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2nd International Symposium on Energy and Finance Issues - (ISEFI-2014)

March 28, 2014

Ipag Business School - 184 boulevard Saint Germain - 75006 Paris

2nd International Symposium on Energy and Finance Issues (ISEFI-2014)

organized by EconomiX (University of Paris West Nanterre La Défense), IPAG Business School, and CGEMP (University of Paris Dauphine)

08:30am-6:40pm | March 28, 2014

IPAG Business School

184, Boulevard Saint-Germain, 75006 Paris

CONFERENCE SCOPE

International stock markets have been very volatile recently, owing their volatility in particular to the occurrence of the US subprime crisis in 2008 and the global financial crisis 2007-2009 as well as to other important economic and political uncertainties. The increased comovements between stock markets during bad times coupled with potential contagious effects have encouraged investors to use commodity assets as a hedge against increasing portfolio risks. They also incentivized policymakers to implement sound and rigorous regulations in order to avoid consequential harmful repercussions on commodity and financial assets.

Among the commodity assets, energy products (mainly oil, oil-related and natural gas contracts) have attracted special attention from practitioners in terms of portfolio diversification because of their different volatile returns and low correlations with stocks (e.g., Arouri and Nguyen, 2010; Conovor et al., 2010; Daskalaki and Skiadopoulos, 2011; Hammoudeh et al., 2013). Undoubtedly, the liberalization of energy markets, which manifests itself by the increase in derivatives trading and financial investor activity, has made diversification strategies possible (Domanski and Heath, 2007; Dwyer et al., 2011; Singleton, 2012; Creti et al., 2013; Basak and Pavlova, 2013).

Together with the above mentioned phenomena, as liberalization advances and environmental and energy derivative markets grow and develop, the interaction between energy and finance is becoming a critical issue. For instance, in the deregulated electricity and gas markets, risk management is complex and challenging. This phenomenon is amplified by the trading opportunities in carbon markets. More generally, energy commodities are becoming closer to financial commodities. In this context, more effective market supervision and improved monitoring competencies will need to be developed by the regulatory institutions. There is also a need to develop energy pricing models which account for equity-commodity risk spillovers, and economic and financial drivers of energy prices.

This second edition of the **International Symposium on Energy and Finance Issues** (ISEFI-2014), jointly organized by *IPAG Business School*, EconomiX (*University of Paris West Nanterre La Défense and CNRS*) and CGEMP (*University of Paris Dauphine*), will shed lights on these issues, by bringing together researchers in economics, finance and econometrics.

KEYNOTE SPEAKERS

Prof. Derek Bunn, London Business School, *United Kingdom*

Derek W. Bunn is currently a Professor at the London Business School. Having read Natural Sciences at Trinity College, Cambridge University, he received a PhD from London Business School in 1975 and was subsequently elected CEGB Fellow in Engineering at Oxford University. Occasionally since then he has been a visiting professor at Stanford University in California.

Author of over 200 research papers and 10 books in the areas of forecasting, decision analysis and energy economics, he has also been recipient of several professional and industry awards, including the Goodeve Medal of the UK Operational Research Society in 1994. His work has been cited in over 4000 publications and translated into many languages. He has been a regular keynote speaker and chair at international research and practitioner conferences, as well as an advisor to several governments and many companies.

Professor Derek Bunn also serves as Chief Editor, *Journal of Forecasting*; Founding Editor, *Journal of Energy Markets*; and Director, *British Institute of Energy*.

Prof. Matteo Manera, University of Milano-Bicocca, Italy

Matteo Manera is a Professor of Econometrics at DEMS - Department of Economics, Management and Statistics, University of Milano-Bicocca, Italy. He is also senior research fellow at the Fondazione Eni Enrico Mattei (FEEM), Milano, Italy, where he has coordinated the research programme on International Energy Markets and he is currently leading the research projects on Financial Speculation in the Oil Markets and on Modelling and Forecasting the Price of Oil.

His research interests include: time series analysis; financial econometrics; energy econometrics; international markets for oil, gas and electricity; environmental Kuznets curves; model selection (non-nested tests); analysis of dynamic factor demands; panel data models; models for qualitative and limited dependent variables. His current research activity is focussed on the econometric analysis of the impact of financial speculation on the energy futures markets.

He has published his work in several international journals, such as: *Applied Financial Economics*, *Bulletin of Economic Research*, *Economic Modelling*, *Empirica*, *Empirical Economics*, *Energy Economics*, *The Energy Journal*, *Energy Policy*, *Environmental Modelling and Software*, *Environmental and Resource Economics*, *Financial Research Letters*, *Journal of Economic Surveys*, *Journal of Futures Markets*, *Journal of Productivity Analysis*, *Resource and Energy Economics*.

