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Current and Future Challenges to Energy Security
the just transition

Shale Oil and The US Economy

A Wavelet Analysis

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Motivation

After a steady decline since the mid-1980s, the US oil production have broken records by surpassing **11m barrels** a day in 2018 after its low point of about **5m b/d** in 2008 due to “fracking”, the so called **shale oil revolution**.

The shift in U.S from the **world’s largest importer** of crude for decades to producing more of its own oil, surpassing Russia and Saudi Arabia is a **structural change** in oil markets.

For instance, the week ending 11/30/18, the EIA reported that the U.S. was for the first time a **net exporter** of 0.2 million bpd of crude plus finished products.

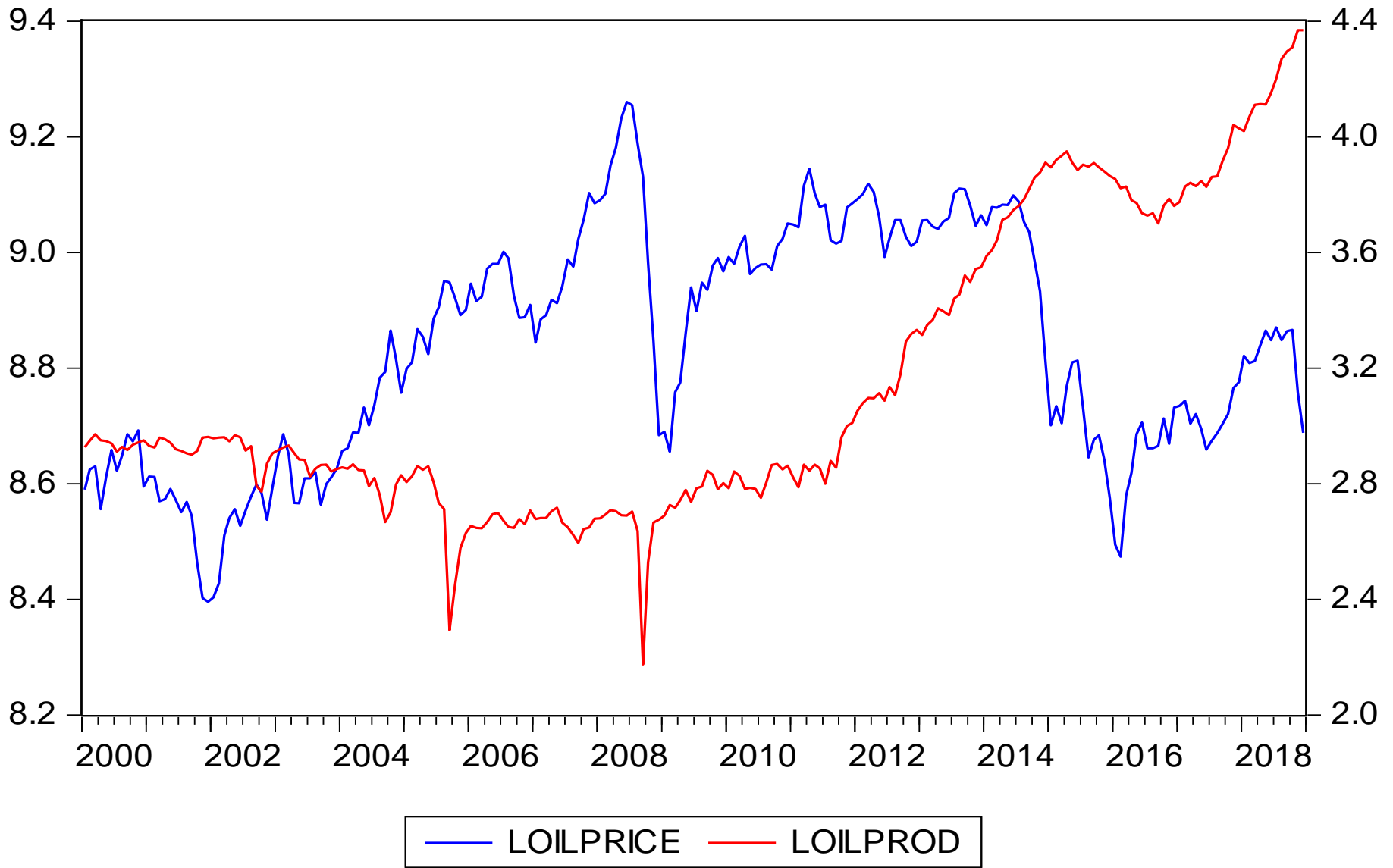


Figure 1. US oil production vs WTI oil prices 2000-2018

Research question

*What are the **impacts** of the **shale oil** revolution on the **oil-U.S economy link**?*

Short literature review

-(Mănescu and Nuño (2015), Ansari (2017), Behar and Ritz (2017), Bataa and Park (2017), [Kim](#) (2018), Salisu and Akanni (2018), Newell and Prest (2018), [Noha](#) and [Michieka](#) (2019)).

-**Baumeister and Kilian**(2016) showed that \$16 of the \$49 cumulative decline in the price of oil prices between **June and December 2014** was linked to positive oil supply shocks.

-**Baumeister and Kilian** (2017) suggest that the oil decline produced a **stimulus** of real GDP growth. However, this stimulus has been largely offset by a reduction in real investment by the oil sector. Thus, the **net stimulus** on US economy since June 2014 has been effectively **zero**.

Research gap

All the empirical studies that explored the comovement between shale oil and US macroeconomy are based upon conventional time domain analysis, and often used Granger causality tests based on vector autoregressive models (VARs).

Problem

In “VAR” models, when the first-difference filter removes non stationary components (unit root) from time series, it also removes most of the cyclical components and a great deal of the nearby low-frequency components. It is equated to *‘throwing the baby out with the bath water’* because first-difference filter, by placing heavy weight on higher-frequency components of the data, induces losing valuable long term information (Baxter, 1994).

Consequences

- 1.The statistical link that could be found between macroeconomic variables is at risk to be just a **short run phenomenon**.
