Cererea de autovehiculele electrice și prețul internațional al petrolului: o abordare wavelet

(preliminary results)

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- **Context:** starting with the first credited electric car of Anderson (circa 1832-1839) to the first delivered modern electric car to costumers of Tesla Motors in 2008, the industry of electric cars exponentially developed over the last decades, seriously challenging worldwide the oil demand and price;
- **Target:** to explore worldwide the co-movement between demand for electric cars and oil prices;
- **Dataset and tool:** from January 3rd, 2020, to March 6th, 2023, wavelet technique;
- **Contribution to literature:** one of the first research inestigating the interaction between demand for electric cars and oil prices across different sub-periods and various time-effect durability.

Content

Introduction (preamble)

- electric cars "replace gasoline vehicles with an average fuel economy of 4.2 mpg above the fleet-wide average and 12 percent of them replace hybrid vehicles." (Xing et al., 2021, p. 1);
- number of electric (including plug-in hybrid) cars and light-duty trucks rapidly growths-up from about 20 million in 2021 to 550-700 million by 2035, with 30-35% of that vehicle park (BP, 2023);
- oil demand is expected to drastically reduce in parallel with a global oil price decline beyond 15-20 years.

Introduction (theoretical resorts)

Theoretical channel 'demand for electric cars - oil price' is relied on consumer theory (i.e. substitution effects between regular gasoline cars to electric ones):

- rise of demand for electric cars (i.e. low prices as battery cost reduction, high competition, supply increase) drops demand for regular gasoline cars, reducing the oil demand and its related prices (Cherif et al., 2017; Arnob, 2021);
- increase in oil prices shifts consumer demand to the most fuel-efficient cars (Baur et al., 2018; Marrouch and Mourad, 2019), often with lag (Gong, 2022);
- several important factors mediate the link, such as geopolitical risk (Nygaard, 2022), pandemic disease (Coffin et al., 2022) or car industry wealth (Lis et al., 2012).

Data and methodology - data I

- **target** = aggregated world level;
- **two time-series** =
  - **Demand for electric cars (EC)** = captured through the interest of people in electric cars measured via the Google Trend Index tool (Arnob, 2021) by searching worldwide the group of words 'electric cars + buy + purchase + acquisition';
  - **Oil price (Brent)** = measured via Europe Brent Spot Price FOB, in dollars per barrel, being taken from Fred (2023) online database.
- **sample** = with daily frequency (January 3rd, 2020 - March 6th, 2023);
- **controls** = geopolitical risk (geopolitical risk index, from Caldara and Iacoviello, 2022, updated in 2023), pandemic disease (number of new COVID-19 cases, from OWD, 2023 online database) and car industry health (S&P BSE Auto index, from Investing, 2023).

