Comovement and the Financialization of Commodities

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Commodity Markets and their Financialization
IPAM May 6, 2015

Commodities generated uncorrelated returns

- Commodity markets were partly segmented from outside financial markets and from each other.

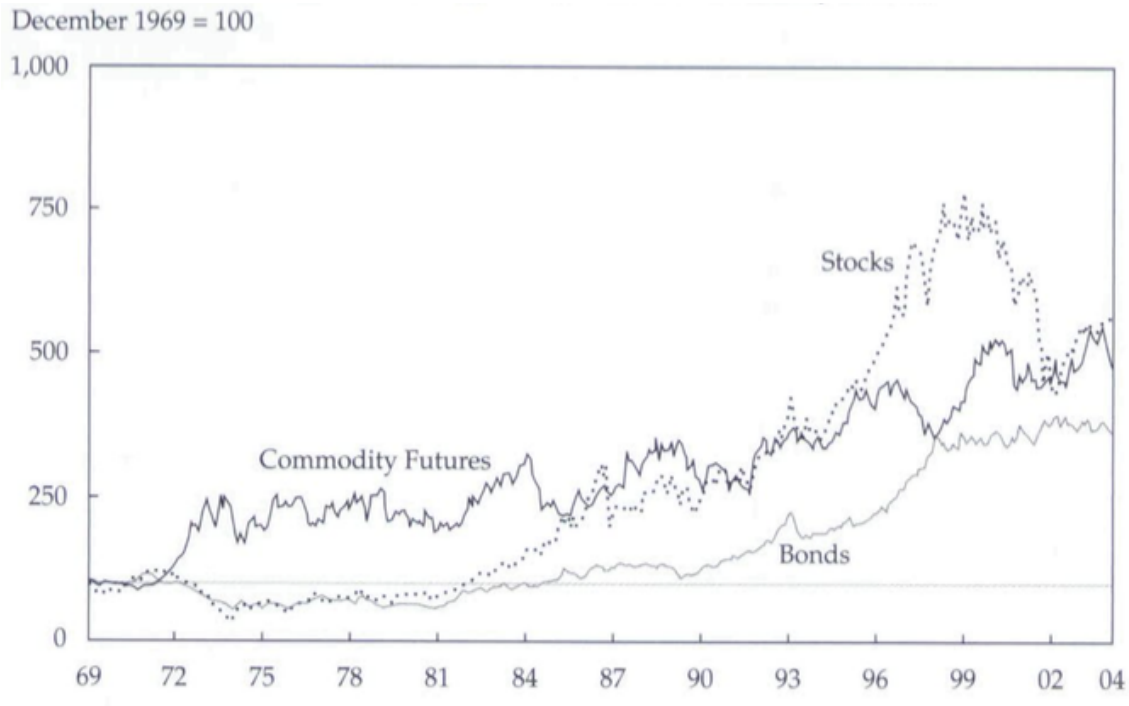


Abbildung: Inflation-Adjusted Performance of Commodities in the UK December 1969-December 2004. Gorton and Rouwenhorst (2006).

Why investing in the commodity markets?

- Hedging strategies (lock-in future prices);
- Commodities as a method of diversification
  - commodities had low positive return correlation with each other;
  - commodities had negligible correlations with other financial markets.

Holding Period	Stocks	Bonds	Inflation
Monthly	0.05	−0.14*	0.01
Quarterly	−0.06	−0.27*	0.14
One year	−0.10	−0.30*	0.29*
Five years	−0.42*	−0.25*	0.45*

