

INTEGRATION IN THE GLOBAL PRODUCTION OF ENERGY COMMODITIES

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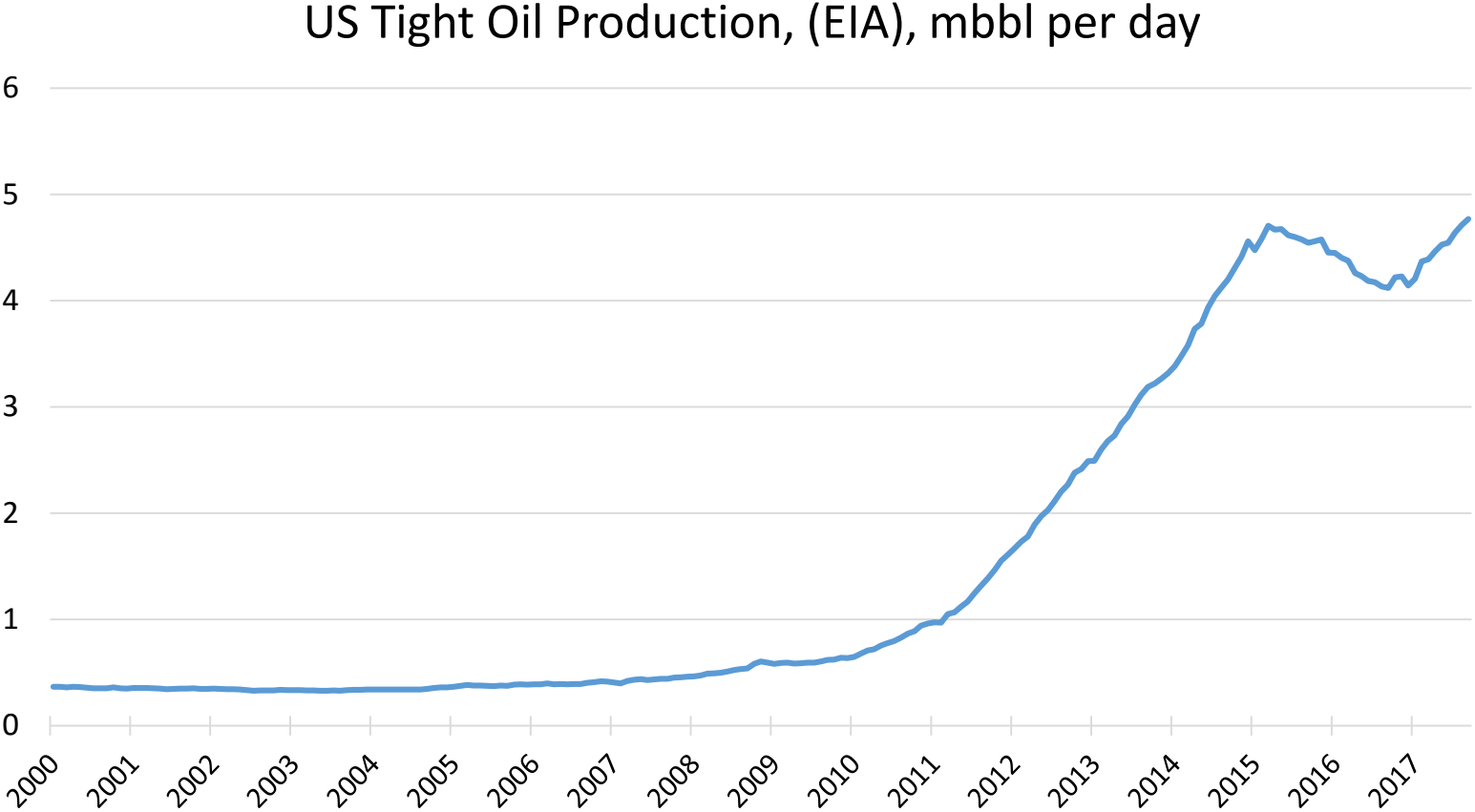
Labovitz School of Business and Economics

