Oil Prices, Exchange Rates and Asset Prices

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Motivation

Sharp rise in oil prices and increased oil price volatility has coincided with a **closer co-movement** of **oil prices with other asset prices**

Link oil prices and asset prices?

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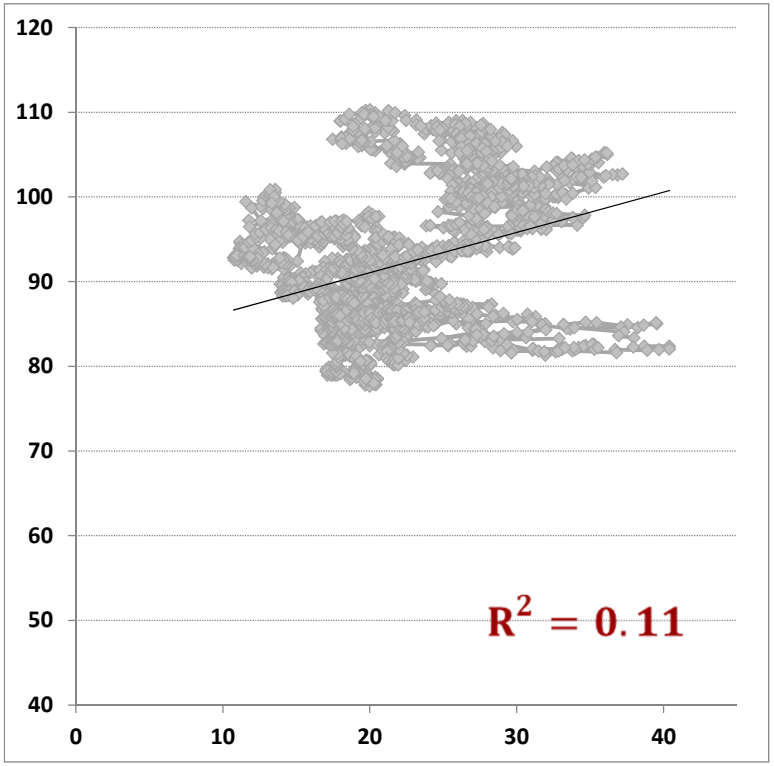
FOR EXAMPLE: Oil prices and exchange rates

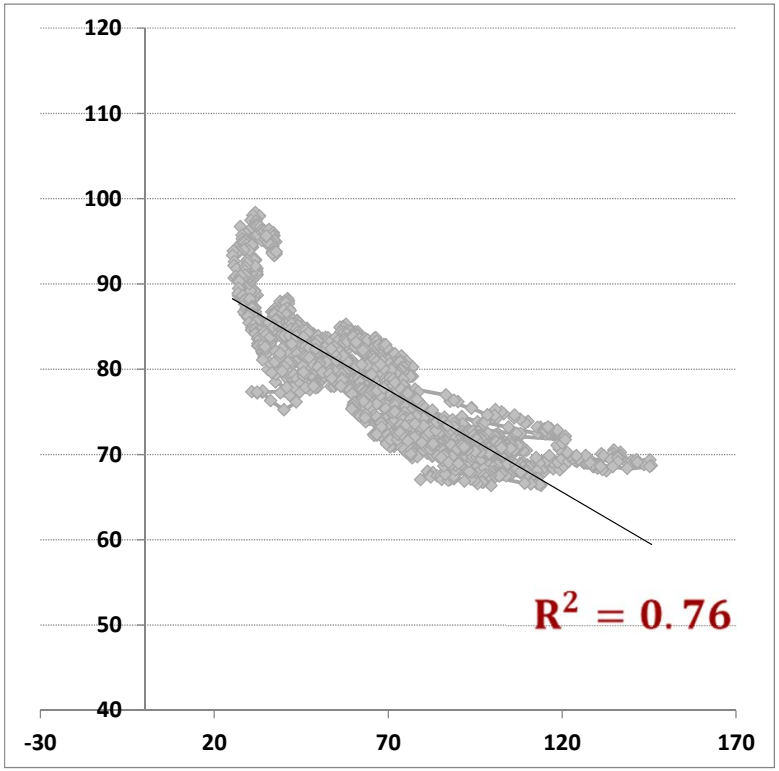
Example: oil and exchange rates

Daily WTI oil prices (y-axis) **and USD effective exchange rate** (x-axis)