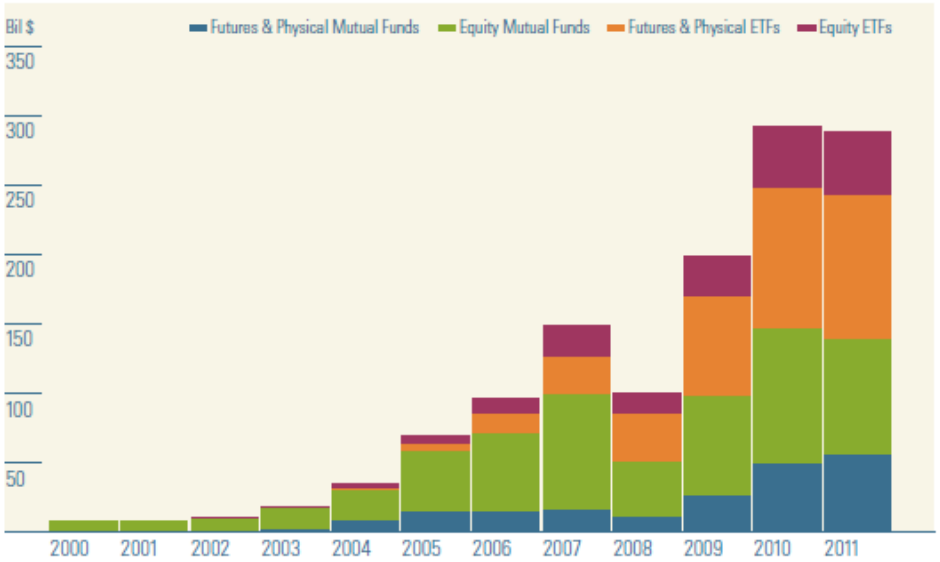
Note: Overlapping return data.

Abbildung: Correlations of commodity futures returns with stocks, bonds, and inflation, July 1959-December 2004. Gorton and Rouwenhorst (2006).

Commodities, the new asset class

- Since the early 2000s, commodity futures have emerged as a popular asset class.

Exhibit 1 Total Assets in Commodity Mutual Funds and Exchange-Traded Funds (U.S.): Commodity-related investment offerings have experienced rapid growth over the past decade.

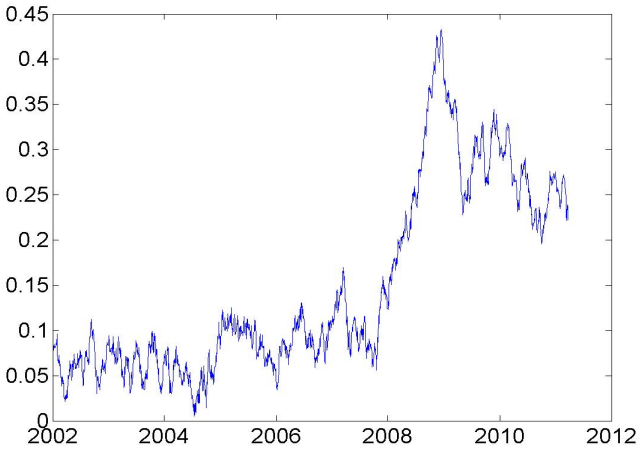


- The increasing presence of investors allocating money in commodities (derivatives) initiated the so called process of 'financialization' of commodities markets.

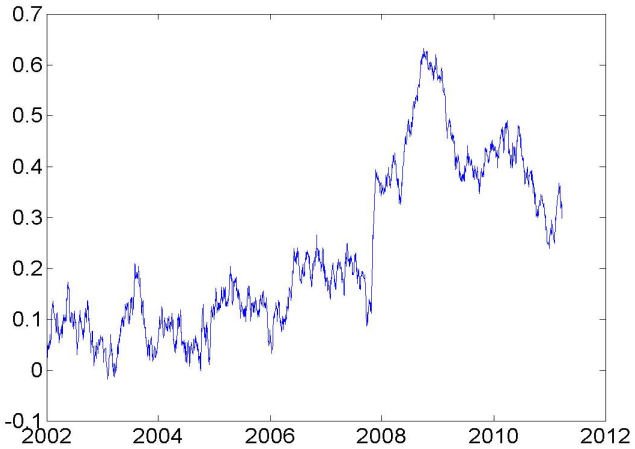
Emerging of new patterns

- After 2004 we observe an increase in price co-movements within commodities.
- Correlations of oil and grains.