Data and methodology - data II

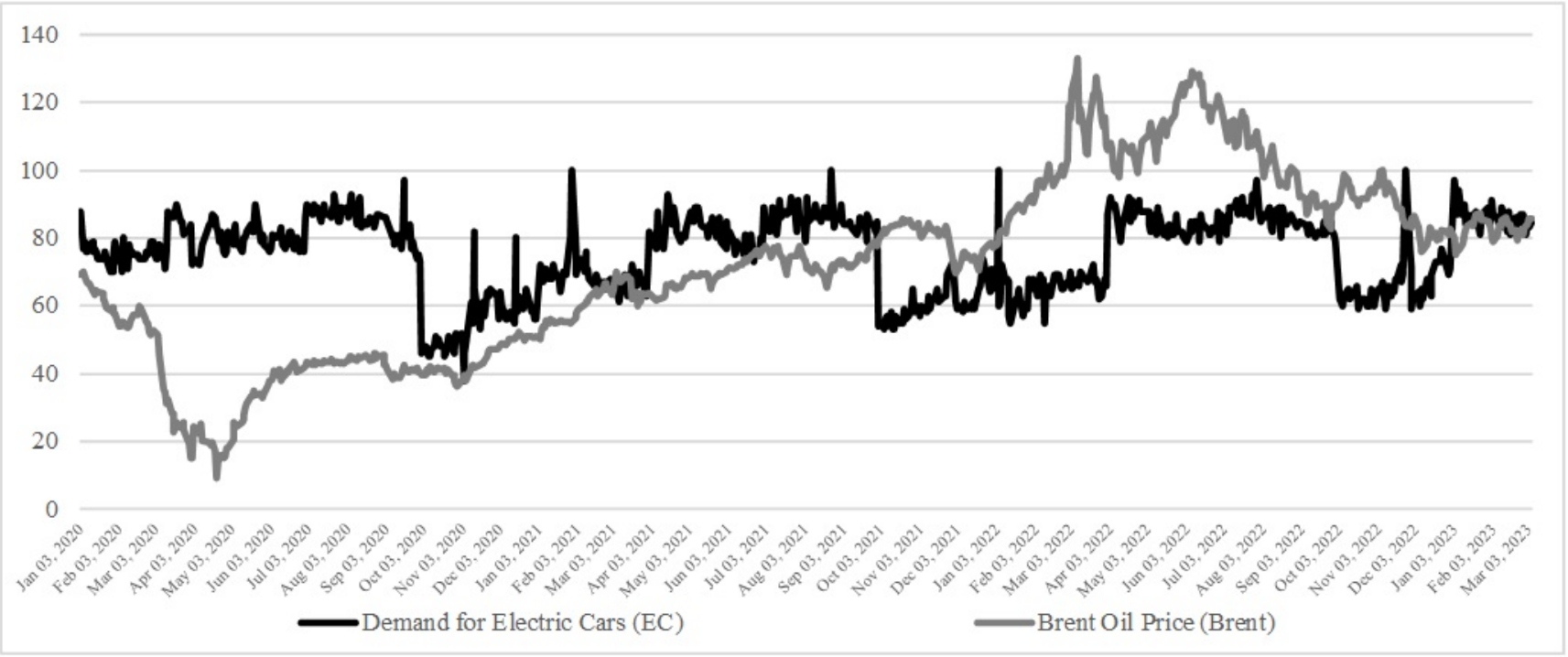

Figure: EC and Brent over January 3th, 2020 - March 6th, 2023 worldwide

Data and methodology - tool: Wavelet

- worldwide co-movement between demand for electric cars and oil prices is tested via a battery of wavelet tools:
  - wavelet transformation (WT); Detail
  - wavelet coherency and phase difference (WTC), according to Torrence and Campo (1998), based on Grinstead et al.'s (2004) work and corrections of Ng and Chan (2012).
- control of co-movement via:
  - multiple wavelet coherency (MWC);
  - partial wavelet coherency (PWC), both proposed by Mihanović et al. (2009).

