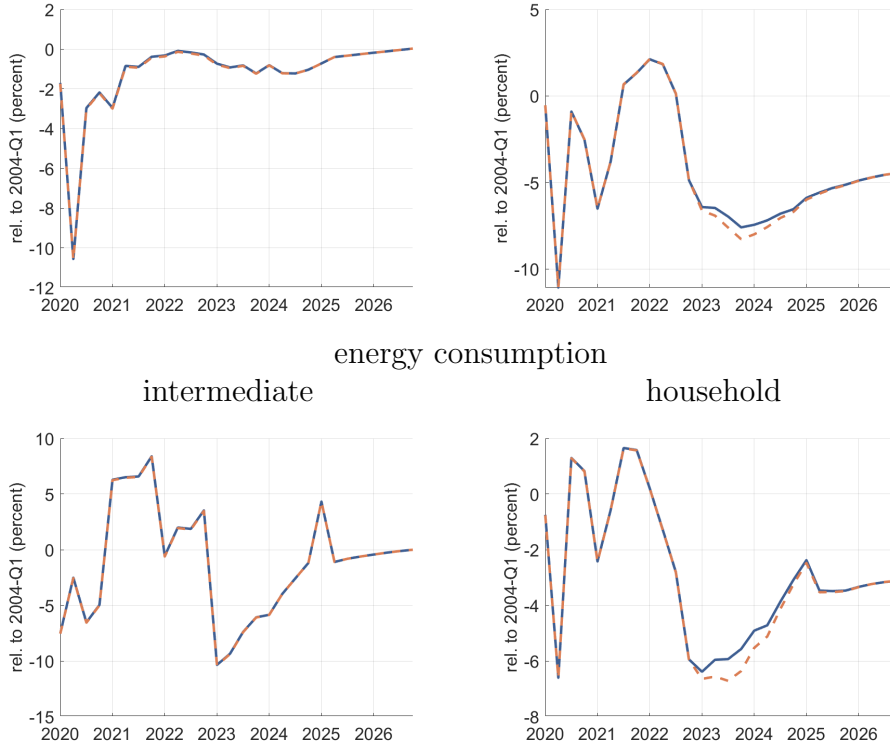
Note: Development of decile-specific consumption and price index for decile 1 (dark red), decile 2 (salmon red), decile 3 (yellow), decile 4 (ocher yellow), decile 5 (light green), decile 6 (green), decile 7 (turquoise), decile 8 (blue), decile 9 (dark blue), and decile 10 (black) in the fiscal policy scenario (solid lines) compared to the baseline scenario without any fiscal intervention (dashed lines). For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

6 Discussion

Our findings provide detailed insights into distributional dynamics, leveraging the strengths of the TENK framework. Unlike TANK models, TENK enables a more granular examination of income distribution without the computational complexity of HANK models. More specifically, our approach accurately replicates Germany’s income decile distribution and captures transition dynamics for key macroeconomic variables. This contribution bridges the gap between HANK and TANK models, circumventing the need for assumptions about idiosyncratic income or wealth risks. By utilizing decile-level data on income, wealth, and consumption, we effectively tailor the model to reflect Germany’s economy. Distinctively, our analysis combines observed trends in GDP, consumption, energy use, and inflation with Germany’s long-term trajectory, incorporating the unique policy measures enacted during the energy crisis. This approach controls for the exceptional circumstance that the energy crisis unfolded directly after the COVID-19 pandemic. By matching energy expenditure shares to total consumption per decile, we employ a streamlined methodology compared to classic HANK models, which rely on intricate micro-foundations of income distribution ([Auclert et al., 2023](#); [Bayer et al., 2023](#)). Our approach retains detailed heterogeneity in energy consumption, enhancing its applicability to real-world data.