- 2.As the relationships between shale oil and macroeconomic variables **may vary across the frequency bands**, they may fail to be captured by time domain analysis.

Contribution

The present paper adopts **wavelet analysis** as an alternative frequency domain **detrending** filter that according to Benhmad (2013) have comparable performances with HP filter (Hodrick-Prescott,1997) and BK filter (Baxter-King ,1999).

(Valérie Mignon and F.Lescaroux (2008):"On the Influence of Oil Prices on Economic Activity and other Macroeconomic and Financial variables", have used HP filter).

Contribution

.We carry out a wavelet decomposition of US oil production, oil prices, the US industrial production at various levels of resolution corresponding to **business cycle**, **seasonality** and **noise** according to **Burns and Mitchell (1946)**.

. It could allow us to **disentangle** the comovement between these variables by decomposing the **full Granger** causal links between these macroeconomic variables into **different frequencies**.

.The **multiscale Granger causality tests** will reveal the frequency bands where these variables could impact each other, and shed more lights on the complex relationship that may link these variables.

Findings

- Shale oil has remarkable **predictive power for oil prices**, US industrial production at the business cycle frequency.
- The impact of shale oil boom, as a structural change, can no longer be a short run phenomenon as is it mainly located at business cycle frequency.
- In contrast to Lutz Kilian, we can assert that the **time is quite different**.

Empirical evidence

Data

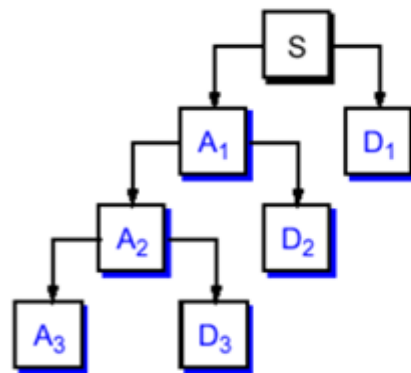
- The dataset covers the period from **2000M1 to 2018M12** and consists of monthly observations on the following variables: WTI oil prices, US oil production and US industrial production index as a measure of US economic activity.
- All these variables are converted to real variables by using the producer price index (PPI) for all commodities as a deflator.
- To take into account the shale oil revolution: We subdivide our data sample to 2 sub-samples: **2000-2009** and **2009-2018**

Wavelet decomposition

Mallat (1989) multiresolution analysis (MRA):

$$S(t) = A_J(t) + D_J(t) + D_{J-1}(t) + \dots + D_1(t)$$

At scale j , the detail component D_j represent the cycles with periodicity between 2^j and 2^{j+1} and the wavelet smooth A_j captures cycles with periodicities greater than 2^{j+1} periods.



