Online Appendix to How Times Have Changed: The Impact of the 2026 Iran War on the U.S. Economy

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A DATA SOURCES

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

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35. **U.S. Crude Oil Imports**
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    https://www.eia.gov/petroleum/data.php

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    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

37. **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/

38. **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/

We also use the following data sources:

1. **World Oil Consumption**, Monthly, Millions of Barrels per Day ($\texttt{o\_w}_t$) from Kilian (2022)

2. **World Oil Inventories**, Monthly, Millions of Barrels per Day ($\texttt{s\_w}_t$) from Kilian (2022)

3. **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.

4. **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.

5. **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.

6. **Crude Oil Options and Futures**, Daily, End of Day, 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**: $y_t = \frac{10^9 \times \text{GDP}_t}{(\text{DGDP}_t/100)(1000 \times \text{LN16N}_t)}$
2. **World Real Oil Price**: $p_t^o = \frac{\text{CUSIQABF}_t}{\text{DGDP}_t/100}$
3. **ROW Consumption-Investment Import Ratio**: $\theta_2^{mci} = \frac{1}{T}\sum_{t=1}^{T} \frac{\text{XMF}_t + \text{XMCN}_t}{\text{XMCD}_t + \text{XMKX}_t + \text{XMKV}_t + \text{XMID}_t}$
4. **U.S. Import Share of Consumer Non-Oil Goods**: $\alpha_1^{mc} = \frac{1}{T}\sum_{t=1}^{T} \frac{\text{MMF}_t + \text{MMCN}_t}{\text{CN}_t + \text{CS}_t - \text{CNG}_t - \text{CNOF}_t}$
5. **U.S. Import Share of Investment Goods**: $\alpha_1^{mi} = \frac{1}{T}\sum_{t=1}^{T} \frac{\text{MMCD}_t + \text{MMKX}_t + \text{MMKV}_t + \text{MMID}_t}{\text{F}_t + \text{CD}_t}$
6. **U.S. GDP Share of World GDP**: $\theta_1^{yr} = \frac{1}{T/4}\sum_{t=1}^{T/4} \frac{\text{A111GPPS}_t}{100}$
7. **U.S. Oil Expenditure Share**: $\bar{o}_1^y = \frac{1}{T/4}\sum_{t=1}^{T/4} \frac{\text{ZUSPATCV}_t}{\text{GDPY}_t}$
8. **U.S. Household-Firm Oil Expenditure Ratio**: $\theta_{1,o}^h = \frac{1}{T/4}\sum_{t=1}^{T/4} \frac{\text{CNGA}_t + \text{CNOFA}_t}{\text{ZUSPATCV}_t/1000 - \text{CNGA}_t - \text{CNOFA}_t}$
9. **Relative Retail Gasoline Price**: $\bar{p}_1^{go} = \frac{1}{T}\sum_{t=1}^{T} \frac{\text{PUSSGHBG}_t \times 42 \text{ gallons}}{\text{CUSIQABF}_t}$
10. **ROW Oil Supply**: $o_{2,t}^s = \text{AWOACAUF}_t - \text{AUSACAUF}_t$
11. **U.S.-ROW Oil Consumption Ratio**: $\theta_{1,o} = \frac{1}{T/4}\sum_{t=1}^{T/4} \frac{\text{DUSADBRF}_t}{\text{DWOADBRF}_t - \text{DUSADBRF}_t}$
12. **U.S. Oil Production-Consumption Ratio**: $\theta_{1,o}^s = \frac{1}{T/4}\sum_{t=1}^{T/4} \frac{\text{DUSACBIF}_t}{\text{DUSADBRF}_t}$
13. **U.S. Oil Inventory-Oil Consumption Ratio**: $\bar{s}_1^o = \frac{1}{T}\sum_{t=1}^{T} \frac{\text{CUSFLAAS}_t}{\text{CUSBHAAS}_t}$
14. **ROW Oil Inventory-to-Oil Consumption Ratio**: $\bar{s}_2^o = \frac{\text{S\_W}_t - \text{CUSFLAAS}_t/1000}{\text{O\_W}_t - \text{CUSBHAAS}_t/1000}$
15. **U.S. Total Economy Labor Share**: $\bar{n}_1^y = \frac{1}{T}\sum_{t=1}^{T} \frac{\text{LXEFL}_t}{\text{GDP}_t}$.
16. **U.S. Share of World Population**: $\theta_1^T = \frac{1}{T/4}\sum_{t=1}^{T/4} \frac{\text{C111TBE}_t}{\text{C001TBE}_t}$

B SOLUTION METHOD

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, $\mathbf{z}_t = [k_{1,t}, k_{2,t}, s_{1,t}, s_{2,t}, a_{1,t}, a_{2,t}, a^o_{2,t}, v^e_{2,t}]$ is the vector of states, and ϑ is the vector of parameters.

