The effects of structural breaks on the long run level of oil and oil products. Evidence from the last two oil price crashes, 2008-09 and 2014-15

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1st AIEE Energy Symposium on
Current and Future Challenges to Energy Security

Milan, December 1st 2016

Agenda

- Scope of research
- Literature review
- Data definition
- Empirical results
- Conclusion

Scope of research

• The main objective of this paper is to investigate whether there is scientific base for a time trend decomposition of oil and oil derivatives and the assessment of the unit root hypothesis in the presence of structural breaks in particular

• The presence of a unit root implying stochastic non-stationary properties, would introduce profound implications not only for our understanding of the nature of the oil price evolution but also to avoid misspecified models

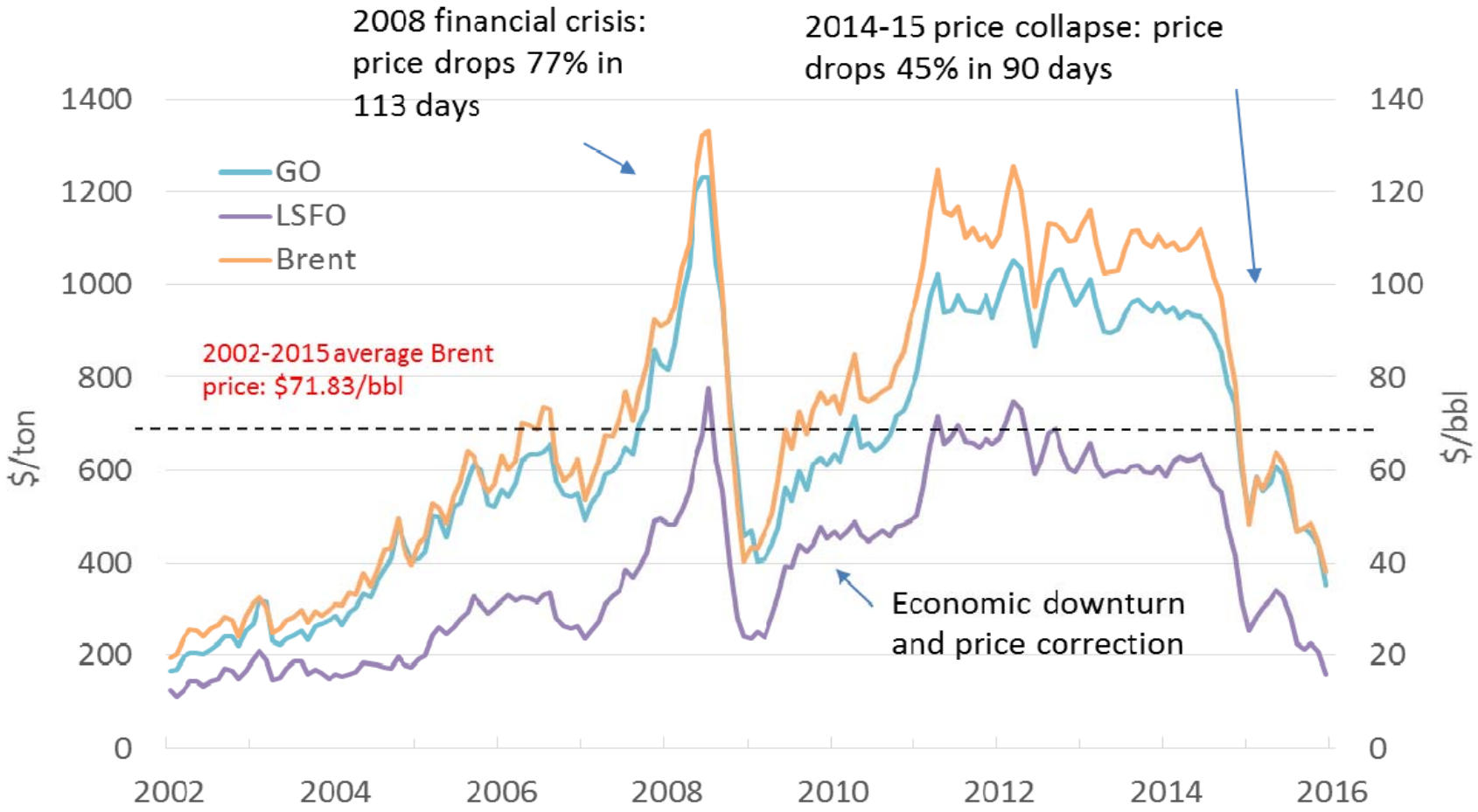
• The purpose of this paper is twofold: on the one side to provide evidence for the presence of unit roots in all series taking oil price crashes into account and on the other side to examine in more detail the influence of those events

• Especially relevant to our study is the presence in the sample period of two major events. Firstly, the credit crunch in 2008 and secondly, the collapse of oil prices since late 2014

• Figure 1 shows the movements in real historic crude oil prices from 2002 until end of 2015 with special attention to large price movements over the period.