Additionally, our study provides a comprehensive examination of the policy mix implemented during Germany’s energy crisis. While previous research has focused on narrower interventions ([Bayer et al., 2023](#); [Blanz et al., 2023](#); [Gustafsson et al., 2025](#)) or broader analyses disconnected from specific countries ([Auclert et al., 2023](#)), we model Germany’s unique context. By evaluating individual instruments within the relief package, we extend

Figure 5.11: Dynamics on aggregate level with cost brake.
GDP CONS



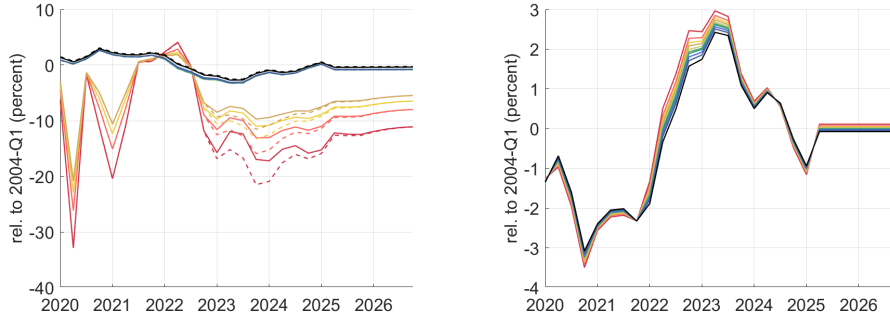
Note: Development of gross domestic product (GDP), consumption expenditures (CONS), energy input (EY), and energy consumption (CE) in the fiscal policy scenario (solid line) compared to the baseline scenario without any fiscal intervention (dashed line).

the literature's scope. Related studies often focus on specific energy sources, such as gas, oil, or electricity (Roeger and Welfens, 2022; Clemens and Röger, 2024). Our broader perspective, similar to Auclert et al. (2023) and Blanz et al. (2023), considers the surge in overall energy inflation during the crisis.

One limitation of our model is the assumption of exogenous energy inflation. This precludes an analysis of potential inflationary pressures arising from fiscal interventions that increase energy demand. However, given Germany's position as a small open economy, changes in domestic demand are unlikely to significantly influence global energy prices. Thus, our study focuses on the distributional and aggregate effects of fiscal measures, including their implications for government debt. To further strengthen the empirical fit of our simulations, quarterly data at the decile level would be valuable. In the meantime, micro-level datasets could serve as a basis for evaluating our results (e.g., Kan et al., 2017).

Future studies should explore systematic differences in outcomes across RANK, HANK, and TENK models, as well as hypothetical policy scenarios. Furthermore, the TENK framework offers considerable potential for analyzing other fiscal and monetary policy questions, particularly when investigating the interplay between aggregate and distribu-

Figure 5.12: Dynamics on decile level with cost brake.
consumption price index



Note: Development of decile-specific consumption and price index for decile 1 (dark red), decile 2 (salmon red), decile 3 (yellow), decile 4 (ocher yellow), decile 5 (light green), decile 6 (green), decile 7 (turquoise), decile 8 (blue), decile 9 (dark blue), and decile 10 (black) in the fiscal policy scenario (solid lines) compared to the baseline scenario without any fiscal intervention (dashed lines). For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

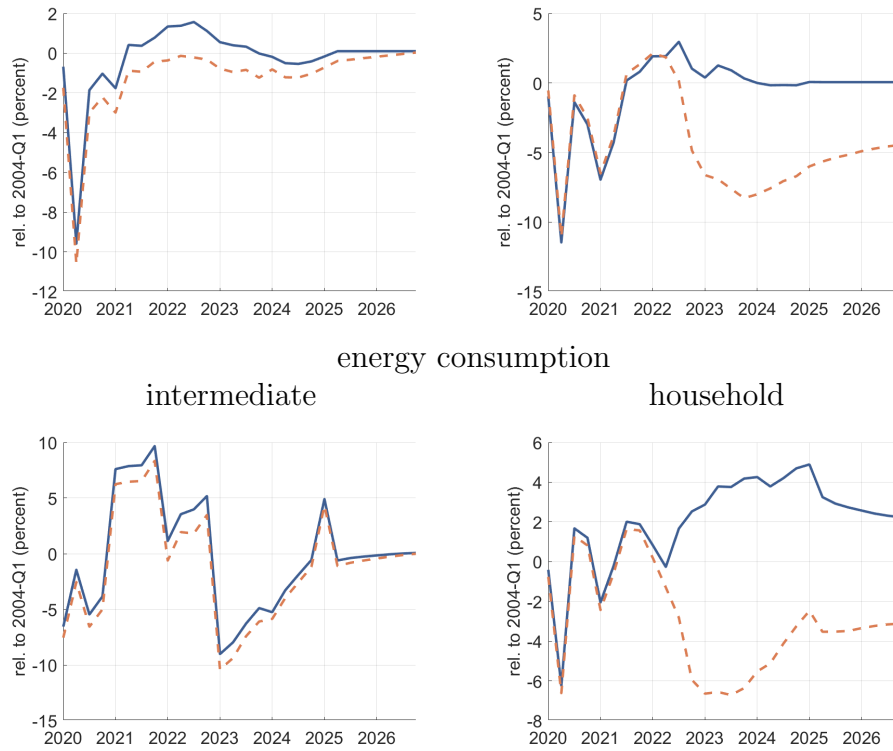
tive effects.