CONFERENCE CO-CHAIRS

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Fatih Karanfil, *University of Paris West Nanterre la Défense*
Duc Khuong Nguyen, *IPAG Business School*

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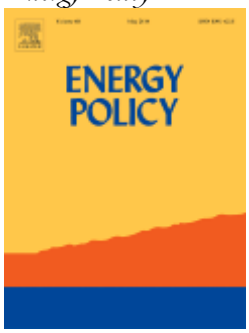
PUBLICATION OPPORTUNITIES

A selection of high-quality papers submitted to the ISEFI-2014 Symposium will be published in a Special Issue of Energy Policy under the Guest Editorships of Anna Creti and Duc Khuong Nguyen. All papers must conform to the journal's content scope and will be processed through the journal's standard editorial review procedures. The theme of this Special Issue is "*Markets' Financialization, Risk Spillovers, Pricing Models and Their Relevance to Energy Policy*".



CONFERENCE VENUE AND PRACTICAL INFORMATION

IPAG Business School
184, Boulevard Saint-Germain
75006 Paris

Program at a Glance

08:30am – 08:50am	Registration & Continental Breakfast	Amphitheatre
08:50am – 09:00am	Opening and Welcome Note By Anna Creti (*University of Paris Dauphine*), Fatih Karanfil (*University of Paris Ouest Nanterre La Défense*), Duc Khuong Nguyen (*IPAG Business School*), and Frédéric Teulon (*IPAG Business School*)	Amphitheatre
09:00am – 10:00am	Keynote Lecture I By **Professor Derek Bunn**, *London Business School*	Amphitheatre
10:00am – 10:30am	Coffee Break	Amphitheatre
10:30am – 12:00am	Parallel Session A Session A1 Session A2	Amphitheatre Room S11
12:00am – 02:00pm	Lunch Break	Restaurant
02:00pm – 03:00pm	Keynote Lecture II By **Professor Matteo Manera**, *University of Milano-Bicocca*	Amphitheatre
03:00pm – 04:30pm	Parallel Session B Session B1 Session B2	Amphitheatre Room S11
04:30pm – 05:00pm	Coffee Break	Amphitheatre
05:00pm – 06:30pm	Session C	Amphitheatre
06:30pm – 06:40pm	Concluding Remarks	Amphitheatre

Detailed Program

08:30am – 08:50am	Registration and Continental Breakfast	
08:50am – 09:00am	Opening and Welcome Note	
09:00am - 10:00am	Keynote Lecture I "Trends and Models of Asset Performance Risk in the Decarbonising Power Markets" By **Professor Derek Bunn**, *London Business School*	Amphitheatre
10:00am – 10:30am	Coffee Break	
10:30am – 12:00am	Parallel Sessions A	
10:30am – 12:00am	Session A1: Carbon and Energy Finance Chair: Julien Chevallier, *IPAG Business School & University of Paris 8*	Amphitheatre
10:30am – 10:50am	**Speculative and hedging activities in the European carbon market** Maria Mansanet-Bataller, *Université Franche-Comté, France* Angel Pardo, *Universitat de València, Spain* Julio. J. Lucia, *Universitat de València, Spain*	
10:50am – 11:10am	**Understanding volatility dynamics in Phase I, II, and III of the EU-ETS markets: Lessons for the future** Maria-Eugenia Sanin, *University of Evry Val d'Essonne, France* Francesco Violante, *Aarhus University, Danemark* Maria Mansanet-Bataller, *Université Franche-Comté, France*	
11:10am – 11:30am	**On the link between oil price and exchange rate: A time-varying VAR parameter approach** Emmanuel Hache, *IFP Énergies Nouvelles / IFP School, France* Vincent Brémond, *EconomiX-CNRS, University of Paris Ouest Nanterre La Défense, France* Tovonony Razafindrabe, *EconomiX-CNRS, University of Paris Ouest Nanterre La Défense, France*	
11:30am – 11:50am	**The goodness-of-fit of the fuel-switching price using the mean-reverting Lévy jump process** Julien Chevallier, *IPAG Business School & University of Paris 8, France* Stéphane Goutte, *University of Paris 8 & ESG Management School, France*	
10:30am – 12:00am	Session A2: Econometric Analysis of Energy Markets Chair: Frederic Lantz, *IFP-School, France*	Room S11
10:30am – 10:50am	**Convenience yield and adjusted basis stylized facts** Julien Fouquau, *Neoma Business School, France* Pierre Six, *NEOMA Business School, France*	
10:50am – 11:10am	**Driven by fear? The tail risk premium in the crude oil futures market** Reinhard Ellwanger, *European University Institute, Italy*	