• There are multiple similarities and differences among the two oil price crashes although possibly differences are more revealing of how traded oil markets behave

Figure 1. Historic crude oil ($/bbl), gasoil and LSFO ($/ton) prices



Scope of research

• The scope of our investigation expands on previous research about stationarity properties of crude oil and oil derivatives time series with a focus on the impact of extreme market events on those properties

• To do this, a formal and reliable methodology is crucial for unit root (UR) hypothesis testing. Possibly investigations initiated by Dickey and Fuller (1979) are at the forefront of this research

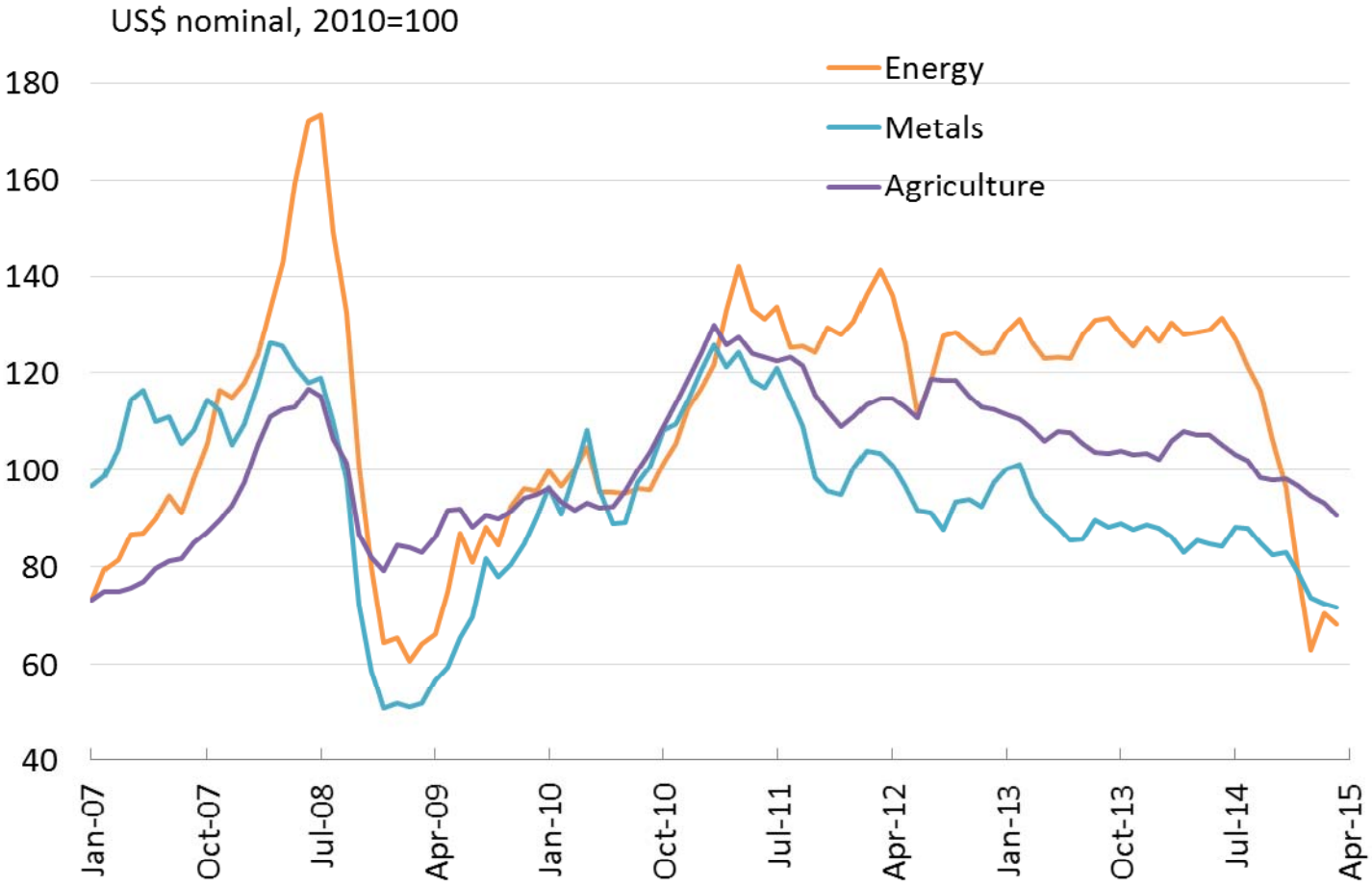
• Since then, a wide variety of models have been suggested to address the possibility that failure to reject the unit root null may be attributable to the omission of structural breaks. The framework developed by Perron (1989) is particularly influential and so necessarily taken into account in any related investigation

