Online Appendix to The Declining Impact of Geopolitical Oil Supply Disruptions on the U.S. Economy

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Contents

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A U.S. MODEL DATA SOURCES

We use the following time-series (Haver mnemonics in parentheses). Each series is mapped to its original public data source with specific table and line references for replication purposes.

1. **U.S. Civilian Noninstitutional Population: 16 Years & Over**
   Monthly, Averaged to Quarterly, Thousands (`LN16N@USECON`)
   Source: Bureau of Labor Statistics, Current Population Survey,
   Series ID: LNU00000000Q
   https://data.bls.gov/timeseries/LNU00000000Q
2. **U.S. Gross Domestic Product: Implicit Price Deflator**
   Quarterly, Seasonally Adjusted, 2017=100 (`DGDP@USNA`)
   Source: Bureau of Economic Analysis, National Income and Product Accounts,
   Table 1.1.9, Implicit Price Deflators for Gross Domestic Product, Line 1
   https://www.bea.gov/itable/national-gdp-and-personal-income
3. **U.S. Gross Domestic Product**
   Quarterly, Seasonally Adjusted, Billions of Dollars (`GDP@USECON`)
   Annual, Millions of Dollars (`GDPY@USNA`)
   Source: Bureau of Economic Analysis, National Income and Product Accounts,
   Table 1.1.5, Gross Domestic Product, Line 1
   https://www.bea.gov/itable/national-gdp-and-personal-income
4. **U.S. Personal Consumption Expenditures: Nondurable Goods**
   Quarterly, Seasonally Adjusted, Billions of Dollars (`CN@USECON`)
   Source: Bureau of Economic Analysis, National Income and Product Accounts,
   Table 1.1.5, Gross Domestic Product, Line 5
   https://www.bea.gov/itable/national-gdp-and-personal-income
5. **U.S. Personal Consumption Expenditures: Services**
   Quarterly, Seasonally Adjusted, Billions of Dollars (`CS@USECON`)
   Source: Bureau of Economic Analysis, National Income and Product Accounts,
   Table 1.1.5, Gross Domestic Product, Line 6
   https://www.bea.gov/itable/national-gdp-and-personal-income
6. **U.S. Personal Consumption Expenditures: Durable Goods**
   Quarterly, Seasonally Adjusted, Billions of Dollars (`CD@USECON`)
   Source: Bureau of Economic Analysis, National Income and Product Accounts,
   Table 1.1.5, Gross Domestic Product, Line 4
   https://www.bea.gov/itable/national-gdp-and-personal-income

7. **U.S. Personal Consumption Expenditures: Motor Vehicle Fuels**
   Quarterly, Seasonally Adjusted, Billions of Dollars (`CNG@USNA`)
   Annual, Billions of Dollars (`CNGA@USNA`)
   Source: Bureau of Economic Analysis, National Income and Product Accounts,
   Table 2.4.5, Personal Consumption Expenditures by Type of Product, Line 37
   https://www.bea.gov/itable/national-gdp-and-personal-income

8. **U.S. Personal Consumption Expenditures: Fuel Oil and Other Fuels**
   Quarterly, Seasonally Adjusted, Billions of Dollars (`CNOF@USNA`)
   Annual, Billions of Dollars (`CNOFA@USNA`)
   Source: Bureau of Economic Analysis, National Income and Product Accounts,
   Table 2.4.5, Personal Consumption Expenditures by Type of Product, Line 38
   https://www.bea.gov/itable/national-gdp-and-personal-income

9. **U.S. Private Fixed Investment**
   Quarterly, Seasonally Adjusted, Billions of Dollars (`F@USECON`)
   Source: Bureau of Economic Analysis, National Income and Product Accounts,
   Table 1.1.5, Gross Domestic Product, Line 8
   https://www.bea.gov/itable/national-gdp-and-personal-income

10. **U.S. Imports of Goods: Foods, Feeds, and Beverages**
    Quarterly, Seasonally Adjusted, Billions of Dollars (`MMF@USNA`)
    Source: Bureau of Economic Analysis, National Income and Product Accounts,
    Table 4.2.5B, Exports and Imports of Goods and Services by Type of Product, Line 95
    https://www.bea.gov/itable/national-gdp-and-personal-income

11. **U.S. Imports of Goods: Nondurable Consumer Goods**
    Quarterly, Seasonally Adjusted, Billions of Dollars (`MMCN@USNA`)
    Source: Bureau of Economic Analysis, National Income and Product Accounts,
    Table 4.2.5B, Exports and Imports of Goods and Services by Type of Product, Line 142
    https://www.bea.gov/itable/national-gdp-and-personal-income

12. **U.S. Imports of Goods: Durable Consumer Goods**
    Quarterly, Seasonally Adjusted, Billions of Dollars (`MMCD@USNA`)
    Source: Bureau of Economic Analysis, National Income and Product Accounts,
    Table 4.2.5B, Exports and Imports of Goods and Services by Type of Product, Line 135
    https://www.bea.gov/itable/national-gdp-and-personal-income

13. **U.S. Imports of Goods: Capital Goods Excluding Automotive**
Quarterly, Seasonally Adjusted, Billions of Dollars (`MMKX@USNA`)
Source: Bureau of Economic Analysis, National Income and Product Accounts,
Table 4.2.5B, Exports and Imports of Goods and Services by Type of Product, Line 114
https://www.bea.gov/itable/national-gdp-and-personal-income

14. **U.S. Imports of Goods: Automotive Vehicles, Engines, and Parts**
Quarterly, Seasonally Adjusted, Billions of Dollars (`MMKV@USNA`)
Source: Bureau of Economic Analysis, National Income and Product Accounts,
Table 4.2.5B, Exports and Imports of Goods and Services by Type of Product, Line 131
https://www.bea.gov/itable/national-gdp-and-personal-income

15. **U.S. Imports of Goods: Durable Industrial Supplies and Materials**
Quarterly, Seasonally Adjusted, Billions of Dollars (`MMID@USNA`)
Source: Bureau of Economic Analysis, National Income and Product Accounts,
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https://www.bea.gov/itable/national-gdp-and-personal-income

16. **U.S. Exports of Goods: Foods, Feeds, and Beverages**
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17. **U.S. Exports of Goods: Nondurable Consumer Goods**
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Source: Bureau of Economic Analysis, National Income and Product Accounts,
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https://www.bea.gov/itable/national-gdp-and-personal-income

18. **U.S. Exports of Goods: Durable Consumer Goods**
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Source: Bureau of Economic Analysis, National Income and Product Accounts,
Table 4.2.5B, Exports and Imports of Goods and Services by Type of Product, Line 43
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19. **U.S. Exports of Goods: Capital Goods Excluding Automotive**
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Source: Bureau of Economic Analysis, National Income and Product Accounts,
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https://www.bea.gov/itable/national-gdp-and-personal-income

20. **U.S. Exports of Goods: Automotive Vehicles, Engines, and Parts**
    Quarterly, Seasonally Adjusted, Billions of Dollars (`XMKV@USNA`)
    Source: Bureau of Economic Analysis, National Income and Product Accounts,
    Table 4.2.5B, Exports and Imports of Goods and Services by Type of Product, Line 39
    https://www.bea.gov/itable/national-gdp-and-personal-income
21. **U.S. Exports of Goods: Durable Industrial Supplies and Materials**
    Quarterly, Seasonally Adjusted, Billions of Dollars (`XMID@USNA`)
    Source: Bureau of Economic Analysis, National Income and Product Accounts,
    Table 4.2.5B, Exports and Imports of Goods and Services by Type of Product, Line 10
    https://www.bea.gov/itable/national-gdp-and-personal-income
22. **U.S. Total Economy Labor Compensation**
    Quarterly, Seasonally Adjusted, Percent (`LXEFL@USECON`)
    Source: Bureau of Labor Statistics, Labor Productivity and Costs, Additional Requests
    https://www.bls.gov/productivity/tables/additional-requests
23. **U.S. GDP Share of World GDP**,
    Annual, Percent (`A111GPPS@IMFWEO`)
    Source: International Monetary Fund, World Economic Outlook Database,
    Gross domestic product, Purchasing power parity international dollar, percent of world GDP
    https://data.imf.org/en/datasets/IMF.RES:WEO
24. **U.S. Crude Oil Imported Acquisition Cost by Refiners**
    Monthly, Averaged to Quarterly, Dollars per Barrel (`CUSIQABF@USENERGY`)
    Source: U.S. Energy Information Administration,
    Refiner Acquisition Cost of Crude Oil: Imported
    https://www.eia.gov/petroleum/data.php
25. **U.S. Petroleum Products Expenditures**
    Annual, Millions of Dollars (`ZUSPATCV@USENERGY`)
    Source: U.S. Energy Information Administration, State Energy Data System,
    Primary energy, electricity, and total energy: United States (Tables ET1 and F27)
    https://www.eia.gov/state/seds
26. **U.S. Retail Gasoline Price (All Grades)**
    Monthly, Averaged to Quarterly, Dollars per Gallon (`PUSSGHBG@USENERGY`)
    Source: U.S. Energy Information Administration,
    Motor gasoline retail prices, U.S. city average: All grades,
    Platt's/ Bureau of Labor Statistics Data
    https://www.eia.gov/petroleum/data.php