11:10am – 11:30am	**Volatility spillover between energy and financial markets** Ugur Soytas, *Middle East Technical University, Turkey* Rangan Gupta, *University of Pretoria, South Africa* Saban Nazlioglu, *Pamukkale University, Turkey*
11:30am – 11:50am	**An econometric analysis of the interactions between oil and oil product prices** Frederic Lantz, *IFP-School, France* Jean-Pierre Indjehagopian, *ESSEC Business School, France* Joren Rombouts, *ESSEC Business School, France*
12:00am – 02:00pm	Lunch Break
02:00pm - 03:00pm	Keynote Lecture II "Forecasting the Oil-Gasoline Price Relationship: Should We Care about the Rockets and the Feathers?" By **Professor Matteo Manera**, *University of Milano-Bicocca* — Amphitheatre
03:00pm – 04:30pm	Parallel Sessions B
03:00pm – 04:30pm	Session B1: Derivative Pricing and Hedging in Energy Markets — Amphitheatre Chair: Jim Hanly, *Dublin Institute of Technology*
03:00pm – 03:20pm	**Utility indifference pricing and hedging for structured contracts in energy markets** Giorgia Callegaro, *University of Padova, Italy* Luciano Campi, *London School of Economics, UK* Tiziano Vargiolu, *University of Padova, Italy*
03:20pm – 03:40pm	**Gas storage valuation and hedging: A quantification of model risk** Patrick Hena, IAE Paris, *University of Paris 1 Panthéon-Sorbonne, France* Ismail Laachir, *ENSTA ParisTech and University of Bretagne-Sud, France* Francesco Russo, *ENSTA ParisTech, France*
03:40pm – 04:00pm	**The relationship between risk and return in financial oil markets** Yannick Le Pen, *University of Paris Dauphine, France* Benoît Sévi, *Aix-Marseille University & EHESS, France*
04:00pm – 04:20pm	**Hedging effectiveness using energy futures: A comparison** Jim Hanly, *College of Business, Dublin Institute of Technology, Ireland*
03:00pm – 04:30pm	Session B2: Finance and Investment in Renewable Energy — Room S11 Chair: Bert Scholtens, *University of Saint Andrews & University of Groningen*
03:00pm – 03:20pm	**WACC the dog: The effect of financing costs on the global levelized cost of solar photovoltaic electricity** Janosch Ondraczek, *University of Hamburg, Germany & International*

	Institute of Applied Systems Analysis (IIASA), Austria Nadejda Komendantova, *International Institute of Applied Systems Analysis (IIASA), Austria & Swiss Federal Institute of Technology, Switzerland* Anthony Patt, *Swiss Federal Institute of Technology, Switzerland*
03:20pm – 03:40pm	**Investing in finite-life carbon emissions reduction program under risk and idiosyncratic uncertainty** Jessica Fouilloux, *University of Rennes 1 and CREM, France* Franck Moraux, *University of Rennes 1 and CREM, France* Jean-Laurent Viviani, *University of Rennes 1 and CREM, France*
03:40pm – 04:00pm	**Energy and economic perspectives of renewable fuels** Jy S. Wu, *University of North Carolina at Charlotte, USA* Huikuan Tseng, *University of North Carolina at Charlotte, USA*
04:00pm – 04:20pm	**Is there a difference? The performance characteristics of renewable energy equity indices** Michael Rezec, *University of Saint Andrews, UK* Bert Scholtens, *University of Saint Andrews, UK & University of Groningen, The Netherlands*
04:30pm – 05:00pm	Coffee Break
05:00pm – 06:30pm	Session C: Economic Analysis of Wind, Electricity, and Crude Oil Markets — Amphitheatre Chair: Anna Creti, *University of Paris Dauphine*
05:00pm – 05:20pm	**Forecasting electricity spot prices using time-series models with a double temporal segmentation** Marie Bessec, *University of Paris Dauphine, France* Julien Fouquau, *NEOMA Business School & University of Paris Dauphine, France* Sophie Meritet, *University of Paris Dauphine, France*
05:20pm – 05:40pm	**The stabilizing effect of hydro reservoir levels on intraday power prices under wind forecast errors** Mehtap Kilic, *Erasmus School of Economics, Erasmus University Rotterdam, The Netherlands* Elisa Trujillo-Baute, *University of Barcelona and CES-IEB, Spain*
05:40pm – 06:00pm	**Location basis differentials in crude oil prices** Yang Li, *Rutgers University, USA* Bruce Mizrach, *Rutgers University, USA* Yoichi Otsubo, *Luxembourg School of Finance, Luxembourg*
06:00pm – 06:20pm	**Hourly seasonal ARMA-GARCH approach for short term forecasting** Faddy Ardian, *Ecole Polytechnique, France* Anna Creti, *University of Paris Dauphine, France* Francesco Vallone, *Cogenpower SpA, Italy*
06:00pm – 06:10pm	Concluding Remarks