• In terms of the benefits provided by the study we believe that globally it will help agents to better understand the nature of major events affecting commodity prices and hence to better understand oil price structure

• Perhaps the most important factor from a market point of view: although after the financial crisis virtually all commodity prices rebounded, helped by large oil production cuts by OPEC and strong emerging market demand, global oil supply started building up

• This development was led by additional sources of oil supply, mainly from shale, but also from other unconventional sources including biofuels, Canadian oil sands, and from non-OPEC members such as Brazil, China, and Russia (Figure 2).

Figure 2. Commodity price indices



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Literature review

- In the past four decades, intensive work has been put into unit root analysis given the importance of non-stationary processes to understand the nature of time series

- Since Nelson and Plosser (1982) sustaining the view that almost all macroeconomic time series have a unit root a number of papers have examined the persistence properties of natural resources, some examples are:

  - ✓ Slade (1982) finds that prices for US commodities appear to follow a U-shaped time path
  - ✓ Slade (1988) also finds empirical support for those prices being non-stationary and concludes that uncertainty appears to be a strong determinant of price formation
  - ✓ Berck and Roberts (1996) examine eight price series including coal, petroleum, and natural gas using annual data from 1870 to 1991. All series were found to be nonstationary
  - ✓ Pindyck (1999) also rejects stationarity for annual averages of producer prices for crude oil, bituminous, coal, and natural gas using the ADF test

- In relation to crude oil price properties, we can highlight research by Serletis (1999) and Maslyuk and Smyth (2008) concluding against stationarity of oil prices. More recent research, i.e. Ozdemir et al. (2013) reveals that overall, there is a high degree of persistence in crude oil spot and future series when structural breaks are not taken into account

- One possible explanation for the great persistence of oil prices is the fact that it is the world's most actively traded commodity.

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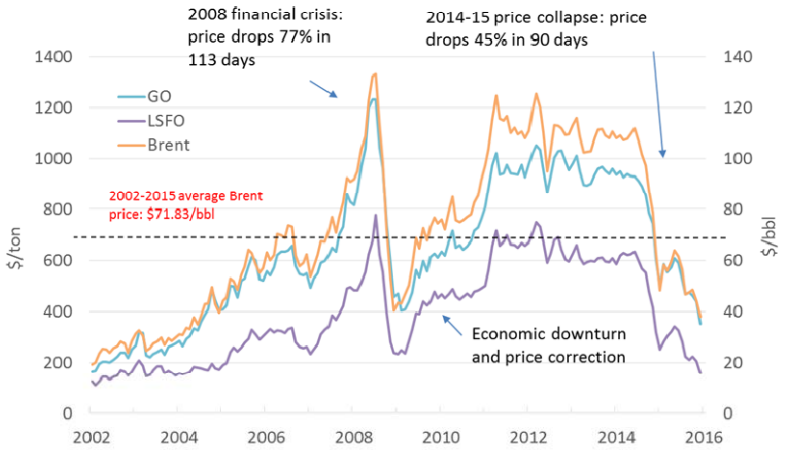
Data definition

- The data used in this study are Brent (Brent), gasoil (GO) and low sulphur fuel oil (LSFO) price series
- At global level, the three commodities are possibly the most relevant in respect of political and industry influence, being influenced in turn by numerous factors ranging from

  - ✓ the prevailing macroeconomic conditions,
  - ✓ the supply-demand balance
  - ✓ regulatory constraints
  - ✓ the impact of geopolitics, etc.