University of Minnesota Duluth

2017 USAEE Meeting Houston, TX

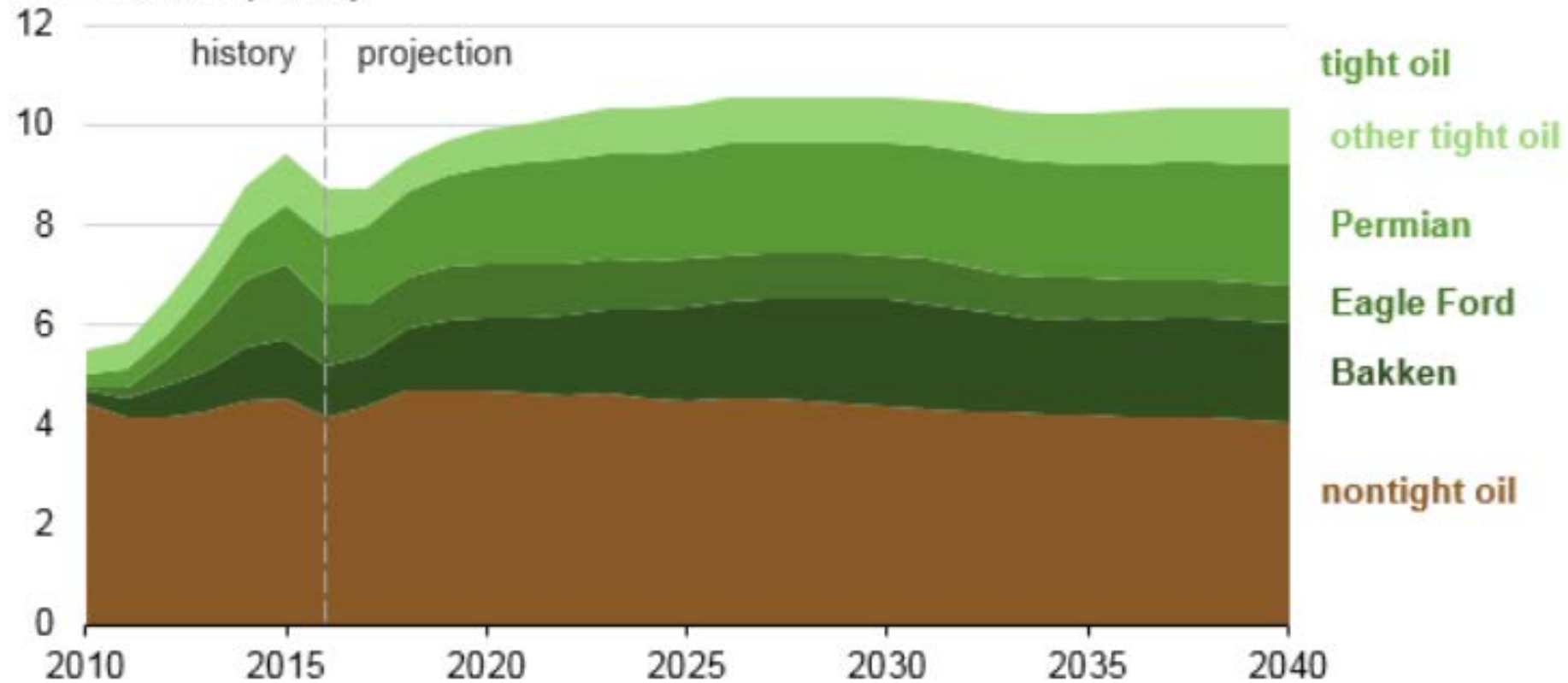
U.S Tight Oil Experience

Tight oil revolution has dramatically changed the extraction of crude in the United States