Corn



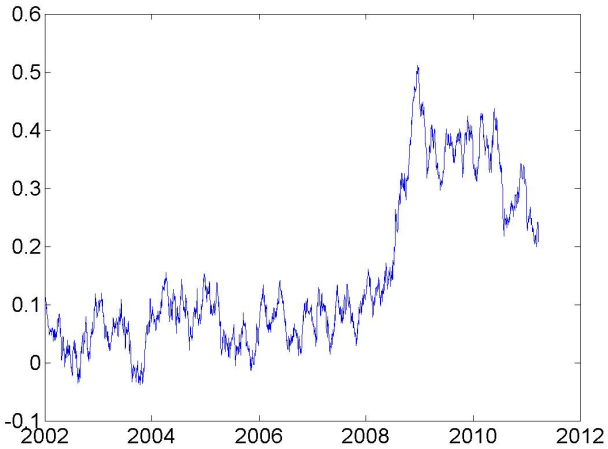
Soy Beans



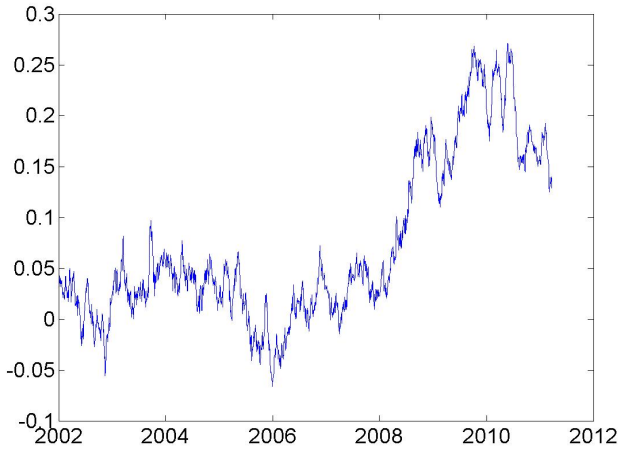
Emerging of new patterns

- Correlations of oil and soft.

Coffee



Cocoa



The paper in a nutshell - 1

- We test differences in price (co)movement building on the theory of co-movement by Barberis et. al. (2005).
- We exploit the difference between indexed and off-index commodities considering 25 commodities – attempt to complement the work by Tang and Xiong (2012).
- We consider three indexes: S&P GS CI, DJ-UBS CI (heavy energy) and Thomson Reuters CI (equally weighted components).
- We provide new evidence in support of the commodity financialization view.

The paper in a nutshell - 2

- Using high-frequency data, we compute realized variance and evaluate changes in return volatility and correlation between indexed and off-index commodities.
- We provide new evidence in support of the price volatility spillover effect.

Theory of co-movement

- Availability of commodity index funds and commodity ETF facilitate participation and trading of commodities (new asset *class*).
- Changes in funds allocation can cause commodities in the fund/index to move together (Barberis and Shleifer (2003)).
- One would expect price co-movements of commodities in the index to be greater than those of off-index commodities.
- Barberis et al. (2005) found that stock's listing can significantly increase the return correlation of that stock with the index.

Index inclusion and exclusion

- Barberis et al (2005) investigate wether the addition to the S&P 500 (index) leads to a shift in the correlation structure of returns.
  - After inclusion: S&P beta should increase and the non-S&P (rest of the world) beta should decrease.
  - After exclusion: S&P beta should decrease and the non-S&P (rest of the world) beta should increase.
  - Changes in co-movement should be stronger in more recent data.

Alternative view of co-movement drivers

- Traditional theory: co-movement in prices reflects co-movement in fundamental values.
- Co-movement in prices is delinked from fundamentals when:
  - Category view: investors group assets in categories and allocated funds at category level rather then at individual asset level.
  - Habitat view: Traders choose to trade only a subset of all available asset.