	Mean price level	*Standard deviation*	*Coefficient of Variation*	*Skewness*	*Kurtosis*
Brent	71,8	31,2	0,43	0,09	1,77
GO	640,4	268,9	0,42	0,05	1,97
LSFO	392,8	187,5	0,48	0,23	1,68
lnBrent	4,2	0,5	0,12	-0,53	2,20
lnGO	6,4	0,5	0,08	-0,69	2,57
lnLSFO	5,8	0,5	0,09	-0,28	1,79

As it can be seen, on average, coefficients of variation (CV) are generally close indicating a similar month-to month variation in all of the prices, with gasoil showing the lowest CV.

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Empirical results. Generic Unit root test

- In this section we examine the unit root properties of the three selected variables and identify the months in which structural breaks occur.
- Throughout the testing process the alternative including a linear trend in the maintained regression seems the most plausible description of the data under both the null and alternative hypotheses
- The standard conventional level for inference used is 5%.

	Log price in levels							
	Without trend				*With trend*			
	ADF	*h*	*KPSS*	*h*	*ADF*	*h*	*KPSS*	*h*
lnB613	0,308	0	9,965	1	0,986	0	2,127	1
lnGO	0,506	0	10,002	1	-0,416	0	2,165	1
lnLSFO	0,047	0	10,210	1	0,999	0	2,026	1
cValue	**-1,942**		**0,463**		**-3,439**		**0,140**	

- Tests results clearly indicate that none of the three variables is stationary at the standard conventional level with and without a trend. The ADF test does not reject the null hypothesis of a unit root for the levels of the three prices. The KPSS test, in which the null hypothesis is stationarity, indicates that the null hypothesis is clearly rejected for the level forms of all series.
- However results from the standard unit root tests can be misleading when structural breaks remain unaccounted for.

Unit root tests with one structural break

- We initially start with a general level specification that incorporates both a changing intercept (Crash model) as well as a changing slope (Mixed model) and then evaluate the significance of the coefficients of the dummy variables

- Table below shows the empirical results from the VP unit root tests either minimizing the t-statistic for the intercept break coefficient t_{Θ} using a Crash model or over the maximum t-statistic for the absolute trend break coefficient $t_{|\delta|}$ when using a Mixed model

	Crash ($t\Theta$)			Mixed ($t|\delta|$)			Shift dummy		
	t-stat	Break date	Significant at 5%	t-stat	Break date	Significant at 5%	t-stat	Break date	Significant at 5%
B613	-3,210	2014-7	**No**	-3,446	2012-6	**No**	-1,529	2015-2	**No**
GO601	-2,666	2014-8	**No**	-2,901	2012-6	**No**	-1,606	2015-2	**No**
LSFO601	-3,488	2014-8	**No**	-3,967	2012-6	**No**	-0,963	2008-9	**No**

- As it can be seen, results from all tests suggest that we cannot reject the unit null in favour of the one break alternative for any of the variables.

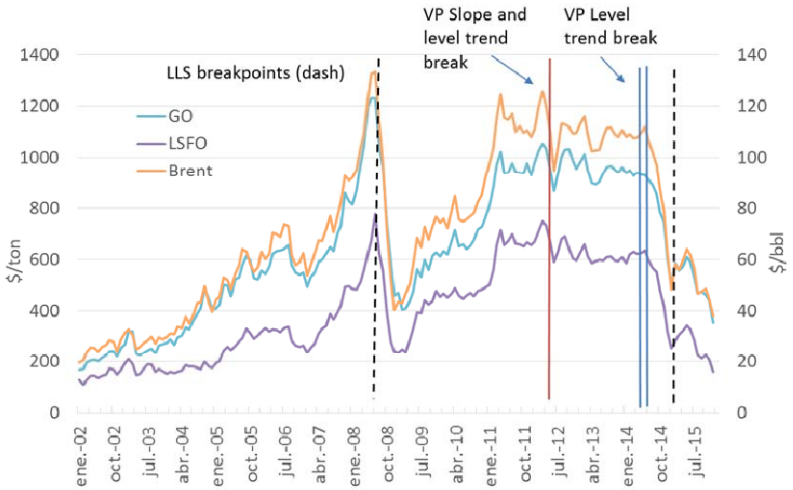
UR tests' break dates suggested

- Table and Figure below show for each of the three variables analyzed corresponding structural breaks following implementation of the devised strategy

- As it can be seen, VP tests allowing for a changing intercept (VP Min) suggest a similar breakpoint for the three variables in July/August 2014 reflecting the intensity of changes in price levels as a consequence of the 2014-15 price crash

- VP Abs tests coincide on the same break date in June 2012, this revealing a relevant change of slope previously to the 2014-15 price drop. This feature supports the importance of the sudden stabilization of oil prices occurring around March 2012, common to oil and oil products and before the serious downturn post-2014.