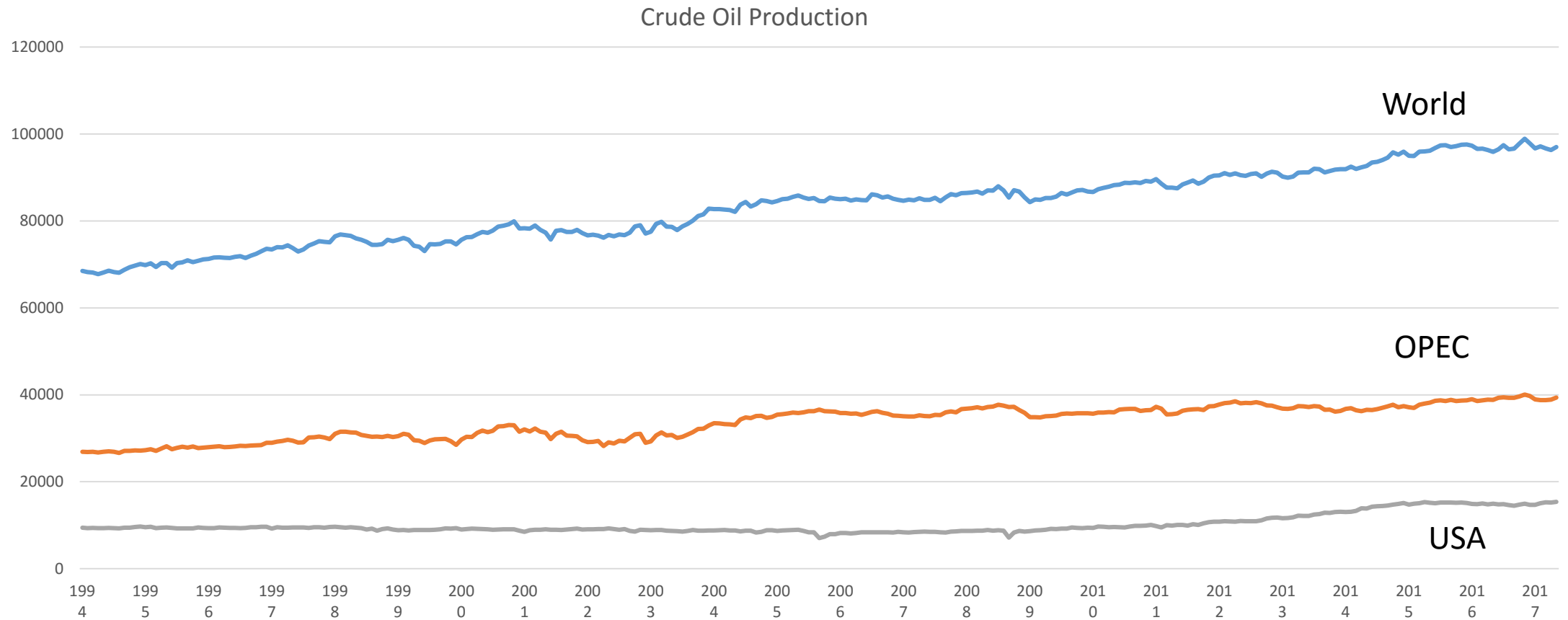
Expectations for US Tight Oil

U.S. oil production (2010-40)
million barrels per day