1992 - 2002



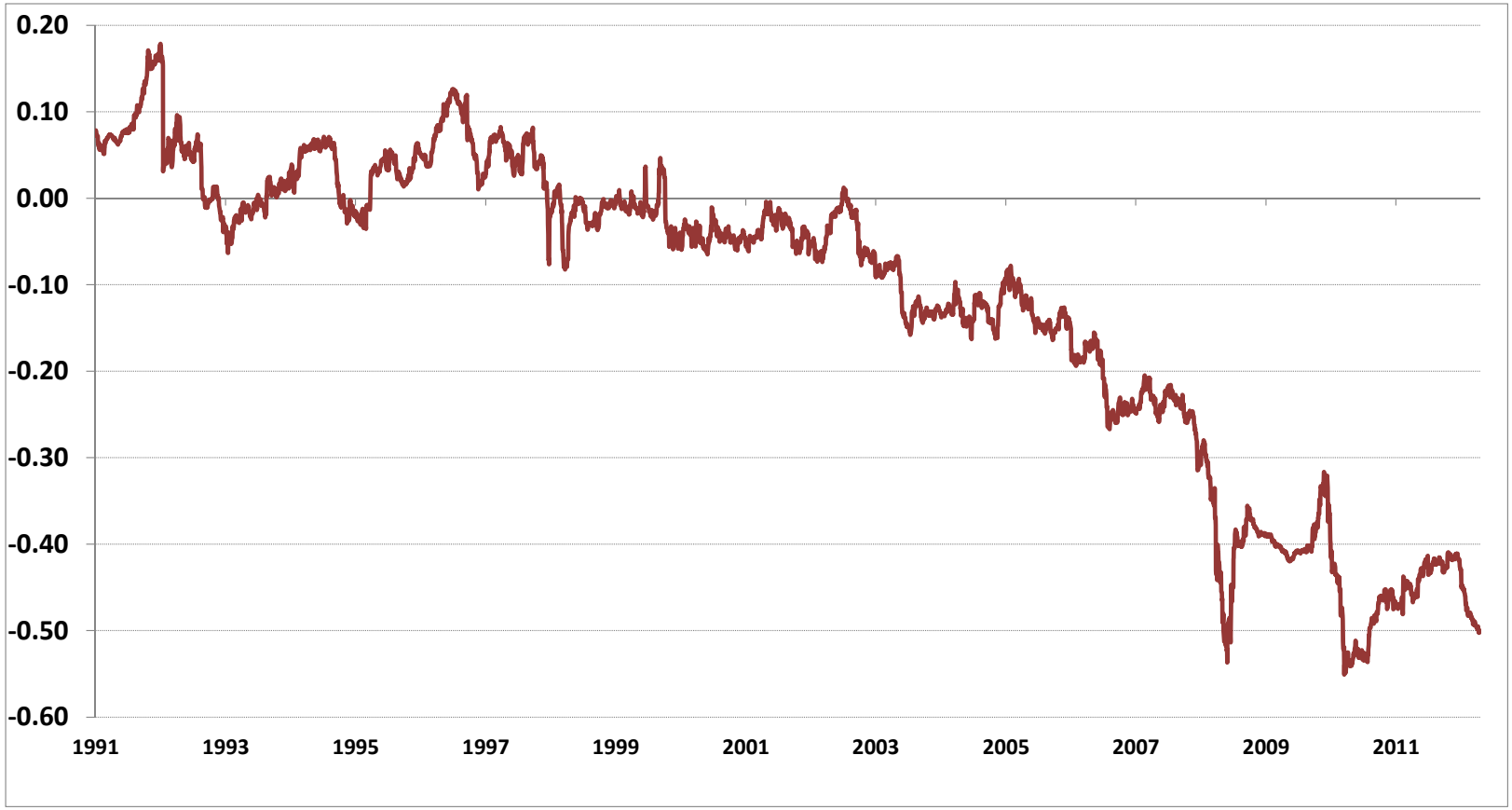
2003 - 2012



Notes: realisations of exchange rates and oil prices over sample 2 Jan 1990 – 31 Dec 2002 and 1 Jan 2003 – 15 October 2012.

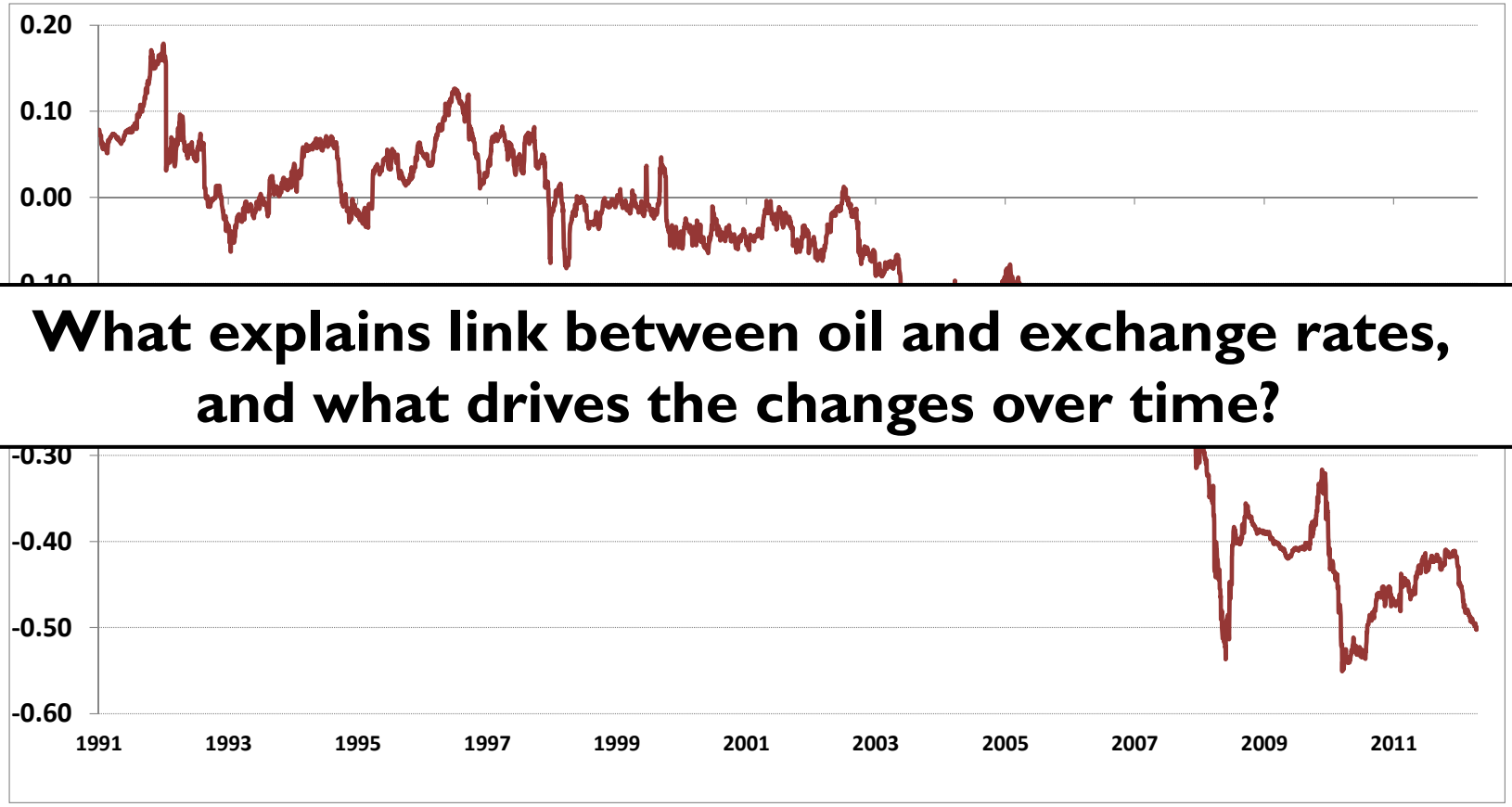
Example: oil and exchange rates

18-month rolling correlation exchange rate and oil prices



Notes: rolling 18-month correlation between first difference of US dollar effective exchange rate and WTI crude oil prices over the period 1 January 1991 – 15 October 2012.

