Do oil prices drive food prices? A natural experiment

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The views expressed in this presentation correspond to the author and do not necessarily represent the views of the BIS.

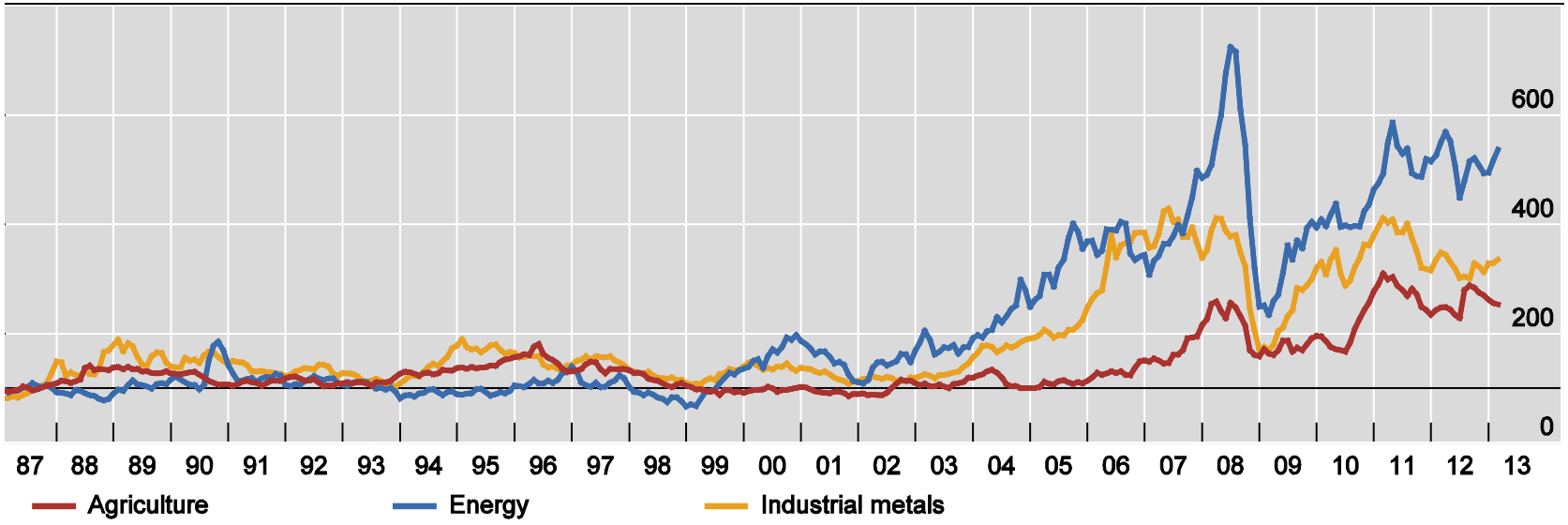
Outline

- Motivation
- A brief (regulatory) history of ethanol
- Empirical analysis
- Conclusions

After a long pause, commodity prices "awakened" in late 1990s

Commodity prices[1]

1987 = 100 Graph 1



[1] S&P GSCI spot price indices, monthly average.

Sources: Standard & Poor's'; Datastream; BIS calculations.

Macroeconomic drivers

- Easy monetary policy
  - Demand side: impulses aggregate expenditure
  - Supply side: reduce costs of carrying inventories / leave stuff in the ground (minerals)
- Global demand by large EMEs (China and India)
- Financialisation of commodity markets

What about food prices? Microeconomic drivers: biofuels

- Biofuel promotion feature of energy policies in AE and EMEs, linked oil and food markets?
- US promotes corn-based ethanol
  - Problem: policy dates back to 1978, but corn prices barely moved until 2006
- And soybeans? Connection with oil through corn
  - Soy-based biodiesel production still relatively small
  - Corn and soybeans are close substitutes in industrial uses
  - Acreage competition

A brief history of ethanol

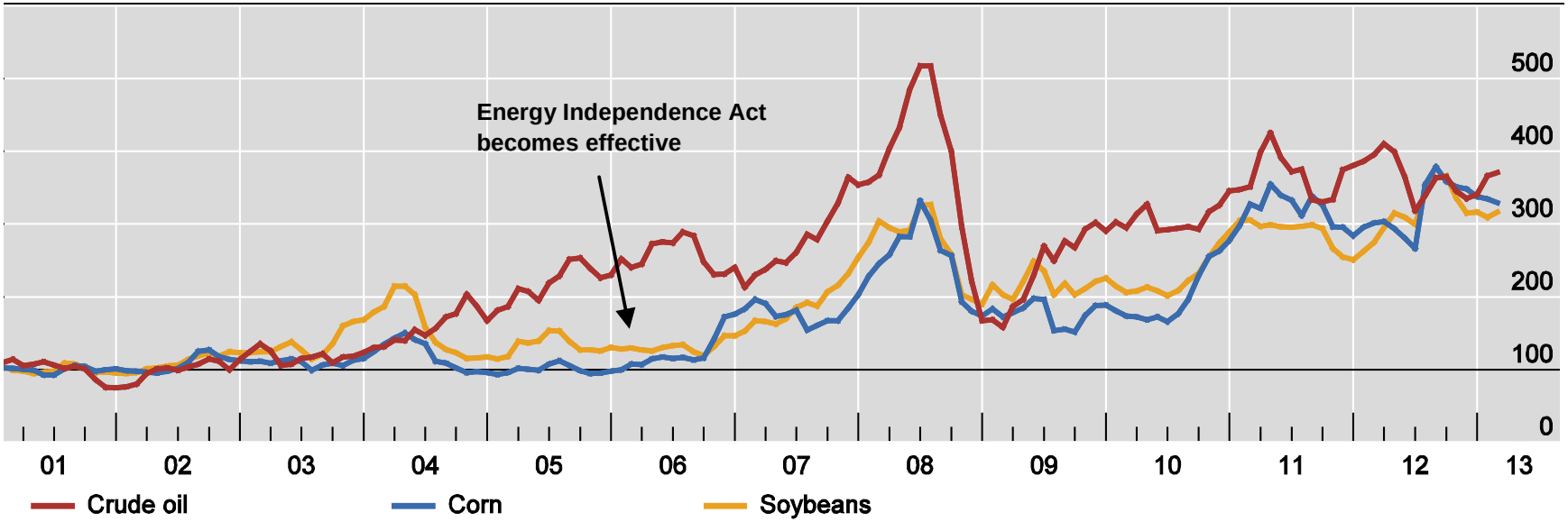
- Energy Policy Act (1978): Ethanol industry launched in US with large subsidies, and tariffs on imported ethanol.
- Clean Air Act (1990) required gasoline vendors minimum oxygen content.
  - Migration from pure subsidy/tariff system to quantitative standard.
- 2003: California and New York banned MTBE.
- 2005: 19 states had banned the use of MTBE as gasoline additive.
- Energy Independence and Security Act (2005) eliminated the oxygenate standard, and imposed renewable fuels standard
  - In May 2006, ethanol became the only viable gasoline additive to comply with the new standard.
- Ethanol subsidies and tariffs discontinued in December 2011.