Our approach

- Motivated by Barberis et al. (2005) and Tang and Xiong (2012), we test this theory of co-movement.
- An increase in price co-movement between indexed commodities and the index indicates the existence of a category/habitat view.
- When investigating the commodity financialization 'process', the choice of 2005 as the breakpoint is innocuous.
- Monthly, weekly, daily and high-frequency data allow construction of reliable measure of changes in return co-movement.

Reduced-from model of co-movement

- $2n$ commodities grouped into two categories, X and Y.
- Funds are allocated at the level of these categories.
- Let $\Delta P_{i,t} := P_{i,t} - P_{i,t-1}$ represent the return.
- A representation of commodity returns is:

$$\begin{aligned} \Delta P_{i,t} &= \epsilon_{i,t} + \Delta u_{X,t}, \quad i \in X, \\ \Delta P_{j,t} &= \epsilon_{j,t} + \Delta u_{Y,t}, \quad j \in Y \end{aligned}$$

where

$$\begin{pmatrix} u_{X,t} \\ u_{Y,t} \end{pmatrix} \sim N\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \sigma_u^2 \begin{pmatrix} 1 & \rho_u \\ \rho_u & 1 \end{pmatrix} \right)$$

and

$$\epsilon_t = (\epsilon_{1,t}, \ldots, \epsilon_{2n,t})' \sim N(0, \Sigma), \text{i.i.d. over time}$$

Testable predictions

Prediction 1

Suppose that the commodity j, previously a member of Y, is reclassified into X. Then the plim of the OLS estimate of $\beta_{j,X}$ in the regression

$$\Delta P_{j,t} = \alpha_j + \beta_j \Delta P_{X,t} + \nu_{j,t}, \tag{1}$$

as well as the plim of the R^2 of this regression, increases after reclassification.

- The presence of commodity j in category X increases the covariance of its return with the return on the category, $\Delta P_{X,t}$, and its beta loading on that return.

Testable predictions

Prediction 2

Suppose that the commodity j, previously a member of Y, is reclassified into X. Then the plim of the OLS estimate of $\beta_{j,X}$ in the regression

$$\Delta P_{j,t} = \alpha_j + \beta_{j,X}\Delta P_{X,t} + \beta_{j,Y}\Delta P_{Y,t} + \nu_{j,t} \qquad (2)$$

rises after reclassification while the plim of the OLS estimate $\beta_{j,Y}$ falls.

- $\Delta P_{X,t}$ in Equation (1) is not a 'clean' measure of the sensitivity to $\Delta u_{X,t}$.
- A substantial part of variation comes from news ϵ_t; $\Delta P_{Y,t}$ controls for such news.

Data

	Commodity	Exchange	GSCI	DJ-UBS	Th. Reu
Energy	WTI crude oil	NYMEX	40.6	15	5.88
	Heating Oil	NYMEX	5.3	4.5	5.88
	RBOB	NYMEX	4.5	4.1	-
	Natural Gas	NYMEX	7.6	16	5.88
Grains	Corn	CME	3.6	6.9	5.88
	Soy beans	CME	0.9	7.4	5.88
	Chicago wheat	CME	3.7	3.4	5.88
	Kansas wheat^c	KCTB	0.7	-	-
	Soybean oil	CME	-	2.9	5.88
	Minn. wheat	MGE	-	-	-
	Soybean meal	CME	-	-	-
	Rough rice	CME	-	-	-
	Oats	CME	-	-	-
Softs	Coffee	ICE	0.5	2.7	5.88
	Cotton	ICE	0.7	2.2	5.88
	Sugar	ICE	2.1	2.8	5.88
	Cocoa	ICE	0.2	-	5.88
	Lumber	CME	-	-	-
	Orange Juice	ICE	-	-	-

Data (cont'd)

