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**Feeding the Planet and Greening Agriculture:
Challenges and opportunities for the bio-economy**

**THE IMPACT OF COMMODITY DERIVATIVES
IN AGRICULTURAL FUTURES MARKETS**

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Background

- In recent years, agricultural markets have experienced a high volatility with prices that boost in a very quick and strong way and drop with the same rapidity and intensity.
- The boom and bust of 2008 agricultural commodities' prices has been investigated by researchers, market analysts and policy makers without reaching a common interpretation of such a dynamic and a unique explanation of the main determinant.
- Despite the researches on demand and supply determinants of the spikes, other authors disputed the role of market speculation as the cause of market bubbles.
- The analysis has been addressed to understand the relation between the price dynamics and the trend of the financial activity that much increases its participation in commodity future markets, the index funds.

Objectives

- Test whether the investing activity in the future market of different traders categories can be identified as a source of the increasing agricultural commodity prices.
- The analysis is carried out by adopting the approach proposed by Irwin and Sanders (2010) adding some relevant innovations and extension:
 - A more extended price time series;
 - A procedure to check outliers inside the dataset;
 - The standardization of each variable included in the model;
 - A test of the inverse relationships, considering the market factors as causal variables;
 - Estimation of the causality with and without the independent variable at contemporaneous time.

Data

The price behavior is described through three major indicators, the market factors:

1) Returns of nearby future prices

The returns are calculated on the series of the nearby future prices as the weekly average of the five daily returns, transformed with natural logarithms

2) Realized volatility

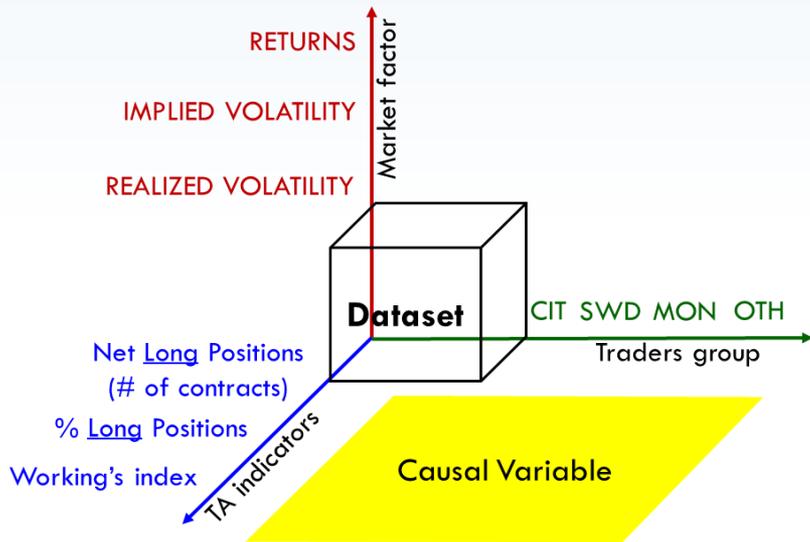
The realized volatility is computed as the standard deviation of the last 20 first differences of natural logarithm on the nearby time series, annualized (factor $\sqrt{240}$).

3) Implied volatility

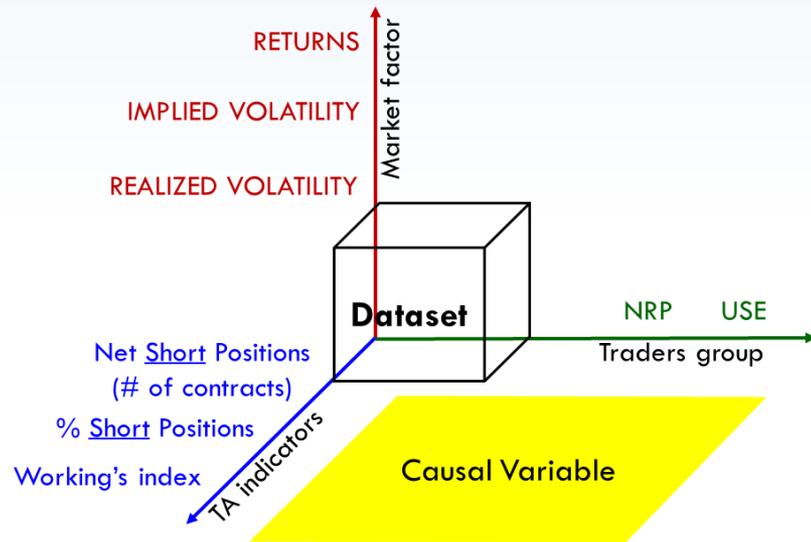
The implied volatility is provided by Thompson-Reuters® online service which calculates the implied volatility “at the money” interpolated, distinguishing between put and call options.

