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The International Spillover Among Sectors and the Interconnectedness to the Global Inflation Cycle

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Abstract:

Purpose: *The main purpose of this article is to shed light on the inflation as catalyst for the production of any other crisis.*
Design/Methdology/Approach: *We are using the Spillover Index to detect the interconnectedness between sectors and inflation in the first step, at the second step we are detecting the cyclicity between the inflation, the commodities, and the financial cycle using the filters.*
Findings: *We provide empirical evidence suggesting that global inflation is subject to cyclicity of oil and in opposition to the cyclicity of gold as hedge fund for money as a substitute in case that the currencies are considered as fiat money.*
Practical implications: *Oil energy cyclicity has an important impact on managing the cyclicity of the global inflation cycle. Gold has an opposite fluctuation to the inflation cycle, suggesting that gold keeps its characteristics as a rely towards any further crisis on an era of cashless transactions.*
Originality/value: *Energy plays a role manager for the fluctuation of the global inflation, which might give a policy for the financialization of the energy system to guarantee more tight relation with the M2 in the system*

Keywords: *Inflation cycle, commodity, filters, spillover.*

JEL codes: *E31, E32, E37.*

Paper type: *Research article.*

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1. Introduction

The inflation is one of the major economic and monetary issues that face all the sectors with tight effect on their factors. The current health crisis has created a more prominent relation between the financial market and the economic system. The inflation cycle is a prominent economic studied issue among the economic issues as it interconnects the macro-economic aggregates directly and indirectly. The interconnection between market sectors shed the light on the inflation as catalyst for the prediction of any further crisis among the current time.

The inflation cycle faces an economic challenge towards any reframe, the sectors might face such as the capital market (Sato, Miyazaki, and Mawaribuchi, 2011), the commodities, (Saleuddin and Coffman, 2018), and the real sector in general. Studying the spillover effect between sectors it is already launched by Diebold and Yilmaz (2009; 2012; 2014). This paper examines the volatility spillover of the financial market among many other sectors and the co-influence between the inflation expectation and the volatility among the sectors of the global economic system during the period Q1 1984 to Q4 2020.

We use the VAR model for the spillover index to detect the interconnectedness between the selected sectors such as energy, the gold, the capital market, the health, the tourism and the investment. In the second part, we use the HP filter and the BAND Pass filter to decompose the cycle of inflation within the selected sectors.
Methodology

2. The International Spillover Calculation

We apply the generalized vector autoregressive (VAR) methodology, (Diebold and Yilmaz 2009; 2012; 2014), and the spillover index to measure the level of the contagious volatility between sectors with reference to the global inflation. As Diebold and Yilmaz (2012), we consider a covariance stationary $VAR(p)$ as:

$$y_t = \sum_{i=1}^{P} \Phi_i y_{t-i} + \varepsilon_t$$

y_t is an $n \times 1$ vector of endogenous variables, Φ_i are $n \times n$ autoregressive coefficient matrices, and ε_t is a vector of error terms assumed to be serially uncorrelated. VAR process is covariance stationary, a moving average representation can be written as $y_t = \sum_{j=0}^{\infty} Z_j \varepsilon_t$, where $n \times n$ coefficient matrices Z_j obey a recursion of the form

$$Z_j = \Phi_1 Z_{j-1} + \Phi_2 Z_{j-2} + \cdots + \Phi_p Z_{j-p}, \text{ with } Z_0 \text{ being } n \times n \text{ identity matrix}$$

and $Z_j = 0$ for $j < 0$.

Diebold and Yilmaz (2012) claimed that the net spillover indexes are generated from the generalized forecast-error variance decomposition of the moving average representation of the VAR model. The forecast error variance decomposition needs orthogonal innovations or shocks. The generalized VAR method, H-step ahead generalized forecast error variance decomposition is written as follows:

$$\Theta_{ij}(H) = \frac{\sigma_{jj}^{-1}\sum_{h=0}^{H-1}(\varepsilon' Z_h \sum \varepsilon_j)^2}{\sum_{h=0}^{H-1}(\varepsilon' Z_h \sum Z_h' \varepsilon_j)^2}$$