27. **World Production of Crude Oil Including Lease Condensate**
    Monthly, Thousands of Barrels per Day (AWOACAUF@ENERGY)
    Source: U.S. Energy Information Administration, International Energy Statistics, Petroleum and Other Liquids Production: World
    https://www.eia.gov/international/data/world
28. **U.S. Production of Crude Oil Including Lease Condensate**
    Monthly, Thousands of Barrels per Day (AUSACAUF@ENERGY)
    Source: U.S. Energy Information Administration
    https://www.eia.gov/petroleum/data.php
29. **U.S. Petroleum Consumption**
    Annual, Thousands of Barrels per Day (DUSADBRF@ENERGY)
    Source: U.S. Energy Information Administration, International Energy Statistics, Refined Petroleum Consumption: United States
    https://www.eia.gov/international/data/country/USA
30. **World Petroleum Consumption**
    Annual, Thousands of Barrels per Day (DWOADBRF@ENERGY)
    Source: U.S. Energy Information Administration, International Energy Statistics, Refined Petroleum Product Consumption: World
    https://www.eia.gov/international/data/world
31. **U.S. Petroleum Production**
    Annual, Thousands of Barrels per Day (DUSACBIF@ENERGY)
    Source: U.S. Energy Information Administration, International Energy Statistics, Petroleum and Other Liquids Production: United States
    https://www.eia.gov/international/data/country/USA
32. **U.S. Crude Oil and Petroleum Products Consumption**
    Monthly, Thousands of Barrels (CUSBHAAS@USENERGY)
    Source: U.S. Energy Information Administration, Petroleum Supply Monthly, Product Supplied of Crude Oil and Petroleum Products
    https://www.eia.gov/petroleum/supply/monthly/
33. **U.S. Crude Oil and Petroleum Products Inventories**
    Monthly, Thousands of Barrels (CUSFLAAS@USENERGY)
    Source: U.S. Energy Information Administration, Petroleum Supply Monthly, Ending Stocks excluding SPR of Crude Oil and Petroleum Products
    https://www.eia.gov/petroleum/supply/monthly/

34. **World Crude Oil Production**
    Monthly, Millions of Barrels per Day (`QWOIMAB9@USENERGY`)
    Source: U.S. Energy Information Administration, Short-Term Energy Outlook
    https://www.eia.gov/outlooks/steo/data.php

35. **World Population**
    Annual, Thousands, as of 1 January (`C001TBE@UNPOP`)
    Source: United Nations Department of Economic and Social Affairs,
    World Population Prospects, Total Population: World
    https://population.un.org/wpp/

36. **U.S. Population**
    Annual, Thousands, as of 1 January (`C111TBE@UNPOP`)
    Source: United Nations Department of Economic and Social Affairs,
    World Population Prospects, Total Population: United States of America
    https://population.un.org/wpp/

37. **WTI Spot Price**
    Daily, Dollars per Barrel (`PETEXA@DAILY`)
    Source: U.S. Energy Information Administration, Spot Prices
    https://www.eia.gov/petroleum/data.php

38. **Brent Spot Price**
    Daily, Dollars per Barrel (`PEBRT@DAILY`)
    Source: U.S. Energy Information Administration, Spot Prices
    https://www.eia.gov/petroleum/data.php

39. **WTI Futures Prices**
    Daily, Dollars per Barrel, 6th, 12th, and 24th position,
    (`PZTEXF6@DAILY`, `PZTEXFY@DAILY`, `PZTEXFB@DAILY`)

40. **Brent Futures Prices**
    Daily, Dollars per Barrel, 6th, 12th, and 24th position,
    (`PZBR06S@DAILY`, `PZBR12S@DAILY`, `PZBR24S@DAILY`)

The following variables were constructed using data outside of Haver:

1. **World Oil Inventories**, Monthly, Millions of Barrels from Kilian (2022), labeled as $\mathtt{SW}_t$.

2. **ROW Real GDP**, Quarterly, Seasonally Adjusted, 2005=100 from the Federal Reserve Bank of Dallas Global Economic Indicators (Grossman et al., 2014), U.S. Trade Weights https://www.dallasfed.org/research/international/dgei/gdp.

3. **ROW Labor Share**, Annual Percent, from Penn World Table, v11.0 (Feenstra et al., 2015). Average of `labsh` is computed using the trade weights of countries in Federal Reserve Bank of Dallas Global Economic Indicators except Belgium, Czechia, Russia, and South Africa https://www.rug.nl/ggdc/productivity/pwt.
4. **Country Imports and Exports**, Millions of USD, from the IMF Direction of Trade Statistics database, countries in Federal Reserve Bank of Dallas Global Economic Indicators https://data.imf.org/en/datasets/IMF.STA:IMTS.
5. **ROW Oil Expenditure Share**, Annual Percent. Calculated using the Long-Run World Input-Output Database (WIOD), Version 1.1 (Woltjer et al., 2021), and the 2025 OECD Inter-Country Input-Output (ICIO) database. Spending on petroleum products is defined as spending on sector D23 (coke, refined petroleum and nuclear fuel) in the Long-Run WIOD and C19 (manufacture of coke and refined petroleum products) in the ICIO database. The share is calculated by aggregating spending over Australia, Austria, Belgium, Brazil, Canada, China, Denmark, Finland, France, Germany, Greece, Hong Kong, India, Ireland, Italy, Japan, Mexico, the Netherlands, Portugal, Spain, Sweden, Taiwan, and the U.K. https://www.rug.nl/ggdc/valuechain/long-run-wiod; https://www.oecd.org/en/data/datasets/inter-country-input-output-tables.
6. **ROW Household-Firm Oil Expenditure Ratio**. Calculated using data from the International Energy Agency's *World Energy Balances* database (July 2025). Total oil consumption is defined as the sum of aviation gasoline, bitumen, ethane, gas/diesel oil excl. biofuels, gasoline-type jet fuel, kerosene-type jet fuel, LPG, lubricants, motor gasoline, naphtha, other kerosene, other non-specified secondary oil products, paraffin waxes, petroleum coke, refinery gas, residual fuel oil, white spirit and SBP. The database provides consumption for agricultural use, fisheries, commercial, industrial, residential, road and non-road transport. We allocate 65% of road transport to household use. This percentage is chosen so that the U.S. household-to-firm oil expenditure share implied by the *World Energy Balances* database equals the ratio implied by the BEA. Household use is defined as the sum of that fraction of road use plus residential consumption. Firm use is equal to total use minus household use.
7. **WTI Crude Oil Options**, Daily, End of Market Summary, from the CME Group, https://datamine.new.cmegroup.com/.

We apply the following data transformations (sample over 1985Q1–2019Q4, $T = 140$):

1. **U.S. Per Capita Real GDP**: $y_t = \frac{10^9 \times \mathtt{GDP}_t}{(\mathtt{DGDP}_t/100)(1000 \times \mathtt{LN16N}_t)}$
2. **World Real Oil Price**: $p^o_t = \frac{\mathtt{CUSIQABF}_t}{\mathtt{DGDP}_t/100}$
3. **ROW Consumption-Investment Import Ratio**: $\theta^{mci}_2 = \frac{1}{T}\sum_{t=1}^{T} \frac{\mathtt{XMF}_t + \mathtt{XMCN}_t}{\mathtt{XMCD}_t + \mathtt{XMKX}_t + \mathtt{XMKV}_t + \mathtt{XMID}_t}$

4. **U.S. Import Share of Consumer Non-Oil Goods**: $\alpha_1^{mc} = \frac{1}{T}\sum_{t=1}^{T}\frac{\texttt{MMF}_t+\texttt{MMCN}_t}{\texttt{CN}_t+\texttt{CS}_t-\texttt{CNG}_t-\texttt{CNOF}_t}$
5. **U.S. Import Share of Investment Goods**: $\alpha_1^{mi} = \frac{1}{T}\sum_{t=1}^{T}\frac{\texttt{MMCD}_t+\texttt{MMKX}_t+\texttt{MMKV}_t+\texttt{MMID}_t}{\texttt{F}_t+\texttt{CD}_t}$
6. **U.S. GDP Share of World GDP**: $\theta_1^{yr} = \frac{1}{T/4}\sum_{t=1}^{T/4}\frac{\texttt{A111GPPS}_t}{100}$
7. **U.S. Oil Expenditure Share**: $\bar{o}_1^{y} = \frac{1}{T/4}\sum_{t=1}^{T/4}\frac{\texttt{ZUSPATCV}_t}{\texttt{GDPY}_t}$
8. **U.S. Household-Firm Oil Expenditure Ratio**: $\theta_{1,o}^{h} = \frac{1}{T/4}\sum_{t=1}^{T/4}\frac{\texttt{CNGA}_t+\texttt{CNOFA}_t}{\texttt{ZUSPATCV}_t/1000-\texttt{CNGA}_t-\texttt{CNOFA}_t}$
9. **Relative Retail Gasoline Price**: $\bar{p}_1^{go} = \frac{1}{T}\sum_{t=1}^{T}\frac{\texttt{PUSSGHBG}_t\times 42\text{ gallons}}{\texttt{CUSIQABF}_t}$
10. **ROW Oil Supply**: $o_{2,t}^{s} = \sum_{i=t-2}^{t}(\texttt{AWOACAUF}_t - \texttt{AUSACAUF}_t)$
11. **U.S.-ROW Oil Consumption Ratio**: $\theta_{1,o} = \frac{1}{T/4}\sum_{t=1}^{T/4}\frac{\texttt{DUSADBRF}_t}{\texttt{DWOADBRF}_t-\texttt{DUSADBRF}_t}$
12. **U.S. Oil Production-Consumption Ratio**: $\theta_{1,o}^{s} = \frac{1}{T/4}\sum_{t=1}^{T/4}\frac{\texttt{DUSACBIF}_t}{\texttt{DUSADBRF}_t}$
13. **Inventory-Consistent World Oil Consumption**: $\texttt{OW}_t = (\texttt{AWOACAUF}_t/1000 - \Delta\texttt{SW}_t)\texttt{D}_t$, where $\Delta\texttt{SW}_t = (\texttt{SW}_t - \texttt{SW}_{t-1})/\texttt{D}_t$ and $\texttt{D}_t$ is the number of days in month t.
14. **U.S. Oil Inventory-Oil Consumption Ratio**: $\bar{s}_1^{o} = \frac{1}{T}\sum_{t=1}^{T}\frac{S_{1,t}}{O_{1,t}}$, where $S_{1,t}$ is the end-of-quarter value of $\texttt{CUSFLAAS}$ and $O_{1,t}$ is the quarterly sum of $\texttt{CUSBHAAS}$.
15. **ROW Oil Inventory-to-Oil Consumption Ratio**: $\bar{s}_2^{o} = \frac{1}{T}\sum_{t=1}^{T}\frac{S_{w,t}-S_{1,t}/1000}{O_{w,t}-O_{1,t}/1000}$, where $S_{w,t}$ is the end-of-quarter value of $\texttt{SW}_t$ and $O_{w,t}$ is the quarterly sum of $\texttt{OW}_t$.
16. **U.S. Total Economy Labor Share**: $\bar{n}_1^{y} = \frac{1}{T}\sum_{t=1}^{T}\frac{\texttt{LXEFL}_t}{\texttt{GDP}_t}$.
17. **U.S. Population Share**: $\theta_1^{T} = \frac{1}{T/4}\sum_{t=1}^{T/4}\frac{\texttt{C111TBE}_t}{\texttt{C001TBE}_t}$