Data

The **weekly** dataset are organized with respect to three dimensions: market factors, traders group and trading activity (TA) indicators.



Dataset structure for **Net Long positions**



Dataset structure for **Net Short positions**

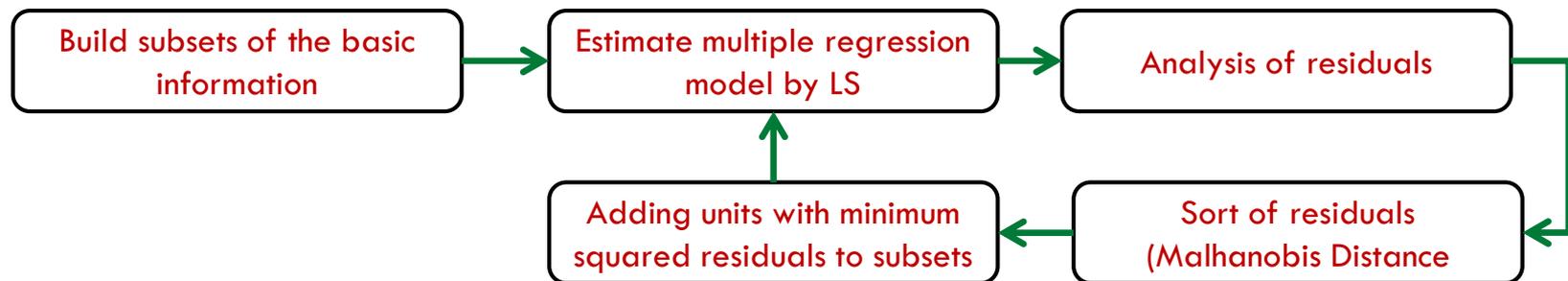
Commodities

The commodities considered in the analysis are the same of those proposed by Irwin and Sanders (2010). More specifically:

No.	Abbreviation	Commodity	Market	Weekly data	Daily data
1	AN	Cocoa	NYBT	20.6.06 - 25.2.14	3.1.95 - 27.2.14
2	CC	Corn	CBOT	20.6.06 - 25.2.14	3.1.95 - 27.2.14
3	DK	HRW Wheat	KCBT	20.6.06 - 25.2.14	3.1.95 - 27.2.14
4	EC	Feeder Cattle	CME	20.6.06 - 25.2.14	3.1.95 - 27.2.14
5	GC	Lean Hogs	CME	20.6.06 - 25.2.14	3.1.95 - 27.2.14
6	HN	Coffee	NYBT	20.6.06 - 25.2.14	3.1.95 - 27.2.14
7	LC	Live Cattle	CME	20.6.06 - 25.2.14	3.1.95 - 27.2.14
8	NN	Cotton	NYBT	20.6.06 - 25.2.14	3.1.95 - 27.2.14
9	OC	Soybean Oil	CBOT	20.6.06 - 25.2.14	3.1.95 - 27.2.14
10	SC	Soybeans	CBOT	20.6.06 - 25.2.14	3.1.95 - 27.2.14
11	WC	SRW Wheat	CBOT	20.6.06 - 25.2.14	3.1.95 - 27.2.14
12	ZN	Sugar	NYBT	20.6.06 - 25.2.14	3.1.95 - 27.2.14

Data pre-treatment

- Each time series has been submitted to an outlier check using an innovative robust method proposed by Riani et al. (2007) aiming to identify outliers using a **Forward Search (FS)** based on a multivariate testing.
- The procedure has the objective **to avoid masking (false negative) and swamping (false positive) problems in the outlier detection.**
- The FS technique identifies the outliers according to a procedure based on the estimation market by market of a multiple regression model and detecting them through the deletion residual analysis



All the variables has been standardized to have the coefficients not affected by the data level and comparable among commodities.