$\sum$ represents the variance matrix of vector of errors ε and σ_{jj}denotes the standard deviation of the error term of the j^{th} equation. The connectedness index is generated by n x matrix $\Theta(H) = \left[\Theta_{ij}(H)\right]$, where each entry provides the contribution of variable *j* to the forecast error variance of variable *i*. The spillover index for all markets is written as follows:

$$TC(H) = \frac{\sum_{i,j=1,i\neq j}^{n}\tilde{\Theta}_{ij}(H)}{\sum_{i,j=1}^{n}\tilde{\Theta}_{ij}(H)} \times 100 = \frac{\sum_{i,j=1,i\neq j}^{n}\tilde{\Theta}_{ij}(H)}{n} \times 100,$$

$\tilde{\Theta}_{ij}(H)$ is the normalized variance decomposition matrix written by its row sum as follow:

$$\tilde{\Theta}_{ij}(H) = \frac{\Theta_{ij}(H)}{\sum_{j=1}^{n}\Theta_{ij}(H)}.$$

The index, $TC(H)$, measures the total transmissions of shocks across all markets and assets.

The shocks from all other markets or assets j to a market or an asset I is the decomposition of the total connectedness into directional connectedness (DC) as follows:

$$DC_{i\leftarrow j}(H) = 2\frac{\sum_{j=1,i\neq j}^{n}\tilde{\Theta}_{ij}(H)}{\sum_{i,j=1}^{n}\tilde{\Theta}_{ij}(H)} \times 100 = \frac{\sum_{j=1,i\neq j}^{n}\tilde{\Theta}_{ij}(H)}{N} \times 100$$ and from a market

or an asset to all the markets or assets as follows:

$$DC_{i\rightarrow j}(H) = \frac{\sum_{j=1,i\neq j}^{n}\tilde{\Theta}_{ij}(H)}{\sum_{i,j=1}^{n}\tilde{\Theta}_{ij}(H)} \times 100 = \frac{\sum_{j=1,i\neq j}^{n}\tilde{\Theta}_{ij}(H)}{N} \times 100,$$

the net directional spillover is written as follows:

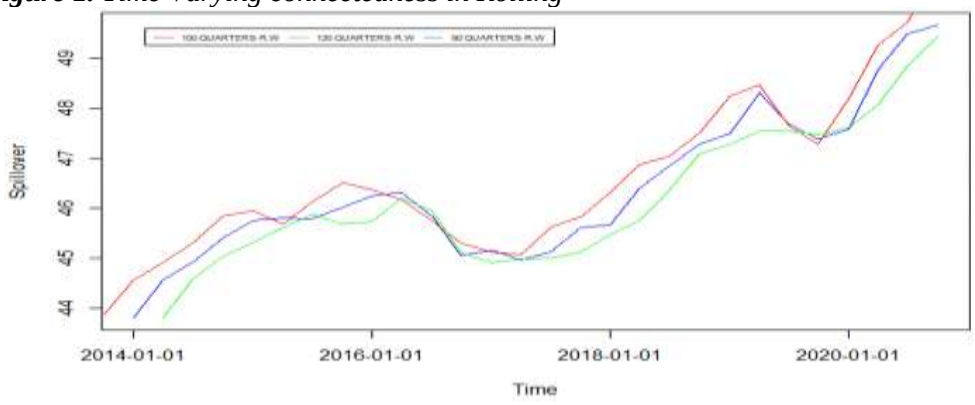
$NC(H) = DC_{i\rightarrow j}(H) - DC_{i\leftarrow j}(H)$, $NC(H)$ examine if the market is a net receiver or a net transmitter.

Table 1 shows that the total connectivity index is quite high (52.3 percent), implying a significant level of interconnectedness between the considered markets for the analyzed period. For instance, while financial assets (MSCIWORLD, FTSEWORLD, and SPGLOBAL) and investment sectors (WTT, WHC, and WIN) have a considerable influence on each other oil, gold, and inflation appear to be relatively immune to shocks in other assets other than energy, precious commodities and inflation (and vice versa). From the net spillover indices, we note that world inflation, price crude oil and gold are net receivers of volatility (-16.58%, -11.92% and -32.95%, respectively), suggesting that their volatilities are relatively more influenced by the volatilities of the other assets.

