DID CARBON EMISSIONS BEHAVE DIFFERENTLY IN THE 2020 RECESSION THAN IN PAST RECESSIONS?

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1 Motivation

- Past research shows recessions have asymmetric impact on CO_2 emissions compared to booms.

- What about 2020?

  It is not a typical recession – negative demand shock for energy particularly in transportation. Instead of oil supply shock or interest rate rises, etc.

2 Methods

2.1 Asymmetry specifications

- **Asymmetric effects of GDP growth and decline (Sheldon, Energy Economics, 2017):**

$$\Delta lnC_t = \alpha_0 + \beta_1 D^+ \Delta lnG_t + \beta_2 D^- \Delta lnG_t + \epsilon_t \quad (1)$$

D^+=1 when GDP grows and zero otherwise; D^-=1 when GDP falls and zero otherwise.

2 Methods

2.1 Asymmetry specifications

- **Asymmetry between recession and non-recession periods:**

$$\Delta lnC_t = \alpha_0 + \beta_3 D_{recession} \Delta lnG_t + \beta_4 D_{non\_recession} \Delta lnG_t + \epsilon_t \quad (2)$$

$D_{recession}$ =1 if one month is in recession and 0 otherwise; $D_{non\_recession}$=1 if one month is not in recession.

2.2 Data

Monthly U.S. real GDP data are derived from the Brave-Butters-Kelley Indexes (BBKI). Federal Reserve Bank of Chicago project (Brave et al., 2019).

Carbon dioxide emissions and other energy-related data come from U.S. Energy Information Administration (EIA) Monthly Energy Review.

Data start from January 1973 and end in December 2020.

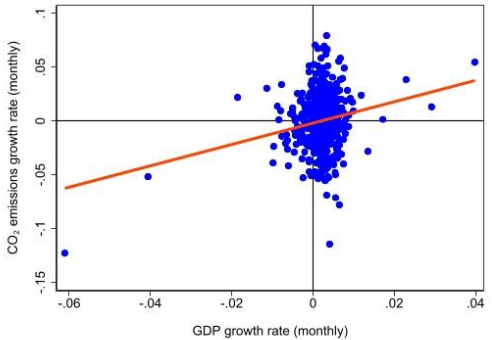


Figure 1. Monthly carbon dioxide emissions and GDP growth rate

3 Results

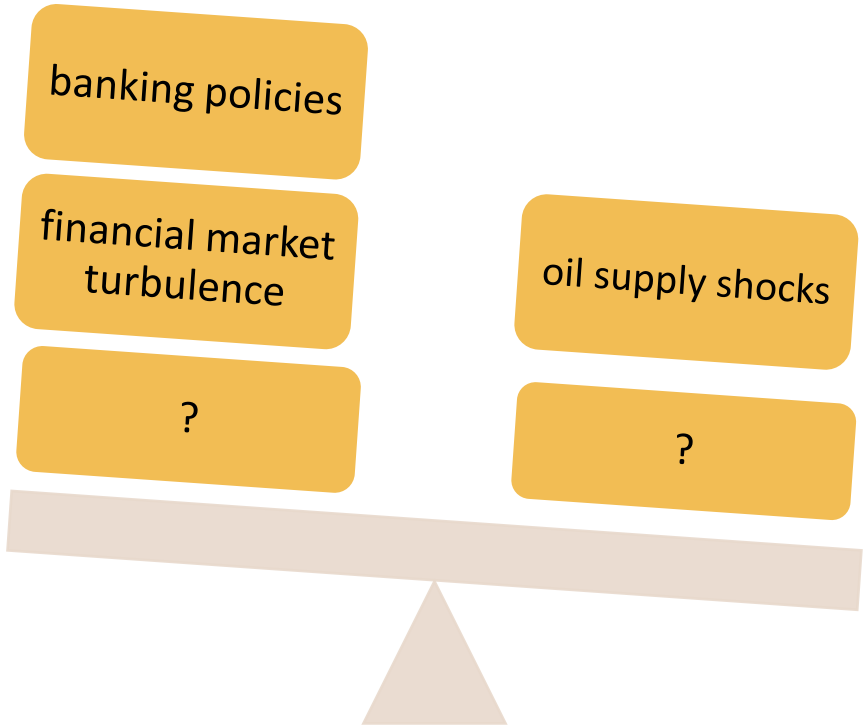
- We find the COVID-19 recession is asymmetric

--larger impact on carbon emissions during this recession compared to boom

Note: Dependent variable is monthly emission growth rate. Robust standard errors in parentheses;*** p<0.01, ** p<0.05, * p<0.1; growth19 and growth20 specification compares positive and negative growth interactions; recession20 (Jan 1973-December 2020) and recession19 (Jan 1973-December 2019) specifications identify the interaction term of the recession dummy and GDP growth change.

recessions

recessions



- We then investigate past recessions individually.