Example: oil and exchange rates



What explains link between oil and exchange rates, and what drives the changes over time?

Example: oil and exchange rates

Suggestions in the financial press:

"Oil prices rose on the back of a weaker dollar after the U.S. Federal Reserve said it would keep interest rates low for longer than planned"
(Reuters, Jan 26, 2012)

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However:

- **Causality? In which direction?**

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However:

- **Causality? In which direction?**
- **Only through other channels?**

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- Explains **why the link** with some assets **has intensified over time**: oil and exchange rates

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YES

- Explains **why the link** with some assets **has intensified over time**: oil and exchange rates

Related to increased use of oil as a financial asset?

YES, partly (but mainly shocks to RISK)

Literature: focus on individual asset prices

	Oil prices	Exchange rate	Monetary policy	Equity markets	Risk, risk aversion and uncertainty
Oil prices	*	**Supply** Yousefi and Wirjanto (2003,2005) **Demand** De Schryder and Peersman (2012) **Financial markets** (financialization)	**Real interest rates** Frankel (2008)	**Demand** Kilian and Park (2009)	**Oil price volatility** Van Robays (2012)
Exchange rate	**Trade balance** Kilian et al. (2009), Ferrero et al. (2012) **Wealth effects** Krugman (1983)	*	**Expectations** (Engle et al. 2007) **UIP, delayed overshooting** (Scholl and Uhlig 2009)	**Demand, expectations**	**Flight-to-safety** Fratzscher (2009)

Contributions of this paper

- Model oil in a **multi-asset price framework**: direct effects and indirect transmission through third asset markets

- Appropriate methodology to deal with problems that arise in simultaneous equation models, i.e. **identification through heteroskedasticity**

Model specification

Structural VAR model

$$A\,Y_t = c + \Pi(L)\,Y_t + \Psi(L)\,z_t + \varepsilon_t$$

Endogenous variables:

1. **WTI Oil prices**
2. **USD effective exchange rates**
3. **US Stock prices: demand** (Kilian and Park 2009)
4. **US Interest rates: monetary policy** (Engle et al 2007, Frankel 2008)
5. **VIX: risk and uncertainty** (Fratzscher 2009, Van Robays 2012)
6. **NYMEX Open interest: financialisation** (Sockin and Xiong 2012)

↘

Interpretation of the structural shocks

Model specification

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Additional controls: US macroeconomic news

(Andersen et al. 2003, Ferrero et al. 2009, Kilian and Vega 2011)

PMI, consumer confidence, GDP, IP, retails sales, trade balance, hours worked, non-farm payroll, housing starts, CPI, PPI and FOMC meetings

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Main interest: *A* matrix captures the **contemporaneous impact** across oil prices, exchange rates and other asset prices **(causality)**

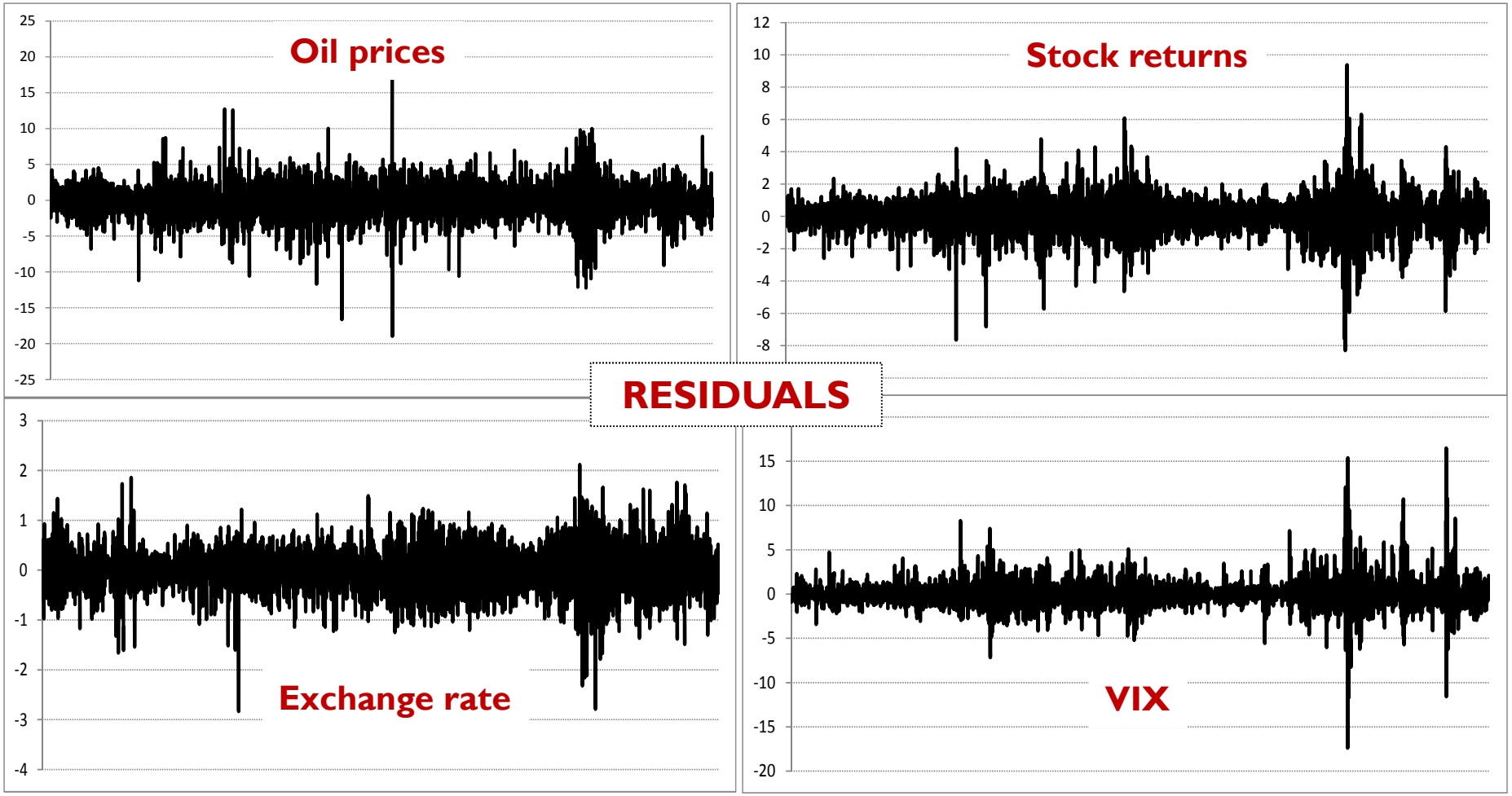
However, A cannot be estimated without additional **restrictions**. Typically, these are…