B EUROPEAN MODEL DATA SOURCES

We use the following time-series (Haver mnemonics in parentheses). Each series is mapped to its original public data source with specific table and line references for replication purposes.

1. **European Union GDP Share of World GDP**,
   Annual, Percent (A998GPPS@IMFWEO)
   Source: International Monetary Fund, World Economic Outlook Database,
   Gross domestic product, Purchasing power parity international dollar, percent of world GDP
   https://data.imf.org/en/datasets/IMF.RES:WEO
2. **Norway GDP Share of World GDP**,
   Annual, Percent (A142GPPS@IMFWEO)
   Source: International Monetary Fund, World Economic Outlook Database,
   Gross domestic product, Purchasing power parity international dollar, percent of world GDP
   https://data.imf.org/en/datasets/IMF.RES:WEO

3. **Switzerland GDP Share of World GDP**,
   Annual, Percent (`A146GPPS@IMFWEO`)
   Source: International Monetary Fund, World Economic Outlook Database,
   Gross domestic product, Purchasing power parity international dollar, percent of world GDP
   https://data.imf.org/en/datasets/IMF.RES:WEO
4. **UK GDP Share of World GDP**,
   Annual, Percent (`A112GPPS@IMFWEO`)
   Source: International Monetary Fund, World Economic Outlook Database,
   Gross domestic product, Purchasing power parity international dollar, percent of world GDP
   https://data.imf.org/en/datasets/IMF.RES:WEO
5. **EU-27 Petroleum Production**
   Annual, Thousands of Barrels per Day (`DQ9ACBIF@ENERGY`)
   Source: U.S. Energy Information Administration, International Energy Statistics
   Refined Petroleum Product Production: EU-27 sum
   https://www.eia.gov/international/data/world
6. **Norway Petroleum Production**
   Annual, Thousands of Barrels per Day (`DNOACBIF@ENERGY`)
   Source: U.S. Energy Information Administration, International Energy Statistics,
   Refined Petroleum Product Production: Norway
   https://www.eia.gov/international/data/country/nor
7. **United Kingdom Petroleum Production**
   Annual, Thousands of Barrels per Day (`DGBACBIF@ENERGY`)
   Source: U.S. Energy Information Administration, International Energy Statistics,
   Refined Petroleum Product Production: United Kingdom
   https://www.eia.gov/international/data/country/gbr
8. **EU-27 Petroleum Consumption**
   Annual, Thousands of Barrels per Day (`DQ9ADBRF@ENERGY`)
   Source: U.S. Energy Information Administration, International Energy Statistics
   Refined Petroleum Product Consumption: EU-27 sum
   https://www.eia.gov/international/data/world
9. **Norway Petroleum Consumption**
   Annual, Thousands of Barrels per Day (`DNOADBRF@ENERGY`)
   Source: U.S. Energy Information Administration, International Energy Statistics,
   Refined Petroleum Product Consumption: Norway
   https://www.eia.gov/international/data/nor

10. **Switzerland Petroleum Consumption**
    Annual, Thousands of Barrels per Day (`DCHADBRF@ENERGY`)
    Source: U.S. Energy Information Administration, International Energy Statistics, Refined Petroleum Product Consumption: Switzerland
    https://www.eia.gov/international/data/che
11. **United Kingdom Petroleum Consumption**
    Annual, Thousands of Barrels per Day (`DGBADBRF@ENERGY`)
    Source: U.S. Energy Information Administration, International Energy Statistics, Refined Petroleum Product Consumption: United Kingdom
    https://www.eia.gov/international/data/gbr
12. **Europe Population**
    Annual, Thousands, as of 1 January (`C170TBE@UNPOP`)
    Source: United Nations Department of Economic and Social Affairs, World Population Prospects, Total Population: Europe
    https://population.un.org/wpp/
13. **Russia Population**
    Annual, Thousands, as of 1 January (`C922TBE@UNPOP`)
    Source: United Nations Department of Economic and Social Affairs, World Population Prospects, Total Population: Russia
    https://population.un.org/wpp/
14. **Belarus Population**
    Annual, Thousands, as of 1 January (`C913TBE@UNPOP`)
    Source: United Nations Department of Economic and Social Affairs, World Population Prospects, Total Population: Belarus
    https://population.un.org/wpp/
15. **Moldova Population**
    Annual, Thousands, as of 1 January (`C921TBE@UNPOP`)
    Source: United Nations Department of Economic and Social Affairs, World Population Prospects, Total Population: Moldova
    https://population.un.org/wpp/
16. **Ukraine Population**
    Annual, Thousands, as of 1 January (`C926TBE@UNPOP`)
    Source: United Nations Department of Economic and Social Affairs, World Population Prospects, Total Population: Ukraine
    https://population.un.org/wpp/

17. **EA11-21: HICP: Consumer Price Index**,
    Seasonally adjusted index, (`H023HICP@EUDATA`)
    Source: European Union (non-seasonally adjusted)
    https://ec.europa.eu/eurostat/databrowser/view/prc_hicp_minr

The following variables were constructed using data outside of Haver:

1. **Oil Expenditure Share**, Annual Percent. Calculated as in the baseline model using the WIOD and ICIO databases. The share is calculated by aggregating spending for Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. The world excluding Europe share is calculated using the remaining countries.
2. **Labor Share** Annual Percent, from Penn World Table, v11.0. Average of `labsh` for 16 European countries is calculated using weights for PPP-adjusted GDP shares. The world excluding Europe labor share is calculated using non-European countries in the Federal Reserve Bank of Dallas Global Economic Indicators except Nigeria and Russia.
3. **Household-Firm Oil Expenditure Ratio**, calculated using the procedure for the World excluding the U.S. ratio. Europe is the OECD Europe aggregate, which includes 27 countries.
4. **Shares of PPP-adjusted World GDP**, percent, from the IMF World Economic Outlook database, https://data.imf.org/en/datasets/IMF.RES:WEO.
5. **Foreign Exchange Rates**, from the Federal Reserve Board of Governors Table G.5 https://www.federalreserve.gov/releases/g5.
6. **CPI indexes**, seasonally adjusted, from the OECD Main Economic Indicators database, https://www.oecd.org/en/data.
7. **European Oil Price**, index that reflects the price of oil in domestic currencies for 12 European economies: 8 countries that use the euro plus Great Britain, Norway, Sweden and Switzerland. Prior to the introduction of the euro in 1999, we convert the monthly average price of Brent crude into domestic currencies using exchange rate data from the Board of Governors. We then deflate using seasonally-adjusted, country-specific CPIs, calculate quarterly growth rates for the real price of oil for each country and construct a weighted average of the growth rates, where the weights are PPP-adjusted shares of GDP among the 12 countries. We assume the index starts at 1 in 1999Q1. The values prior to 1999Q1 are calculated iteratively using the growth rates. After the introduction of the euro, the same process is repeated except there is a single euro price of oil that applies for the 8 countries and that price is deflated by a harmonized consumer price index from the European Union.

Trade share group definitions:

- Foods, feeds, and beverages is defined as the sum of sectors A01 (agriculture and hunting), A03 (fishing and aquaculture) and C10T12 (food products, beverages and tobacco products).
- Nondurable consumer goods (non-oil) are defined as sectors C13T15 (textiles, wearing apparel, leather and related goods), and C21 (basic pharmaceutical products), which corresponds to the sub-categories in the nondurable consumer goods category for the U.S.
- Investment goods are defined as sectors C26 through C33. C26 is computer, electronic and optical products; C27 is electrical equipment; C28 is machinery and equipment n.e.c.; C29 motor vehicles, trailers and semi-trailers; C301 building of ships and boats; C302T309 other transport equipment; and C31T33 is furniture and other manufacturing.
- Non-oil consumption expenditure is calculated using the appropriate columns for household final consumption expenditures (HFCE), subtracting spending on sectors B06 (extraction of crude petroleum and natural gas) and C19 (coke, refined petroleum and nuclear fuel).