After EISA 2005 becomes effective, corn and soybean prices rose quickly

Selected commodity prices[1]

2001 = 100

Graph 4



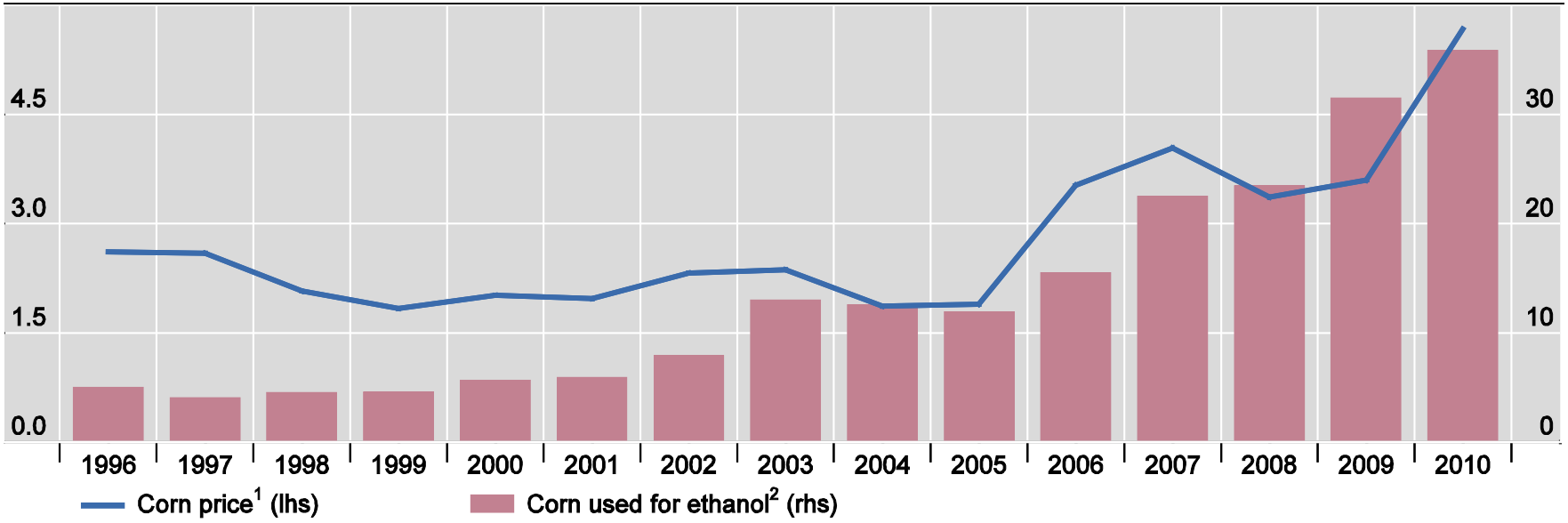
[1] S&P GSCI spot price indices, monthly average.

Sources: Standard & Poor's; Datastream; BIS calculations.

Use of corn for ethanol production surged

Use of the United States corn for ethanol production and corn prices

Graph 5



[1] In US dollars per bushel. [2] As a percentage of the United States ethanol production.