- **Zero restrictions**
- **Sign restrictions** …but none of these can be justified

⇨ **Identification through HETEROSKEDASTICITY**

Identification through heteroskedasticity

Intuition: use information from **heteroskedasticity** in data



Identification through heteroskedasticity

Outline of method:

Consider a structural VAR (I) and its reduced form (II):

(I) $AY_t = c + \Pi_1 Y_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim (0, \Sigma),\ \Sigma\ diagonal$

(II) $Y_t = \tilde{c} + \widetilde{\Pi_1} Y_{t-1} + u_t \qquad u_t = A^{-1}\varepsilon_t$

Estimate $var(u_t) = \Omega$ and use $\boldsymbol{\Omega = A^{-1}\Sigma A^{-1\prime}}$ to decompose $\widehat{\Omega}$ into contemporaneous coefficients $\hat{A}$ and structural shock variances $\hat{\Sigma}$.

Since there are more unknowns than equations, this requires additional restrictions.

Identification through heteroskedasticity

Outline of method:

If the data allow us to define distinct volatility regimes

$$u_{t,i} \sim iid(0, \Omega_i)\,, \qquad i = 1, \ldots, s$$

we get more moment conditions

$$\Omega_i = A^{-1} \Sigma_i A^{-1\prime}, \qquad i = 1, \ldots, s$$

This enables us to estimate the parameters of A without restrictions.

Two maintained assumptions:

- Orthogonality of structural shocks
- Contemporaneous impact matrix is stable (cfr. GARCH models)

Estimation procedure

Determination of the heteroskedastic regimes:

- Based on reduced form shock variability
- Provides the additional moment conditions needed to estimate structural model

Estimation:

- Daily data (sampled at NY close): nominal effective USD, nominal WTI spot oil price, US short-term interest rates, stock prices, VIX and CFTC open interest NYMEX oil futures market (interpolated)
- 7 Jan 2003 – 19 October 2012
- Two lags and endogenous variables in first differences
- Bootstrap techniques for significance

Empirical results: Summary

- **Multi-directional causal links** between oil prices, exchange rates and other asset prices

(direct effects)

- Link often reinforced **indirectly via third asset markets**

(overall effects)

- **Stock market shocks** and **risk shocks** important drivers of oil prices and exchange rates

(variance decomposition)

- **Financialisation** may have contributed in explaining some part of the increased co-movement between oil prices and exchange rates

(historical decomposition)

Empirical results: Overview

1. **Overall effects:** allow all transmission channels to work
2. **Direct effects:** direct causality, keeping other variables constant
3. **Variance decomposition:** importance of the shocks
4. **Historical decomposition:** explain correlation over time

Empirical results: OVERALL EFFECTS

Oil prices and exchange rates

ENDOGENOUS VARIABLES	STRUCTURAL SHOCKS					
	Oil price	Exchange rate	Stock returns	Interest rate	VIX	Open interest
Oil price	0.947***	**-0.866*** **	**0.695***	1.462	**-0.423*** **	**1.388** **
Exchange rate	**-0.024*** **	0.967***	**-0.159*** **	0.895	**0.076*** **	-0.106
Stock returns	-0.020	0.204	0.872***	**-2.783***	**-0.484*** **	-0.021
Interest rates	**-0.002***	-0.007	**0.046***	0.503***	0.023	-0.007
VIX	0.056	0.168	**-0.752***	-1.890	1.076***	-0.049
Open interest	**-0.029***	0.007	0.002	-0.234	-0.004	0.960***

***, ** and * denote significance at the 1%, 5% and 10% levels.

Empirical results: OVERALL EFFECTS

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- 10% increase in oil leads to 0.24% USD depreciation

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Empirical results: OVERALL EFFECTS

Oil prices and exchange rates ⇨ **causality runs in both directions!**

- 10% increase in oil leads to 0.24% USD depreciation
- 1% USD depreciation leads to 0.86% increase in oil prices

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Empirical results: OVERALL EFFECTS

Oil prices, exchange rates and other asset prices

- **Stock market shocks**

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- **Risk and risk aversion shocks (VIX)**

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- **Shocks open interest NYMEX (financialisation)**

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Empirical results: OVERALL EFFECTS

Almost all shocks could drive the negative correlation!

Opposite effect on oil and exchange rates

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Empirical results: DIRECT EFFECTS

Direct causality oil prices and other asset prices

- Effect between exchange rate and oil is a direct causal effect

ENDOGENOUS VARIABLES	STRUCTURAL SHOCKS					
	Oil price	Exchange rate	Stock returns	Interest rate	VIX	Open interest
Oil price	I	**-0.834*** **	0.099	**4.173***	**-0.373****	**1.369****
Exchange rate	**-0.028****	I	**-0.224****	0.400	-0.050	-0.074
Stock returns	-0.017	0.203	I	**-7.071****	**-0.322*****	-0.045
Interest rates	-0.006	-0.048	**0.111***	I	0.072	0.001
VIX	**0.033****	0.256	**-0.473****	**-6.984**	I	-0.134
Open interest	-0.031	-0.029	0.032	-0.134	0.003	I

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Empirical results: DIRECT EFFECTS

Difference in strength transmission: direct vs. overall effects

- No direct effect stock market shock on oil; via other assets

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- Direct effects are often weaker (importance indirect channels!)