Results

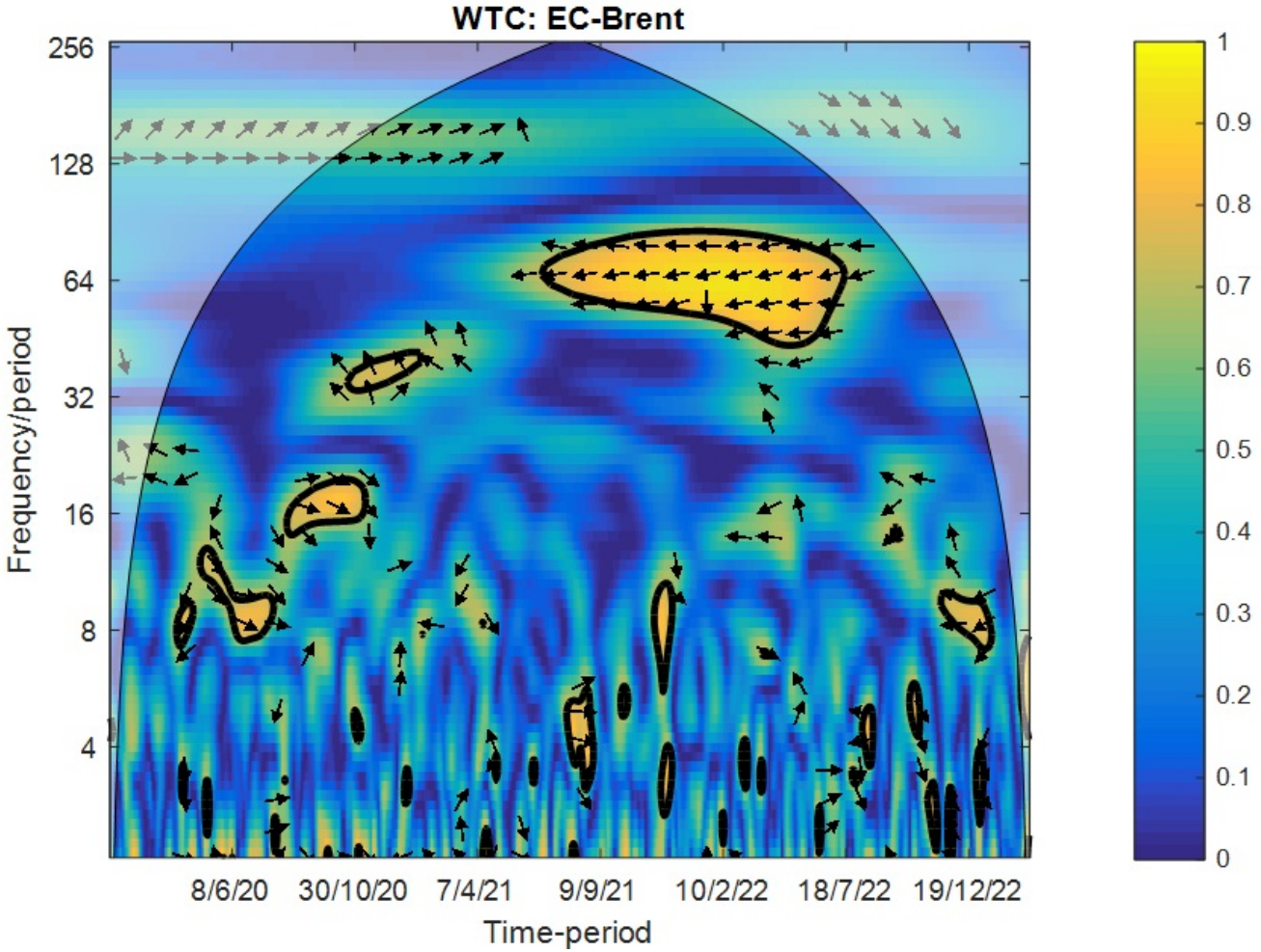

Figure: WTC of the pair 'EC - Brent' worldwide

Results (cont.)