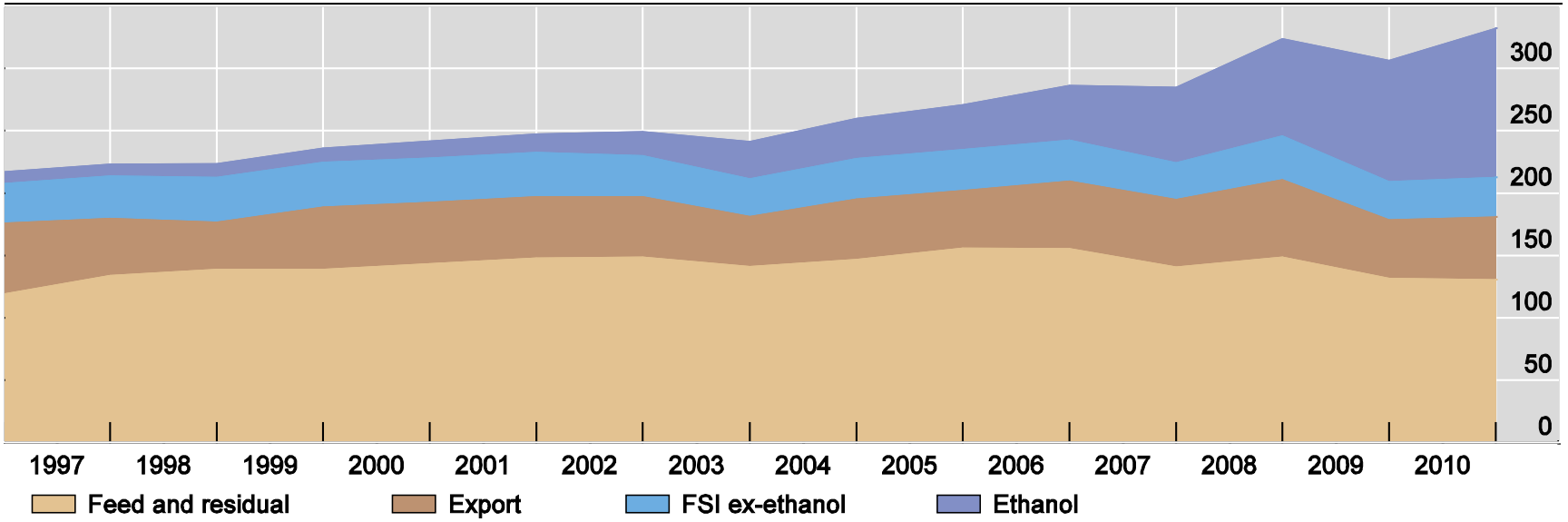
Sources: United States Department of Agriculture; BIS calculations.

Ethanol-use absorbed all additional US corn production (+38%) since 2003

Use of the United States corn production

In millions of tons

Graph 6



Sources: United States Department of Agriculture; BIS calculations.

Empirical analysis

- Explore transmission mechanism from oil prices to food prices: did it change in/around 2006?
- Intuition:
  - Higher oil price → gasoline with higher ethanol content
  - Ethanol producers bid up corn prices
  - Price of corn close substitutes (soybeans) increase
  - Medium term: acreage competition distributes gains
- Analyse price dynamics before/after May 2006
- Data: monthly averages of daily price data from Jan. 1986 to April 2012

Data description

Descriptive statistics

Table 1

Statistic[1]	Oil	Corn	Soybean	Copper[2]	Gold
	Sample				
	January 1986 to April 2012				
Mean	37.458	2.781	6.938	3840.587	521.127
Median	23.343	2.383	5.986	2672.138	384.913
Standard deviation	27.566	1.231	2.414	2576.155	339.416
Minimum	11.346	1.330	4.078	1377.376	256.164
Maximum	133.890	7.327	14.853	9880.938	1772.136
	January 1986 to April 2006				
Mean	24.580	2.297	5.950	2257.926	364.530
Median	20.311	2.263	5.667	1913.112	367.879
Standard deviation	11.422	0.539	1.127	839.605	60.792
Minimum	11.346	1.330	4.078	1377.376	256.164
Maximum	69.448	4.862	9.765	6389.900	609.735
	May 2006 to April 2012				
Mean	81.097	4.422	10.284	7225.724	1051.819
Median	77.289	3.695	10.158	7539.858	942.060
Standard deviation	20.585	1.482	2.607	1568.047	358.594
Minimum	39.015	2.064	5.144	3079.391	586.295
Maximum	133.890	7.327	14.853	9880.938	1772.136

[1] For oil, in US dollars per barrel; for corn and soybean, in US dollars per bushel; for copper, in US dollars per metric tonne; for gold, in US dollars per troy ounce. [2] Data available since June 1993.

Sources: Datastream; BIS calculations.

Large correlation increase between subperiods, not observed for other commodities

Correlation matrix

Table 2

Simple correlation[1]	Oil	Corn	Soybean	Copper[2]	Gold
			Sample		
			January 1986 to April 2006		
Oil	1.000				
Corn	–0.143	1.000			
Soybean	–0.065	0.622	1.000		
Copper	0.204	–0.012	0.173	1.000	
Gold	0.194	–0.076	0.061	0.278	1.000
			May 2006 to April 2012		
Oil	1.000				
Corn	0.314	1.000			
Soybean	0.435	0.701	1.000		
Copper	0.675	0.277	0.394	1.000	
Gold	0.165	0.294	0.291	0.208	1.000

[1] Calculated over prices (in logarithms), first difference. [2] Data available since June 1993.

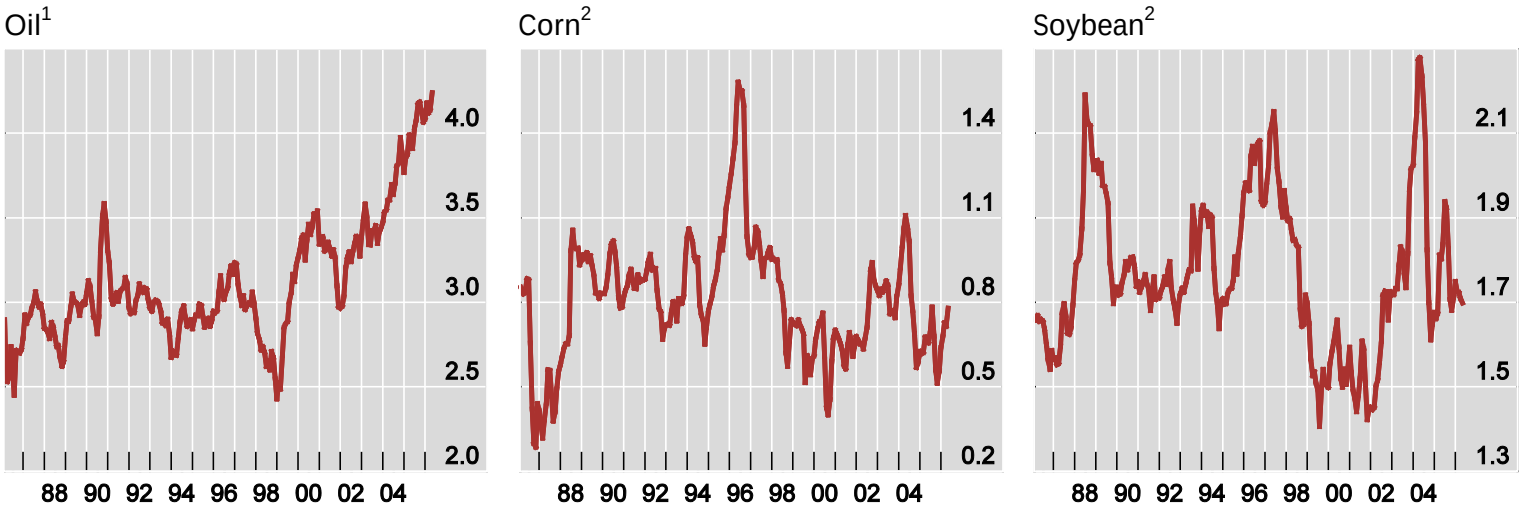
Sources: Datastream; BIS calculations.