Causality Evaluation Strategy

- We have tested the causality of the trading activity indicators in respect to market factors using the Granger's approach. Each market was analysed considering two time series as the linear causality technique requires. For the time t and the commodity k :

$$y_{t,k} = \alpha_k + \sum_{i=1}^4 \gamma_{i,k} y_{t-i,k} + \sum_{i=1}^4 \beta_{i,k} x_{t-i,k} + \varepsilon_{t,k}$$

The diagram illustrates the components of the regression equation with green arrows indicating relationships:

- Market factor** (top left) points up to $y_{t,k}$.
- Intercept** (bottom left) points down to α_k .
- Market factor coefficient** (top middle) points up to $\gamma_{i,k}$.
- Lagged Market factor** (bottom middle) points down to $y_{t-i,k}$.
- Causal coefficient** (top right) points up to $\beta_{i,k}$.
- Causal variable** (bottom right) points down to $x_{t-i,k}$.
- Residuals** (top far right) points up to $\varepsilon_{t,k}$.

The term $\sum_{i=1}^4 \beta_{i,k} x_{t-i,k}$ is highlighted in a yellow box.

- Following the Irwin and Sanders' proposal, in order to increase the power of the causality test, we estimated the k markets as a system of Seemingly Unrelated Regression (SUR).

Causality Evaluation Strategy

SUR system for evaluating causality

$$\begin{array}{rclclcl} y_{t,1} & = & \alpha_1 & + & \sum_{i=1}^4 \gamma_{i,1} y_{t-i,1} & + & \sum_{i=1}^4 \beta_{i,1} x_{t-i,1} & + & \varepsilon_t \\ y_{t,2} & = & \alpha_2 & + & \sum_{i=1}^4 \gamma_{i,2} y_{t-i,2} & + & \sum_{i=1}^4 \beta_{i,2} x_{t-i,2} & + & \varepsilon_t \\ y_{t,3} & = & \alpha_3 & + & \sum_{i=1}^4 \gamma_{i,3} y_{t-i,3} & + & \sum_{i=1}^4 \beta_{i,3} x_{t-i,3} & + & \varepsilon_t \\ \vdots & & & & \vdots & & \vdots & & \vdots \\ y_{t,12} & = & \alpha_{12} & + & \sum_{i=1}^4 \gamma_{i,12} y_{t-i,12} & + & \sum_{i=1}^4 \beta_{i,12} x_{t-i,12} & + & \varepsilon_t \end{array}$$

We assume that in the market there is an erratic force that affects all the commodities prices in the same way (correlation between market equation residuals)

Causality Evaluation Strategy

- SUR models are tested considering:

With and without Contemporaneity variables

Non contemporaneous equation

$$y_{t,1} = \alpha_1 + \gamma_{t-1,1}y_{t-1,1} + \dots + \gamma_{t-4,1}y_{t-4,1} + \beta_{t-1,1}x_{t-1,k} + \dots + \beta_{t-4,1}x_{t-4,k} + \varepsilon_t$$

Contemporaneous equation

$$y_{t,1} = \alpha_1 + \gamma_{t-1,1}y_{t-1,1} + \dots + \gamma_{t-4,1}y_{t-4,1} + \beta_{t,1}x_{t,k} + \beta_{t-1,1}x_{t-1,k} + \dots + \beta_{t-4,1}x_{t-4,k} + \varepsilon_t$$

- The coefficients of the lagged causal variables are cleaned from the influence of the independent series at time t .
- This last model provides an ex-post analysis of the degree of causality between the series.