Session A1

Speculative and hedging activities in the European carbon market

Maria Mansanet-Bataller, *Université Franche-Comté, France*
Angel Pardo, *Universitat de València, Spain*
Julio. J. Lucia, *Universitat de València, Spain*

We explore the evolution of speculative and hedging activities in futures carbon markets by combining volume and open interest data. A comparison of the three phases in the European Carbon Market reveals that the Phase II of the EU ETS seems to be the most speculative phase to date and a high degree of speculative behavior at the moment of listing the contracts for the first time, for every Phase. A seasonality analysis identifies a higher level of speculation in the first quarter of each year, related to the scheduled deadlines of the EU ETS. Finally, a time series analysis confirms that for each year the front contract concentrates the majority of the speculative activity whereas the second-to deliver futures contract congregates the hedging demand.

Understanding volatility dynamics in Phase I, II, and III of the EU-ETS markets: Lessons for the future

Maria-Eugenia Sanin, *University of Evry Val d'Essonne, France*
Francesco Violante, *Aarhus University, Danemark*
Maria Mansanet-Bataller, *Université Franche-Comté, France*

In this paper we study the short-term price behavior of future prices for EU emission allowances for Phase I, II and II (until June 2013). We model returns and volatility dynamics of this price showing that a standard ARMAGARCH framework is not adequate and that the gaussianity assumption is rejected due to the occurrence of a number of level and volatility outliers. To improve the fitness of the model, we combine the underlying price process with an additive stochastic jump process. The resulting distribution, a mixture of Gaussians, allows for endogenously determined jumps in the process governing the returns, while the mixing law determines the jump probability. The performance of the model is improved by introducing a time varying jump probability explained by two variables. The first one is the daily relative change in the volume of transactions and suggests that sharp increases in volume increase volatility even in the absence of changes in what recent literature considers as market fundamentals. The second one accounts for changes in the jump probability associated to the European Commission's announcements regarding the NAPs. We find that announcements concerning the NAPs induce jumps in the process and tend to increase volatility. The previous result suggests the authority faces a tradeoff between disseminating information effectively and promoting market stability, which is crucial for traders to realize efficient trading strategies and informed investment decisions regarding pollution reduction.

On the link between oil price and exchange rate: A time-varying VAR parameter approach

Emmanuel Hache, *IFP Énergies Nouvelles / IFP School, France*
Vincent Brémond, *EconomiX-CNRS, University of Paris Ouest, France*
Tovonony Razafindrabe, *EconomiX-CNRS, University of Paris Ouest, France*

The aim of this paper is to study the relationship between the effective exchange rate of the dollar and the oil price dynamics from 1982 to 2013. In this context, we propose to explore two important segments of classical explanations of the oil prices determination: the literature based on the co-movement theory and the economic literature dedicated to financial channels factors (interest rate, international liquidity) that could affect the oil price dynamic. In addition to oil prices and the effective exchange rate of the dollar, we use the dry cargo index as a proxy for the real economic activity and prices for precious and industrial raw materials. We then perform a Bayesian time-varying parameter vector auto-regressive estimation based on Kalman filter recursion. Our main results show that the crude oil prices elasticity to the effective exchange rate of the dollar is not constant across the time and remains negative. It then highlights that a depreciation of the effective exchange rate of the dollar leads

to an increase of the crude oil prices. Our paper also demonstrates the growing influence of Chinese development upon the global economy through financial and raw materials channels.

The goodness-of-fit of the fuel-switching price using the mean-reverting Lévy jump process

Julien Chevallier, *IPAG Business School, France*
Stéphane Goutte, *University of Paris 8 & ESG Management School, France*

This article analyzes the interactions between the electricity and CO_2 (carbon) markets. In particular, we describe the dynamics of the fuel-switching price (from coal to gas) when taking into account carbon costs. Several stochastic processes are considered to model the fuel-switching price: (i) the Brownian motion, and (ii) the Lévy jump process. Besides, the probability density function is evaluated by considering the Gaussian case versus the Normal Inverse Gaussian and the Variance Gamma distributions. The results unambiguously point out the need to resort to jump modeling techniques to model satisfactorily the fuel-switching price. The Gaussianity assumption is also clearly rejected in favor of its main competitors. Taken together, these empirical results convey implications for risk managers looking to forecast and hedge their utilities' production.