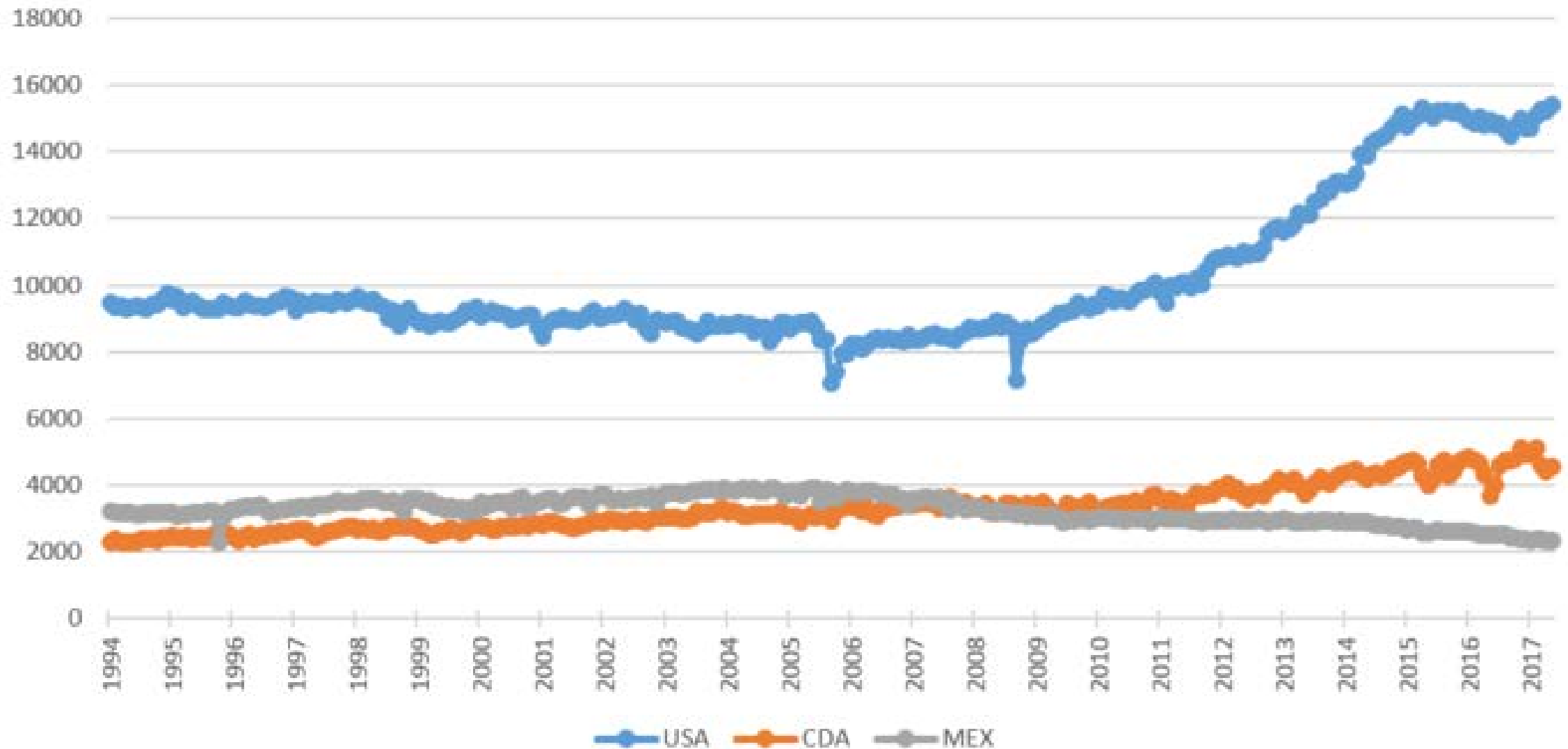
Source: U.S. Energy Information Administration, [Annual Energy Outlook 2017](#) Reference case