	Commodity	Exchange	GSCI	DJ-UBS	Th. Reu
Livestock	Feeder cattle	CME	0.3	-	-
	Lean hogs	CME	0.8	2.5	5.88
	Live cattle	CME	1.6	4.1	5.88
	Pork bellies	CME	-	-	-
Metals	Gold	NYMEX	1.5	6.1	5.88
	Silver	NYMEX	0.2	2.4	5.88
	Copper	NYMEX	2.6	6.7	5.88
	Platinum	NYMEX	-	-	5.88
	Palladium	NYMEX	-	-	-

Data description

- We consider 25 commodities (US traded) - except Kansas wheat, Minn. wheat, Palladium.
- Futures contracts rolled over before expiry to the next available contract.
- Sample data spanning the period 9, April 1998 to 24, March 2011 $\longrightarrow$ 3,222 trading day.
- We have 1-minute frequency and consider only overlapping trading hours – from 10:30 to 14:00 NYT.
- Soybean meal, Rough Rice, Oats (Grains), Lumber and Orange Juice (Softs) and Pork Bellies (Livestock) are off-index commodities.

Estimation results - univariate regression

- We estimate the change in βs before and after January 2005 (daily, weekly and monthly).
- We test Prediction 1 for every commodity (vs. mean of βs and vs. pooled βs).
- Statistically significant increase in co-movement between indexed non-energy commodities and heavy-energy indexes.
- Statistically significant increase in co-movement between indexed non-energy commodities and equally weighted index.
- No significant increase in co-movement between off-index non-energy commodities and equally weighted index.

Univariate regression

	S&P GSCI		UBS-DJ CI		Th. Reuters CI	
Commodity	$\Delta\beta$	ΔR^2	$\Delta\beta$	ΔR^2	$\Delta\beta$	ΔR^2
WTI crude oil	-0.27	0.10	0.07	0.20	0.12	0.28
Heating Oil	-0.25	0.01	-0.35	0.11	-0.13	0.24
RBOB un. gas	-0.06	0.01	-0.12**	0.11	-0.21	0.18
Natural Gas	-0.13	0.00	-0.64	-0.01	-0.45	0.02
Corn	0.52	0.15	0.54	0.19	0.39	0.21
Soy beans	0.55	0.21	0.57	0.26	0.37	0.29
Chicago wheat	0.46	0.11	0.46	0.14	0.36	0.16
Soybean oil	0.67	0.31	0.65	0.37	0.53	0.39
Soybean meal	0.42	0.12	0.36	0.17	0.12*	0.17
Rough rice	0.16	0.03	0.16	0.04	0.07	0.05
Oats	0.37	0.09	0.30	0.11	0.02	0.11
Coffee	0.36	0.08	0.43	0.11	0.29	0.16
Cotton	0.37	0.10	0.39	0.12	0.43	0.17
Sugar	0.49	0.10	0.55	0.13	0.52	0.16
Cocoa	0.32	0.08	0.35	0.1	0.31	0.14
Lumber	0.12**	0.01**	0.12**	0.01*	0.11	0.02**
Orange Juice	0.13*	0.01**	0.12**	0.02**	0.09	0.02*

Univariate regression

	S&P GSCI		UBS-DJ CI		Th. Reuters CI	
Commodity	$\Delta\beta$	ΔR^2	$\Delta\beta$	ΔR^2	$\Delta\beta$	ΔR^2
Feeder cattle	0.10	0.03	0.06**	0.02	0.01	0.02
Lean hogs	0.07	0.01	0.01	0.01	-0.10	0.01
Live cattle	0.14	0.05	0.12	0.05	0.12	0.07
Pork bellies	0.04	0.00	-0.03	0.00	-0.28	-0.01
Gold	0.26	0.13	0.27	0.14	0.22	0.19
Silver	0.59	0.19	0.63	0.21	0.63	0.24
Copper	0.73	0.25	0.80	0.25	0.86	0.31
Platinum	0.38	0.16	0.39	0.20	0.40	0.26

Tabelle: $*$ and $**$ denote positive significant difference from zero at 10% and 5% level in two-sided test. Dark grey cell negative and significant at the 10%; light grey cell denote difference is not significant at the 10%. Rest significant at 1% level.