We apply the following data transformations (sample over 1990Q1–2019Q4, $T = 120$):

1. **Europe Share of World GDP**: $\theta_1^{yr} = \frac{1}{T/4}\sum_{t=1}^{T/4} \frac{\mathtt{A998GPPS}_t + \mathtt{A142GPPS}_t + \mathtt{A146GPPS}_t + \mathtt{A112GPPS}_t}{100}$
2. **Europe Oil Production-Consumption Ratio**: $\theta_{1,o}^s = \frac{1}{T/4}\sum_{t=1}^{T/4} \frac{o_{1,t}^s}{o_{1,t}^c}$, where European oil supply is $o_{1,t}^s = \mathtt{DQ9ACBIF}_t + \mathtt{DNOACBIF}_t + \mathtt{DGBACBIF}_t$ and European oil consumption is $o_{1,t}^c = \mathtt{DQ9ADBRF}_t + \mathtt{DNOADBRF}_t + \mathtt{DCHADBRF}_t + \mathtt{DGBADBRF}_t$.
3. **Europe-ROW Oil Consumption Ratio**: $\theta_{1,o} = \frac{1}{T/4}\sum_{t=1}^{T/4} \frac{o_{1,t}^c}{\mathtt{DWOADBRF}_t - o_{1,t}^c}$
4. **Europe Population Share**: $\theta_1^T = \frac{1}{T/4}\sum_{t=1}^{T/4} \frac{\mathtt{C170TBE} - \mathtt{C922TBE}_t - \mathtt{C913TBE}_t - \mathtt{C921TBE}_t - \mathtt{C926TBE}_t}{\mathtt{C001TBE}_t}$

C SOLUTION METHOD AND ACCURACY

The equilibrium system of the two-country model is summarized by $E[g(\mathbf{x}_{t+1}, \mathbf{x}_t, \varepsilon_{t+1})|\mathbf{z}_t, \vartheta] = 0$, where g is a vector-valued function, $\mathbf{x}_t$ is the vector of model variables, ε_t is the vector of shocks, $\mathbf{z}_t = [k_{1,t}, k_{2,t}, s_{1,t}, s_{2,t}, a_{1,t}, a_{2,t}, a_{2,t}^o, v_{2,t}^e]$ is the vector of states, and ϑ is the vector of parameters.

We discretize the shocks $\{\varepsilon_{1,t}^a, \varepsilon_{2,t}^a, \varepsilon_{2,t}^o\}$ each into 7 points using the Rouwenhorst (1995) method. We discretize each continuous state variable into 7 evenly-spaced points. The disaster indicator $v_{2,t}^e \in \{0, 1\}$. The product of the points in each dimension is the total number of nodes in the state space, $D = 7^7 \times 2 = 1{,}647{,}086$. The bounds of the continuous state variables are chosen to cover at least 99% of the ergodic distribution, so there is minimal extrapolation. Specifically, for the baseline calibration with a 5% oil supply disruption, the bounds on U.S. capital, $k_{1,t}$, range from -5.0% to $+4.25\%$ of the deterministic steady state, the bounds on ROW capital, $k_{2,t}$, range from -4.0% to $+4.25\%$, the bounds on U.S. oil inventories, $s_{1,t}$, range from -20% to $+35\%$, and the bounds on ROW oil inventories, $s_{2,t}$, range from -10% to $+15\%$. These bounds are adjusted for alternative model specifications to ensure equivalent coverage of the ergodic distribution.[1]

The realization of $\mathbf{z}_t$ on node d is denoted $\mathbf{z}_t(d)$. The Rouwenhorst method provides integration nodes for the continuous shocks, $[\varepsilon^a_{1,t+1}(m), \varepsilon^a_{2,t+1}(m), \varepsilon^o_{2,t+1}(m)]$. The transition matrix for the discrete disaster state determines the integration weights for its future realizations, $[v^e_{2,t+1}(m)]$. The weight for a particular realization of the continuous and discrete shocks is $\phi(m)$, where $m \in \{1, \ldots, M\}$ and $M = 7^3 \times 2 = 686$ is the product of the number of realizations of each shock.

The vector of policy functions and its realization on node d are denoted by pf_t and $\mathrm{pf}_t(d)$, where

$$\mathrm{pf}_t = [n_1(\mathbf{z}_t), o_1(\mathbf{z}_t), J_1(\mathbf{z}_t), i_1(\mathbf{z}_t), n_2(\mathbf{z}_t), o_2(\mathbf{z}_t), J_2(\mathbf{z}_t)].$$

The following steps outline the algorithm:

1. To obtain an initial conjecture, pf_0, first solve the log-linearized model (setting $\sigma = \sigma_h = 0.5$ and abstracting from disaster risk) using the GENSYS algorithm of Sims (2002) and then map the linear solution onto the discretized state space.
2. On iteration $j \in \{1, 2, \ldots\}$ and each node $d \in \{1, \ldots, D\}$, use Sims' `csolve` code to find the $\mathrm{pf}_j(d)$ that satisfies $E[g(\cdot)|\mathbf{z}_t(d), \vartheta] \approx 0$. Guess $\mathrm{pf}_j(d) = \mathrm{pf}_{j-1}(d)$. Then
   (a) Solve for all variables dated at time t, given $\mathrm{pf}_j(d)$ and $\mathbf{z}_t(d)$.
   (b) Linearly interpolate the policy functions, pf_{j-1}, at the updated state variables, $\mathbf{z}_{t+1}(m)$, to obtain $\mathrm{pf}_{t+1}(m)$ on every integration node, $m \in \{1, \ldots, M\}$.
   (c) Given $\{\mathrm{pf}_{t+1}(m)\}_{m=1}^M$, solve for the other elements of $\mathbf{x}_{t+1}(m)$ and compute

$$E[g(\mathbf{x}_{t+1}, \mathbf{x}_t(d), \varepsilon_{t+1})|\mathbf{z}_t(d), \vartheta] \approx \sum_{m=1}^{M} \phi(m)\, g(\mathbf{x}_{t+1}(m), \mathbf{x}_t(d), \varepsilon_{t+1}(m)).$$

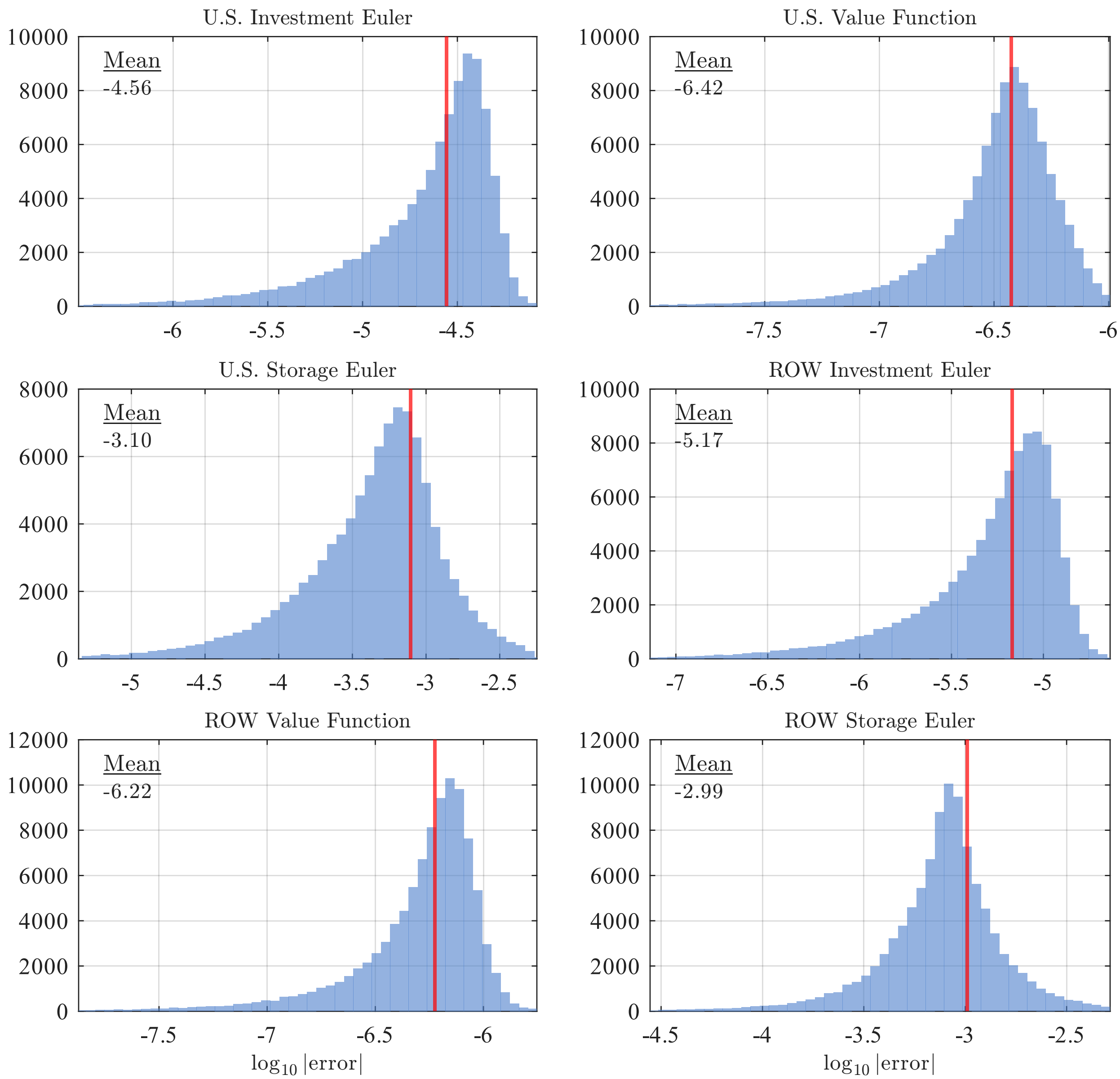
   When `csolve` has converged, set $\mathrm{pf}_j(d) = \mathrm{pf}_t(d)$.
3. Repeat step 2 until $\mathrm{maxdist}_j < 10^{-8}$, where $\mathrm{maxdist}_j \equiv \max\{|(\mathrm{pf}_j - \mathrm{pf}_{j-1})/\mathrm{pf}_{j-1}|\}$. When that criterion is satisfied, the algorithm has converged to an approximate solution.