However, MSCIWORLD and FTSEWORLD as well as investment sectors (health sector, tourism sector and investment sector) are net volatility transmitters among themselves (24.53%, 25.67%, 9.35%, 16.75% and 2.28%, respectively). In other words, the aforementioned sectors transfer volatility externalities to other sectors, and the financial indices that transmit volatility interact with one another. We now estimate total time varying connection using multiple rolling window lengths (80, 100, and 120 quarters rolling windows) and a 10-day forecast horizon, as in Diebold and Yilmaz (2012).

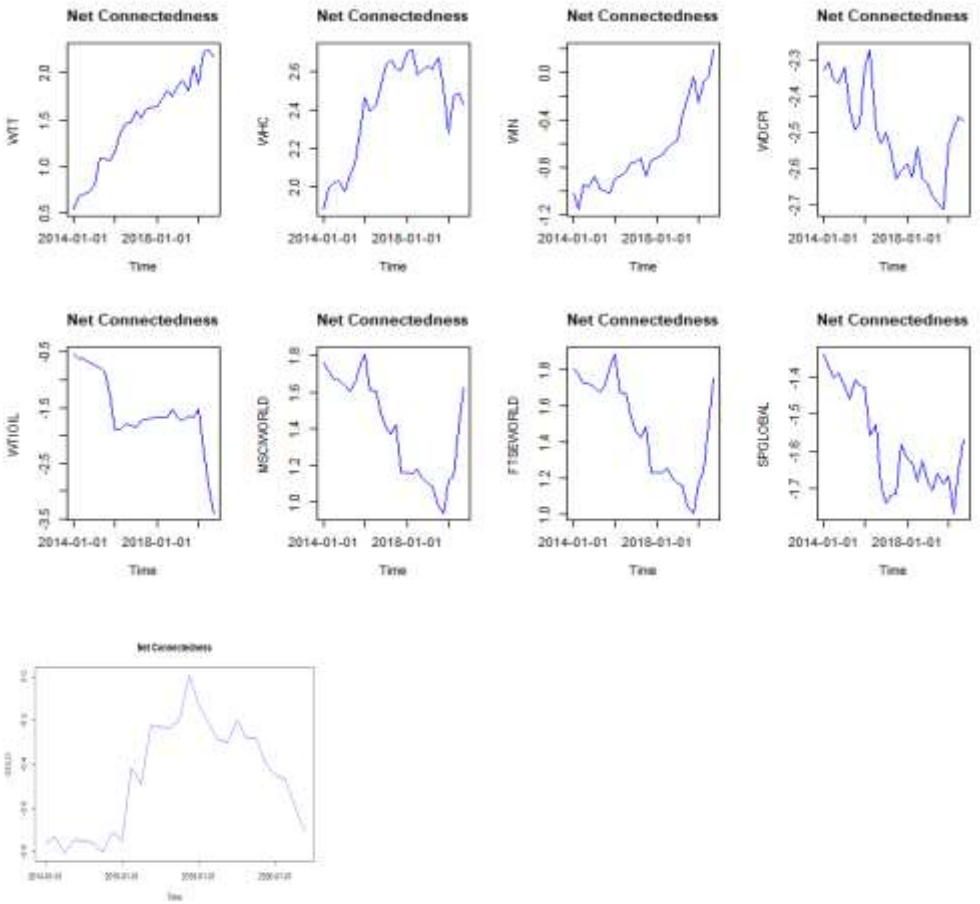
Figure 1 depicts the total connection index's evolution over time. Regardless of the length of the estimation-rolling window, a first global visual evaluation reveals that the time varying connection exhibits broadly similar temporal patterns. Figure 2 also depicts how market connection changes over time. During times of crisis, market connectedness becomes stronger, and during periods of calm, connectivity reduces to very low levels. Our result are confirmed by a prominent filtering approach in the above section.