7 Conclusion

We analyze the aggregate, distributive, and welfare effects of fiscal policy interventions during an energy crisis using a novel ten-agent new Keynesian (TENK) model. This framework incorporates ten income deciles, enabling a detailed distributional analysis. Our theoretical model provides a case study for the German economy, replicating the empirical development of macroeconomic key variables. As expected, a positive exogenous energy price shock induces a recession at the aggregate level. In our simulation of a double-crisis scenario—combining the COVID-19 pandemic and energy price increases—the second crisis appears relatively milder in aggregate terms. However, its impact remains significant, as it disrupts the ongoing recovery from the pandemic. At the income decile level, consumption losses reveal notable disparities in the burden of this crisis. Lower-income households are particularly affected due to their higher share of energy expenditures relative to total consumption and their limited capacity to smooth consumption without savings.

In our evaluation of fiscal policy during an energy crisis for a small open economy relying on energy imports based on measures implemented in Germany, we find qualitatively similar responses across interventions, with quantitative effects influenced by the duration of fiscal support and the magnitude of the shock. Untargeted transfers, which made up a substantial portion of the total package, proved to be more effective in stabilizing aggregate key variables and mitigating consumption losses among lower-income deciles. Finally, an assessment of cumulative discounted welfare relative to public debt indicates

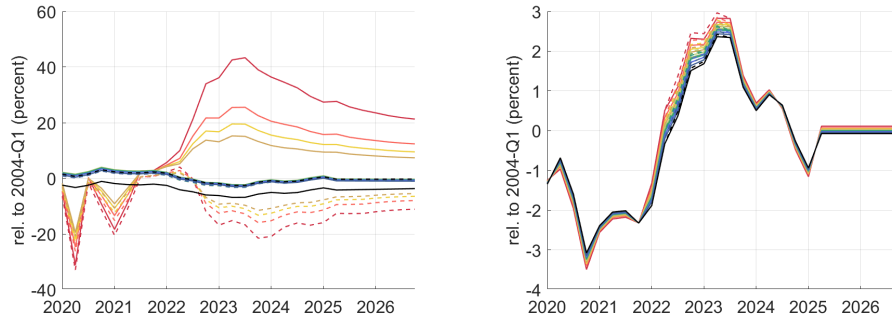
Figure 5.13: Dynamics on aggregate level with fiscal package.
GDP aggregate consumption



Note: Development of gross domestic product (GDP), consumption expenditures (CONS), energy input (EY), and energy consumption (CE) in the fiscal policy scenario (solid line) compared to the baseline scenario without any fiscal intervention (dashed line). For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