Baseline period: January 1986 – April 2006

Oil, corn and soybean prices, January 1986 to April 2006

In logarithms

Graph 7



[1] In US dollars per barrel. [2] In US dollars per bushel.

Sources: Datastream; BIS calculations.

- Log prices of corn and soybeans not integrated
- Log price of oil is I(1)
- Run a VAR in log price differences for all variables, 1 lag based on AIC and SIC

Granger-causality rejected in baseline period

VAR model Granger causality tests[1]

Sample: January 1986 to April 2006[2] Table 3

Excluded variable	Chi-sqared	Degrees of freedom	P-value
		Dependent variable	
		Oil	
Corn	2.392	1	0.122
Soybean	0.851	1	0.356
Both	2.395	2	0.302
		Corn	
Oil	0.119	1	0.730
Soybean	0.118	1	0.732
Both	0.228	2	0.892
		Soybean	
Oil	0.545	1	0.460
Corn	1.776	1	0.183
Both	2.646	2	0.266

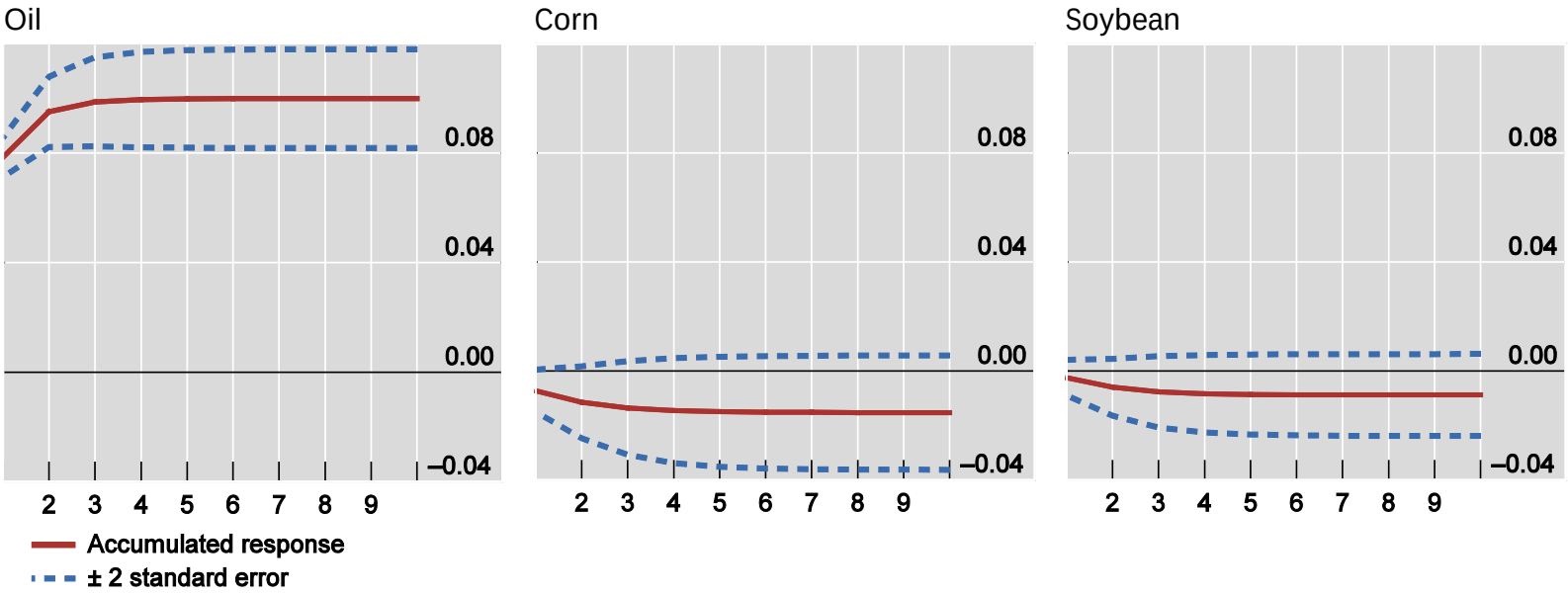
[1] Tested over prices (in logarithms), first difference. [2] Included observations: 242.

Sources: Datastream; BIS calculations.