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Empirical results

In sum:

Oil prices reacts to other asset prices:

hints at role of oil prices as financial asset

(responds immediately to information captured in other assets)

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In this light, **Kilian and Vega (2011): oil is not as asset price** as it does **not respond to macro news**, whereas other asset prices do.

Empirical results

Evaluate the relevance of macro economic news:

MACROECONOMIC NEWS	Exchange rates	Oil prices
Fed surprise	**4.8***	-6.2
Real GDP, Advance	0.3	-0.7
CPI	0.2	-0.3
Industrial production	**0.1***	-0.3
Total Nonfarm payroll	**0.5*****	0.7
Retail Sales	0.0	-0.0
Unemployment Rate	**-1.7*****	4.6
Consumer Confidence	0.1	-0.7
Housing Starts	0.1	-0.4
Purchasing Managers Index	0.1	0.8
PPI	-0.1	0.2
Trade Balance	**0.6***	-0.3
Average Weekly Hours	-0.3	-0.3
F-test of joint significance	**2.8*****	0.9

Confirm findings of Kilian and Vega (2011).

Nevertheless, oil prices immediately reflect information captured in other asset prices.

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Empirical results: VARIANCE DECOMP.

Weighted average over different volatility regimes (1 day horizon)

	Contribution of STRUCTURAL SHOCKS						
ENDOGENOUS VARIABLES		Oil price	Exchange rate	Stock returns	Interest rate	VIX	Open interest
	Oil price	79.5	3.1	5.7	0.3	4.5	6.9
	Exchange rate	1.3	84	7.4	2.7	3.7	0.9
	Stock returns	0.3	1.3	58.3	6.9	33.2	0.0
	Interest rates	0.9	0.3	34.7	47.6	16.1	0.3
	VIX	1.2	0.5	21.1	1.6	75.6	0.0
	Open interest	2.9	0.0	0.0	0.3	0.0	96.7

Empirical results: VARIANCE DECOMP.

Weighted average over different volatility regimes

- **Oil prices**: **21%** is explained by other shocks

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=21%

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Weighted average over different volatility regimes

- **Oil prices**: **21%** is explained by other shocks
- **Exchange rate** shock contribution is **limited**

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Empirical results: VARIANCE DECOMP.

Instead,

- **Stock market shocks** and **risk shocks** are important drivers

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ENDOGENOUS VARIABLES		Oil price	Exchange rate	Stock returns	Interest rate	VIX	Open interest
	Oil price	79.5	3.1	5.7	0.3	4.5	6.9
	Exchange rate	1.3	84	7.4	2.7	3.7	0.9
	Stock returns	0.3	1.3	58.3	6.9	33.2	0.0
	Interest rates	0.9	0.3	34.7	47.6	16.1	0.3
	VIX	1.2	0.5	21.1	1.6	75.6	0.0
	Open interest	2.9	0.0	0.0	0.3	0.0	96.7

=10%

=11%

Empirical results: VARIANCE DECOMP.

Instead,

- **Stock market shocks** and **risk shocks** are important drivers
- Contribution rises considerably in **high volatility periods** (fin. crisis)

Contribution of STRUCTURAL SHOCKS

ENDOGENOUS VARIABLES	Oil price	Exchange rate	Stock returns	Interest rate	VIX	Open interest
Oil price	76.3	1.9	(5.7) 9.5	0.6	(4.5) 8.9	3.0
Exchange rate	1.4	68.9	(7.4) 14.6	6.2	(3.7) 8.5	0.5
Stock returns	0.1	0.4	52.0	7.1	40.5	0.0
Interest rates	0.4	0.1	30.9	49.5	19.1	0.1
VIX	0.4	0.1	15.9	1.3	82.3	0.0
Open interest	4.8	0.0	0.0	1.0	0.1	94.2

=18%

=23%

Empirical results: Overview

1. **Overall effects:** allow all transmission channels to work
2. **Direct effects:** direct causality, keeping other variables constant
3. **Variance decomposition:** importance of the shocks
4. **Historical decomposition:** explain correlation over time

Empirical results: HISTORICAL DECOMP.

What explains the correlation between oil and exchange rates over time?

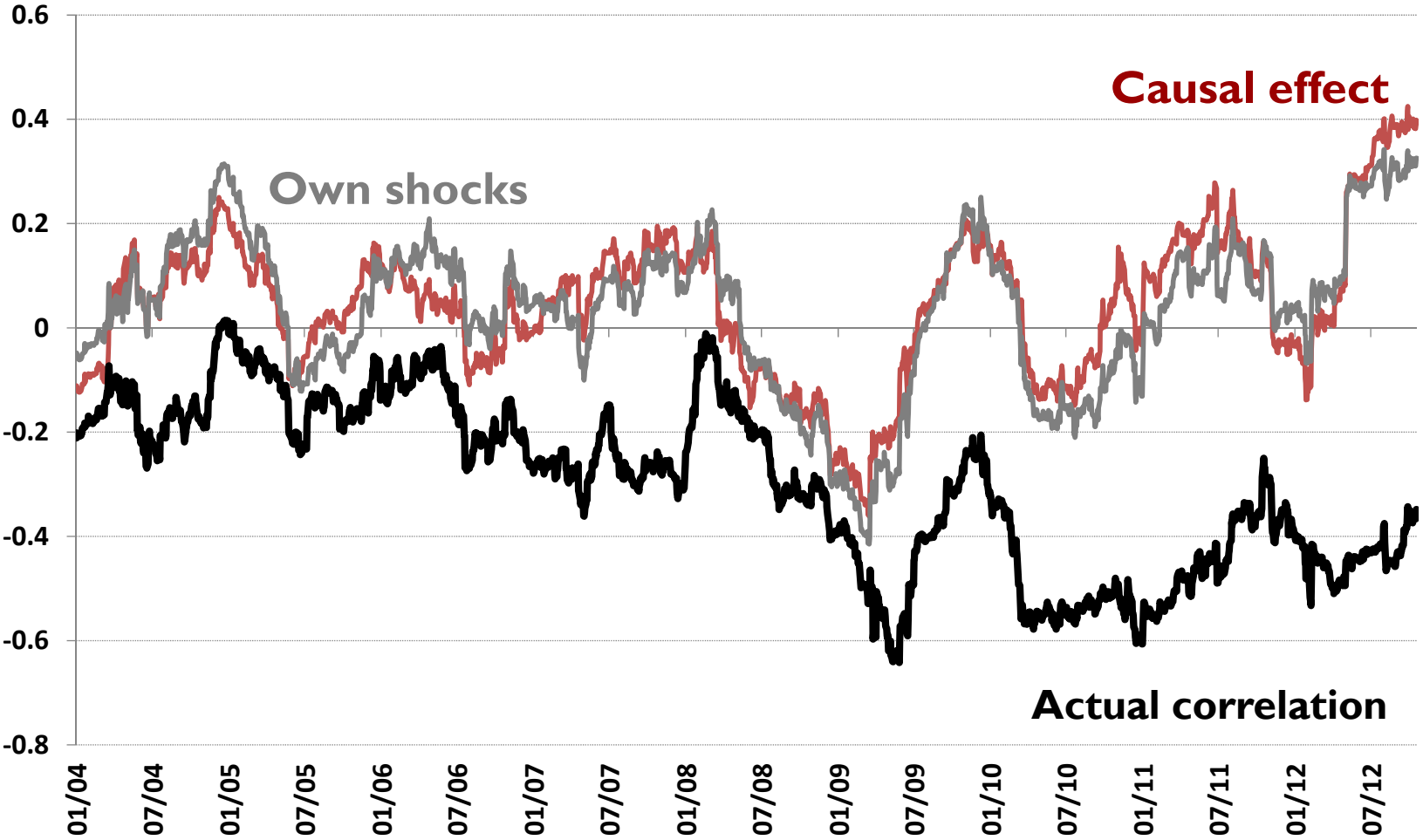
⇨ Generate **implied correlations** based on historical contributions and compare with observed correlation