The algorithm described above is applied iteratively to the production and consumption elasticities of substitution. Starting from the initial value of $\sigma = \sigma_h = 0.5$, we solve the nonlinear model and use the converged solution as the initial conjecture for the next step, reducing $\sigma = \sigma_h$ by 0.01 at each step until reaching the calibrated value of 0.21. This approach is necessary to ensure convergence of the nonlinear solver given the high degree of nonlinearity introduced by disaster risk and the CES aggregators. The algorithm is implemented in Fortran and parallelized using MPI.

[1] For example, under the present calibration with a 15% oil supply disruption, the grid bounds range from -4.75% to $+4.75\%$ for $k_{1,t}$, -4.0% to $+4.25\%$ for $k_{2,t}$, -40% to $+55\%$ for $s_{1,t}$, and -22.5% to $+17.5\%$ for $s_{2,t}$. These bounds cover the responses to a 15% disruption, as the paths of all state variables remain well within the grid bounds.

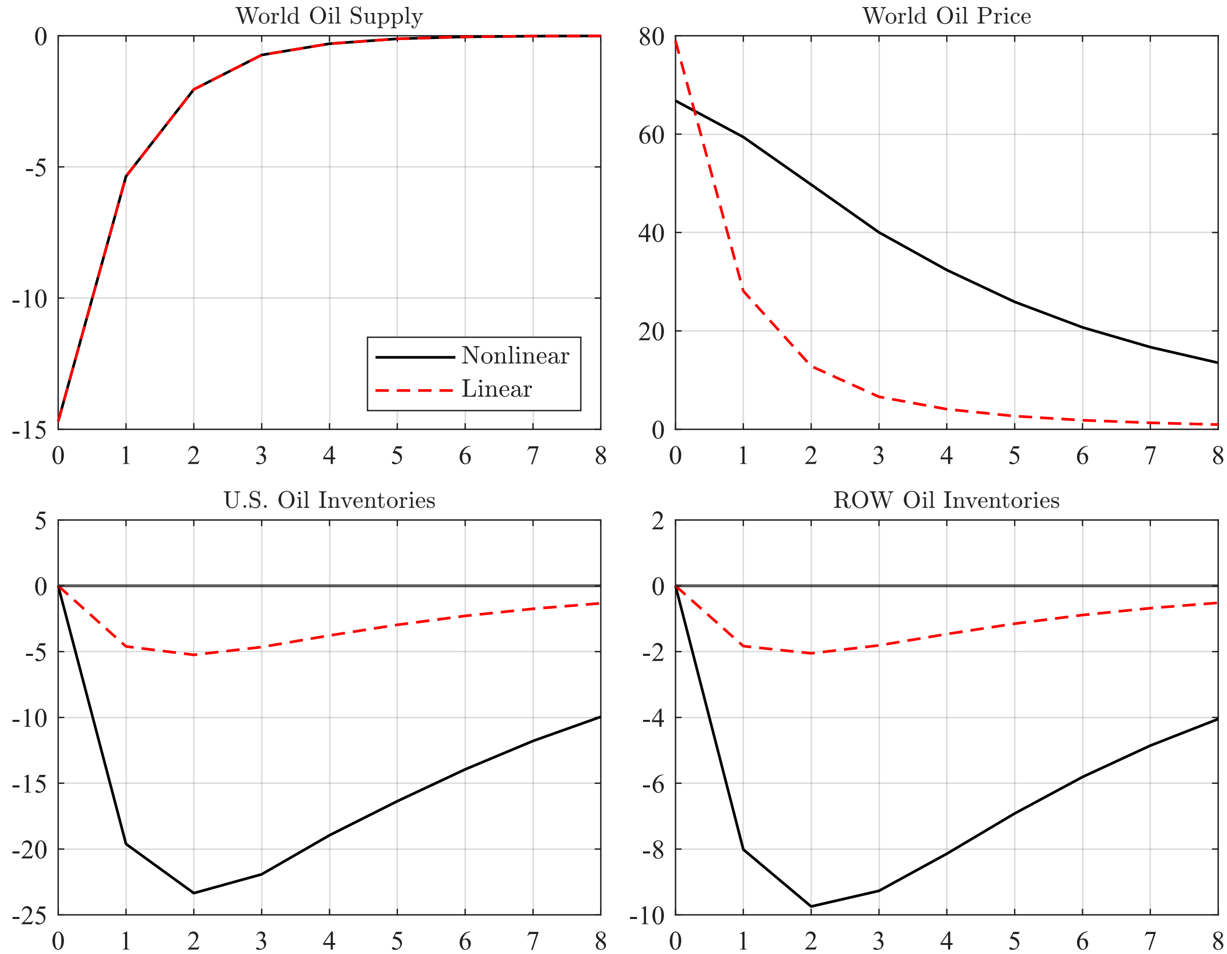
Euler Equation Errors Following Aruoba et al. (2006), we evaluate the accuracy of the solution using simulated Euler equation errors. In each period, we use Gauss-Hermite quadrature with $N_{GH} = 5$ nodes for each continuous shock to approximate the conditional expectations in the six equilibrium equations of the model. We simulate $N = 100$ paths of length $T = 1000$ periods and report the distribution of $\log_{10}$ mean absolute errors in Figure 1 for the baseline calibration. The mean errors range from -6.4 to -3.0 in $\log_{10}$ units, indicating that the solution is accurate to between three and six decimal places. These results are in line with the accuracy benchmarks established by Aruoba et al. (2006). We obtain similar results for the past and present calibrations.

Figure 1: Distribution of Euler equation errors under the baseline calibration



Notes: Absolute error in base 10 logarithms. The vertical line is the mean of the distribution.

Figure 2: Nonlinear vs. linearized model responses to a 15% oil supply disruption



Notes: The horizontal axis denotes quarters. The responses are percent changes from the baseline.

D IMPORTANCE OF THE SOLUTION METHOD

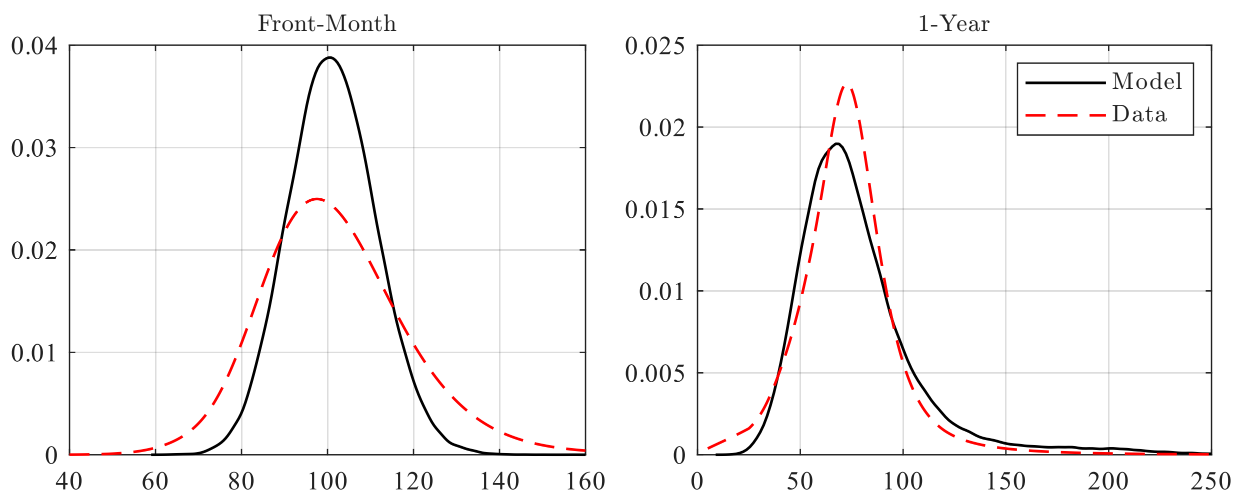
This appendix shows that a nonlinear solution method is essential for accurately quantifying the effects of large geopolitical oil supply disruptions. To isolate the role of nonlinearity, we feed the same oil supply path into both the nonlinear and linearized versions of the model and compare the resulting responses. Specifically, we extract the path of world oil supply from the nonlinear model following a 15% decline in global oil production lasting one quarter and then construct a sequence of oil supply shocks for the linearized model that exactly replicates this path. Any differences in the responses therefore reflect genuine model nonlinearity rather than differences in the shock.

Figure 2 compares the responses of the oil price and oil inventories. In the nonlinear model, the oil price rises by 67% on impact, whereas in the linearized model it rises by 79%. The divergence flips signs and widens considerably over time. One year after the shock, the oil price in the nonlinear model remains 40% above the pre-shock baseline, compared to only 7% in the linearized model. The linearized model therefore severely understates the persistence of the oil price. The differences in the inventory responses are equally striking. In the nonlinear model, U.S. oil inventories fall by 23% at their peak, while ROW oil inventories fall by 10%. In the linearized model, these peak declines are only 5% and 2% respectively, roughly one-fifth of the nonlinear responses.

The large quantitative differences in the oil market responses directly feed into the broader economy. For example, the nonlinear model generates substantially larger declines in gross output in both the U.S. and the ROW. These results underscore that a nonlinear solution method is essential for accurately quantifying the effects of major geopolitical oil supply disruptions.