Figure 1. *Time Varying connectedness in Rolling*



Source: *Own study.*

Figure 2. *Net Externalities in Rolling*



Source: *Own study.*

Table 1. *Externality effects between markets Using Spill over Index*

	WTT	WHC	WIN	WDCPI	WTIOIL	MSCIWORLD.	FTSEWORLD	SPGLOBAL	GOLD	C. from others
WTT	43.035961	21.572383	18.351041	*2.1563284*	*2.480722*	*5.114034*	*5.384833*	*1.050781*	*0.8539177*	56.96404
WHC	20.846733	44.629884	12.753283	*1.9988071*	*1.411199*	*7.591813*	*7.696150*	*2.083810*	*0.9883204*	55.37012
WIN	18.176720	14.527908	44.825871	2.5287270	1.939688	6.585023	6.794989	2.802707	1.8183671	55.17413
WDCPI	4.351532	12.504625	5.373593	69.5106410	1.794320	1.811841	1.850316	1.625566	1.1775661	30.48936
WTIOIL	3.638322	1.577006	3.151576	3.7625211	65.862748	8.318552	8.825189	1.671443	3.1926419	34.13725
MSCIWORLD	5.043550	4.623979	3.697318	0.8915262	2.870874	35.280007	35.201431	11.249212	1.1421032	64.71999
FTSEWORLD	5.014544	4.449004	3.691290	0.9124124	2.886703	35.289864	35.401399	11.252542	1.1022417	64.59860
SPGLOBAL	3.286710	2.979179	3.462941	1.2910724	1.775776	17.244443	17.088377	48.706206	4.1652969	51.29379
GOLD	5.956213	9.891436	6.977968	0.3383457	7.057323	7.294645	7.430671	2.451424	52.6019746	47.39803
C. to others (spillover)	66.314324	72.125519	57.459008	13.8797403	22.216606	89.250215	90.271957	34.187485	14.4404549	
C. to others including own	109.350285	116.755404	98.284879	87.3903812	88.079354	124.530222	125.673355	82.893691	67.0424294	900.00000
Net spillover indices	9.350284	16.754319	2.284878	-16.589619	-11.92059	24.530225	25.673357	-17.106305	-32.957575	CONIND = 52.3%

Source: *Own study.*

3. The Filtering Approach: HP Trend ACP Band Pass Filter

3.1 HP Trend

As Hodrick and Prescott (1997) pointed, the HP trend of time series data $\{y_t\}, t = 1, \dots, T$ is the solution $\{x_t\}$ based on the process of minimization of the following equation:

$$\sum_{t=1}^{T}(y_t - x_t)^2 + \lambda \sum_{t=3}^{T}(\Delta^2 x_t)^2$$

It is penalized least squares problem, penalizing the smoothness of its solution. T is the sample size and Δ denotes the difference operator, $\Delta x_t = x_t - x_{t-1}$ and

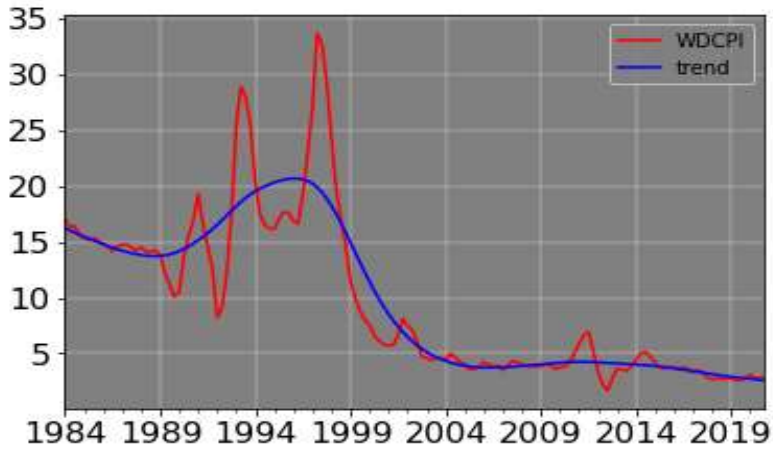
$\Delta^2 x_t = \Delta x_t - \Delta x_{t-1} = x_t - 2x_{t-1} + x_{t-2}$. $\sum_{t=1}^{T}(y_t - x_t)^2$ measures the error

of $y_t - x_t$. $\sum_{t=3}^{T}(\Delta^2 x_t)^2$ is the smoothness trend. $\lambda > 0$ is a regularization or

smoothing parameter that controls the trade-off between the size of the error and the smoothness of the trends.

Figure 3 refers to the trend and the cycle of the global financial within the referred period. The fluctuation of the global inflation cycle denotes a decreasing trend starting from the third petroleum shock in 2000 with a stable trend for the rest of the period, providing a fluctuation of the inflation which is totally disconnected from any currencies which might influence on it.