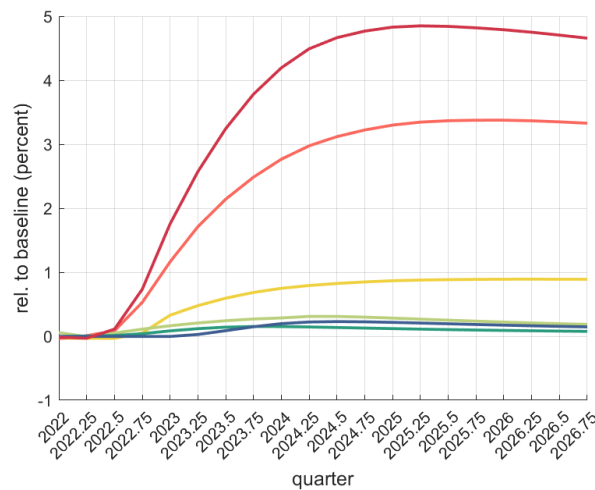
that targeted transfers were the most cost-effective intervention. Our findings are likely to apply to other small open economies relying on energy imports.

Figure 5.14: Dynamics on decile level with fiscal package.
consumption price index



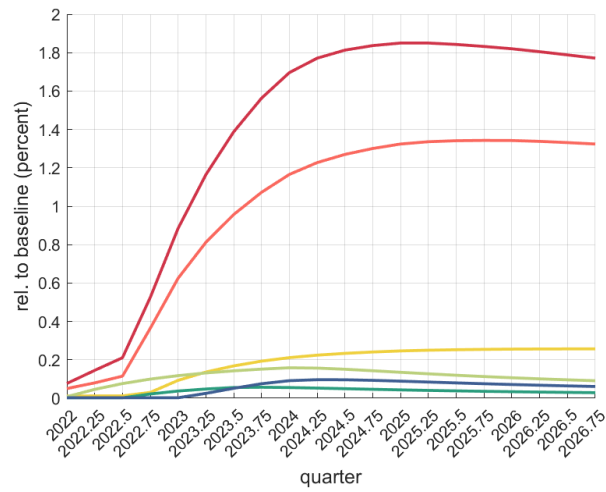
Note: Development of decile-specific consumption and price index for decile 1 (dark red), decile 2 (salmon red), decile 3 (yellow), decile 4 (ocher yellow), decile 5 (light green), decile 6 (green), decile 7 (turquoise), decile 8 (blue), decile 9 (dark blue), and decile 10 (black) in the fiscal policy scenario (solid lines) compared to the baseline scenario without any fiscal intervention (dashed lines). For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

Figure 5.15: Welfare effects



Note: Welfare effects in scenarios with targeted transfers (yellow), untargeted transfers (salmon red), value-added tax cut (light green), gas and fuel tax reductions (turquoise), energy cost brake (dark blue), and total fiscal package (dark red) compared to the baseline without intervention. For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

Figure 5.16: Fiscal burden



Note: Debt driving effect of targeted transfers (yellow), untargeted transfers (salmon red), value-added tax cut (light green), gas and fuel tax reductions (turquoise), energy cost brake (dark blue), and total fiscal package (dark red) compared to the baseline without intervention. For simulations we use the toolkit Dynare provided by [Adjemian et al. \(2023\)](#) and assume perfect foresight since the duration of fiscal intervention periods is common knowledge when politicians publicly announce their actions.