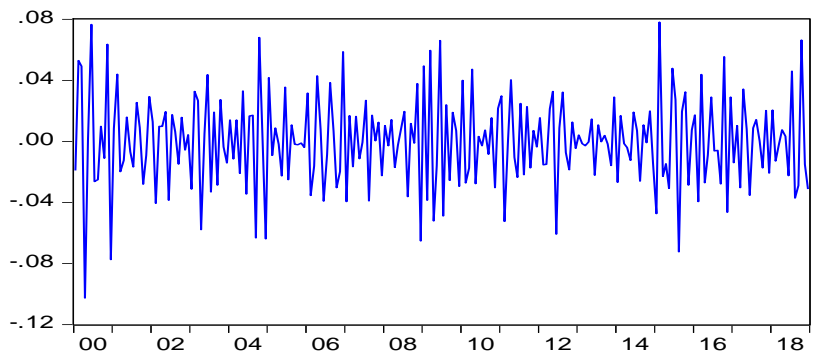
$$S = A_1 + D_1$$

$$= A_2 + D_2 + D_1$$

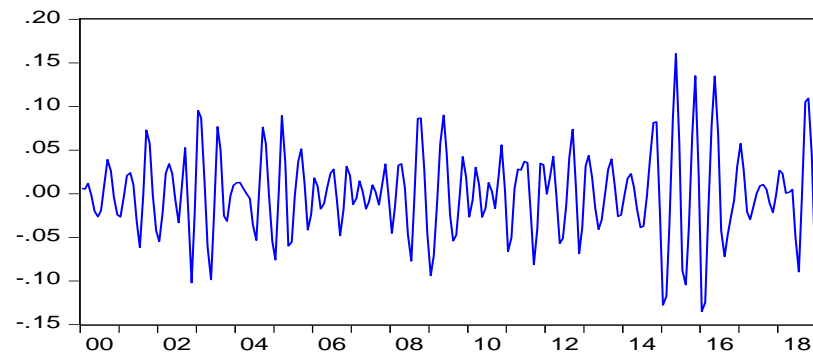
$$= A_3 + D_3 + D_2 + D_1$$

For $J=6$ \longrightarrow $S = A_6 + D_6 + D_5 + D_4 + D_3 + D_2 + D_1$

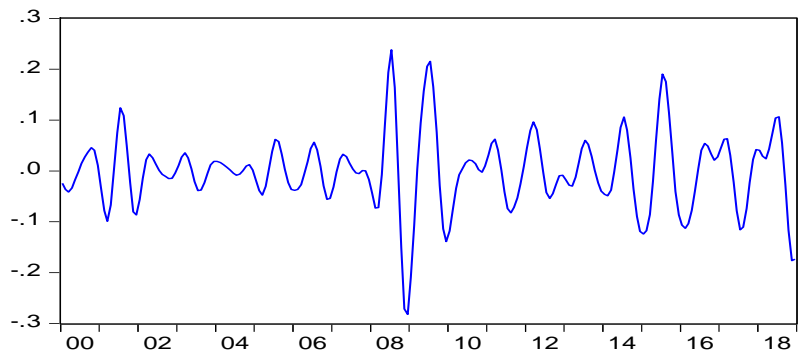
D1OIL



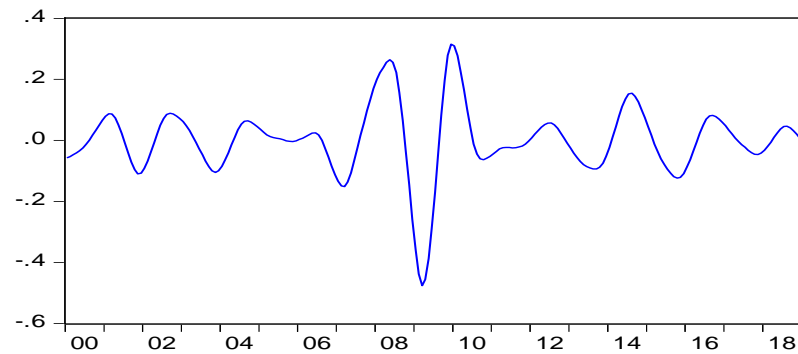
D2OIL



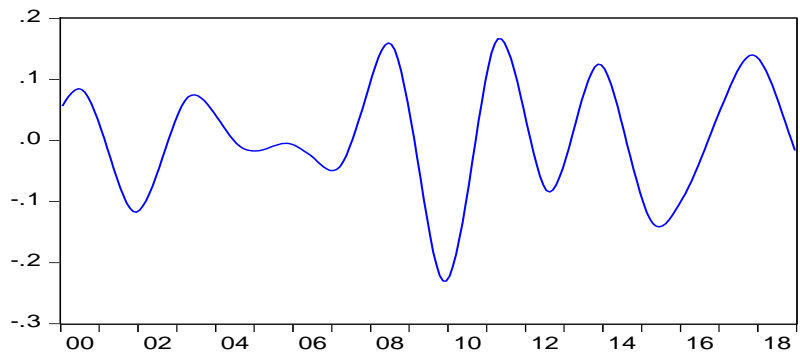
D3OIL



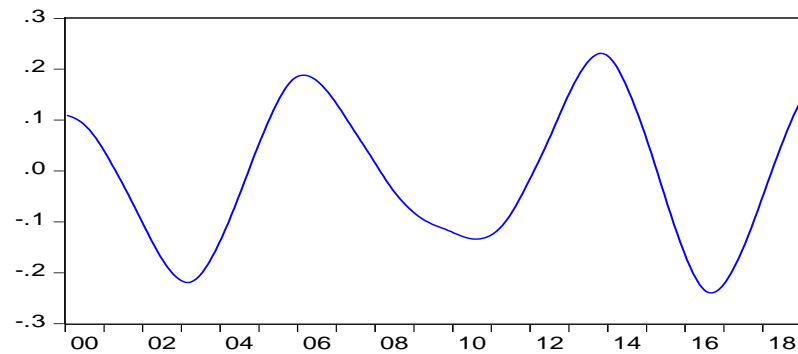
D4OIL



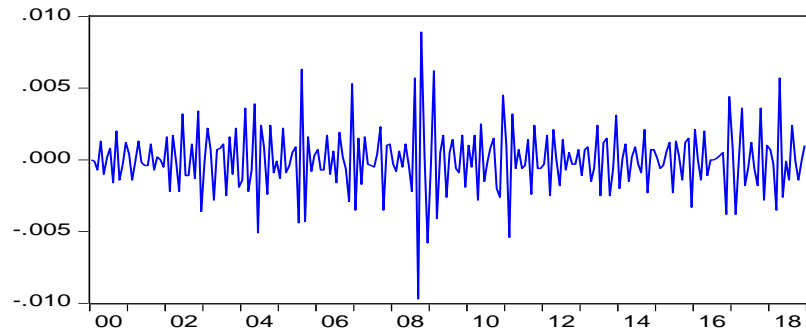
D5OIL



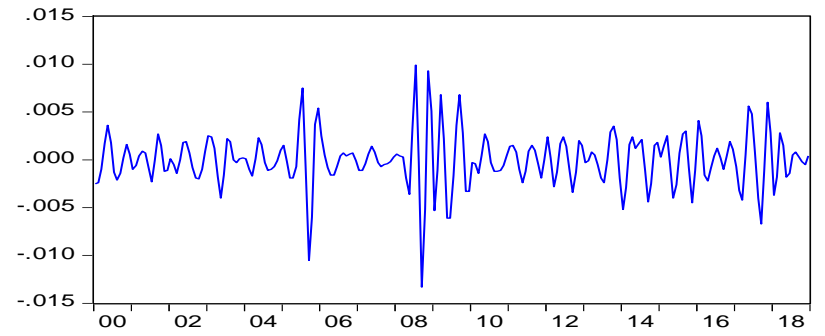
D6OIL



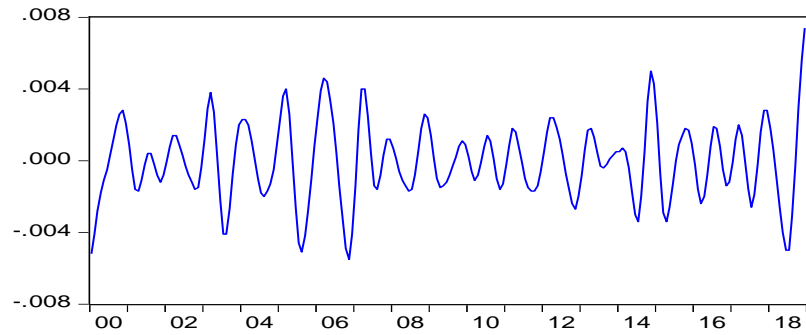
D1INDUS



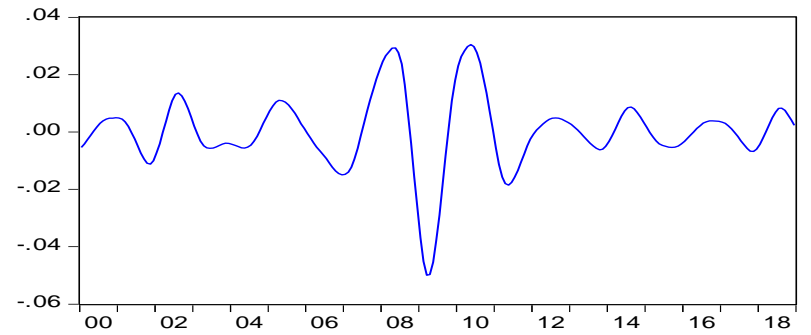
D2INDUS



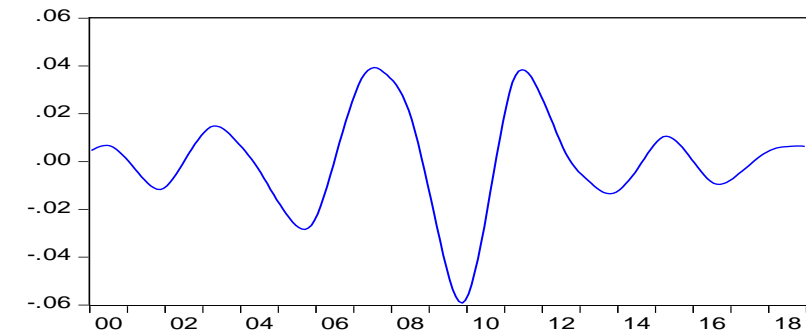
D3INDUS



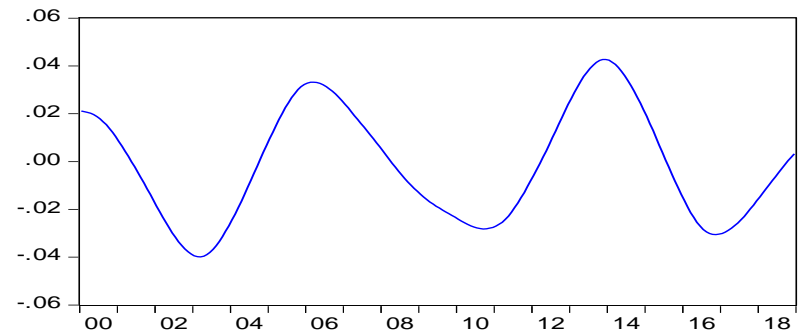
D4INDUS



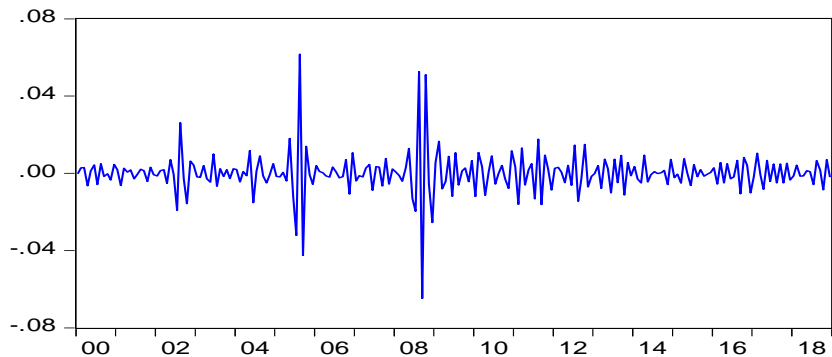