Crude oil production



North American Production, EIA

000s b/d

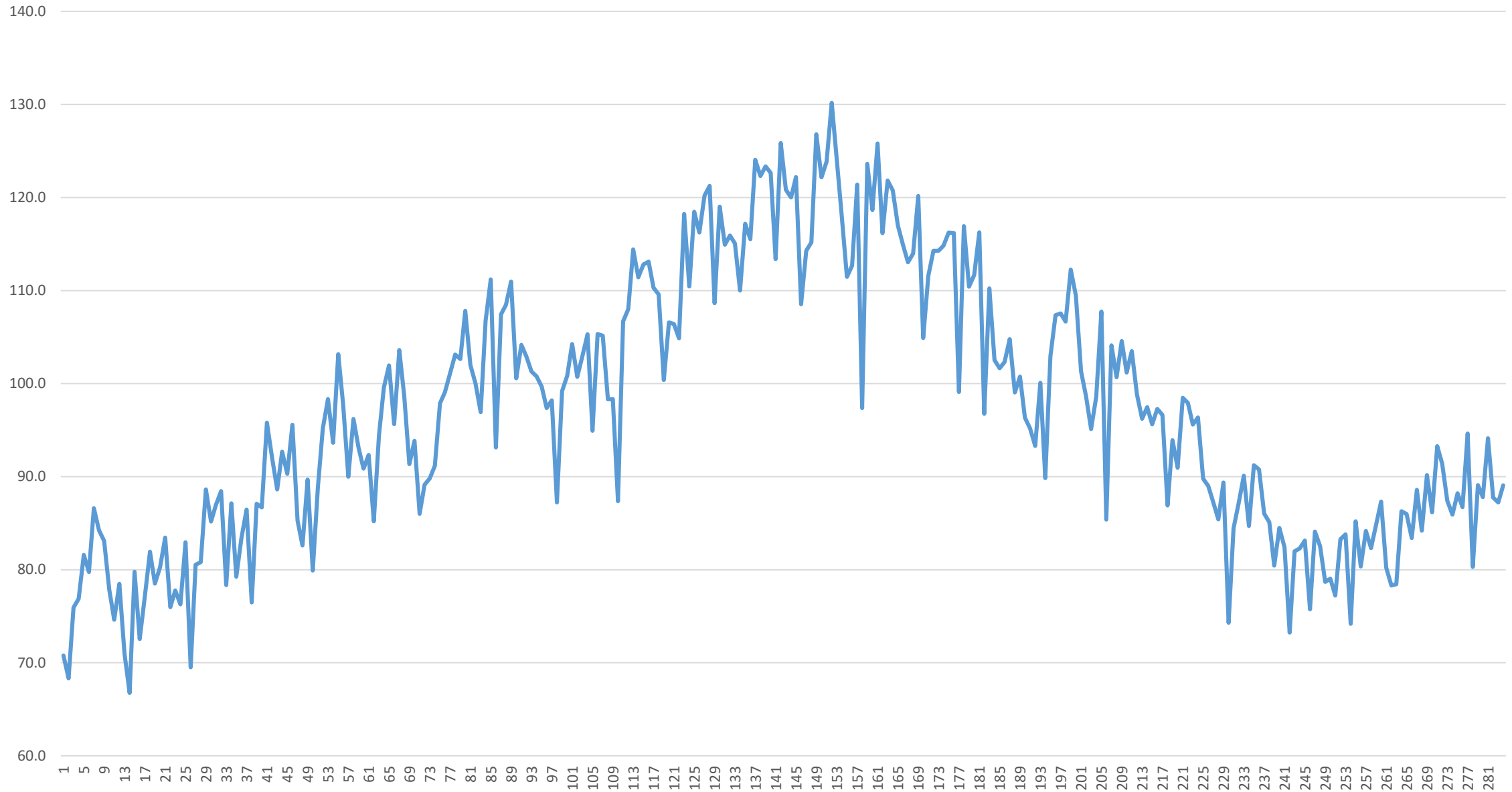


Scale of change in US Production

US production; % of World Production



US Imports of Crude Oil



Motivation

- Global crude oil production has been increasing
 - US production gains largely due to the Shale Revolution
- Literature Review
 - Wilmot and Taivan (2017)
 - Kilian (2017) examine the impact of the Fracking Boom on Production in Saudi Arabia
 - Structural Breaks in Crude oil prices (Wilmot, 2013 ; Mensi *et al*, 2014)
- Recent Events
 - Lifting of the US Export restriction (end 2015)
 - OPEC decision (2016)

Econometric 'Game plan'

- Univariate Unit Root tests
 - No break: DFGLS, Phillips-Perron, KPSS
 - Break: Zivot Andrews
- Bivariate Cointegration Tests
 - Engel Granger
 - Gregory Hansen (1996)
- Panel Data
 - Unit root tests
 - Cointegration test with breaks Westerlund (2006)