We discretize the continuous shocks $\{\varepsilon^a_{1,t}, \varepsilon^a_{2,t}, \varepsilon^o_{2,t}\}$ each into 7 points using the Rouwenhorst (1995) method. The bounds of the seven continuous state variables are chosen so they cover at least 99% of the ergodic distribution, reducing the need for extrapolation. Specifically, for the baseline calibration, 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 calibrations to ensure adequate coverage of the ergodic distribution. We discretize each continuous state variable into 7 evenly spaced points. The disaster indicator $v^e_{2,t}$ takes two values, $\{0, 1\}$. 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 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 $M = 343$ 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 $\sigma = \sigma_h = 0.4$ 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 $\{\text{pf}_{t+1}(m)\}_{m=1}^{M}$, 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 $\text{pf}_j(d) = \text{pf}_t(d)$.

3. Repeat step 2 until $\text{maxdist}_j < 10^{-8}$, where $\text{maxdist}_j \equiv \max\{|(\text{pf}_j - \text{pf}_{j-1})/\text{pf}_{j-1}|\}$. 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 $\sigma = \sigma_h = 0.4$, 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 0.17. 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.

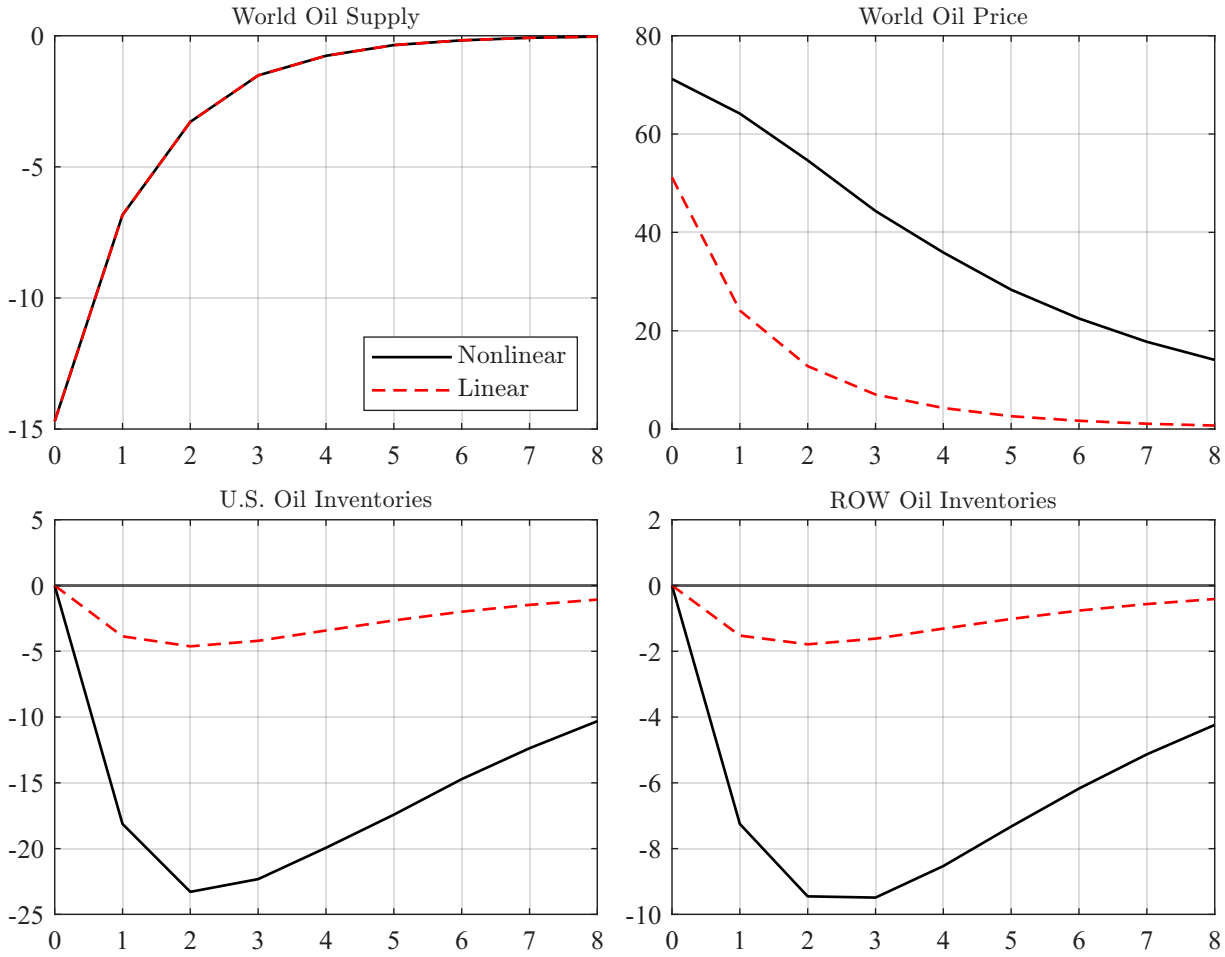
C IMPORTANCE OF THE SOLUTION METHOD

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, 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 1 compares the responses of the oil price and oil inventories. In the nonlinear model, the oil price rises by 71% on impact, whereas in the linearized model it rises by only 51%. The divergence widens over time. One year after the shock, the oil price in the nonlinear model remains 44% above the pre-shock baseline, compared to only 7% in the linearized model. The linearized model therefore severely understates the magnitude and persistence of the oil price response. 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 9%. 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.

Figure 1: 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.

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