- It can be inferred that supply-demand fundamentals were at the heart of drastic changes in slope over the period analyzed



	B613	GO601	LSFO601
VP Min	2014-7	2014-8	2014-8
VP Abs	2012-6	2012-6	2012-6
LLS	2015-2	2015-2	2008-9

UR tests' break dates suggested

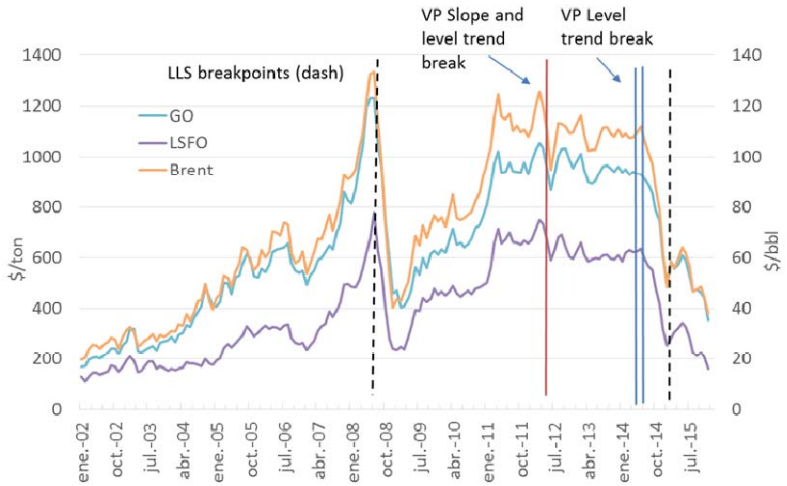
- Table and Figure below show for each of the three variables analyzed corresponding structural breaks following implementation of the devised strategy

- LLS test break date pick breakpoints that slightly differ from VP results. For Brent and gasoil the selected break date is Feb-2015 while for fuel-oil it is Aug-2008

- Regarding Brent and gasoil prices, strong supply growth effects, especially from unconventional sources in the US, prevail

- Equity market shocks and greater volatility in 2008-09 seem to be more influential to changes in trend for fuel-oil prices

- This could be a reflection that the fuel-oil market is somehow more reactive to fast and sudden unexpected events than to market related forces. Maybe the fact that fuel-oil is the least traded commodity of the three, might be a reason for that.



	B613	GO601	LSFO601
VP Min	2014-7	2014-8	2014-8
VP Abs	2012-6	2012-6	2012-6
LLS	2015-2	2015-2	2008-9

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Conclusions

- Based on a range of econometric procedures, our study investigates whether the main non-renewable commodity prices, i.e. Brent crude oil, gasoil and fuel-oil, contain stochastic trends

- At the same time, we measure the underlying effects of structural breaks using fourteen years of monthly data over a highly representative period including the last two oil price crashes

- The main conclusion drawn from our research is that once trend breaks are accounted for, the unit root hypothesis cannot be rejected for any of the three variables analyzed

- Aside from stationarity testing, we investigate into the impact of the two large price declines since 2002.
  - ✓ As a result of our work we find that VP Min and VP Abs models give more weight to the changing patterns of prices since 2012 and until the end of 2015 rather than to the effects of the financial crisis
  - ✓ On the other hand, when considering the impact of the break almost instantaneously results are slightly different: for Brent and gasoil supply-demand fundamentals prevail over effects from the financial crisis whereas in the case of fuel-oil, equity market shocks associated with greater volatility in 2008-09 seem to be more influential.

- Considering these results, it could be said that fuel-oil markets seem to be somehow more reactive in sentiment to fast and sudden unexpected events rather than to other market related forces. The fact that fuel-oil is less traded than oil and gasoil could be an underlying reason for that.