Energy derivative Markets and systemic risk

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1 Objectives of the report

This report examines the integration of derivative markets, with particular emphasis on energy products. Integration is considered to be a necessary condition in order for systemic risk to appear. Concerns about such risk have recently grown. The latter are supposed to be more and more integrated, both as regards each other and as regards other markets. For some months now, fluctuations in the prices of energy commodities have often been invoked to explain those of soft commodities like soy, corn or wheat. Moreover, since commodities are nowadays considered as a new class of assets, they are used by portfolio managers for diversification purposes.

Financial literature has looked into such questions in various ways: herding behavior, co- integration techniques, spatial integration, etc. These studies only take into account two dimensions of integration: space and observation time, or maturity and observation time. The time analysis of the relationships linking different spot prices of a commodity being simultaneously traded in several financial places has to do with the spatial dimension of integration. When the focus is placed on the relationship linking, several futures contracts with different delivery dates, it is the maturity dimension of integration which is examined.

None of these studies tried to study spatial and maturity evolutions simultaneously. Such an analysis is however crucial as it gives a complete understanding of systemic risk, namely the possibility that a prices shock occurring on a specific asset's physical market can spread, not only through its own futures market, but also onto other physical and / or paper markets, and vice versa.

2 Methodology

Taking into account three dimensions requires collecting a huge volume of data. Thus during the past year an important effort has been done in order to collect 655000 prices on fourteen markets. The understanding of the behavior of complex evolving systems leaded us to use recent methods originated from statistical physics. Many theoretical and numerical tools have been developed recently in order to investigate the behavior of dynamic complex systems. Moreover, since the pioneer work of Mantegna in 1999 physicists started to apply the graph-theory to financial markets.
In this literature we choose several measures which we found relevant for studying integration. We first use minimum spanning trees (MST) as a way to filter the information contained in the graph. We then study the topology of the filtered networks in order, first to see how they are organized, second to quantify the degree of randomness in this organization. Lastly, the time dependent properties of the trees are examined.

3 Main Results

The visualization of the MST first shows a star-like organization of the trees in the spatial dimension, whereas the maturity dimension is characterized by chain-like trees. These two topologies merge in the three-dimensional analysis, but the star-like organization still dominates. The star-like organization reproduces the three different sectors studied: energy, agriculture and finance, and the chain-like structure reflects the presence of a Samuelson effect. These intuitive results are very important, as they are a key justification for the use of our methodology.
The American and European crude oils are both found at the center of the graph and ensure the links with agricultural products and financial assets. Thus crude oil is the best candidate for the transmission of prices shocks. If such a shock appears at the periphery of the graph, unless it is absorbed quickly, it will necessarily pass through crude oil before spreading to other energy products and sectors. Moreover, a shock will have an impact on the whole system that will be all the greater the closer it is to the heart of the system.
Another important conclusion is that the level of integration is more important in the maturity dimension than in the spatial one. This result is intuitive: arbitrage

operations are far easier with standardized futures contracts written on the same underlying asset than with products of different natures. The analysis of how this level evolves over time shows that integration increases significantly on both the spatial and maturity dimensions. Such an increase can be observed on the whole prices system. It is even more evident in the energy sector. Thus, as time goes on, the heart of the price system becomes stronger whereas where the peripheral assets are found does not change significantly.

Such results have very important consequences, for regulatory and hedging purposes. The move towards integration started some time ago and there is probably no way to stop or refrain it. However, knowledge of its characteristics is important, as regulation authorities may act in order to prevent prices shocks from occurring, especially in places where their impact may be important. Moreover, one important concern for hedging is the information conveyed by futures prices and its meaning. The increasing integration of energy derivative markets is probably not a problem for hedging purposes, until a prices shock appears somewhere in the system. In such a case, the information related to the transmission path of the shock is important, as prices might temporarily become irrelevant.