Causality Evaluation Strategy

- SUR models are tested considering:

Causal variables as independent and dependent variables

Market factors = f(lagged **Market factors**, lagged **Causal variables**)



Causal variables = f(lagged **Causal variables**, lagged **Market factors**)

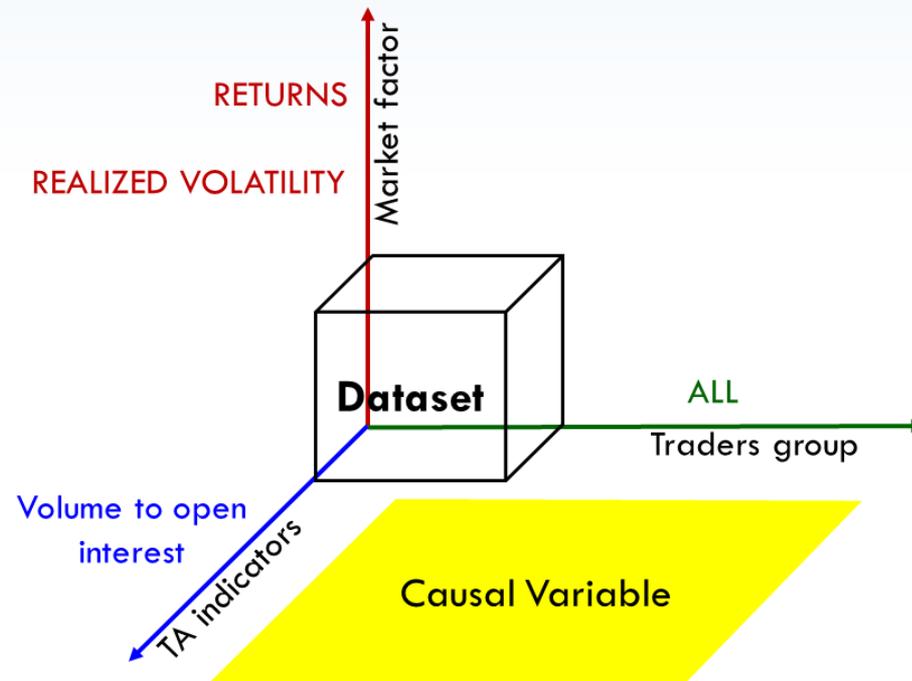
- Two types of models have been estimated: the **primary model** with the market factor as dependent variable and the **reverse model** with the causal variable as dependent variable.
- The analysis is consistent with the Granger's theory that does not restrict the causality evaluation to only one direction of the relationship.