FINDINGS: explain <u>both</u> dynamics and strengthening

- **Dynamics** in correlation: oil shocks, exchange rate shocks and use of oil futures markets
- **Strengthening** of the correlation **over time**: risk shocks and financialisation

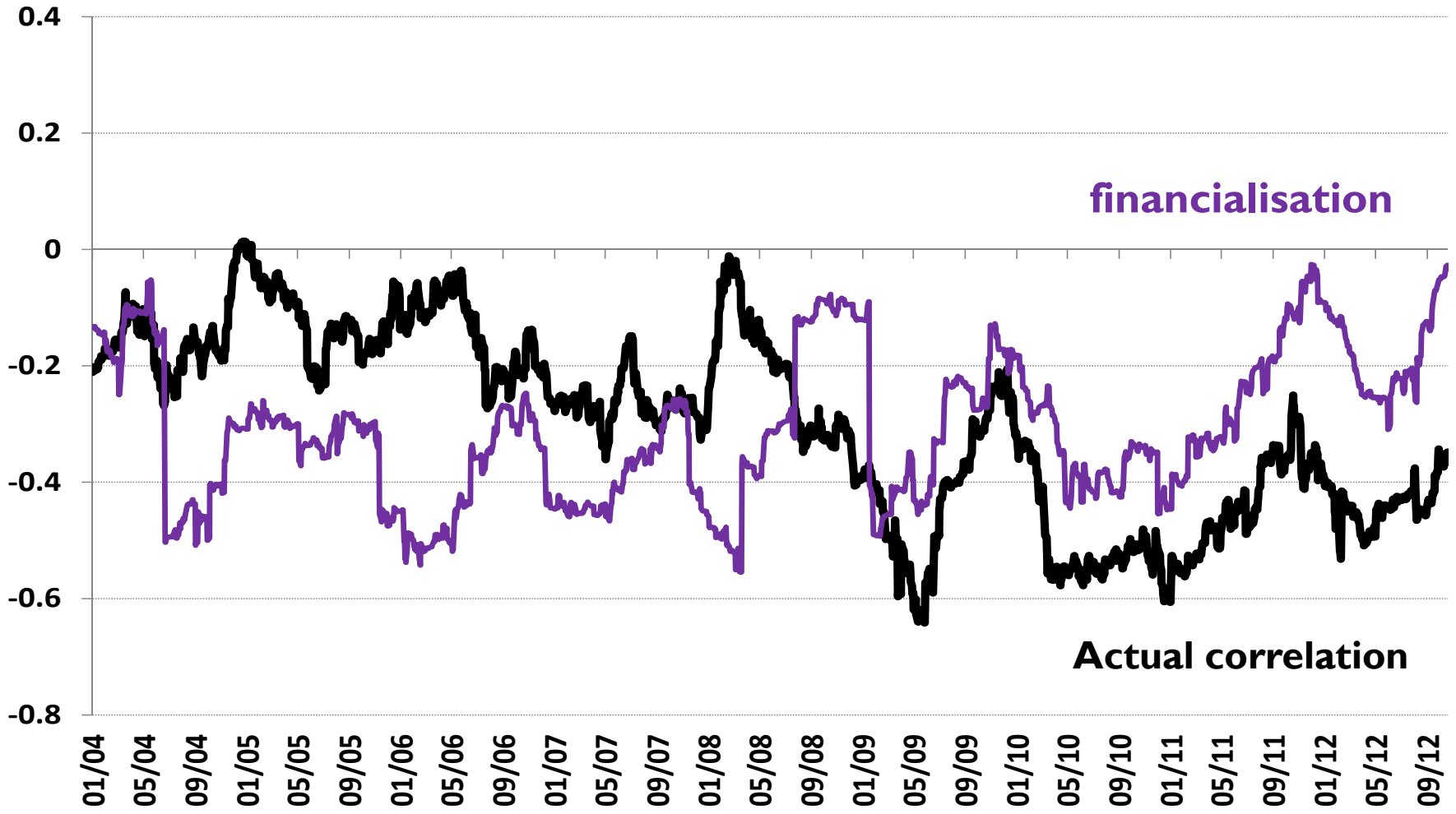
Empirical results: HISTORICAL DECOMP.