Duration of a recession:

National Bureau of Economic Research (NBER),

"Contractions (recessions) start at the peak of a business cycle and end at the trough."

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Table 1. Recession identification and duration

Recession	Recession starts (peak)	Recession ends(trough)
1973-1975 recession	November 1973	March 1975
1980 recession	January 1980	July 1980
1981-1982 recession	July 1981	December 1982
1990-1991 recession	July 1990	March 1991
2001 recession	March 2001	November 2001
2007-2009 recession	December 2007	June 2009
2020 recession	February 2020	December 2020[1]

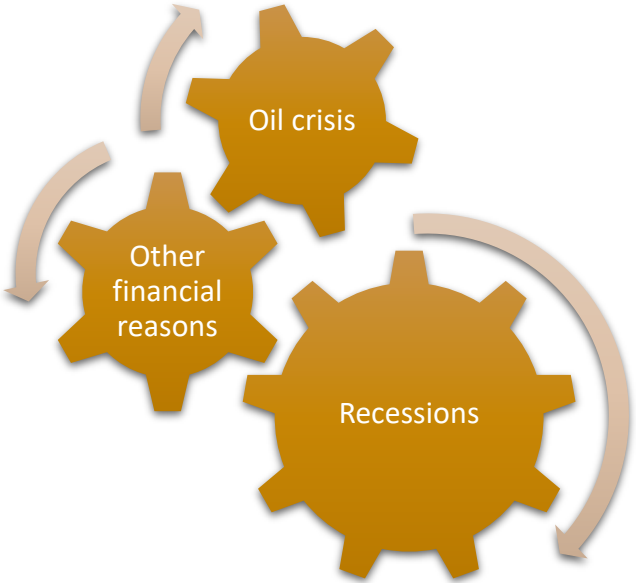
Source: Business Cycle Dating by NBER, https://www.nber.org/research/data/us-business-cycle-expansions-and-contractions

[1] Due to data availability, we only identify the COVID-19 recession as February-December 2020.

Comparing recessions individually

$$\Delta lnC_t = \alpha_0 + \tau T_{recession\ identification=i} + \gamma \Delta lnG_t + \sum_{i=0}^{7} \rho_i T_{recession\ identification=i} \Delta lnG_t + \epsilon_t \quad (3)$$

The recession identification term ($T_{recession\ identification}$) identifies each economic recession recognized by National Bureau of Economic Research (NBER) in the U.S. history since 1973. The subscript i denotes each recession.



- Only some of them had larger impact compared to boom
- These are associated with negative oil shocks

Recessions associated with negative oil demand & supply shocks may cause asymmetry

- Regress with emissions only from oil
- Residual comparison

Regress with emissions only from oil

- Only oil emissions have larger asymmetric impact than total energy-related emissions between most identified recessions and booms

Residual comparison

$$\Delta lnoil_t = \alpha_0 + \gamma \Delta lnG_t + \varepsilon_{oil\_t} \quad (4)$$

$$\Delta lnother\_energy_t = \alpha_0 + \gamma \Delta lnG_t + \varepsilon_{energy\_t} \quad (5)$$

Excess changes of petroleum, ε_{oil}

Excess other energy, ε_{energy}, (primary energy minus petroleum consumption)