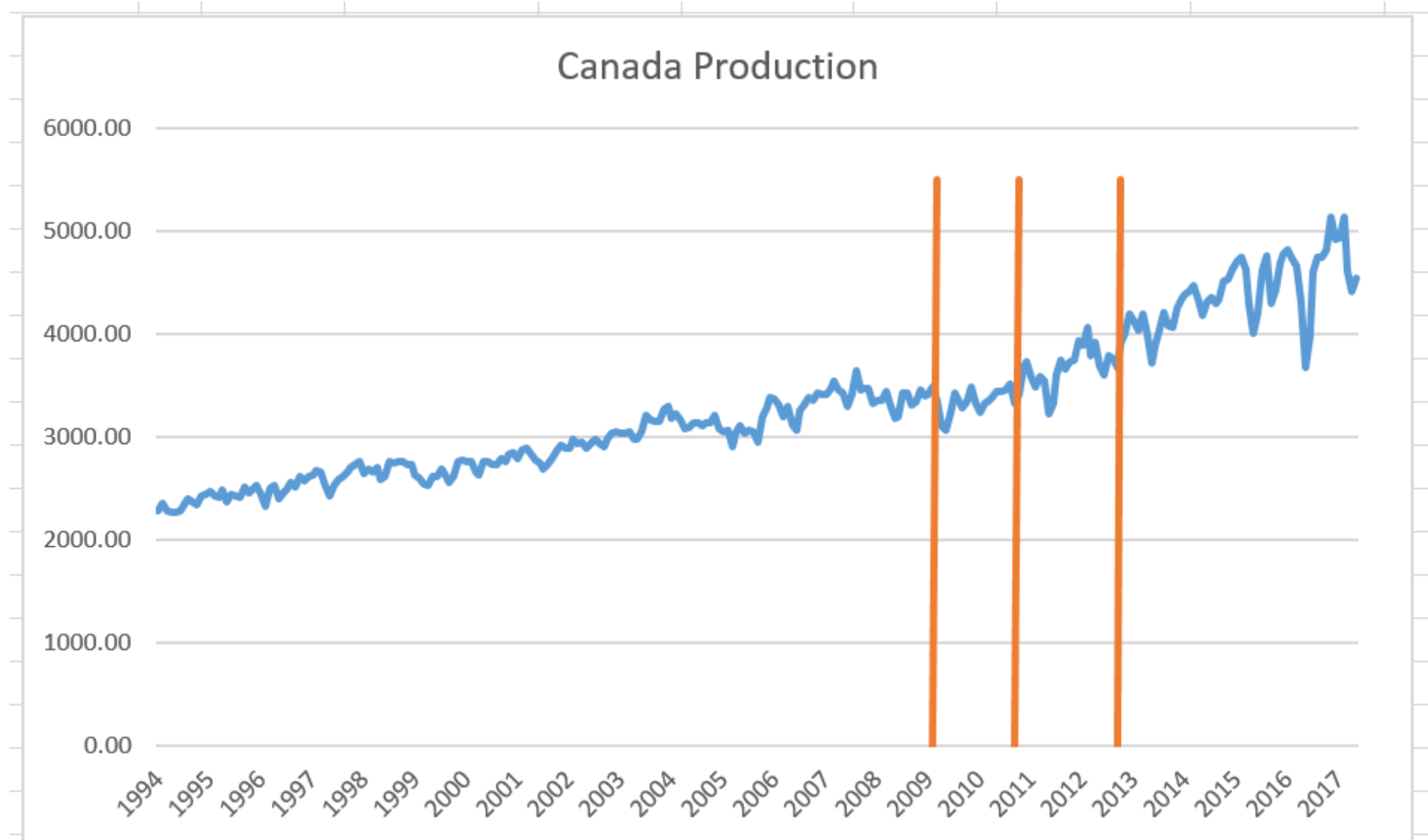
Univariate tests

Table 2.A: Univariate Unit Root Tests (No Trend)							
	DFGLS		Phillips - Perron		KPSS		
<i>Production</i>		Lags		Lags		Lags	
USA	1.963	3	1.513 (0.998)	3	1.17 ***	13	
Canada	3.156	15	-0.608 (0.869)	13	1.96 ***	13	
OPEC	0.647	1	-1.183 (0.681)	13	1.96 ***	13	
ROW	0.358	15	-2.527 (0.109)	13	1.96 ***	13	
<i>D.Production</i>							
USA	-2.176 **	6	-19.916 *** (0.000)	13	0.782 ***	13	
Canada	-2.331 ***	10	-20.268 *** (0.000)	13	0.0647	13	
OPEC	-5.301 ***	6	-16.762 *** (0.000)	13	0.0404	13	
ROW	-2.597 ***	8	-24.154 *** (0.000)	13	0.534 **	13	

Univariate Tests with structural break

Table 2.B: Zivot Andrews Univariate Unit Root Tests with structural break										
Break:	Intercept			Trend			Intercept and Trend			
	t-stat	Lags	Break Date	t-stat	Lags	Break Date	t-stat	Lags	Break Date	
<i>Production</i>										
USA	-2.787	2	Oct-11	-3.646	2	Mar-08	-3.929	2	Jun-05	
Canada	-6.724 ***	2	Oct-12	-7.050 ***	2	Oct-10	-7.694 ***	2	Mar-09	
OPEC	-4.638 *	0	Aug-03	-3.402	0	Sep-05	-4.643	0	Aug-03	
ROW	-3.491	3	Feb-11	-4.099	3	Oct-05	-4.275	3	Jul-03	
<i>D.Production</i>										
USA	-16.197 ***	1	Oct-08	-15.66 ***	1	Nov-13	-16.186 ***	1	Oct-08	
Canada	-10.173 ***	4	Jun-11	-10.08 ***	4	Feb-99	-10.191 ***	4	Jul-11	
OPEC	-13.117 ***	1	May-02	-12.87 ***	1	Oct-13	-13.158 ***	1	May-02	
ROW	-13.124 ***	2	Apr-13	-13.04 ***	2	Nov-13	-13.243 ***	2	Apr-13	