VAR model: response to oil price shock

Accumulated impulse-responses[1] from VAR model: shock to oil prices

Sample (adjusted): March 1986 to April 2006 Graph 8



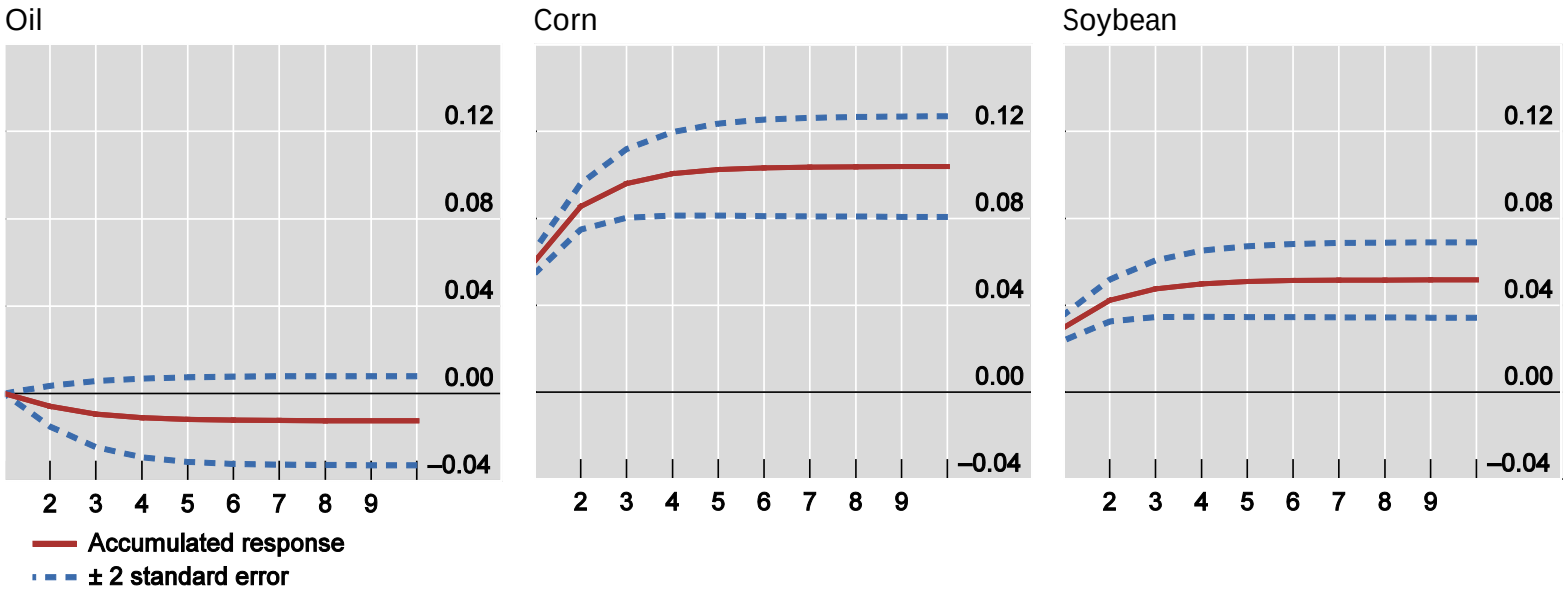
[1] Prices (in logarithms), first difference. Accumulated response to Cholesky one standard deviation innovation. Cholesky ordering: oil, corn and soybean.

Sources: Datastream; BIS calculations.

VAR model: response to corn price shock

Accumulated impulse-responses[1] from VAR model: shock to corn prices

Sample (adjusted): March 1986 to April 2006 Graph 9



[1] Prices (in logarithms), first difference. Accumulated response to Cholesky one standard deviation innovation. Cholesky ordering: oil, corn and soybean.

Sources: Datastream; BIS calculations.

Testing for structural break: May 2006

Chow test for structural break[1]

Sample: March 1986 to April 2012[2] Table 4

	Test value	Bootstrapped p-value	Asymptotic p-value[3]	Degrees of freedom
Sample split Chow test	13.371	0.367	0.343	12
Break point Chow test	47.858	0.019	0.000	18
Chow forecast test	1.591	0.006	0.000	216, 708

[1] Tested break date: May 2006 (242 observations before break). [2] Included observations: 314. [3] For break point and sample split Chow tests, asymptotic Chi^2 p-value; for Chow forecast test, asymptotic F p-value.

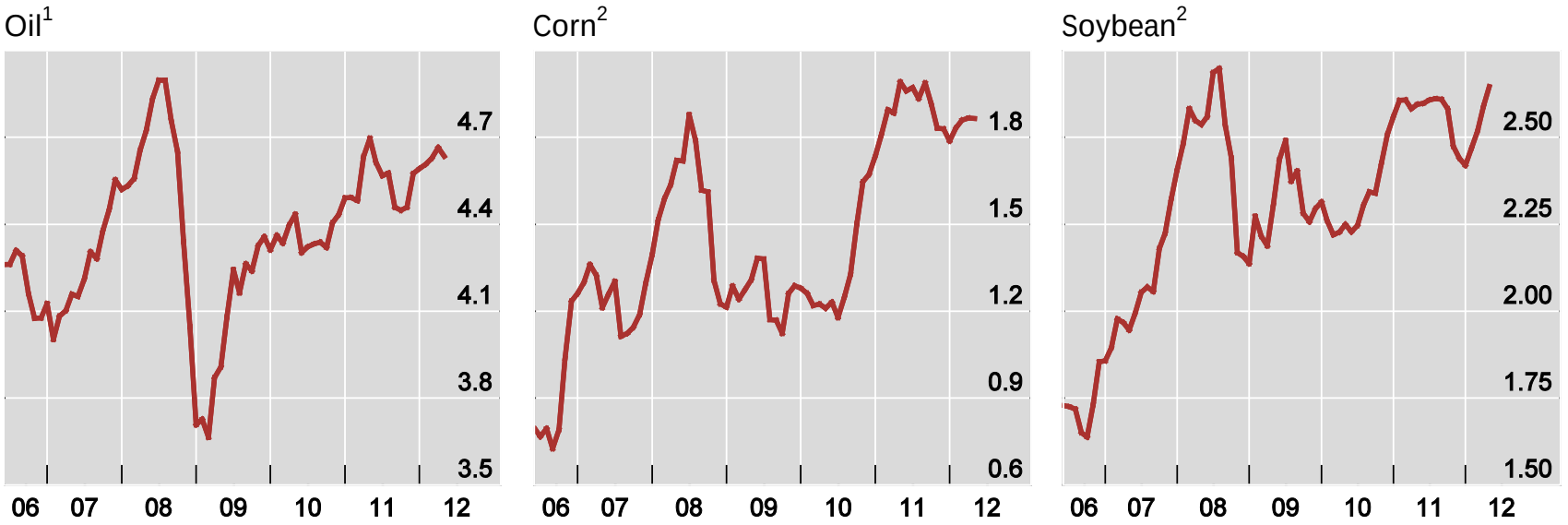
Sources: Candelon and Lütkepohl (2001); Datastream; BIS calculations.