Dynamics correlation: oil and exchange rate shocks



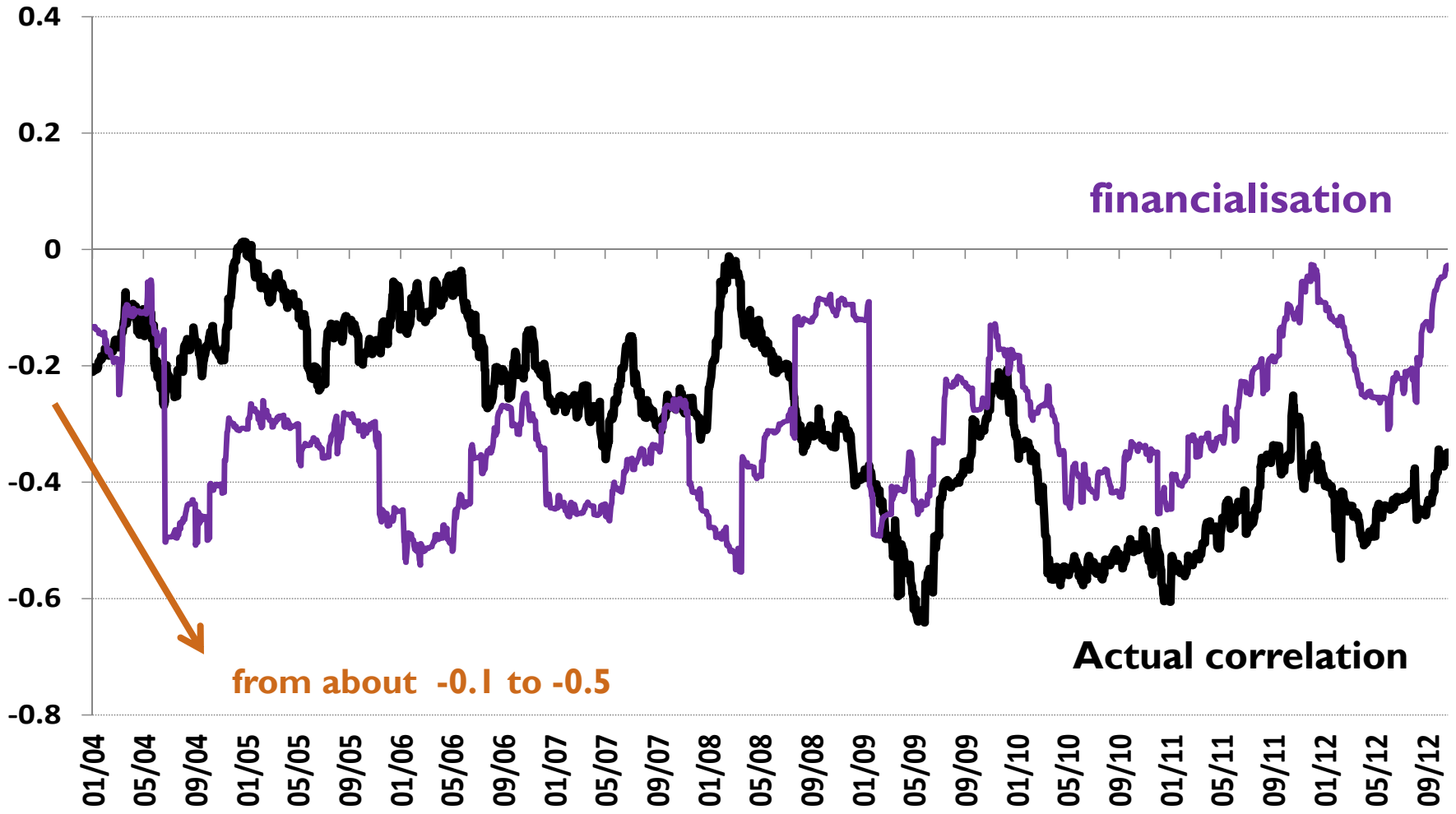
Empirical results: HISTORICAL DECOMP.

Dynamics correlation: NYMEX open interest shock



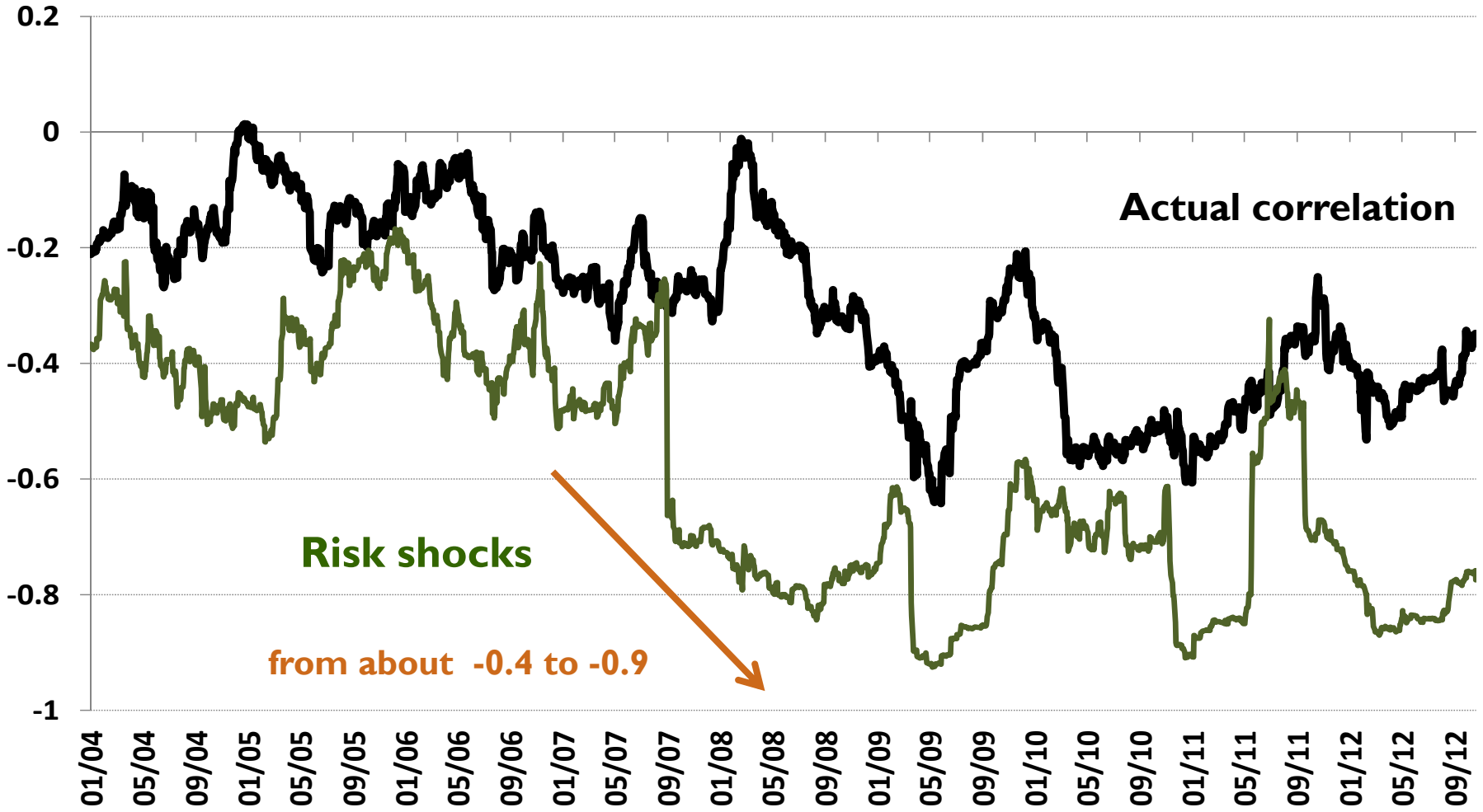
Empirical results: HISTORICAL DECOMP.