Univariate regression (only oil for energy)

	S&P GSCI		UBS-DJ CI		Th. Reuters CI	
Commodity	$\Delta\beta$	ΔR^2	$\Delta\beta$	ΔR^2	$\Delta\beta$	ΔR^2
WTI crude oil	3.40	25%	1.59	29%	1.03	30%
Corn	0.68	16%	0.61	22%	0.29	19%
Soya beans	0.70	22%	0.62	30%	0.22	26%
Chicago wheat	0.61	12%	0.44	16%	0.30	16%
Soybean oil	0.84	32%	0.66	41%	0.38	35%
Soybean meal	0.54	13%	0.10	17%	-0.07	15%
Rough rice	0.20	3%	0.09	5%	0.00	5%
Oats	0.46	9%	0.00	11%	-0.19	10%
Coffee	0.44	8%	0.48	13%	0.15	15%
Cotton	0.50	11%	0.59	17%	0.49	19%
Sugar	0.63	10%	0.79	15%	0.55	15%
Cocoa	0.42	8%	0.45	13%	0.29	14%
Lumber	0.18**	1%**	0.22	2%	0.14	2%
Orange Juice	0.17**	1%**	0.19	2%	0.11	2%

Univariate regression (only oil for energy)

	S&P GSCI		UBS-DJ CI		Th. Reuters CI	
Commodity	$\Delta\beta$	ΔR^2	$\Delta\beta$	ΔR^2	$\Delta\beta$	ΔR^2
Feeder cattle	0.13	3%	0.08	2%	0.00	1%
Lean hogs	0.10	1%	-0.12	1%	-0.17	1%
Live cattle	0.19	5%	0.20	7%	0.15	7%
Pork bellies	0.06	0%	-0.22	0%	-0.45	-2%
Gold	0.34	14%	0.33	17%	0.21	19%
Silver	0.76	20%	0.83	25%	0.66	24%
Copper	0.94	26%	1.27	31%	0.94	31%
Platinum	0.50	18%	0.52	26%	0.42	27%

Tabelle: $*$ and $**$ denote positive significant difference from zero at 10% and 5% level in two-sided test. Dark grey cell negative and significant at the 10%; light grey cell denote difference is not significant at the 10%. Rest significant at 1% level.

Bivariate regression

- We estimate daily change in βs before and after January 2005 considering index and off-index returns as explanatory variables.
- Statistically significant increase in co-movement between indexed non-energy commodities and index.
- No significant increase in co-movement between off-index commodities and index and off-index.
- Co-movement between indexed non-energy commodities and off-index increases with heavy-energy indexes
- ... and does not increase with equally weighted index $\longrightarrow$ misspecification issue?

Bivariate regression

	S&P GSCI		UBS-DJ CI		Th. Reuters CI	
Commodity	$\Delta\beta'^{ind}$	$\Delta\beta'^{off}$	$\Delta\beta'^{ind}$	$\Delta\beta'^{off}$	$\Delta\beta'^{ind}$	$\Delta\beta'^{off}$
WTI crude oil	-0.44	0.40	-0.07	0.46	0.24	-0.21
Heating Oil	-0.24	0.07	-0.36	0.22	-0.06	-0.12
RBOB un. gas	-0.05	0.12	-0.12	0.22	-0.32	0.29
Natural Gas	-0.12	-0.17	-0.53	-0.14	-0.30	-0.23
Corn	0.18	0.22	0.29	0.20	0.33	0.09
Soya beans	0.20	0.11	0.31	0.16	0.32	0.07
Chicago wheat	0.16	0.26	0.25	0.22	0.33	0.05
Soybean oil	0.50	0.10	0.51	0.04	0.47	0.10
Soybean meal	0.21	0.07	0.27	0.04	0.13	-0.02
Rough rice	0.05	0.02	0.09	0.01	0.11	-0.05
Oats	0.15	0.08	0.19	0.05	-0.05	0.14
Coffee	0.21	0.23	0.29	0.16	0.22	0.13
Cotton	0.17	0.31	0.21	0.34	0.38	0.09
Sugar	0.36	0.24	0.43	0.22	0.48	0.06
Cocoa	0.21	0.13	0.31	0.03	0.43	-0.21
Lumber	0.04	0.13	0.05	0.08	0.07	0.06
Orange Juice	0.06	0.13	0.08	0.07	0.05	0.07