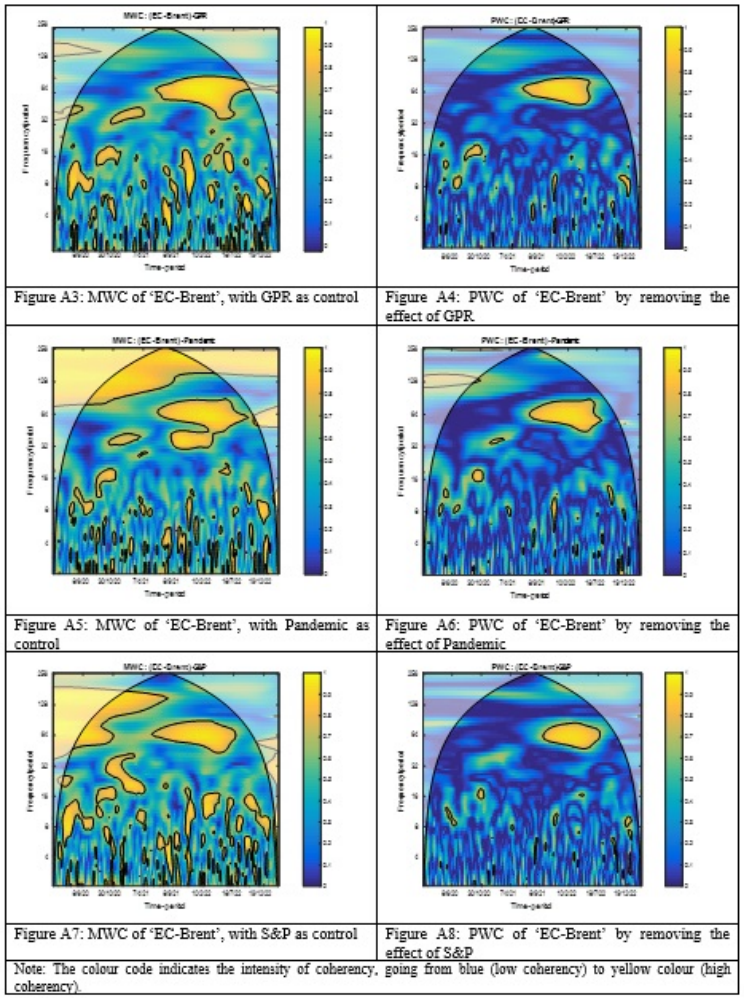

Figure A3: MWC of 'EC-Brent', with GPR as control

Figure A4: PWC of 'EC-Brent' by removing the effect of GPR

Figure A5: MWC of 'EC-Brent', with Pandemic as control

Figure A6: PWC of 'EC-Brent' by removing the effect of Pandemic

Figure A7: MWC of 'EC-Brent', with S&P as control

Figure A8: PWC of 'EC-Brent' by removing the effect of S&P

Note: The colour code indicates the intensity of coherency, going from blue (low coherency) to yellow colour (high coherency).

Figure: MWC and PWC of the pair 'EC - Brent' worldwide with controls

Robustness check

An alternative time-frequency tool to WTC is used for robustness check, namely the wavelet cohesion - WC (Rua, 2010):