E Additional U.S. Model Results

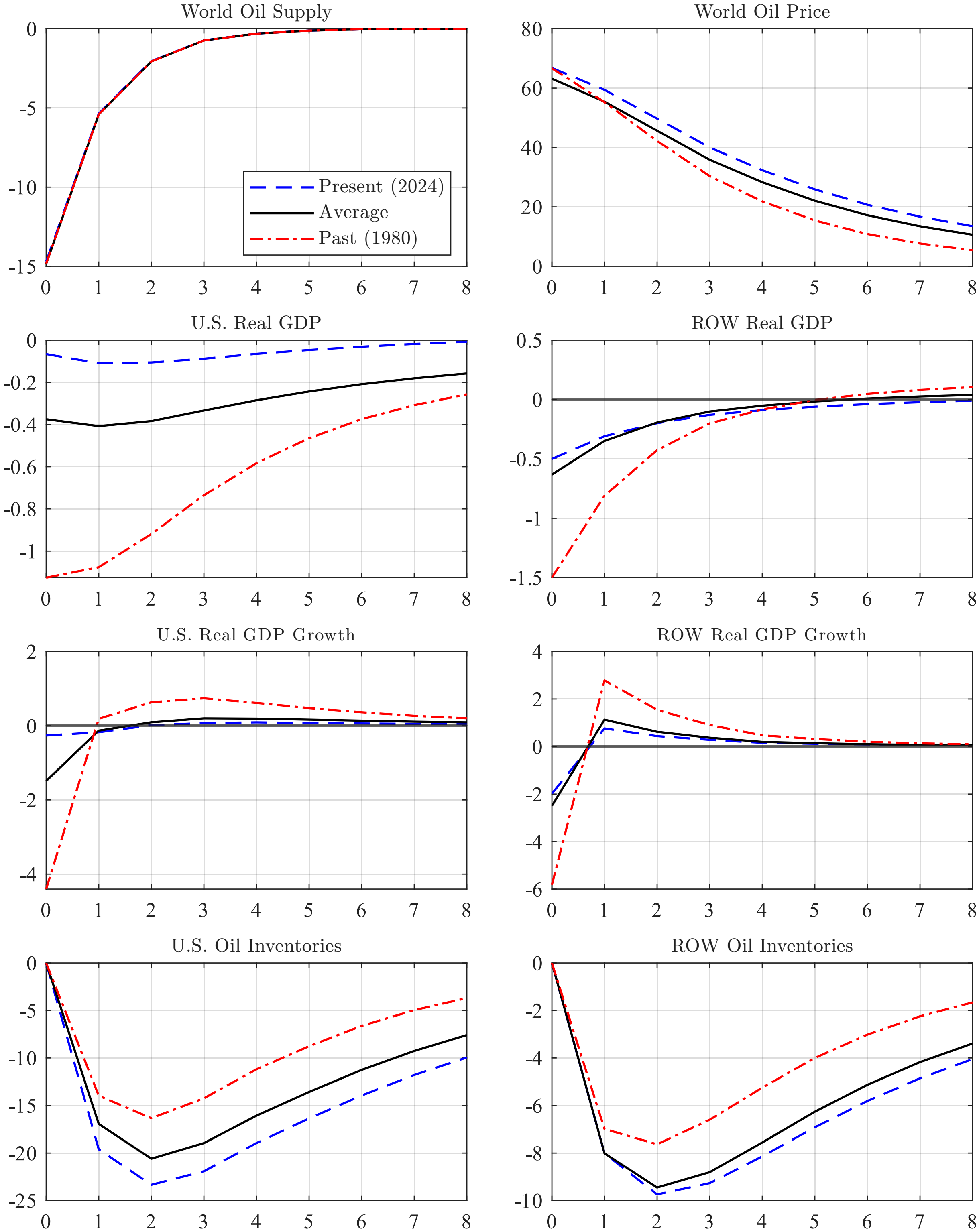
Figure 3: Model and options-implied predictive oil price densities



Notes: The model-implied risk-neutral density is conditional on a 15% oil supply disruption. The data density is the average option-implied risk-neutral density computed from WTI crude oil options on April 27–May 1, 2026. The front-month contract expires in June 2026, and the one-year contract expires in June 2027.

Figure 3 reports the model- and option-implied risk-neutral densities for the last week of April 2026 to complement the results for the first week of May in Figure 7 of the paper. The front-month interquartile range is $90 to $112, slightly wider than in the first week of May but still closely aligned with the model-implied range of $94 to $108. The front-month distribution exhibits somewhat fatter tails in the last week of April, with a standard deviation of $18 compared with $13 in the first week of May. At the one-year horizon, the distribution is nearly unchanged. As in the first week of May, there is little skewness at either horizon. Overall, the model-implied densities closely align with the option-implied densities during both weeks, showing that our results are robust to the date range once financial markets no longer viewed the disruption as short-lived.

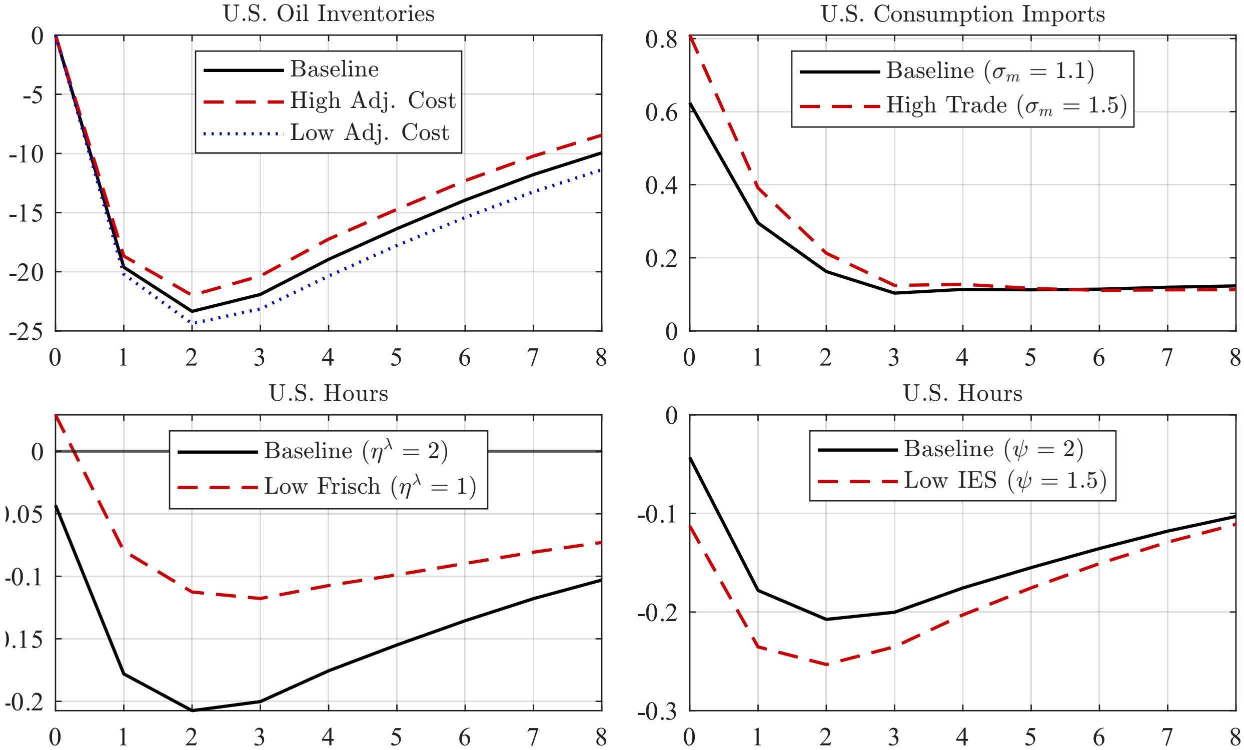
Figure 4: Responses to a 1-quarter disruption of 15% of global oil supplies



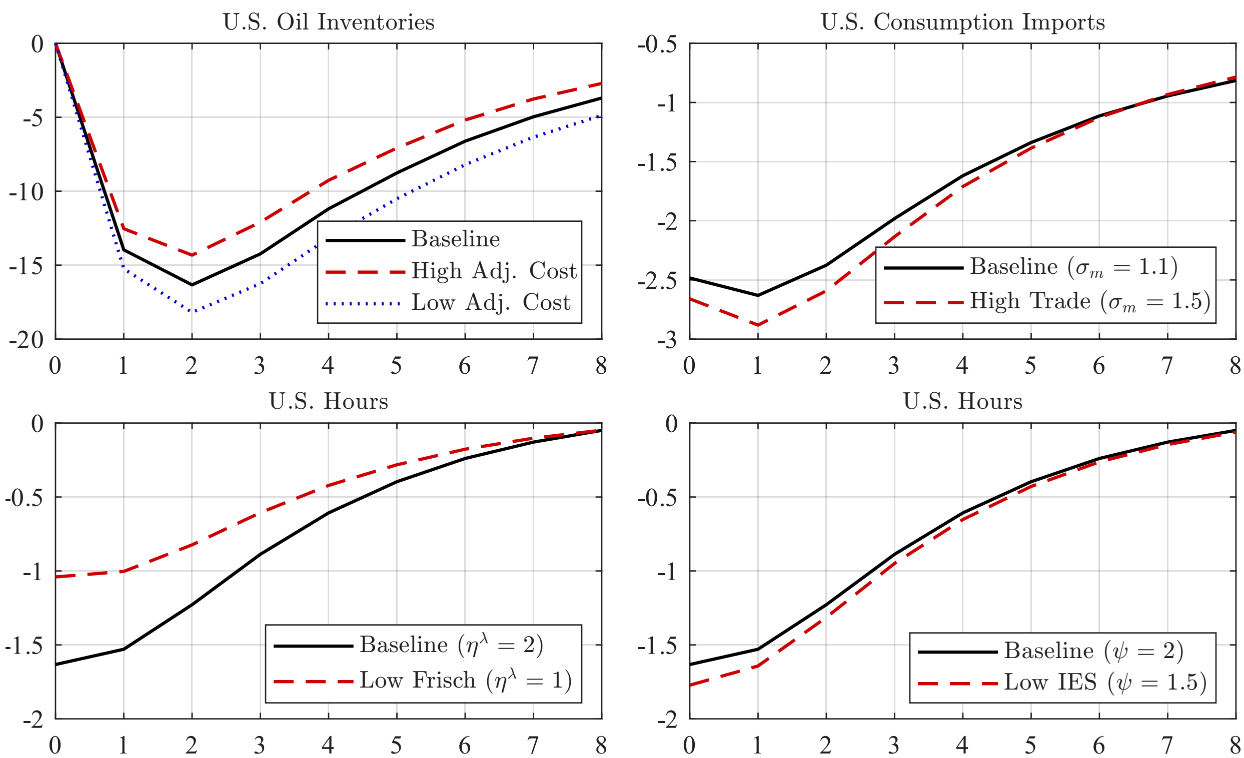
Notes: The horizontal axis denotes quarters. Real GDP is chain-weighted. The growth rates are annualized percentage point deviations, while the other variables are percent deviations from the pre-shock baseline.