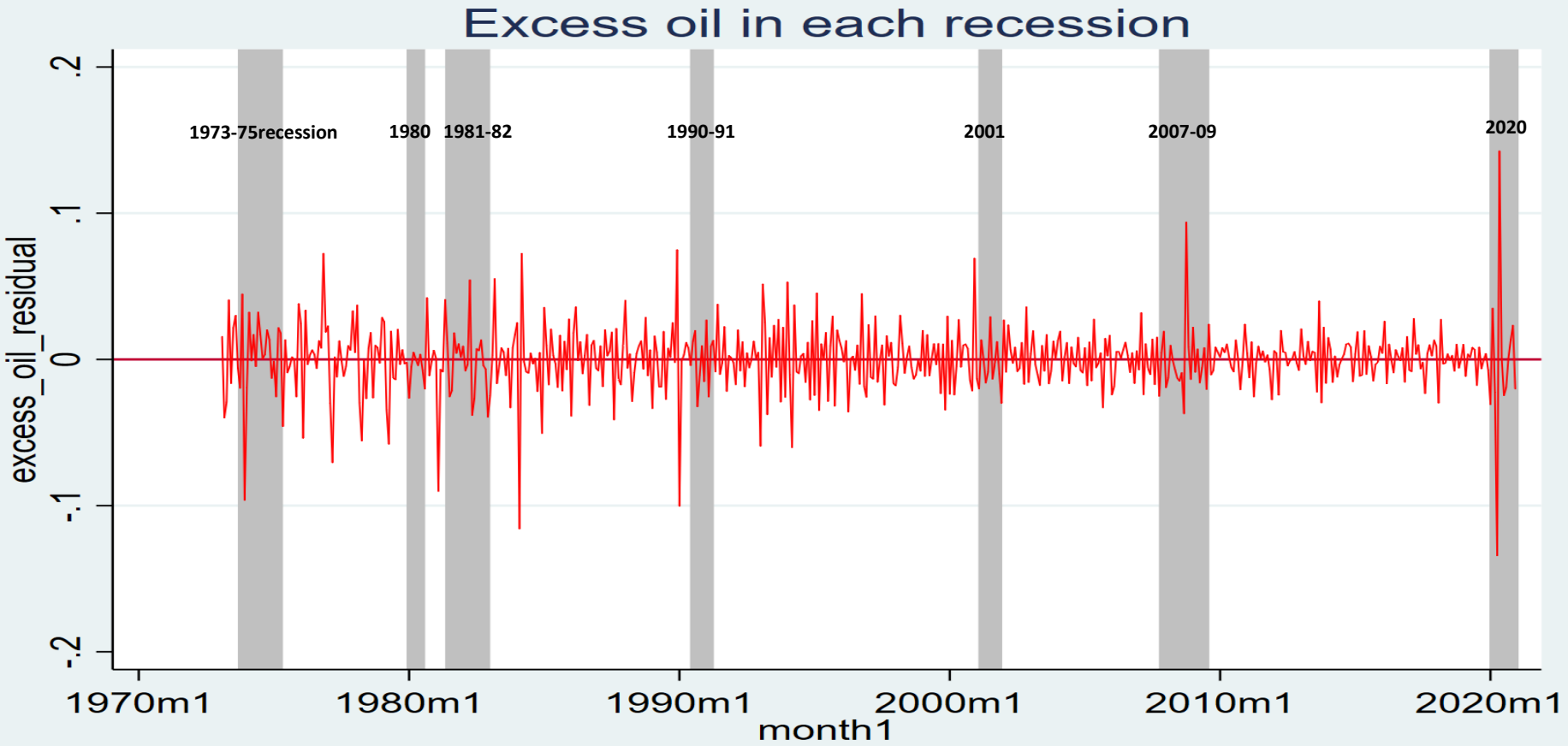


Figure 2. Excess oil in each recession

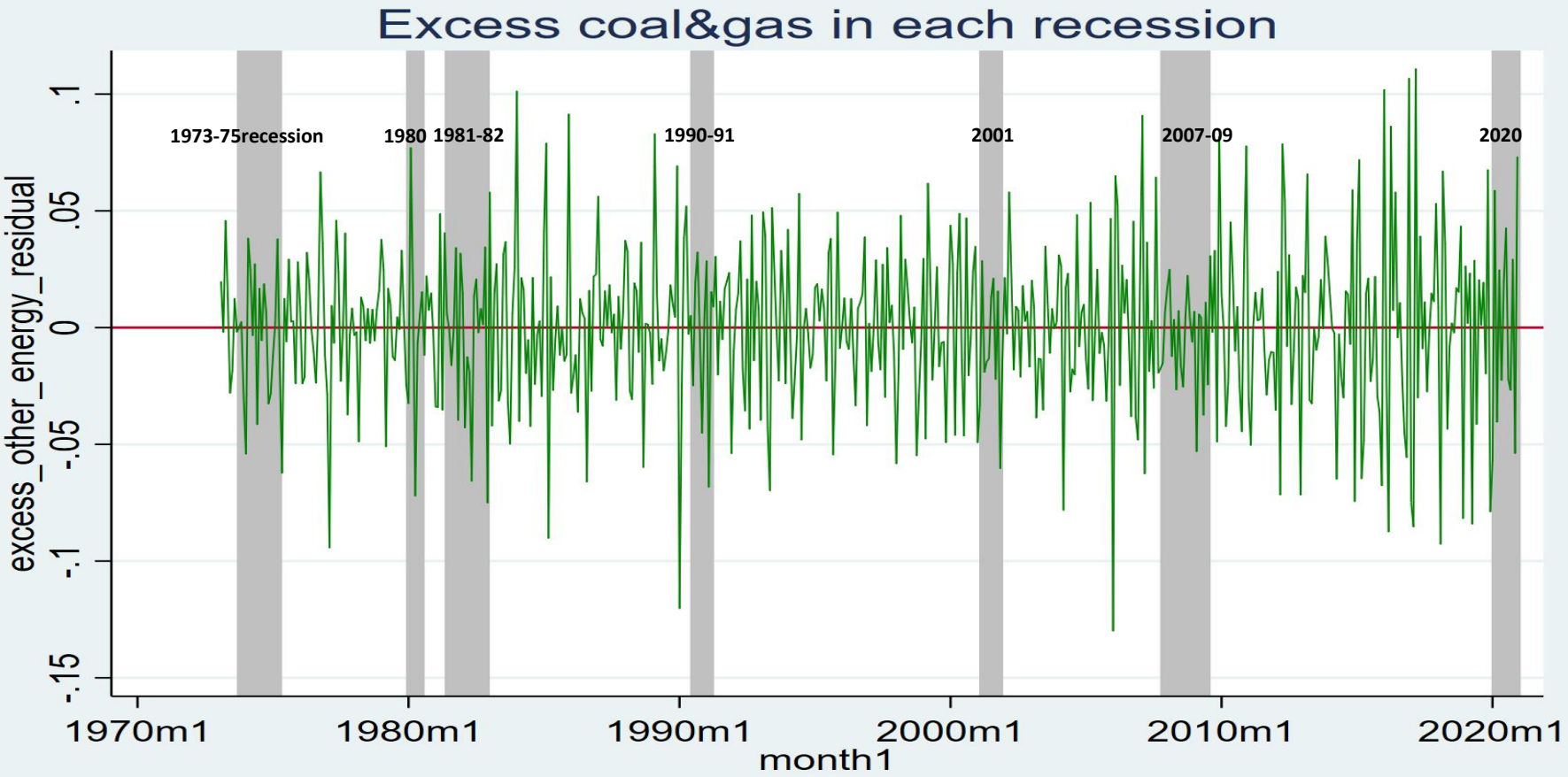


Figure 3. Excess coal and gas in each recession

Driver of asymmetric effects

- Most asymmetric impact on carbon emissions during recessions comes from energy use

- While still some comes from fuel switching etc.

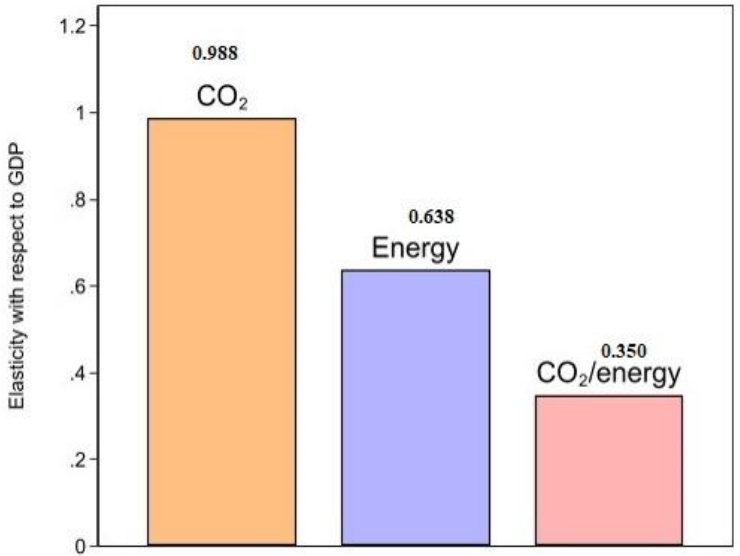


Figure 4. Elasticities for decomposition factors

Sectoral contribution to asymmetry

- Transportation, commercial sectors had greater asymmetric impacts on energy use growth during recessions than booms.

- Industrial and electric power sectors also contributed significantly to asymmetry.

Conclusion

Sources of recessions are important in affecting the response of carbon dioxide emission to GDP

Recessions associated with oil crisis or other financial reasons

Significant asymmetry effect on carbon emissions during 1973-1975, 1980, 1990 and 2020 recessions are detected compared to booms.

The asymmetry to carbon emissions than booms during COVID-19 recession is associated with negative demand shock to oil while the past three recessions are associated with crude oil supply shock.

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