References

- Adjemian, S., Bastani, H., Juillard, M., Karamé, F., Mihoubi, F., Mutschler, W., Pfeifer, J., Ratto, M., Rion, N., Villemot, S., 2023. Dynare: Reference Manual Version 5. Technical Report 72. Dynare Working Papers Series, CEPREMAP. 48, boulevard Jourdan, 75014 Paris, France. URL: <https://www.dynare.org/wp-repo/dynarewp072.pdf>. initial revision: January 2022.
- Aiyagari, S., McGrattan, E.R., 1998. The optimum quantity of Debt. *Journal of Monetary Economics* 42, 447–469. URL: <https://www.sciencedirect.com/science/article/pii/S0304393298000312>, doi:[https://doi.org/10.1016/S0304-3932\(98\)00031-2](https://doi.org/10.1016/S0304-3932(98)00031-2).
- Arregui, N., 2022. Targeted, Implementable, and Practical Energy Relief Measures for Households in Europe. *IMF Working Papers* 2022, 1. URL: <http://dx.doi.org/10.5089/9798400227400.001>, doi:[10.5089/9798400227400.001](https://doi.org/10.5089/9798400227400.001).
- Atalay, E., 2017. How important are sectoral shocks? *American Economic Journal: Macroeconomics* 9, 254–80. URL: <https://www.aeaweb.org/articles?id=10.1257/mac.20160353>, doi:[10.1257/mac.20160353](https://doi.org/10.1257/mac.20160353).
- Atkeson, A., Heathcote, J., Perri, F., 2025. The End of Privilege: A Reexamination of the Net Foreign Asset Position of the United States. Technical Report 7. URL: <https://www.aeaweb.org/articles?id=10.1257/aer.20230732>, doi:[10.1257/aer.20230732](https://doi.org/10.1257/aer.20230732).
- Auclert, A., Monnery, H., Rognlie, M., Straub, L., 2023. Managing an Energy Shock: Fiscal and Monetary Policy. Working Paper 31543. National Bureau of Economic Research. URL: <http://www.nber.org/papers/w31543>, doi:[10.3386/w31543](https://doi.org/10.3386/w31543).
- Bachmann, R., Baqaee, D., Bayer, C., Kuhn, M., Löschel, A., Moll, B., Peichl, A., Pittel, K., Schularick, M., 2024. What if? the macroeconomic and distributional effects for germany of a stop of energy imports from russia. *Economica* 91, 1157–1200. URL: <https://onlinelibrary.wiley.com/doi/abs/10.1111/ecca.12546>, doi:<https://doi.org/10.1111/ecca.12546>.
- Bayer, C., Kriwoluzky, A., Müller, G.J., Seyrich, F., 2023. The Distributional and Disruptive Effects of Energy Supply Shocks and Fiscal Responses in a Monetary Union. Discussion Paper 2056. Deutsches Institut für Wirtschaftsforschung (DIW Berlin). URL: <http://hdl.handle.net/10419/279487>.
- Bayer, C., Kriwoluzky, A., Seyrich, F., Vogel, A., 2025. Makroökonomische effekte der finanz- und wirtschaftspolitischen maßnahmen der entlastungspakete i –

- iii sowie des wirtschaftlichen abwehrschirms: Endbericht; forschungsprojekt im auftrag des bundesministeriums der finanzen. URL: https://www.diw.de/documents/publikationen/73/diw_01.c.969314.de/diwkompakt_2025-207.pdf.
- Bilbiie, F.O., 2008. Limited asset markets participation, monetary policy and (inverted) aggregate demand logic. *Journal of Economic Theory* 140, 162–196. URL: <https://www.sciencedirect.com/science/article/pii/S0022053107001159>, doi:<https://doi.org/10.1016/j.jet.2007.07.008>.
- Blanz, A., Eydam, U., Heinemann, M., Kalkuhl, M., Moretti, N., 2023. Fiscal policy and energy price shocks. Available at SSRN 4732418 doi:<http://dx.doi.org/10.2139/ssrn.4732418>.
- Calvo, G.A., 1983. Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics* 12, 383–398. URL: <https://www.sciencedirect.com/science/article/pii/0304393283900600>, doi:[https://doi.org/10.1016/0304-3932\(83\)90060-0](https://doi.org/10.1016/0304-3932(83)90060-0).
- Celasun, O., Mineshima, A., Arregui, N., Mylonas, V., Ari, A., Teodoru, I., Black, S., Zhunussova, K., Iakova, D., Parry, I., 2022. Surging Energy Prices in Europe in the Aftermath of the War: How to Support the Vulnerable and Speed up the Transition Away from Fossil Fuels. Technical Report 152. URL: <http://dx.doi.org/10.5089/9798400214592.001>, doi:[10.5089/9798400214592.001](https://doi.org/10.5089/9798400214592.001).
- Christiano, L.J., Trabandt, M., Walentin, K., 2011. Introducing financial frictions and unemployment into a small open economy model. *Journal of Economic Dynamics and Control* 35, 1999–2041. URL: <https://www.sciencedirect.com/science/article/pii/S0165188911001710>, doi:<https://doi.org/10.1016/j.jedc.2011.09.005>. *frontiers in Structural Macroeconomic Modeling*.
- Ciola, E., Turco, E., Gurgone, A., Bazzana, D., Vergalli, S., Menoncin, F., 2023. Enter the matrix model: a multi-agent model for transition risks with application to energy shocks. *Journal of Economic Dynamics and Control* 146, 104589. URL: <https://www.sciencedirect.com/science/article/pii/S0165188922002925>, doi:<https://doi.org/10.1016/j.jedc.2022.104589>.
- Clemens, M., Röger, W., 2024. What is the difference between fossil fuel embargo and price shocks? *Energy Economics* 132, 107419. URL: <https://www.sciencedirect.com/science/article/pii/S0140988324001270>, doi:<https://doi.org/10.1016/j.eneco.2024.107419>.