Canadian Production with Breaks



Cointegration test

- Engel Granger Cointegration tests

	Trend		No Trend	
	Test Statistics	Lags	Test Statistics	Lags
USA / Canada	-3.215	5	-1.568	5
USA / OPEC	-1.149	5	-0.11	5
USA/ROW	-2.896	5	0.817	5
OPEC / ROW	-2.313	5	-2.313	5

Gregory Hansen (1996) Cointegration tests

	ADF			Z_t			Z_a		
Production	Test Statistic		Break	Test Statistic		Break	Test Statistic		Break
USA and Canada									
<i>C</i>	-4.80	**	Feb-02	-5.66	***	Apr-02	-54.52	***	Apr-02
<i>C/T</i>	-5.34	***	Aug-08	-6.44	***	Jan-09	-70.78	***	Jan-09
<i>C/S</i>	-9.10	***	Sep-07	-7.98	***	Oct-08	-99.83	***	Oct-08
USA and OPEC									
<i>C</i>	-3.98		Apr-13	-3.92		Dec-12	-30.31		Dec-12
<i>C/T</i>	-3.97		Apr-13	-3.88		Dec-12	-29.76		Dec-12
<i>C/S</i>	-4.56		Jul-12	-4.51		Jul-12	-38.42		Jul-12
USA and ROW									
<i>C</i>	-3.99		Apr-13	-3.94		Dec-12	-30.68		Dec-12
<i>C/T</i>	-5.83	***	Nov-13	-5.84	***	Nov-13	-61.26	***	Nov-13
<i>C/S</i>	-6.13	***	Nov-11	-5.98	***	Nov-11	-70.14	***	Nov-11
OPEC and ROW									
<i>C</i>	-4.21		Oct-00	-3.8		Jan-01	-30.16		Jan-01
<i>C/T</i>	-4.72		Sep-03	-4.57		Feb-04	-37.22		Feb-04
<i>C/S</i>	-4.56		Oct-00	-4.07		Jul-01	-36.52		Jul-01

Panel Data: Unit Root test

Table: Panel Unit Root Test Results

	Breitung Statistic		lags	Im et al. Statistic		lag avg
<i>Production</i>	0.1858 (0.574)		10	0.3348 (0.631)		4.00
<i>D.Production</i>	-6.1662 *** (0.000)		10	-25.235 *** (0.000)		2.75
<i>Price</i>	-0.468 (0.320)		10	-1.8345 (0.033)		5.00
<i>D.Price</i>	-7.288 *** (0.000)		10	-17.228 *** (0.000)		4.50

Panel Data: Cointegration of Production and Prices

	Production - Price	
	Test Statistic	<i>p-value</i>
Panel v-stat	-1.564	0.1178
Panel ρ -stat	1.802	0.0715
Panel PP-stat	2.065	0.0389
Panel adf-stat	2.1442	0.0320
Group ρ -stat	-0.05757	0.9541
Group PP-stat	0.8507	0.3949
Group adf-stat	0.7506	0.4529

Panel Cointegration

- Westerlund (2006)

Table: Results of the panel cointegration test					
<i>Breaks</i>	1		2		
<i>Test Statistic</i>	16.205	***	9.732	***	
<i>Production</i>					
Country	Date		Dates		
USA	Aug-08		Aug-08	Nov-13	
Canada	Mar-09		Mar-09	Oct-13	
OPEC	May-04		Nov-01	Oct-05	
ROW	Sep-03		Sep-03	Aug-11	

Conclusions

- Crude oil production appears to be nonstationary, even when accounting for a possible structural break
- While the hypotheses of cointegration is rejected, the resulting timing of the breaks do correspond to late 2008 early 2009 period of expanding US shale production
- Next steps:
 - Russian production?
 - Separation of the OPEC countries?

Thank you!