Bivariate regression

	S&P GSCI		UBS-DJ CI		Th. Reuters CI	
Commodity	$\Delta\beta'^{ind}$	$\Delta\beta'^{off}$	$\Delta\beta'^{ind}$	$\Delta\beta'^{off}$	$\Delta\beta'^{ind}$	$\Delta\beta'^{off}$
Feeder cattle	0.10	-0.02	0.06	-0.01	-0.01	0.03
Lean hogs	0.02	-0.39	0.02	-0.49	0.23	-0.60
Live cattle	0.08	0.09	0.04	0.09	0.10	0.04
Pork bellies	-0.01	-0.02	-0.07	-0.02	-0.32	0.06
Gold	0.17	0.14	0.19	0.14	0.28	-0.11
Silver	0.37	0.41	0.42	0.42	0.64	-0.02
Copper	0.54	0.38	0.61	0.40	0.80	0.11
Platinum	0.28	0.19	0.30	0.19	0.38	0.03

Tabelle: $*$ and $**$ denote positive significant difference from zero at 10% and 5% level in two-sided test. Dark grey cell negative and significant at the 10%; light grey cell denote difference is not significant at the 10%. Rest significant at 1% level.

Characteristic and demand effects

- Alternative explanation: indexed commodities cover larger commodity production.
- We attempt to address this competing explanation with a 'matching' exercise using soy beans (index), soybean oil (index) and soybean meal (off-index).
- Soybean meal is a solid residue by-product, flour, created after grinding the soybean to extract soybean oil.
- We observed that Soybean meal exhibits much smaller shifts in betas than indexed soy beans and soybean oil.

Non-trading effects

- Indexed commodities are highly liquid and frequently traded (vs. off-index).
- Results might have some spurious upward bias due to non-trading effects.
- We investigate trading activity of each commodity pre and post 2005 and test the non-trading hypothesis.
- We use the number of trades per day (up and down ticks) as a proxy for trading activity (10:30 - 14:00 time interval).
- Grains, for example, show a decrease in trading activity but indexed grain experienced an increase in co-movement and off-index grains do not co-move with the index.

Directions of trading activity after 2005

Grains	Corn	↘
	Soya beans	↘
	Chicago wheat	↘
	Soybean oil	↘
	Soybean meal	↘
	Rough rice	↘
	Oats	↘
Softs	Coffee	↗
	Cotton	↗
	Sugar	↗
	Cocoa	↗
	Lumber	↘
	Orange Juice	↗
Energy	WTI crude oil	↗
	Heating Oil	↗
	RBOB unleaded gas	↗
	Natural Gas	↗
Livestock	Feeder cattle	↘
	Lean hogs	↘
	Live cattle	↘
	Pork bellies	↘
Metals	Gold	↗
	Silver	↗
	Copper	↗
	Platinum	↗

Where ↘ indicates decrease and ↗ indicates increase.

Volatility spillover in commodity markets

- We investigates the change in risk transmission in commodity markets using intra-day prices.