- Drygalla, A., Holtemöller, O., Kiesel, K., 2020. The effects of fiscal policy in an estimated dsge model—the case of the german stimulus packages during the great recession. *Macroeconomic Dynamics* 24, 1315–1345. doi:[10.1017/S1365100518000858](https://doi.org/10.1017/S1365100518000858).
- Eugeni, S., 2024. Nominal exchange rates and net foreign assets’ dynamics: The stabilization role of valuation effects. *Journal of International Money and Finance* 141, 103018. URL: <https://www.sciencedirect.com/science/article/pii/S0261560624000056>, doi:<https://doi.org/10.1016/j.jimonfin.2024.103018>.
- Fetzer, T., Gazze, L., Bishop, M., 2024. Distributional and climate implications of policy responses to energy price shocks*. *Economic Policy* 39, 711–756. URL: <https://doi.org/10.1093/epolic/eiae038>, doi:[10.1093/epolic/eiae038](https://doi.org/10.1093/epolic/eiae038).
- Galí, J., López-Salido, J.D., Vallés, J., 2007. Understanding the Effects of Government Spending on Consumption. *Journal of the European Economic Association* 5, 227–270. URL: <https://doi.org/10.1162/JEEA.2007.5.1.227>, doi:[10.1162/JEEA.2007.5.1.227](https://doi.org/10.1162/JEEA.2007.5.1.227). eprint: <https://academic.oup.com/jeea/article-pdf/5/1/227/10313297/jeea0227.pdf>.
- Golosov, M., Hassler, J., Krusell, P., Tsyvinski, A., 2014. Optimal taxes on fossil fuel in general equilibrium. *Econometrica* 82, 41–88. URL: <https://onlinelibrary.wiley.com/doi/abs/10.3982/ECTA10217>, doi:<https://doi.org/10.3982/ECTA10217>.
- Grimm, V., Schnitzer, M., Truger, A., Wieland, V., Werding, M., 2022. Jahresgutachten 2022/23: Gesamtausgabe. Technical Report. Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung. Wiesbaden. URL: <https://www.sachverstaendigenrat-wirtschaft.de/jahresgutachten-202223.html>.
- Gustafsson, J., Ma, X., Maih, J., Vesterberg, M., 2025. Macroeconomic effects of fiscal policy under an energy supply shock. *Energy Policy* 203, 114616. URL: <https://www.sciencedirect.com/science/article/pii/S0301421525001235>, doi:<https://doi.org/10.1016/j.enpol.2025.114616>.
- Hassler, J., Krusell, P., Olovsson, C., 2021. Directed technical change as a response to natural resource scarcity. *Journal of Political Economy* 129, 3039–3072. URL: <https://doi.org/10.1086/715849>, doi:[10.1086/715849](https://doi.org/10.1086/715849).
- Henkel, M., Seidel, T., Suedekum, J., 2021. Fiscal transfers in the spatial economy. *American Economic Journal: Economic Policy* 13, 433–68. URL: <https://www.aeaweb.org/articles?id=10.1257/pol.20180294>, doi:[10.1257/pol.20180294](https://doi.org/10.1257/pol.20180294).
- Jappelli, T., Pistaferri, L., 2014. Fiscal policy and mpc heterogeneity. *American Economic Journal: Macroeconomics* 6, 107–136. URL: <https://www.aeaweb.org/articles?id=10.1257/mac.6.4.107>, doi:[DOI:10.1257/mac.6.4.107](https://doi.org/10.1257/mac.6.4.107).