Main results

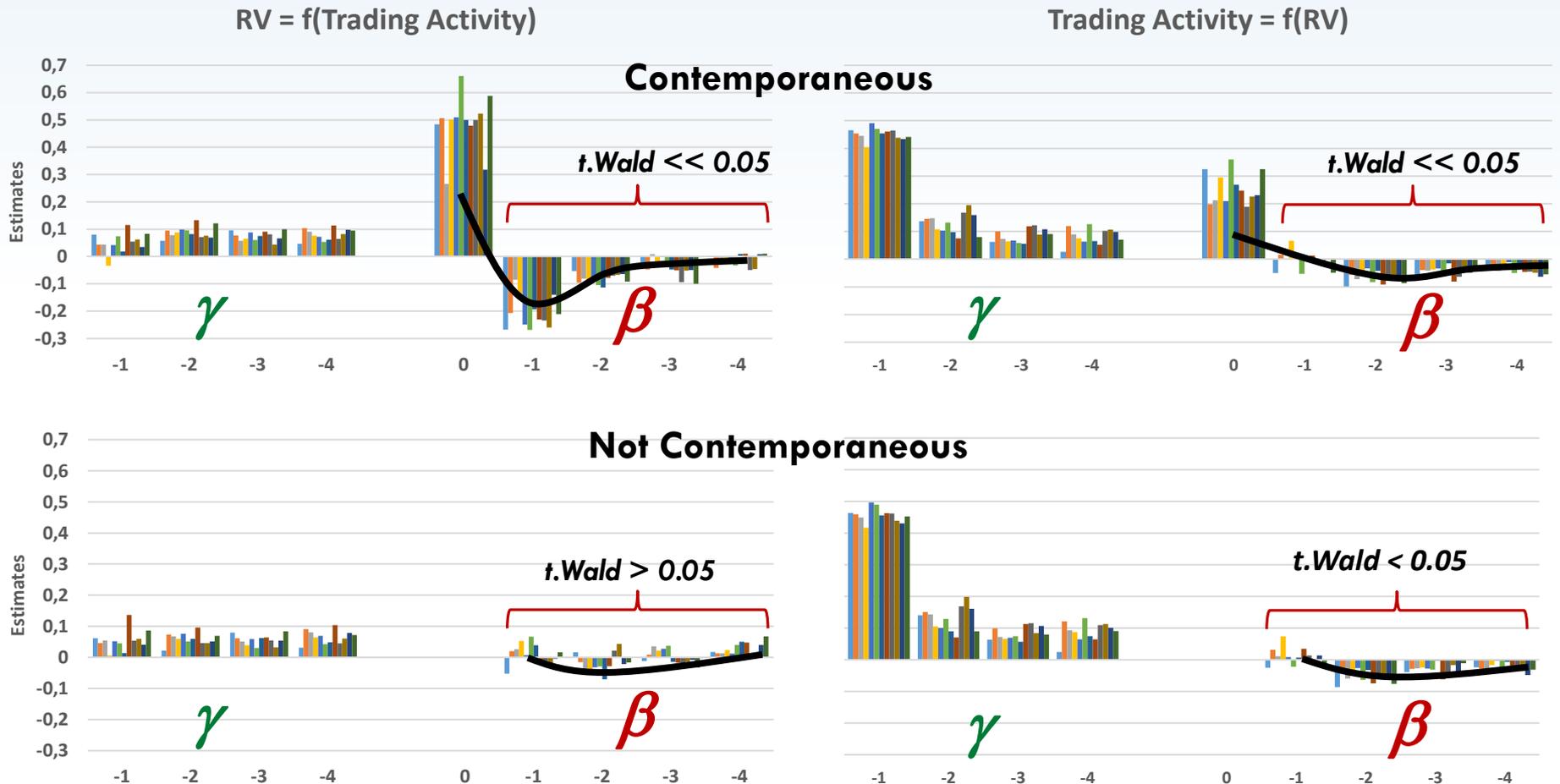
- The results achieved for all the **weekly series** widely confirm those achieved by Irwin and Sanders: **a substantial absence of causality interference of traders behaviour** on the dynamics of returns, realized and implied volatilities.
- Despite this results, the Lagrange multiplier statistics developed by Breusch and Pagan (1980) confirms that the SUR approach to model estimation is always the most adequate. **This highlights a significance correlation of the residuals along all the markets.**
- All the markets seem, thus, to react to exogenous information with a **clear homogeneity.**
- However, it is possible that the **weekly data provide a distorted information** about the real trading activity that is carried out on a daily basis.
- This is the reason for **we have tested the model using the only available daily information, that is the VOIR.**
- This analysis option does not allow to distinguish the data according to the trading groups.