Figure 3. *Trend and Origin of the global Inflation cycle using the HP filter*



Source: *Own study.*

3.2 ACP Band Pass Filter

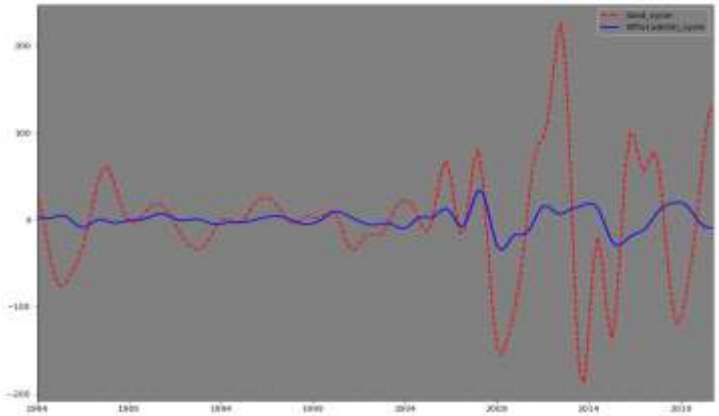
The Band Pass filter has more robust features. It is devoted for a long-term trend that evolve gradually over time whereas the univariate models of stochastic or deterministic trends assume that the trends remain constant until a structural break occur in the series. BP filter is built by Baxter and King (1999) to give an alternative to the HP filter by extracting stochastic cyclical components with a specified range of periodicities from individual time series.

We are referred to Christiano and Fitzgerald (2003) which allow to decompose the cycle component within a specified window or various frequencies. We use the asymmetric BP filter to decompose the oil price, the gold, and the financial cycle.

Figure 4 shows the cyclicity of oil and gold per time and frequency. The cycle of oil shows stable fluctuation to the global inflation however, the global inflation shows different trend of depreciation starting from the third petroleum shock, which reflect that oil influences the global inflation cycle and not the opposite. Subsequently, the gold moving in opposite fluctuation to the global inflation cycle which might reflect that gold protects the value of the money.

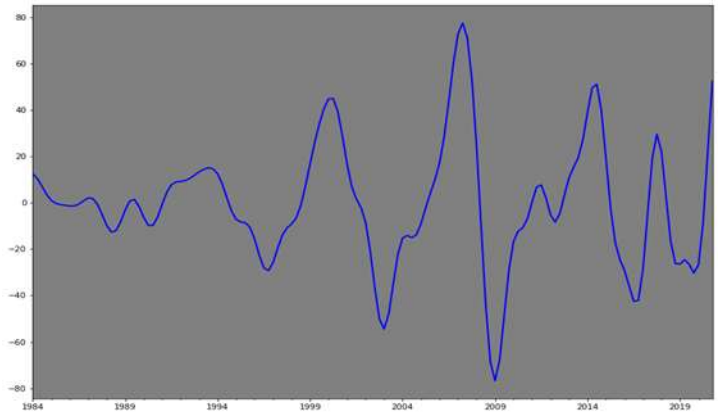
Figure 5 shows the decomposition of the global financial cycle which is constructed as combined index between the three strongest assets in the capital market. The cyclicity of the financial cycle show independence to the global inflation cycle, which contradicting the theory however it is explained that the globalization of the capital market enters to the era of the cashless economic system which lead to disconnection with the monetary system.

Figure 4. *The decomposition Trend of the Gold and Energy*



Source: *Own study.*

Figure 5. *The decomposition of the financial cycle*



Source: *Own study.*

4. Discussion

We present empirical evidence suggesting that oil energy cyclicity has an important impact on managing the cyclicity of the global inflation cycle. However, the global inflation cycle does not have an influence on the cyclicity of oil energy. Gold has an opposite fluctuation to the inflation cycle, suggesting that gold keeps its characteristics as a rely towards any further crisis on an era of cashless transactions.

The global financial cycle shows a neutrality towards the fluctuation of the global inflation cycle, which it might be explained as a tight relation about the globalization of the financial market and the cashless system. The spillover index between the real sectors such as health, tourism and investment show a tight relation with the inflation, for which our result confirms the theory.

Two policy conclusions follow:

First, energy plays a role manager for the fluctuation of the global inflation, which might give a policy for the financialization of the energy system to guarantee more tight relation with the M2 in the system.

Second, gold plays a catalyst role as hedge fund nowadays, however it is also a source for keeping the value of the money, which might give as policy to reintroducing gold again as currency within the international monetary system.

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