- Kan, K., Peng, S.K., Wang, P., 2017. Understanding consumption behavior: Evidence from consumers' reaction to shopping vouchers. *American Economic Journal: Economic Policy* 9, 137–53. URL: <https://www.aeaweb.org/articles?id=10.1257/pol.20130426>, doi:10.1257/pol.20130426.
- Kehrig, M., Ziebarth, N.L., 2017. The effects of the real oil price on regional wage dispersion. *American Economic Journal: Macroeconomics* 9, 115–148. URL: <https://www.aeaweb.org/articles?id=10.1257/mac.20150097>, doi:DOI:10.1257/mac.20150097.
- Kharroubi, E., Smets, F., 2024. Energy shocks as keynesian supply shocks: Implications for fiscal policy. *European Economic Review* 170, 104875. URL: <https://www.sciencedirect.com/science/article/pii/S0014292124002046>, doi:<https://doi.org/10.1016/j.euroecorev.2024.104875>.
- Levell, P., O'Connell, M., Smith, K., 2024. Distributional effects of the european energy crisis. Cowles Foundation for Research in Economics Discussion Paper URL: <https://cowles.yale.edu/sites/default/files/2024-05/0%27Connell-levelloconnellsmith2024.pdf>.
- Levinson, A., Silva, E., 2022. The electric gini: Income redistribution through energy prices. *American Economic Journal: Economic Policy* 14, 341–65. URL: <https://www.aeaweb.org/articles?id=10.1257/pol.20200543>, doi:10.1257/pol.20200543.
- Misra, K., Surico, P., 2014. Consumption, income changes, and heterogeneity: Evidence from two fiscal stimulus programs. *American Economic Journal: Macroeconomics* 6, 84–106. URL: <https://www.aeaweb.org/articles?id=10.1257/mac.6.4.84>, doi:DOI:10.1257/mac.6.4.84.
- Peersman, G., Wauters, J., 2024. Heterogeneous household responses to energy price shocks. *Energy Economics* 132, 107421. URL: <https://www.sciencedirect.com/science/article/pii/S0140988324001294>, doi:<https://doi.org/10.1016/j.eneco.2024.107421>.
- Pieroni, V., 2023. Energy shortages and aggregate demand: Output loss and unequal burden from hank. *European Economic Review* 154, 104428. URL: <https://www.sciencedirect.com/science/article/pii/S0014292123000570>, doi:<https://doi.org/10.1016/j.euroecorev.2023.104428>.
- Priftis, R., Schoenle, R., 2025. Fiscal and macroprudential policies during an energy crisis. *European Economic Review* 179, 105117. URL: <https://www.sciencedirect.com/science/article/pii/S0014292125001679>, doi:<https://doi.org/10.1016/j.euroecorev.2025.105117>.

- Roeger, W., Welfens, P.J., 2022. Gas price caps and electricity production effects in the context of the russo-ukrainian war: Modeling and new policy reforms. *International Economics and Economic Policy* 19, 645–673. doi:<https://doi.org/10.1007/s10368-022-00552-7>.
- Turco, E., Bazzana, D., Rizzati, M., Ciola, E., Vergalli, S., 2023. Energy price shocks and stabilization policies in the matrix model. *Energy Policy* 177, 113567. URL: <https://www.sciencedirect.com/science/article/abs/pii/S0301421523001520>, doi:<https://doi.org/10.1016/j.enpol.2023.113567>.

Halle Institute for Economic Research –
Member of the Leibniz Association

Kleine Maerkerstrasse 8
D-06108 Halle (Saale), Germany

Postal Address: P.O. Box 11 03 61
D-06017 Halle (Saale), Germany

Tel +49 345 7753 60
Fax +49 345 7753 820

www.iwh-halle.de

ISSN 2194-2188



The IWH is funded by the federal government and the German federal states.