Session A2

Convenience yield and adjusted basis stylized facts

Julien Fouquau, *Rouen Business School, France*
Pierre Six, *Neoma Business School, France*

This article examines the theory of storage in directly considering the convenience yield. Indeed, other empirical studies focus on the risk adjusted basis of commodity prices to analyze the stylized facts of storable commodities. However, we show in this article that this basis is unlikely to be a good proxy for the convenience yield. We run a first qualitative analysis for oil and copper and prove that the stylized facts predicted by the theory of storage are much more validated when the convenience yield is considered as opposed to the risk adjusted basis.

Driven by fear? The tail risk premium in the crude oil futures market

Reinhard Ellwanger, *European University Institute, Italy*

This paper evaluates the effect of expected large price jumps - and the fear thereof - on WTI crude oil futures returns by computing a daily Tail Risk Premium (TRP) from 2006 to 2012. In the same spirit as the return risk premium, the TRP is defined as the difference of the expectation of large jumps under the objective and the risk neutral measure. An oil investors' fears index is then computed by comparing the risk premium of large positive jumps to the one of large negative jumps. The contribution of this paper is threefold. First, we explore the empirical characteristics of the oil investors' tail risk premium and show how they compare to those of equity indexes. Conveniently, the fear index is computed at a daily frequency, allowing for a granular identification of the impact of macroeconomic and political events on crude oil market. Second, we show that this new risk measure significantly forecasts weekly and monthly crude oil futures returns. The predictive power is shown to be robust to the inclusion of other oil market specific and aggregate macroeconomic indicators and extends to crude oil spot prices. Finally, we investigate the interaction of the oil tail risk premium with the tail risk in equity markets and monetary policy over the recent financial crisis.

Volatility spillover between energy and financial markets

Ugur Soytas, *Middle East Technical University, Turkey*
Rangan Gupta, *University of Pretoria, South Africa*
Saban Nazlioglu, *Pamukkale University, Turkey*

It is well established in the literature that oil price shocks have detrimental effect on economic activity. This negative impact is assumed to be higher than the positive impact of a fall in oil prices. It is argued that monetary policy alone cannot account for this asymmetry. Transaction costs as well as financial stress are among the factors counted that lead to this asymmetric effect. The impact of financial stress on economic activity is also well-studied. Financial stress has a negative correlation to economic activity. However, the inter-temporal relationship between oil price and financial stress index is not

well known. The dynamic link between oil prices and financial stress can be considered through two channels: impact on economic activity, and impact on investor behavior. A rise in oil prices depresses economic activity, may put pressure on credit markets, and negatively affect stock markets and the banking system. In times of high financial stress, economic activity slows down, leading to low energy demand and declining oil prices. As for the investment channel, the financialization of oil markets may have added another dimension through which oil prices may lead financial stress or vice versa. Investors see oil markets as alternative investment areas to financial markets. Furthermore, empirical work usually finds that prices lead positions in commodity markets, but the reverse is not true. Hence, a shock in the oil market will cause changes in the positions held in that market. As investors adjust their portfolios, this will have repercussions on financial asset prices. On the other hand, increased financial stress will also cause investors to change their portfolios and this will have an impact on oil markets. Which one leads the other is an important question for both policy makers and investors, and to which we seek an answer in this study. From the perspective of either channel, it looks like there is a rich and complicated relationship between oil prices and financial stress.

This paper aims at examining volatility or risk transmissions between energy and financial markets by employing oil prices and financial stress index over the pre-crisis and the in- and post-crisis sub-periods. The data set includes daily observations from September 25, 1991 to January 02, 2014 and it is divided two sub-periods: the pre-crisis period from September 25, 1991 to December 31, 2007 and the in- and post crisis period from January 01, 2008 to January 02, 2014. To explore the risk transmission, we benefit from the developments in time series analysis and thereby rely on the causality-in-variance test recent developed by Hafner and Herwartz (2006). In addition to the causality-in-variance analysis, we derive the volatility impulse response functions to compare how energy and financial markets respond to short-run temporary shocks in volatility.

An econometric analysis of the interactions between oil and oil product prices

Frederic Lantz, *IFP-School, France*
Jean-Pierre Indjehagopian, *ESSEC Business School, France*
Joren Rombouts, *ESSEC Business School, France*

This study examines the dynamic relationship between spot and futures prices in the markets for crude oil (West Texas Intermediate, WTI), gasoil and gasoline in the USA over the last decade with weeky figures. The objective is to estimate the equilibrium between the crude oil price and the final product prices (spot and future) and to analyse these equilibriums (transmission of price's fluctuation between the prices). For this purpose, we develop a statistical model, based on the predictions of the absence of arbitrage pricing theory, of the relationship between futures and spot price for the three markets. The model incorporates both the existence of an equilibrium relationship between the spot and futures prices whilst allowing for a changing association between them depending upon the sub-period. Finally, we test the causality between the spot and future price of the crude oil and the final product prices.