Figure 5: Responses to a 15% oil supply disruption under alternative parameters

(a) Present (2024)

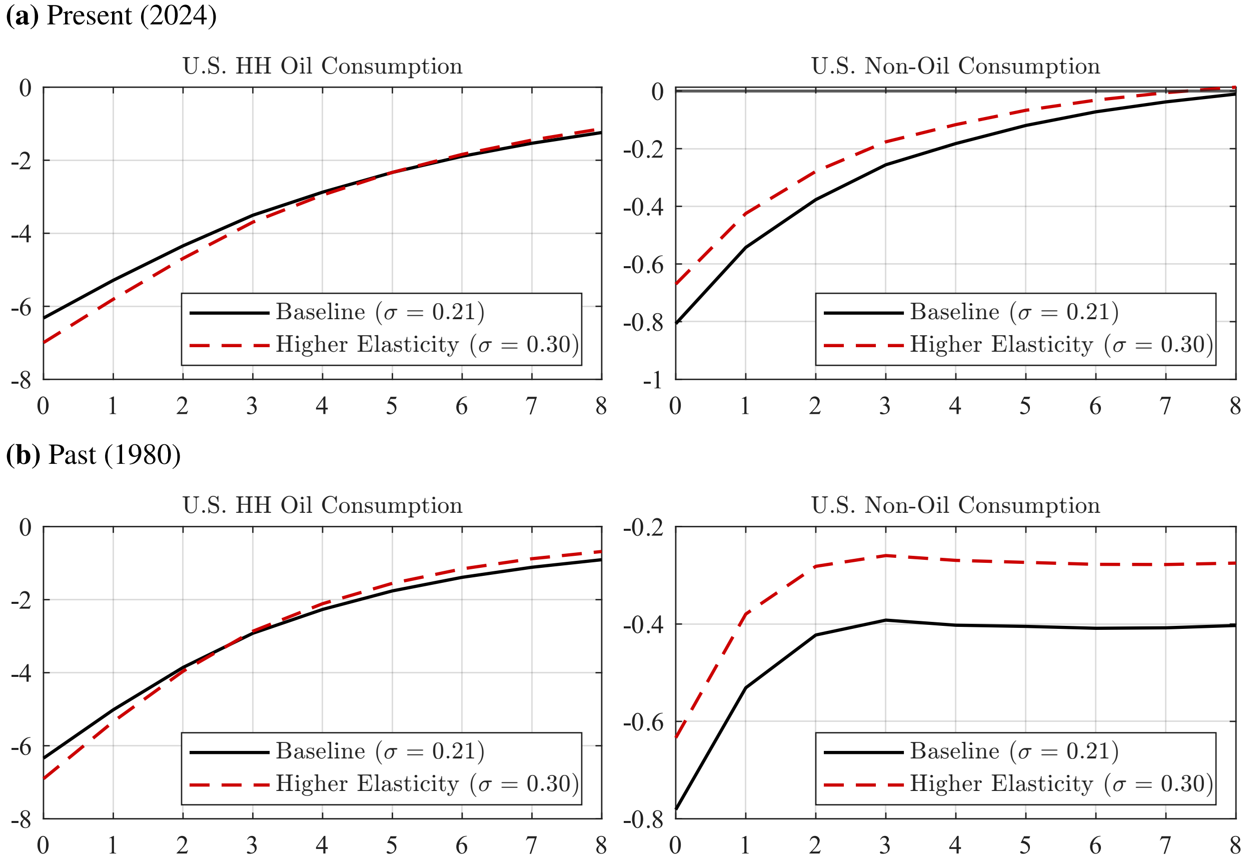


(b) Past (1980)



Notes: The horizontal axis denotes quarters. Responses are percent deviations from the pre-shock baseline.

Figure 6: Responses to a 15% oil supply disruption under alternative elasticities



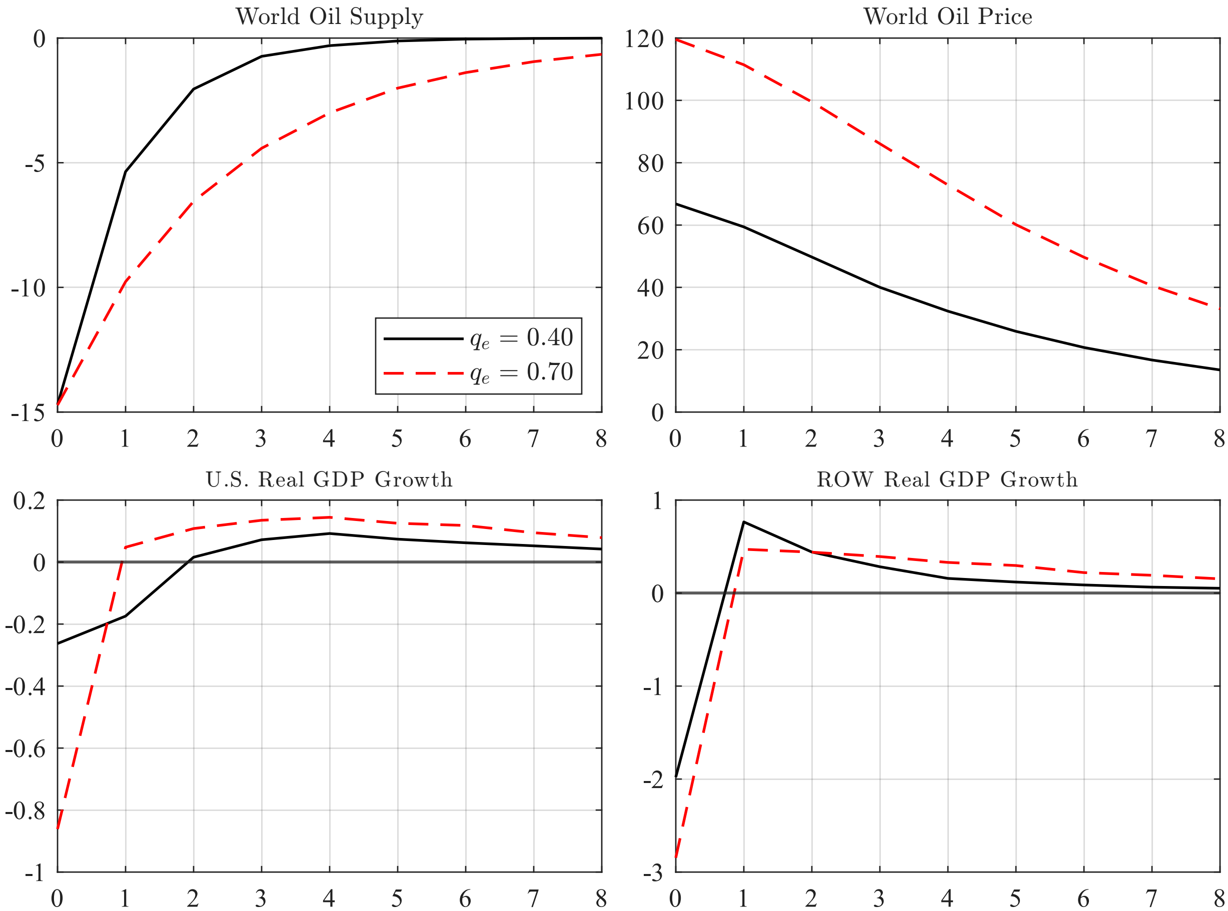
Notes: The horizontal axis denotes quarters. Responses are percent deviations from the pre-shock baseline.

Figure 4 plots the responses to a one-quarter, 15% drop in oil supply under the past, present, and average calibrations. It is the analogue of Figure 3 in the paper, which considers a 5% disruption.

Figure 5 shows how key variables respond to the disruption under the alternative parameter values in Table 6 of the paper. Oil inventories are an important buffer. Higher adjustment costs generate a smaller inventory drawdown and amplify the decline in GDP, while lower costs do the opposite. The import elasticity operates through the oil trade balance. Under the present calibration, the U.S. is a net oil exporter and non-oil imports rise, whereas under the past calibration they fall. A higher import elasticity strengthens substitution between domestic and foreign goods in both cases, which amplifies the GDP response today and dampens it in the past. The remaining two parameters work through hours. A lower Frisch elasticity makes hours less responsive to the fall in real wages and reduces the GDP impact, while a lower IES works in the opposite direction.