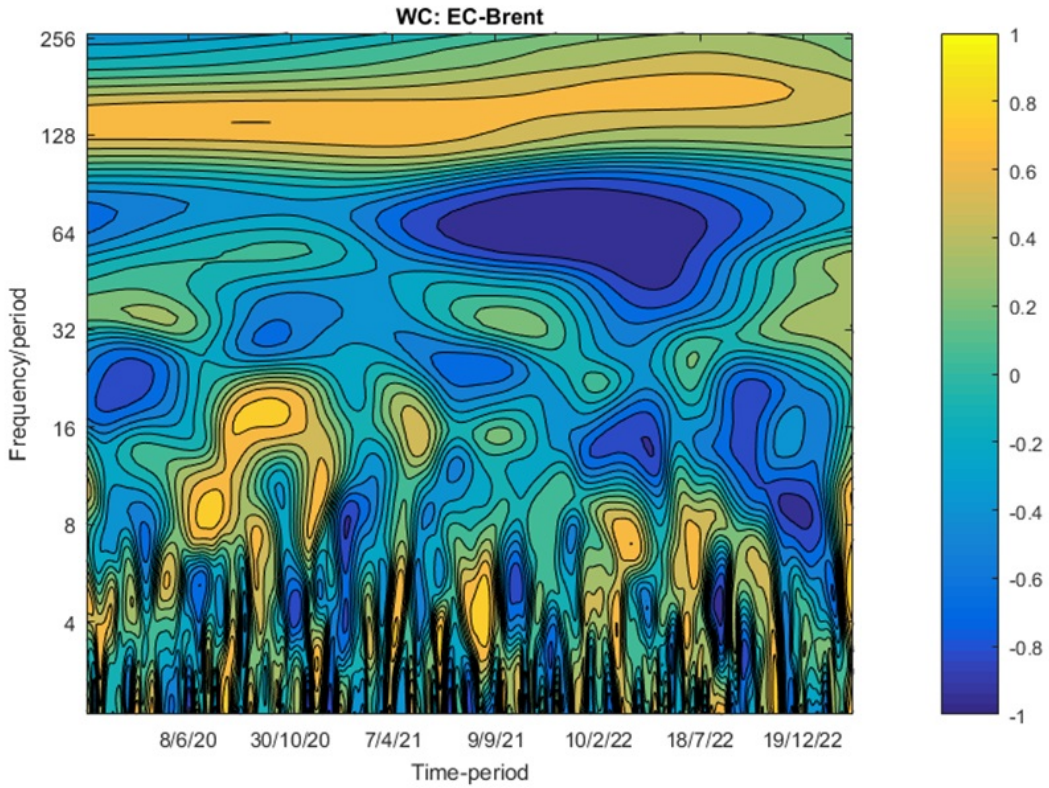

Figure: WT of the pair 'EC - Brent' worldwide

Conclusions

1. a 'switching effect' between demand for electric cars and oil prices is observed in the short-term (i.e. 50-60 days) for a particular global market context, over June, 2020 - July, 2021;
2. outstanding rise in demand for electric cars relaxes the pressure on oil demand (Arnob, 2021), reducing its prices (i.e. this is explained by steady electric car prices due to the long-term decline of battery prices as technological progress, lag between material price spikes and battery price increases, and wide use of lithium ferrophosphate chemistries in batteries that additionally relax their prices - IEA, 2022);
3. despite oil price decline, electric cars segment seems to be strongly supported by dedicated eco-friendly government policies (IEA, 2022; Lu, 2023);
4. co-movements are very stable, not being sensitive to geopolitical turbulence, pandemic disease or any syncope in the car industry production.

Conclusions (cont.)

Policy implications:

1. in order to stimulate the demand for electric cars, policymakers should follow measures to stabilise the prices of electric cars by subsidising the technological research in the field, acquisition of electric cars or cost of certain inputs;
2. further researches can be focused on panel approaches, including more countries, with an extended set of control determinants.

Thank you very much!

For any suggestions/comments:
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Morlet wavelet: Detail

$$\psi(t) = \pi^{-1/4} e^{i\omega t} e^{(-1/2)t^2}, \tag{1}$$

Continuous wavelet transform:

$$W_X(\tau, s) = \frac{1}{\sqrt{s}} \int_{-\infty}^{+\infty} x(t) \psi^* \left(\frac{t - \tau}{s} \right) dt \tag{2}$$

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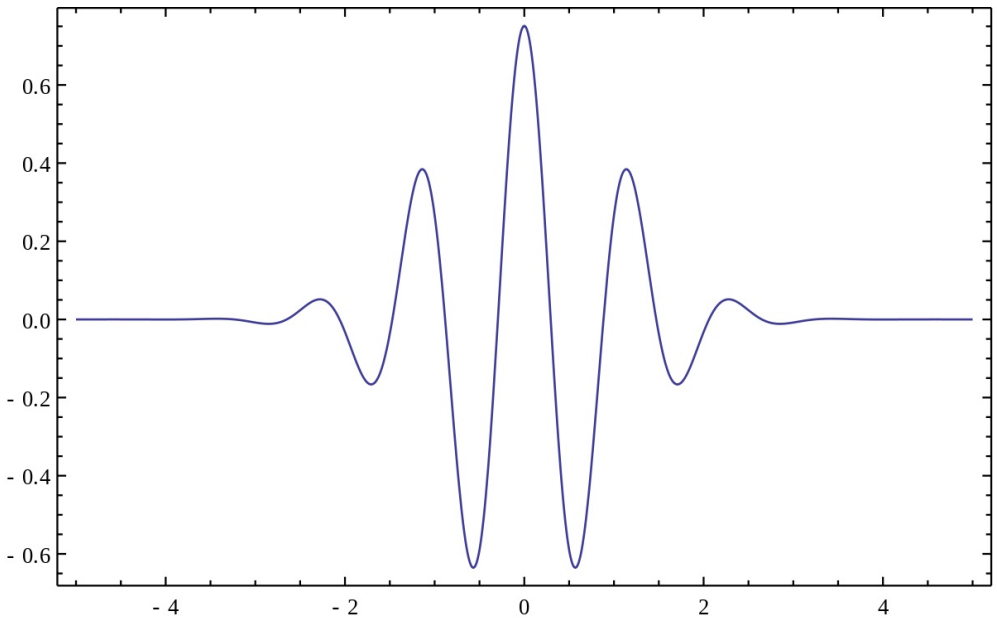