As an initial stage, we carried out unit root tests on each of the series studied. However, the period covered by the analysis was marked by contrasting price movements, which may show up as possible breaks. This led us to implement the testing procedure suggested by Perron (1997), which grew out of the work of Perron and Vogelsang (1992a,b) as well as that of Zivot and Andrews (1992). In these tests, the null hypothesis is that the temporal series is characterised by the presence of a unit root and a constant, which may be null, with the presence of a break. Subsequently, we tested for the existence of a long-term equilibrium (a cointegration relationship) between the future price and the spot price. As with the tests for unit root, we tested for the presence of a potential break during the period under study with a Gregory and Hansen test (1996a,b). Furthermore, we tested for changing variability of the error term (an autoregressive conditional heteroscedasticity - ARCH test) in the estimated relationship for the WTI market as well as for the gasoline market. Estimating the short-term dynamic between the prices is more difficult, and manifests several changes that are shown up by the structural break tests. Finally, we carry out the causality tests between the prices.

Session B1

Utility indifference pricing and hedging for structured contracts in energy markets

Giorgia Callegaro, *University of Padova, Italy*

Luciano Campi, *London School of Economics, UK*
Tiziano Vargiolu, *University of Padova, Italy*

In this paper we consider structured products in energy markets and price them using the utility indifference pricing approach. We compute the buyer's price of such derivatives for an agent investing in the forward market, whose preferences are described by an exponential utility function. Such a price is characterized as the unique viscosity solution of a suitable non-linear PDE that can be solved numerically and gives an effective way to compute both an optimal withdrawal strategy for the structured product and a portfolio strategy to partially hedge the financial position. In the complete market case, the financial hedge turns out to be perfect and the PDE reduces to particular cases already treated in previous studies.

Gas storage valuation and hedging: A quantification of model risk

Patrick Hena, IAE Paris, *University of Paris 1 Panthéon-Srobone, France*
Ismail Laachir, *ENSTA ParisTech and University of Bretagne-Sud, France*
Francesco Russo, *ENSTA ParisTech, France*

In this presentation we consider the problem of gas storage valuation. We present a joint modeling framework for the futures curve and the spot, with two different spot models. Using Monte Carlo simulations, we estimate the extrinsic optimal spot strategy; for the purpose of variance reduction of the cumulative cash flow, we set up a financial hedging strategy. Historical backtesting demonstrates the better performance of the extrinsic strategy compared to the classic intrinsic strategy. Furthermore, we discuss the model uncertainty and its effect on storage value. After a quantitative comparison of the two spot models we proposed, we conclude that the model based on the spot-prompt spread performs better. In order to quantify the stability of these results with respect to model uncertainty, we define two model risk measures based on historical prices.

Using those risk measures, we observe the great sensitivity of gas storage value with respect to the modeling assumptions. In fact the model uncertainty, as measured by the size of price range, represents a large proportion of storage value. This puts into perspective the extensive literature on gas storage valuation, and calls for a more careful study of the model risk inherent to our problem. We believe that it is crucial to turn more attention to the choice of the spot-futures modeling framework, rather than concentrate all the effort on the specification of an optimal trading strategy.

The relationship between risk and return in financial oil markets

Yannick Le Pen, *University of Paris Dauphine, France*
Benoît Sévi, *Aix-Marseille University & EHESS, France*

We investigate the relationship between risk and return in oil futures markets in the vein of Merton's (1973) ICAPM. Finding a risk-return tradeoff for any asset can help to improve our understanding of the asset under consideration. It answers the fundamental question in financial economics as to whether the risk in a given market is rewarded with an appropriate return. In addition, as oil is a major alternative investment vehicle, a better knowledge of the relation between oil market and the broad market has very practical implications for hedger and noncommercial users of oil futures. In particular, our analysis sheds light on the potential ability of oil to diversify a large portfolio of financial assets, as recently examined in Daskalaki et al. (2010) for the more general case of commodities.

Our main contribution is twofold. First, we study the risk and return properties of oil futures returns, and in particular the link between these two quantities. To our best knowledge, this is the first time that this issue is raised in the economic literature. While some authors have examined risk and return properties for stock indices, foreign exchange (Christiansen, 2012; Daigler et al., 2013; Atilgan et al., 2012), or even specific portfolios (Gonzalez-Rivera, 1996), such an analysis is still missing despite the importance of the oil market. Second, we use a conditional correlation approach that does not assume the covariance between oil and stock returns to be constant. This is methodology has only been used in Bali and Engle (2010) for such a purpose.