Strengthening correlation: NYMEX open interest shock



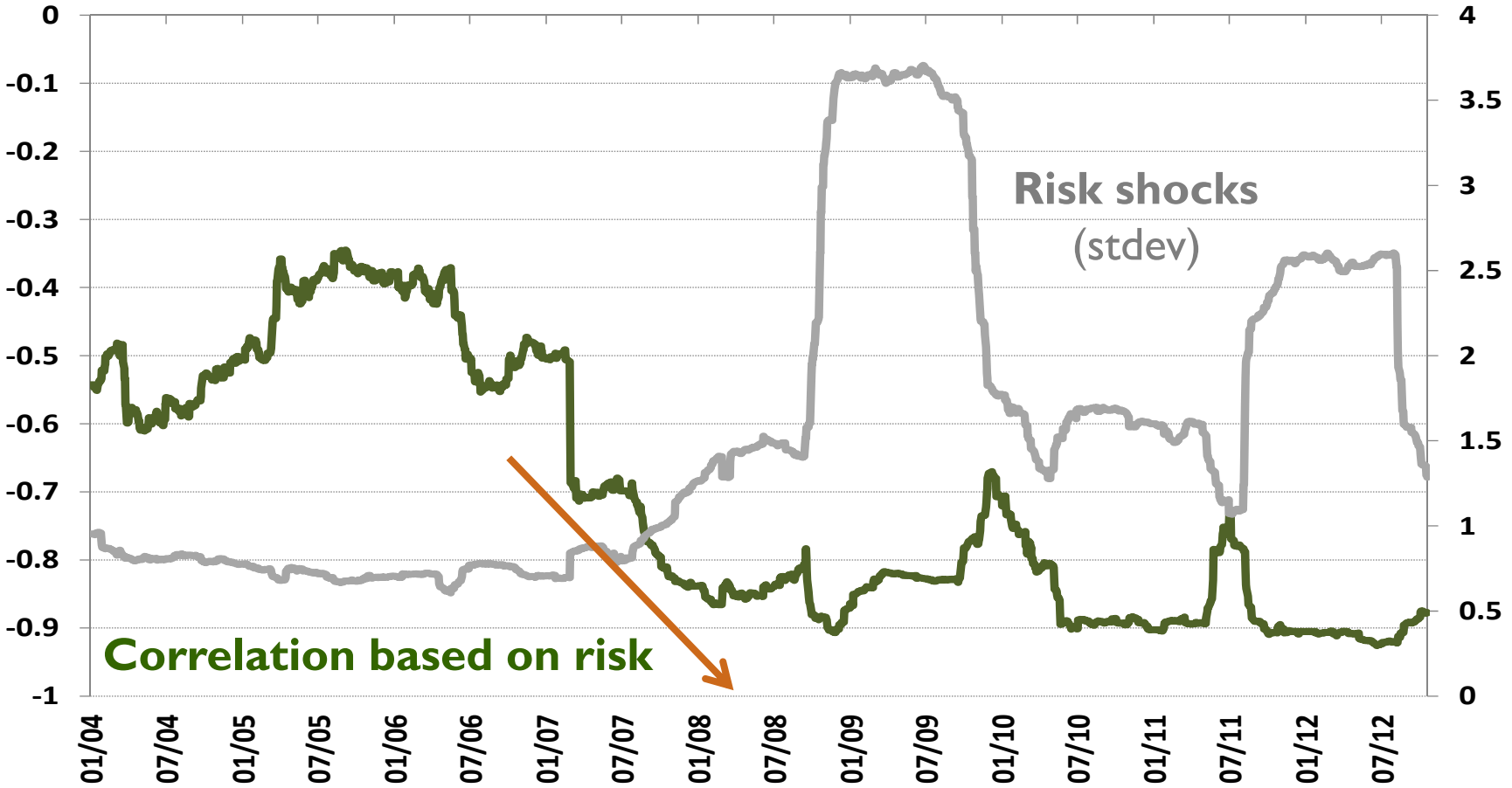
Empirical results: HISTORICAL DECOMP.

Strengthening correlation: mainly risk shocks



Empirical results: HISTORICAL DECOMP.

Strengthening correlation: **increased importance risk shocks**



Conclusions

- By using appropriate identification techniques to analyse multi-directional link between oil prices and asset prices: **oil reacts to other asset prices**
- Link between oil and other asset prices **often** reinforced **via third asset markets**
- **Shocks to stock returns and risk** explain non-negligible part of oil prices and exchange rate variability, in **high volatile periods** in particular (financial crisis)
- Evidence that **increased use** of oil as **financial asset** has **intensified co-movement of oil with other asset prices** (exchange rates), together with risk shocks which became more relevant over time