D5INDUS



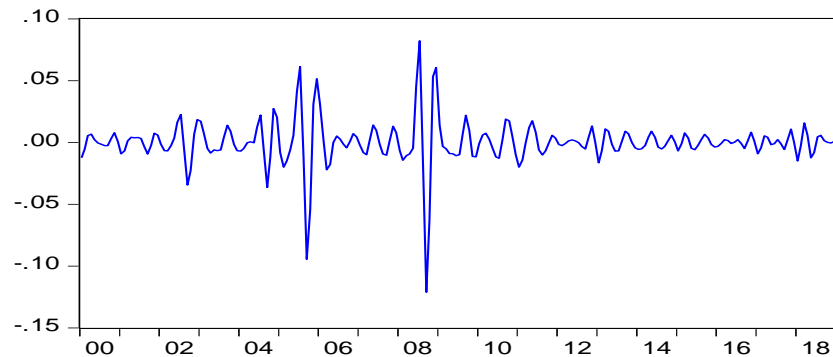
D6INDUS



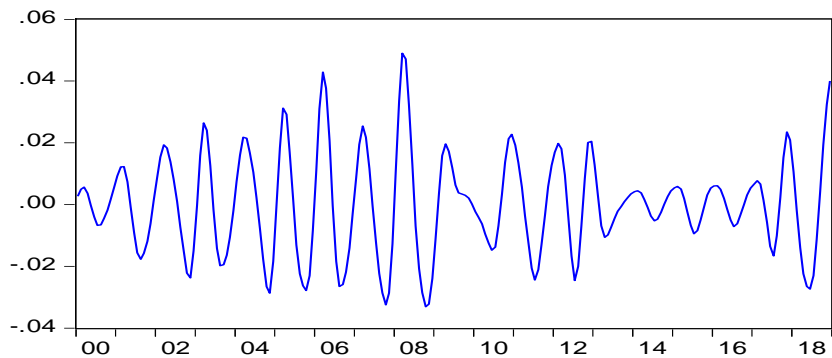
D1PROD



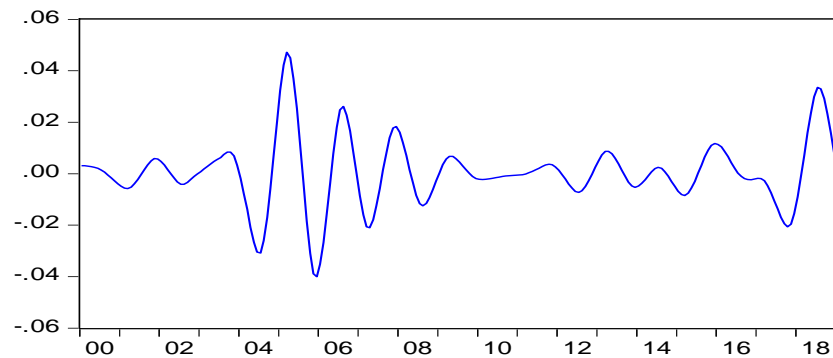
D2PROD



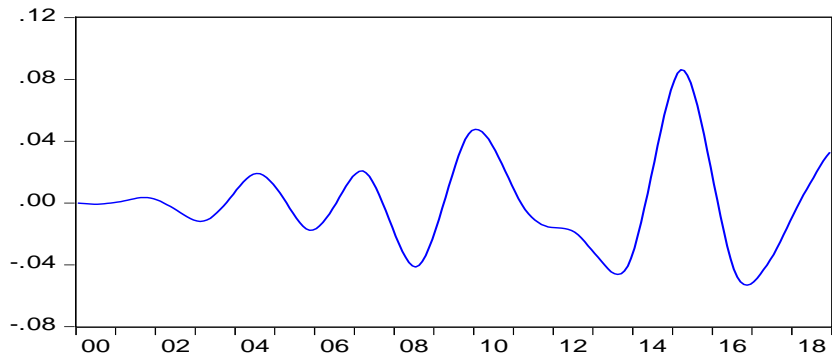
D3PROD



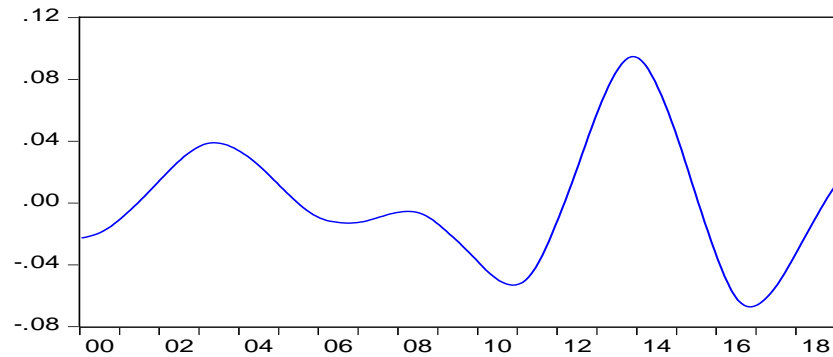
D4PROD



D5PROD



D6PROD



Empirical Findings

(i)

-At time scale of 2-4 months, we cannot find any relationship between **US oil production and oil prices** during the two sub-periods.

-At 4-8 months time scale, a Granger causality runs from oil prices to US oil production during 2000-2008, but runs from oil production to oil prices at 2009-2018 sub-period.

This switching in the causality direction can be well explained by shale oil revolution.