Hedging effectiveness using energy futures: A comparison

Jim Hanly, *College of Business, Dublin Institute of Technology, Ireland*

Energy market participants carry a significant level of price risk given the innate volatility and susceptibility of energy products to political, economic and weather events. Futures contracts were created in large part to facilitate the management of these types of risks and hedging of spot exposures using futures has become a relatively simple and cost effective way to manage energy price risk. In energy markets, futures trade in six major products, WTI and Brent Oil, Heating Oil, Gasoil, Gasoline Oil, and Natural Gas. While the literature has examined hedging in some of these markets, no study to our knowledge has carried out a broad based comparison of the hedging effectiveness of futures contracts for these different assets. Furthermore, of the studies that have examined energy hedging, few have incorporated some of the newer risk metrics that are of importance to investors. In this paper we address this by estimating and comparing hedging strategies using come of the most commonly applied strategies including constant and time-varying methodologies. Uniquely, we carry out a hedge comparison using a variety of risk measures including Variance, VaR, and Expected Shortfall. We also acknowledge that hedgers are also investors and as such they are concerned with both risk and return; however the role of both returns and investor risk aversion has received little attention by its focus on minimum variance hedging. We therefore also incorporate a utility based performance metric to evaluate the hedging effectiveness of energy hedges for hedgers with both moderate and high risk aversion. We apply our approach using three different hedging horizons, daily weekly and monthly. We also carry out an analysis of hedging effectiveness both before and after the financial crisis of 2008. We find that hedging is effective in reducing not only the variance of the energy hedgers underlying position but it also effective in terms of reducing both VaR and expected shortfall and in terms of increased utility. We also find significant differences in both the hedging strategies and the hedging effectiveness of different energy assets. Better performance is found for West Texas Intermediate Oil, Brent oil and Heating Oil while the poorest performer in hedging terms is Natural Gas. These differences can be attributed in part to the higher basis risk inherent in natural gas hedges. Finally we find that futures hedges are just as effective in the period after the financial crisis of 2008 as before the crisis despite periods of high volatility.

Session B2

WACC the dog: The effect of financing costs on the global levelized cost of solar photovoltaic electricity

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The photovoltaic (PV) power industry has grown rapidly in recent years, and associated with that growth has been a decline in costs. There are indications that PV has already reached cost-parity with power off the grid in some markets and projections that it will attain such grid parity in many more markets over the coming decade. Analysts have suggested that the growth in PV has come at an unnecessarily high price, with unnecessarily high subsidies. However, the factors influencing the cost of PV, and the subsidies required to sustain its construction, include more than just the strength of the sun. While differences in costs of such factors as initial capital spending, operation and maintenance, and decommissioning are hard to ascertain, it is possible to account for the cost of capital, on a country-by-country basis. In this paper, we therefore map the cost of solar PV globally, accounting for both the quality of the solar resource and the cost of capital in order to differentiate levelized costs of electricity (LCOE) from PV. Our results suggest that northern countries may not be an unwise location to subsidize PV construction, and further suggest that efforts to expand PV installation in developing countries may benefit greatly from policies designed to make low cost finance more widely available.

Investing in finite-life carbon emissions reduction program under risk and idiosyncratic uncertainty

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This paper aims at emphasizing the ability of new frameworks of real option approach to capture key characteristics of green investment. We develop both theoretical arguments and numerical simulations with structural parameters calibrated on real-life data. We find that both radical uncertainty and strategic interactions lead to speed-up green investments, compared to the predictions of real option models that are normally used in green investment literature. The conventional ―wait and see‖ attitude, questioned in recent developments of the real option theory, is not validated. In conclusion, our results should foster companies to implement green investments and help governments to define appropriate incentives to trigger green investments. Of particular note, the paper highlights that finance theory is not necessarily an obstacle to green investment decisions.

Energy and economic perspectives of renewable fuels

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The Energy Independent and Security Act of 2007 calls for increased production of renewable fuels as a source of renewable energy to replace a certain percentage of liquid transportation fuels, using locally grown and produced resources. The Act defines various categories of renewable fuel standard and sets volume requirements for the next 10 years. Currently, about 90% of ethanol blended into gasoline is from corn kernels grown in the Midwest. Corn price has been doubled from two to four dollars per bushel since the early 2000's, even with governmental financing and subsidies to corn growers and renewable fuel investors. Obviously, corn-derived ethanol is not a sustainable option to the Nation's long-term energy needs but a step toward the right direction. Recently, the United States initiated an effort to examine the reduction of ethanol mix, which generates a great interest to further examine the energy and economic aspects of renewable fuels.