After EIA 2005: May 2006 – April 2012

Oil, corn and soybean prices, May 2006 to April 2012

In logarithms

Graph 9



[1] In US dollars per barrel. [2] In US dollars per bushel.

Sources: Datastream; BIS calculations.

After EISA 2005: preliminary testing

- Log prices of corn and soybeans are I(1) now
- ADF tests reject non-stationary of oil log prices
- PP tests reject non-stationarity null, oil log prices are I(1)
- Cointegration testing: Johansen (1991)
  - Cointegration between oil and corn in bilateral tests
  - With pooled data, testing can't reject existence of 1 cointegration vector
  - Additional constraint of zero coefficient on soybean is not rejected

After EISA 2005: VEC model results

- Estimate a VEC model with endogenous variables lagged two periods

$$\Delta Y_t = \gamma + \alpha\beta' Y_{t-1} + \sum_{i=1}^{2} \boldsymbol{\Phi}_i \Delta Y_{t-i} + \varepsilon_t$$

- Cointegrating vector β

intercept	*oil*	*corn*	*soybean*
-3.566	*1.000*	*-0.551*	*0.000*

- Loadings α

Oil	*Corn*	*Soybean*
-0.200	*0.014*	*-0.069*
[-3.943]	*[0.233]*	*[-1.532]*

Food driving oil?

VEC model Granger causality tests[1]

Sample: May 2006 to April 2012[2] Table 5

Excluded variable	Chi-sqared	Degrees of freedom	P-value
	Dependent variable		
		Oil	
Corn	5.116	2	0.078
Soybean	4.945	2	0.084
Both	9.718	4	0.046
		Corn	
Oil	1.276	2	0.528
Soybean	0.055	2	0.973
Both	1.644	4	0.801
		Soybean	
Oil	4.901	2	0.086
Corn	2.327	2	0.312
Both	6.994	4	0.136

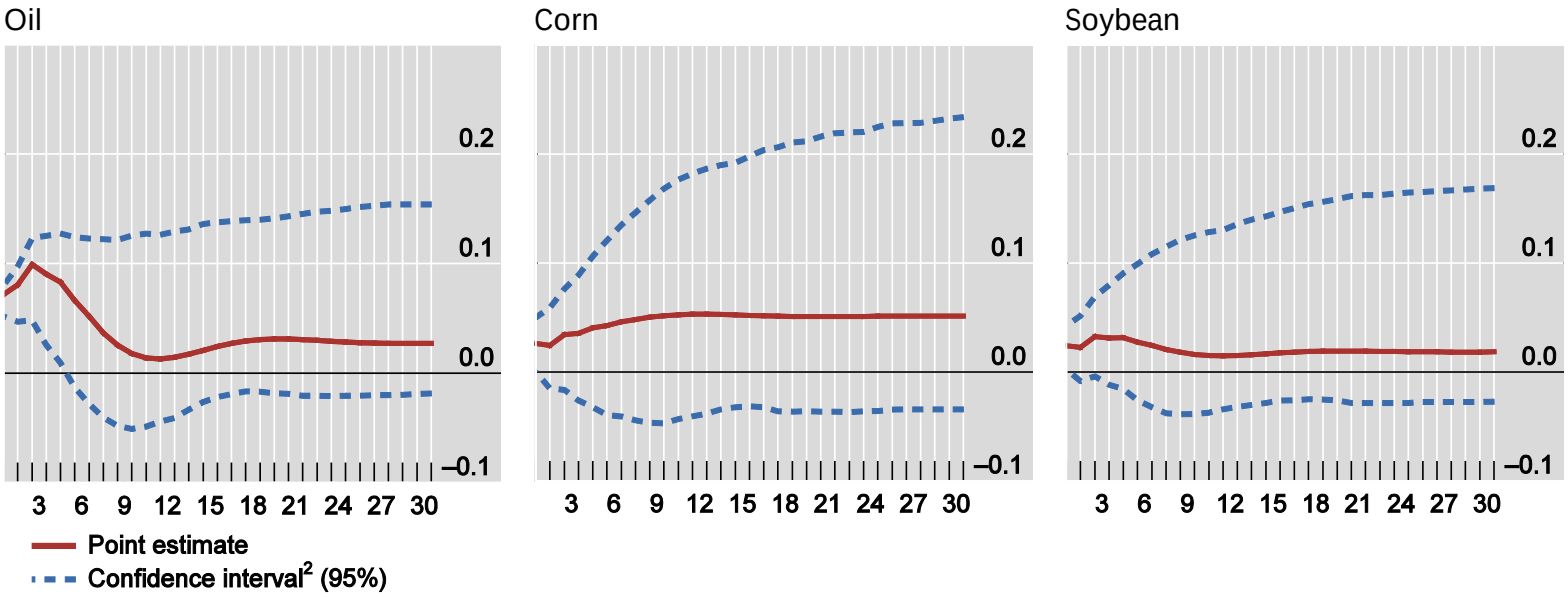
[1] Tested over prices (in logarithms), first difference. [2] Included observations: 69.