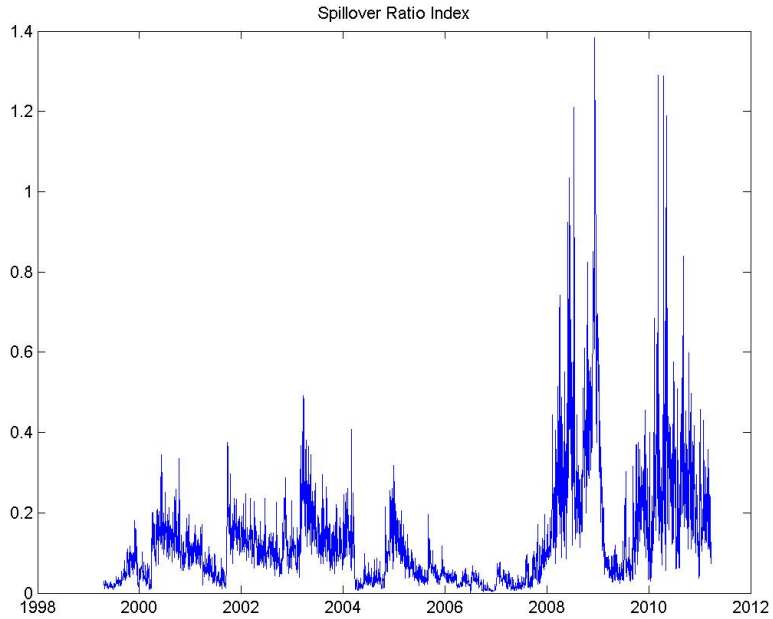


Abbildung: Volatility spillover in the energy commodity group.

Wishart Autoregressive model

- Volatility spillover is measured using a multivariate realized volatility model, the Wishart Autoregressive model (WAR).
- Y_t follows a Wishart process when the expected value of Y_{t+1} is given by:

$$E_t\left(Y_{t+1}\right) = MY_tM' + K\Sigma.$$

where for the case of (2x2)

$$M = \begin{pmatrix} m_{11} & m_{12} \\ m_{21} & m_{22} \end{pmatrix}$$

and M takes care of the spillover effect.

Spillover ratio

- The conditional variance of asset 1 can be written as

$$E_{t-1}[Y_{11,t}] = a_1 Y_{11,t-1} + b_1 Y_{12,t-1} + c_1 Y_{22,t-1} + d_1.$$

  where b_1 and c_1 capture the covariance spillover and volatility spillover.

- The volatility spillover ratio is:

$$SR_{2,1,t} = \frac{c_1 Y_{22,t-1}}{a_1 Y_{11,t-1} + b_1 Y_{12,t-1} + c_1 Y_{22,t-1} + d_1}$$

- The covariance spillover ratio is:

$$SR_{12,1,t} = \frac{b_1 Y_{12,t-1}}{a_1 Y_{11,t-1} + b_1 Y_{12,t-1} + c_1 Y_{22,t-1} + d_1}$$

Spillover ratio

- Let define the Spillover Ratio Index as

$$SRI_t = \frac{\sum_{j=1,i=1,1\neq j}^{N} SR_{ij,t}}{N(N-1)}$$

	Spillover Ratio		
Sector	Pre	Post	Δ
Energy	0.10	0.17	**0.07**
Grains	0.05	0.05	0.00
Softs	0.01	0.02	0.00
Livestock	0.05	0.03	**-0.02**
Precious Metals	0.03	0.05	**0.02**
Oil with Agricultural	0.01	0.02	**0.00**

Tabelle: 'Pre' and 'Post' indicate before of after the end of 2005, respectively. Δ column denotes the difference in spillover. Bold numbers indicate that the difference is significant at 1% confidence level

Conclusions

- Building on the theory of co-movement by Barberis et. al. (2005), we test the alternative theory of price co-movment.
- We test differences in price (co)movement and provide new evidence in support of the commodity financialization view.
- We extend the analysis by computing the so-called realized betas and obtaining corroborating results.

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