Figure: Morlet wavelet

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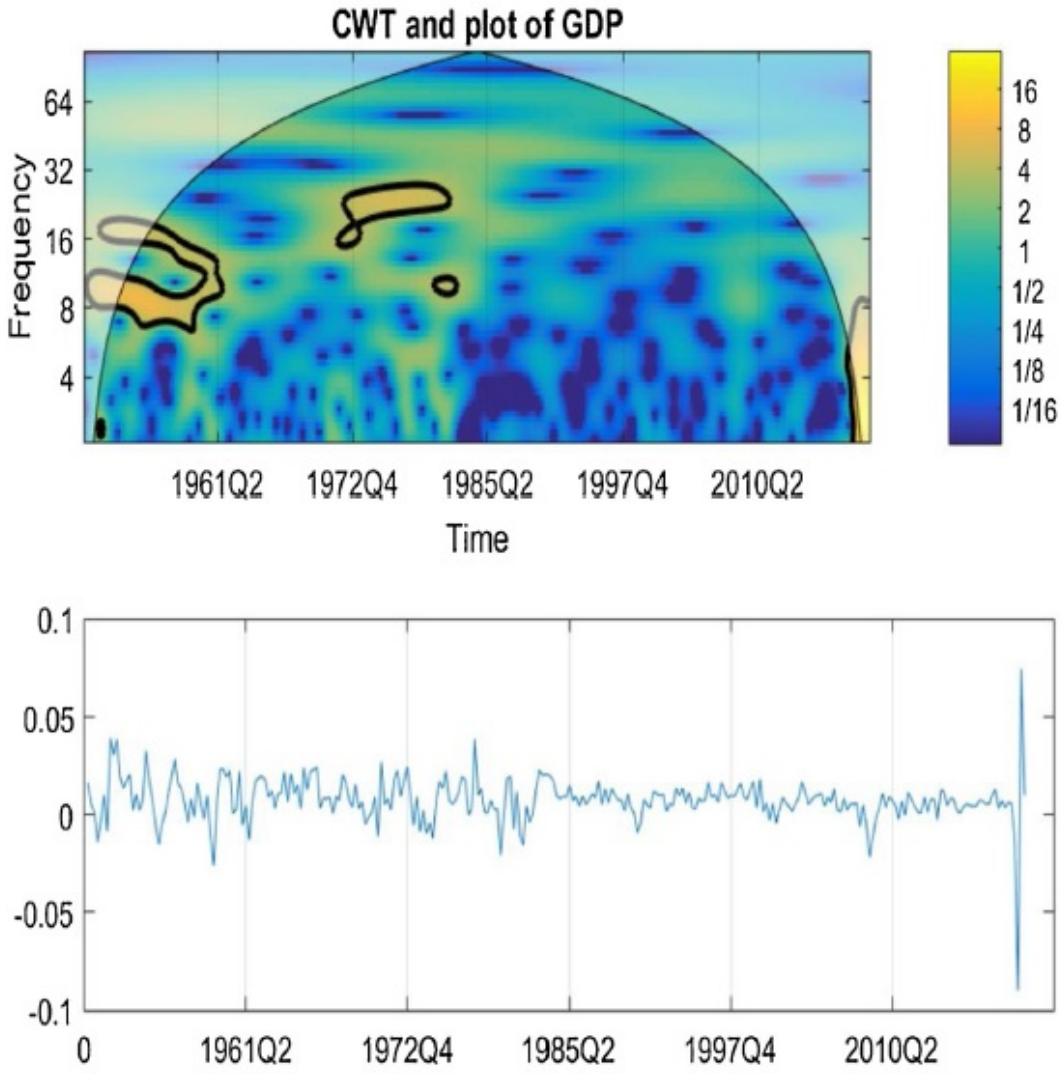

Figure: Wavelet transformation of GDP series

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