Data

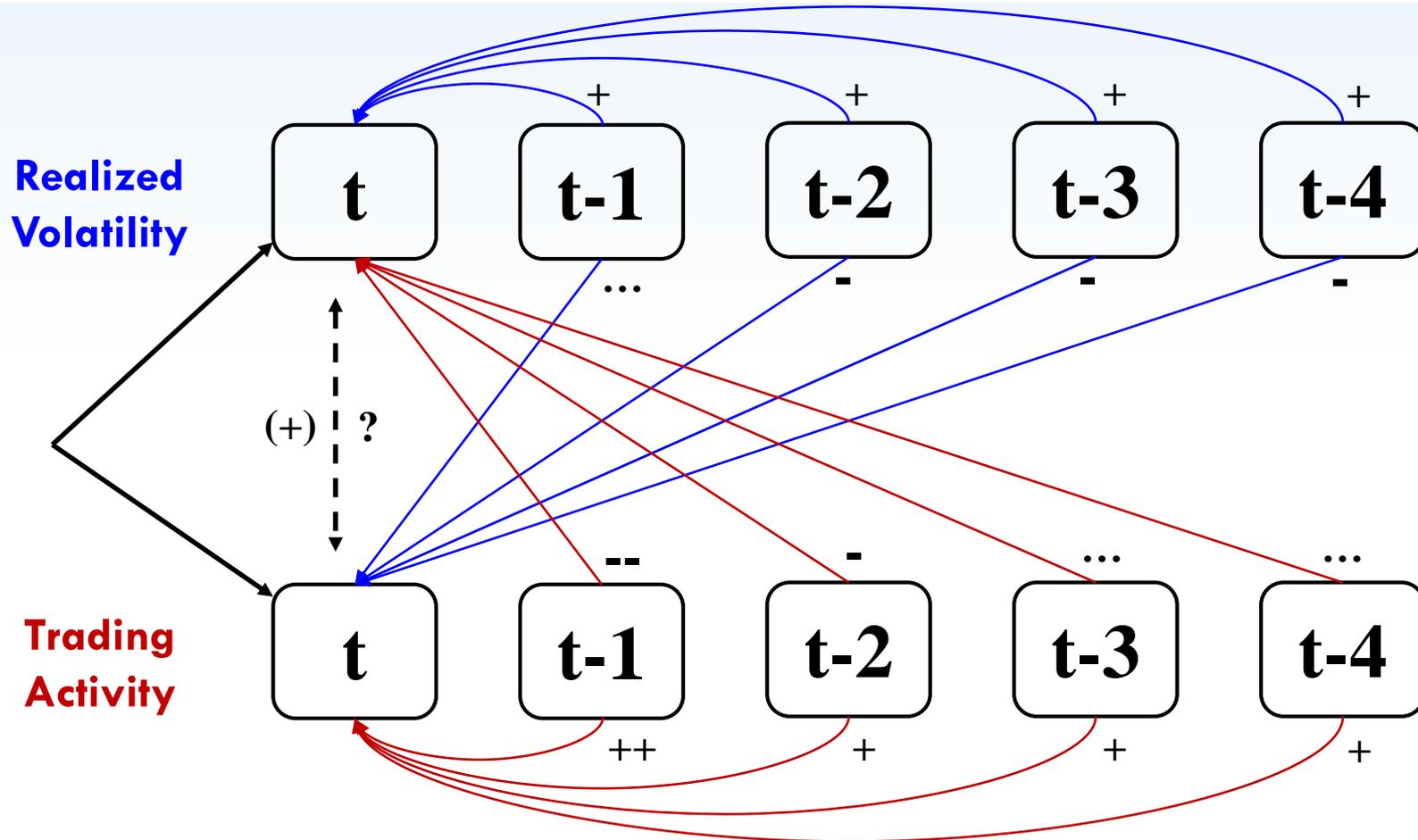
The relationships between market factors and the Volume to Open Interest (VOIR) has been estimated using **daily data**.



Main results – Daily VOIR analysis



Main results – Daily VOIR analysis



Conclusions

- The outcomes of the model based on weekly data reproduces the conclusion achieved by Sanders and Irwin, confirming that **there are any signal of causality inside the investigated markets.**
- **The SUR model is statistically adequate** to analyse the causality effect between trading activity and market factor dynamics.
- **The daily data include an important part of the information that might be not captured by the weekly data.**
- The use of contemporaneous independent variable allows to better interpret the relationships in an ex-post perspective.
- The homogeneity between coefficients due to preliminary standardisation shows **a common behaviour among the markets.**
- Finally, we cannot assert that it is likely a non-causality relationship between speculative activity and commodity prices, but **we can just suggest an in-depth analysis of the influence of the information frequency for evaluating causality in commodity futures markets.**