Sources: Datastream; BIS calculations.

VEC model: responses to oil price shock

Impulse-responses[1] from estimated VEC model: oil price shock

Sample (adjusted): August 2006 to April 2012 Graph 11



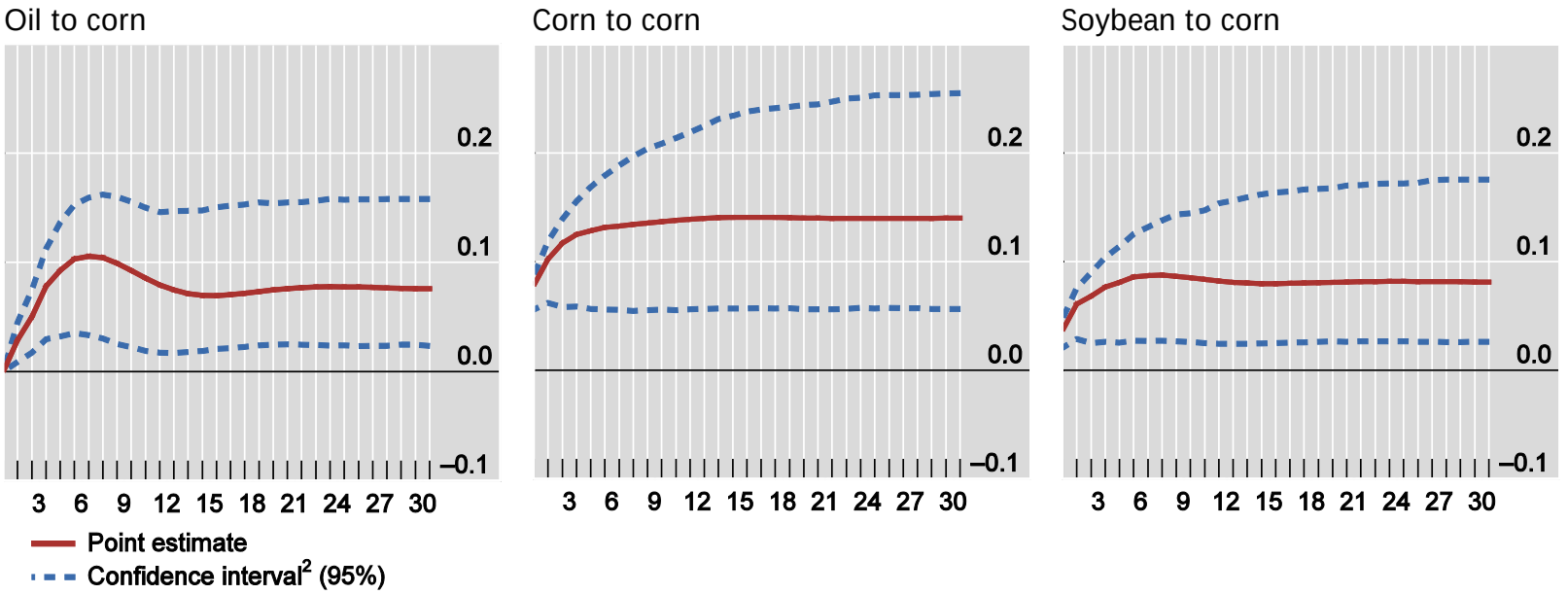
[1] Prices (in logarithms). Response to Cholesky one standard deviation innovation. Cholesky ordering: oil, corn and soybean. [2] Efron's percentile method.

Sources: Datastream; BIS calculations.

VEC model: responses to corn price shock

Impulse-responses[1] from estimated VEC model: corn price shock

Sample (adjusted): August 2006 to April 2012 Graph 12



[1] Prices (in logarithms). Response to Cholesky one standard deviation innovation. Cholesky ordering: oil, corn and soybean. [2] Efron's percentile method.

Sources: Datastream; BIS calculations.

Conclusions

- RFS imposed by EISA 2005 changed price dynamics between oil and some crop prices.
- Direction of causality (oil to food or the reverse) is unclear
- Relative size of response to shocks: not obvious that oil price shocks are larger
- Structural approach needed to disentangle the relevance of other factors like global demand, monetary policy or financialisation of commodity markets

Thanks!

Comments?