Growing cellulosic feedstock using switchgrass or other biofuel crops on marginal lands will not only relieve pressures on lands for food and feed production, but also lesson the potential environmental impacts of meeting biofuel mandates. In this paper, we have examined the production of biofuels from three different land types including closed landfill sites, highway right-of-ways, and cooperative arrangement with forage and pasture land owners. Our initial estimates on turnover of the statewide acreages of closed landfills include more than 1,700 acres, based on a population of 9.6 million producing six pounds of solid wastes per day. The estimated biofuel production will amount to 0.1-0.2 million gallons per year. Estimates of biofuel production from the other two land types will be included in the final paper. We will employ a GIS-based InVest model to map the ecological services with economic models, with emphasis on determining the economics of biofuel production relative to the preservation of ecological services.

Is there a difference? The performance characteristics of renewable energy equity indices

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This study analyses whether stock indices that try to capture renewable energy investments perform different from conventional benchmark energy stock indices. We focus on indices and not on individual investment funds. As such, we do not have to make do with funds' transaction costs, timing activities and managerial skills. By investigating indices, we can examine the performance effects of the 'renewable screens' in a very direct manner. We investigate fourteen renewable energy indices which cover investments all over the world. These indices are investigated by single and multi-equation systems. We find that the renewable energy indices' risk-adjusted return is well in line with that of the conventional energy indices. However, their risk is substantially higher compared to these benchmarks.

Session C

Forecasting electricity spot prices using time-series models with a double temporal segmentation

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The French wholesale market is set to expand in the next few years under European pressure and national decisions. In this paper, we assess the forecasting ability of several classes of time series models for electricity wholesale spot prices at a day-ahead horizon in France. Electricity spot prices display a strong seasonal pattern, particularly in France given the high share of electric heating in housing during winter time. To deal with this pattern, we implement a double temporal segmentation of the data. For each trading period and season, we use a large number of specifications based on market fundamentals: linear regressions, markov-switching models, threshold models with a smooth transition. Non-linear models designed to capture the sudden and fast-reverting spikes in the price dynamics yield more accurate forecasts. Modeling each season independently also leads to better results. Finally, pooling forecasts gives more reliable results. Individual models are generally superior but their performance is more unstable across hours and seasons.

The stabilizing effect of hydro reservoir levels on intraday power prices under wind forecast errors

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The power system has to deal with three main sources of uncertainty: demand uncertainty and load prediction errors, failure of power plants and uncertainty of wind. The growing share of wind and other intermittent generation sources in the European supply increases the uncertainty about power production in day-ahead and longer-term predictions. As EU member states increase the deployment of wind power and other intermittent renewable energy sources, the intraday and balancing market will gain more interest, as additional demand for reserve and response operations is needed. Hence, it becomes relevant to analyze the effect of wind power forecasting errors on intraday prices. A higher forecast error will increase the need of the use of intraday markets to balance out the oversupply or deficit of wind on hourly basis. This oversupply or deficit can be corrected though flexible hydropower plants; however the power price is highly influenced by the fluctuations in the reservoir level (Huisman et al., 2013). In this paper, we question to what extent hydropower has a stabilizing effect on the impact of wind forecasting errors on NordPool intraday prices. To do so, we examine the hourly imbalance power prices for the Scandinavian market (ELBAS) from 2011 until 2013 with a Markov regime-switching model for periods with low and high hydro reservoir levels.

Location basis differentials in crude oil prices

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We examine the long-run pricing relationship among crude oil prices at the North Sea (Brent), Cushing (WTI) and Louisiana Gulf (LLS) delivery points. The Brent-WTI location basis differential is stable until January 2010, but it widens to record levels in the next two years. Brent prices adjust to WTI prices prior to this structural break, but after January 2010, they are no longer cointegrated. We show that the recent Brent-WTI price differential is Granger-caused by Chinese demand. U.S. retail gas prices respond to Brent and WTI before January 2010 and then only to Brent afterwards. We report on recent changes in the supply chain designed to profit from the Brent-WTI gap. Crude oil, once it reaches the Gulf of Mexico, is still cointegrated with the Brent benchmark. Refining capacity constraints in the Gulf region and export restrictions prevent U.S. suppliers from re-integrating WTI prices with the Brent benchmark.

Hourly seasonal ARMA-GARCH approach for short term forecasting

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In deregulated markets, electricity price has proven to be very volatile and subject to spikes. Hence, accurate forecast and modeling is a great importance for market participants. This model examines different models of ARMA-GARCH and Seasonal ARMA-GARCH that could be used for forecasting on daily basis with auto-calibration on actual data to forecast, on a seven-day horizon, the Italian Day-

ahead market. In addition, it proposes a separable model where hourly price over days are treated as a time series. The study has produced twenty four different models to forecast electricity price for the whole day and has proven to be reliable for short-term forecasting in Italian electricity market.

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