-However, at **business cycle frequency** range corresponding to 16-128 months time scale, the relationship between US oil production and WTI oil prices is found to be bidirectional before and after shale oil boom.

(ii)

-For the two sub-periods, in time scales from 2 months to 16 months, no Granger causality relationship is found between **oil production** and **US industrial production** index in USA.

-However, during 16-128 months time scale, the Granger causality, that was running from industrial production to US oil production during 2000-2008, have **switched its direction** and runs from **US oil production** to **industrial production** during 2009-2018 shale oil revolution era.

(iii)

-For both 2 two sub-periods, we can find a short run Granger causality relationship running from **oil prices to US industrial production** index during 2-8 months time scale.

-However, the causality relationship becomes **bidirectional** during 16-128 months time scale.

Policy implications

- Policy makers should pay more attention to the **long-term** effects of shale oil boom not only on US economy but also on global economy and geopolitics.
- Beyond the US industrial sector, the shale oil revolution will have far reaching consequences on US trade balance: “**trade balance channel**”.
- The US economy is becoming resilient to oil shocks that historically impacted it negatively. Moreover, using less dollars abroad in order to buy oil improves the US current account and thus allow **US dollar** to be more stronger against the currencies of the United States’ main trading partners.

Policy implications

- The shale oil revolution is also a **game changer** of the balance of **power** in global oil markets. Indeed, OPEC's (and its leader Saudi Arabia) ability to play its historical role as a **swing producer** may be substantially weakened by the US shale oil boom.
- There is a **shift of power** from OPEC to USA as the **marginal** source of oil is shale oil and for the foreseeable future oil prices will be set by US shales.
- Falling oil prices due to shale oil revolution make the OPEC members facing a **severe** budgetary, challenging their ability to meet social commitments that maintain **political stability**.

Thank you for your attention.
Any Questions?