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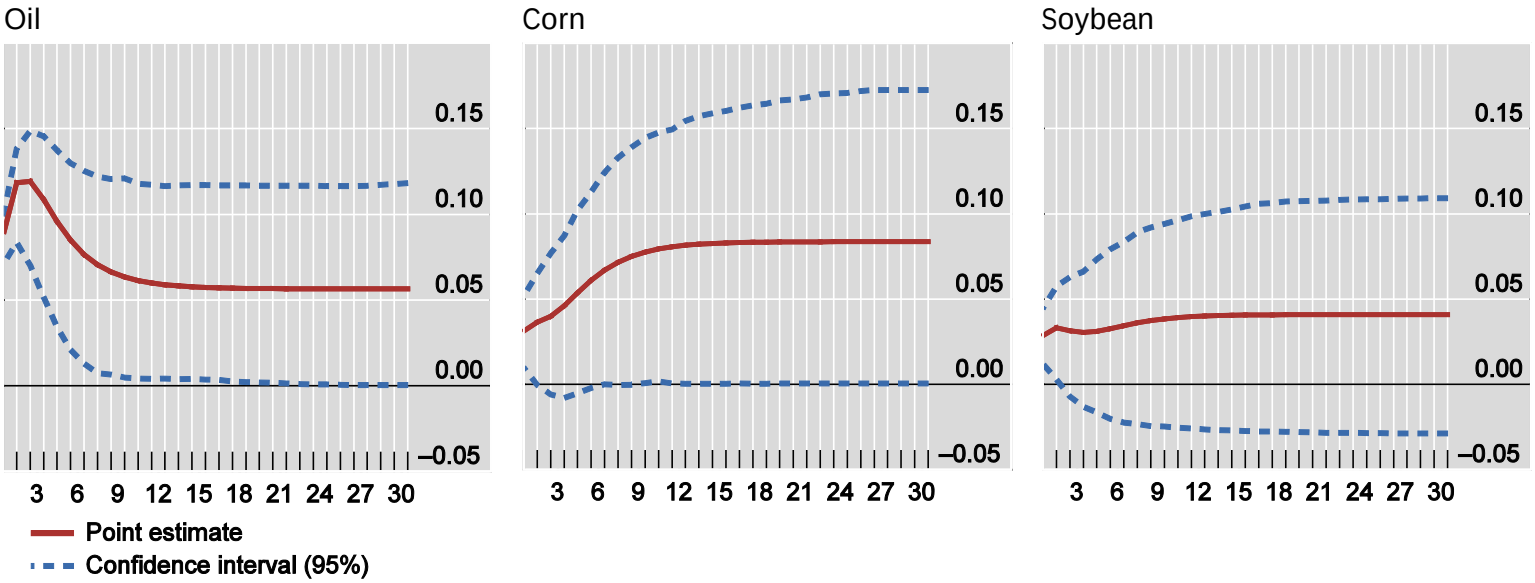
Appendix

Generalized IR: response to oil shock

Generalized impulse-responses[1] from estimated VEC model[2]

Sample: July 2006 to April 2012 Graph 13



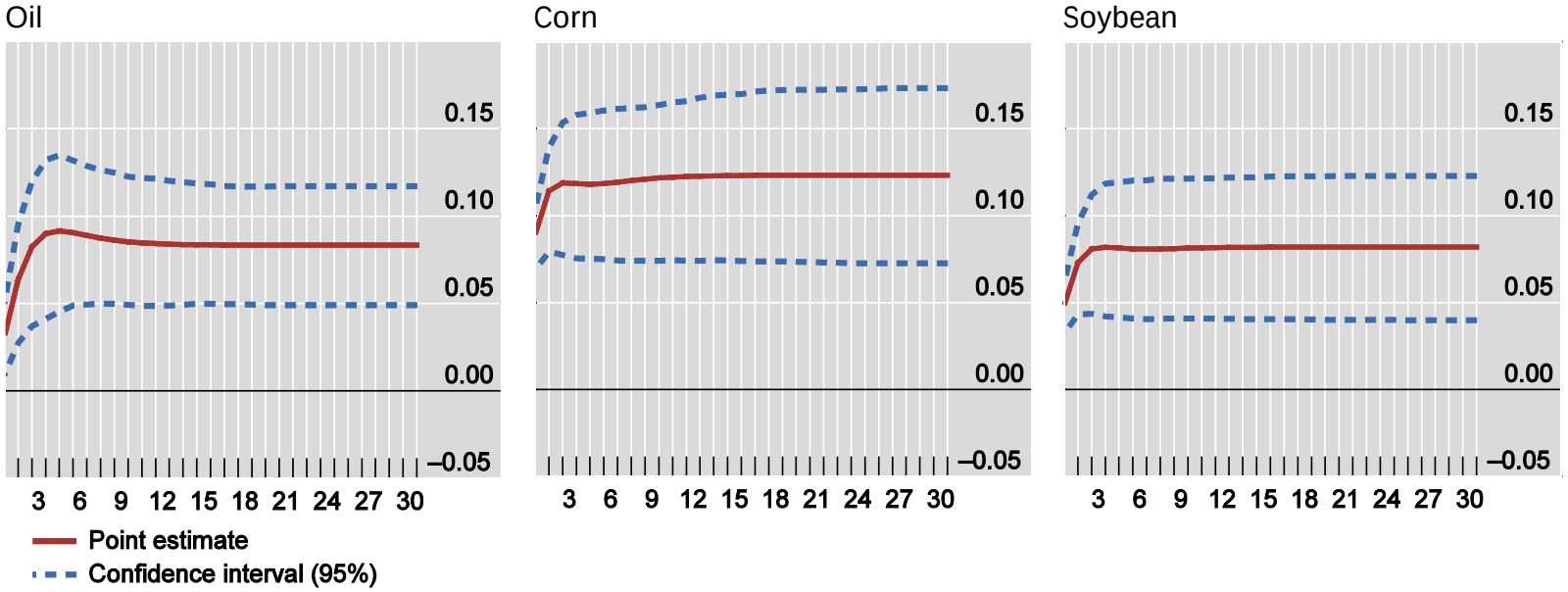
[1] Prices (in logarithms). Response to one standard deviation innovation. [2] Restrictions in cointegrating equation 1: Oil coefficient = 1; Soybean coefficient = 0.

Sources: Datastream; BIS calculations.

Generalized IR: response to corn price shock

Generalized impulse-responses[1] from estimated VEC model[2] (cont.)

Sample: July 2006 to April 2012 Graph 14



[1] Prices (in logarithms). Response to one standard deviation innovation. [2] Restrictions in cointegrating equation 1: Oil coefficient = 1; Soybean coefficient = 0.

Sources: Datastream; BIS calculations.