Figure 6 plots household oil and non-oil consumption under the two elasticities of substitution. A higher elasticity generates a larger drop in oil consumption, but the demand destruction limits the rise in the fuel price and reduces the decline in non-oil consumption. On net, GDP responds less.

Figure 7: Responses to a 15% oil supply disaster by expected recovery, present calibration



Notes: The horizontal axis denotes quarters. Real GDP is chain-weighted. The growth rates are annualized percentage point deviations, while the other variables are percent deviations from the baseline.

The Role of Expectations The oil futures curve and option-implied densities suggest that markets did not price in a 15% disruption of global oil supplies beyond May 2026. However, it is interesting to consider how the responses would have differed under a longer expected duration. Figure 7 compares our baseline expected duration (5 months, $q_e = 0.4$) with a longer expected duration (10 months, $q_e = 0.7$). The longer expected duration causes the oil price to rise by 120% on impact compared to 67% under our baseline, and to remain higher throughout the recovery. The larger and more persistent price response amplifies the real effects. Annualized U.S. real GDP growth falls by 0.86 percentage points on impact rather than 0.26, while the ROW decline rises from 2 to 2.84 percentage points. The expected duration also affects the relative exposure of the two economies. When $q_e = 0.4$, the U.S. GDP response is roughly one-eighth of the ROW response, compared to only one-third when $q_e = 0.7$. These results highlight that the consequences of the 2026 Iran War would have been larger if agents had expected a more persistent oil supply disruption.

F EUROPEAN MODEL CALIBRATION AND RESULTS

Table 1: European model calibration

Parameter	Value	Parameter	Value
Common Parameters Across Countries			
Subjective Discount Factor (β)	0.995	Capital Depreciation Rate (δ)	0.025
Relative Risk Aversion Coefficient (γ)	10	Import Elasticity of Substitution (σ_m)	1.1
Intertemporal Substitution Elasticity (ψ)	2	Oil Storage Cost (ω)	0.025
Country-Specific Parameters			
Europe Prod. Elasticity of Substitution (σ_1)	0.30	ROW Prod. Elasticity of Substitution (σ_2)	0.21
Europe Cons. Elasticity of Substitution ($\sigma_{1,h}$)	0.30	ROW Cons. Elasticity of Substitution ($\sigma_{2,h}$)	0.21
Europe Storage Adjustment Cost (ν_1)	32.0	ROW Storage Adjustment Cost (ν_2)	12.0
Europe Capital Share of Value Added (ξ_1)	0.38	ROW Capital Share of Value Added (ξ_2)	0.42
Europe Utility Weight on Leisure (χ_1)	0.465	ROW Utility Weight on Leisure (χ_2)	0.477
Europe Oil Share of Production (α_1)	0.012	ROW Oil Share of Production (α_2)	0.023
Europe Oil Share of Consumption (α_1^h)	0.020	ROW Oil Share of Consumption (α_2^h)	0.025
Europe Gasoline Price Markup (ϑ_1)	1.310	ROW Gasoline Price Markup (ϑ_2)	1.476
Europe Import Share of Consumption (α_1^{mc})	0.030	ROW Import Share of Consumption (α_2^{mc})	0.010
Europe Import Share of Investment (α_1^{mi})	0.160	ROW Import Share of Investment (α_2^{mi})	0.054
Europe-Specific Parameters			
Europe World Population Share (θ_1^T)	0.081	Europe World GDP Share (θ_1^{yr})	0.24
Exogenous Process Parameters			
Persistence of Europe Productivity (ρ_1^a)	0.89	Std. Deviation of Europe Productivity (σ_1^a)	0.013
Persistence of ROW Productivity (ρ_2^a)	0.90	Std. Deviation of ROW Productivity (σ_2^a)	0.010
Persistence of ROW Oil Shocks (ρ^o)	0.92	Std Deviation of ROW Oil Shocks (σ^o)	0.015
Prob. of Entering Oil Disaster (p_e)	0.02	Prob. of Remaining in Oil Disaster (q_e)	0.40
Ergodic Probability of Oil Disaster (π_e)	0.032	Oil Production Disaster Size (ζ_e)	0.05

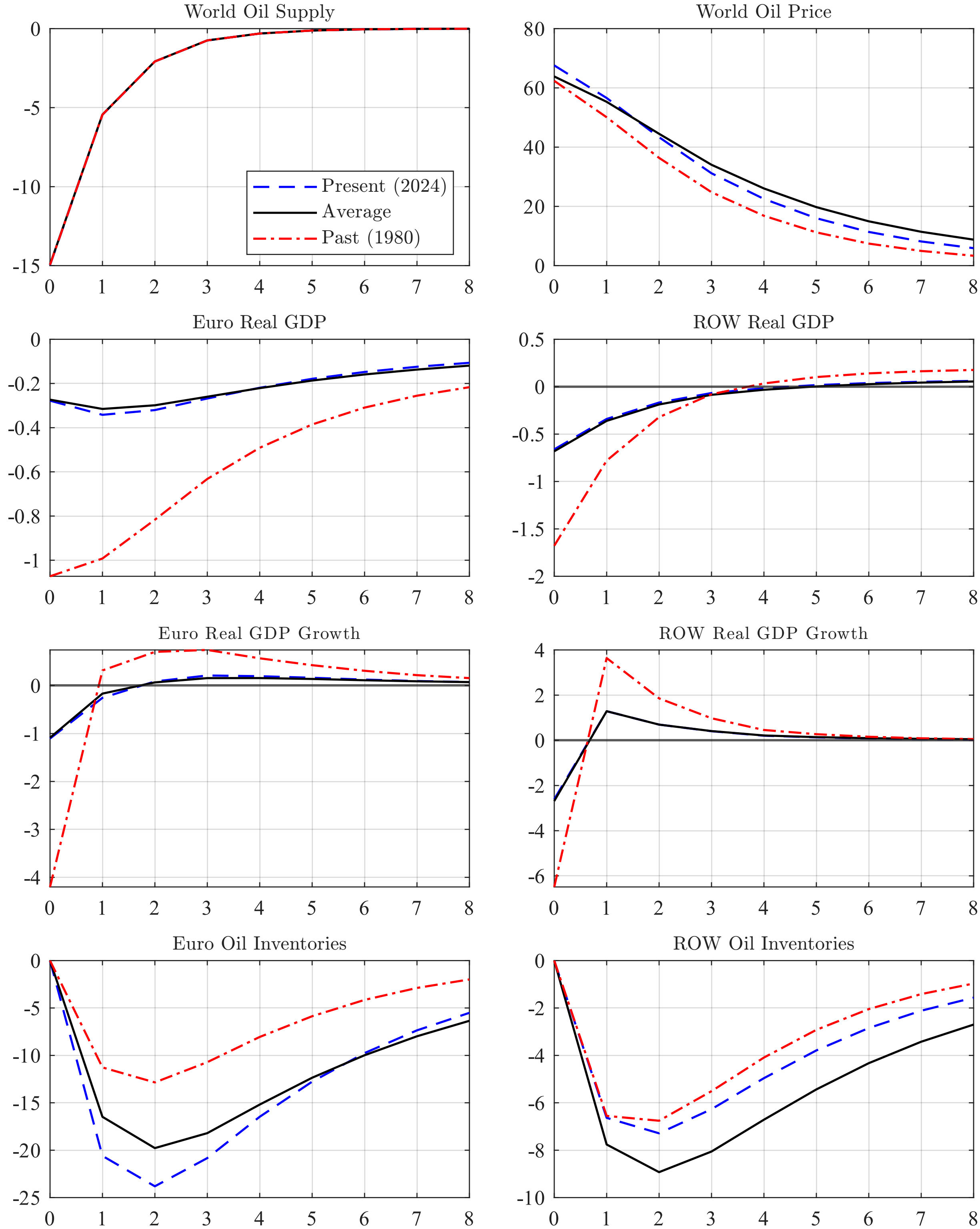
Notes: The model is calibrated at a quarterly frequency using data from 1990Q1–2019Q4.

Table 2: European data and simulated moments

Moment	Data	SE	Model	Moment	Data	SE	Model
$E(s_1/o_1^c)$	0.72	0.01	0.72	$SD(p_{eu}^o)$	36.7	2.8	37.2
$E(s_2/o_2^c)$	1.19	0.01	1.18	$SD(y_1^{rcw})$	2.28	0.33	2.29
$E(p_1^g o_1^c/y_1^r)$	0.026	0.002	0.026	$SD(y_2^{rcw})$	1.76	0.23	1.72
$E(p_2^g o_2^c/y_2^r)$	0.040	0.003	0.040	$SD(o_2^s)$	3.40	0.54	3.44
$E(o_1^h/o_1)$	1.16	0.01	1.16	$SD(s_1)$	6.64	0.69	6.72
$E(o_2^h/o_2)$	0.72	0.01	0.72	$SD(s_2)$	2.65	0.35	2.73
$E(o_1^c/o_2^c)$	0.22	0.01	0.22	$AC(y_1^{rcw})$	0.89	0.05	0.87
$E(o_1^s/o_1^c)$	0.36	0.01	0.36	$AC(y_2^{rcw})$	0.90	0.03	0.88
$E(y_1^r/y_w^r)$	0.24	0.01	0.24	$AC(o_2^s)$	0.90	0.05	0.85

Notes: The model is calibrated to data from 1990Q1–2019Q4. The standard deviations are percents. Standard errors on the data are estimated using a two-step GMM procedure with a Bartlett kernel and five lags.

Figure 8: European model responses to a 1-quarter disruption of 15% of global oil supplies



Notes: The horizontal axis denotes quarters. Real GDP is chain-weighted. The growth rates are annualized percentage point deviations, while the other variables are percent deviations from the pre-shock baseline.

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