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ABSTRACTS

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Blockchain-based Academic Journals

Kyoung Jin Choi,[*,1]   **Jaevin Park**[2]

Inspired by the recent computer science literature, we study the economic implications of blockchain-based academic journals in which authors and referees are *individually incentivized*. We construct a model in which the journal publishes qualified papers under two types of information asymmetry: paper quality and type of referees. We investigate the conditions under which equilibrium in decentralization exists or fails and leads to a better outcome. The results from the model can be widely applied to information-production processes in funding decisions, loan inspections, and credit ratings. Our research helps to understand how to design an incentive structure for information providers.

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Stochastic approximation in adaptive Monte Carlo variance reduction

Rei-ichiro Kawai[*,1]

We discuss an application of stochastic approximation algorithms in a forward problem, rather than inverse problems of great interest to the Machine Learning community. The forward problem here is a general framework of Monte Carlo variance reduction adaptively updating the variance reduction parameters by stochastic approximation. To address the extreme sensitivity of performance to the choice of learning rates, we mainly focus on the case of finite computing budget and derive constant learning rates via minimization of an upper bound of the theoretical variance of the empirical mean, rather than minimization of the objective function as in the existing stochastic gradient framework. We present numerical results to support the theoretical findings and to illustrate the effectiveness of the proposed algorithm, especially the robustness of the performance to the choice of learning rates.

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Are suspicious activity reporting requirements for cryptocurrency exchanges effective?

Daehan Kim,[*,1]   **Mehmet Huseyin Bilgin,**[2]   **Doojin Ryu**[3]

This study analyzes the impact of a newly emerging type of anti-money laundering regulation that obligates cryptocurrency exchanges to report suspicious transactions to financial authorities. We build a theoretical model of the reporting decision structure of a private bank or cryptocurrency exchange and show that an inferior ability to detect money laundering (ML) increases the ratio of reported transactions. If a representative money launderer makes an optimal portfolio choice, then this ratio increases further. Our findings suggest that cryptocurrency exchanges will exhibit more severe excessive reporting behavior under this regulation relative to private banks. We attribute this result to cryptocurrency exchanges' inferior ML detection abilities and their proximity to the underground economy.

Keywords : Cryptocurrency; Cryptocurrency Exchange; Money Laundering; Portfolio Choice; Financial Regulation

JEL classification : E26, G11, K42

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The Thermodynamic Approach to Whole-Life Insurance: A Method for Evaluation of Surrender Risk

Yuuki Ida[*,1]

We introduce a collective model for life insurance where the heterogeneity of each insured, including the health state, is modeled by a diffusion process. This model is influenced by concepts in statistical mechanics. Using the proposed framework, one can describe the total pay-off as a functional of the diffusion process, which can be used to derive a level premium that evaluates the risk of lapses due to the so-called adverse selection. Two numerically tractable models are presented to exemplify the flexibility of the proposed framework.

Joint work with Jiro Akahori, Maho Nishida, and Shuji Tamada.

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Equilibrium multi-agent model with heterogeneous views on fundamental risks

Keisuke Kizaki[1], Taiga Saito[*,2], Akihiko Takahashi[3]

In this talk, we present an equilibrium-based asset pricing model incorporating market sentiments, where multi-agents have heterogeneous (optimistic, pessimistic, neutral) views on fundamental risks represented by Brownian motions. Each agent maximizes its expected utility on consumption under its subjective probability measure, reflecting its heterogeneous views on fundamental risks. Specifically, we formulate the optimal consumption and portfolio problem with a choice of a probability measure. Moreover, we provide an expression of the state-price density process that includes information on the interest rate and the market price of risk in equilibrium. Finally, we present a numerical example on pricing zero-coupon bonds, which shows the effects of the agents' heterogeneous views on the term structure of interest rates.

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Effect of the elderly on household's financial transactions: Evidence from Japan and Korea

Young-Min Kim[*,1]

Understanding the effect of the elderly on the household's financial transaction has become more important as the elderly population and their need for wealth during retirement and beyond increase.

We investigate the effect of the elderly demography on the household's financial transactions in terms of size and growth in Japan and Korea, who are facing an increasing aging population.

The main findings are as follows: First, the size (or proportion) of those aged over 70 and 80 has a relatively more significant effect on the financial transactions in Japan and Korea, respectively. Second, the growth rate of those aged 60 has a significant effect on the household's financial transactions in Japan while the growth rate of 80+ has a more significant effect in Korea. Third, the interaction between the size and growth of those in their 60s and 80s+ has the most significant effect on the household's financial transactions in Japan and Korea, respectively. Also, the interaction between the growing elderly population and life expectancy has no effect on the financial transactions in Japan while it has a significant effect in Korea. The interactions indicate that the demographic size of the elderly has more of an effect in Japan while the growth rate has more of an effect in Korea.

The evidence from Japan and Korea gives implications to many other countries who are currently going through changes in their demography.

Keywords : The elderly, household, financial transaction, demography, life expectancy.

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Risk models for the Japanese double-debt problem

Yuri Imamura[*,1]

Inspired by the classical collective insurance risk model, we introduce a risk model to describe the evolution of a "collective" mortgage repayment in a market in which, in case of natural disasters, the mortgagor is exempt to pay the remaining loan. The model is motivated by the so-called Japanese double-debt problem, which describes the opposite phenomenon, in which a mortgagor still has to pay the remaining loan, although the house was destroyed by a natural disaster, for instance an earthquake. We show that by introducing a very small "insurance" premium in the loan repayment, the probability that the bank will recover its money. We calculate this probability explicitly, in a few concrete scenarios.

This is joint work with Jiro Akahori (Ritsumeikan University), Corina Constantinescu (University of Liverpool) and Hai-Ha Pham   International University, Vietnam - National University HCM City).

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Convergence rates of large-time sensitivities with the Hansen–Scheinkman decomposition

Hyungbin Park[*,1]

This work investigates the large-time asymptotic behavior of the sensitivities of cash flows. In quantitative finance, the price of a cash flow is expressed in terms of a pricing operator of a Markov diffusion process. We study the extent to which the pricing operator is affected by small changes of the underlying Markov diffusion. The main idea is a partial differential equation (PDE) representation of the pricing operator by incorporating the Hansen–Scheinkman decomposition method. The sensitivities of the cash flows and their large-time convergence rates can be represented via simple expressions in terms of eigenvalues and eigenfunctions of the pricing operator. In addition, we discuss the application of our results to three practical problems: utility maximization, entropic risk measures, and bond prices. Finally, as examples, explicit results for several market models such as the Cox–Ingersoll–Ross (CIR) model, 3/2 model and constant elasticity of variance (CEV) model are presented.

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Tempered Stable Processes with Time-Varying Exponential Tails

Young Shin Kim,[*,1]   **Kum-Hwan Roh,**[2]   **Raphael Douady**[3]

In this paper, we introduce a new time series model with a stochastic exponential tail. This model is constructed based on the Normal Tempered Stable distribution with a time-varying parameter. It captures the stochastic exponential tail, which generates the volatility smile effect and volatility term structure in option pricing. Moreover, the model describes the time-varying volatility of volatility. The model empirically indicates the stochastic skewness and stochastic kurtosis in the S&P 500 index return data. We present the Monte-Carlo simulation technique for the parameter calibration of the model for the S&P 500 option prices. We see that the stochastic exponential tail improves the calibration performance.

Keywords : Option pricing, Stochastic exponential tail, Volatility of volatility. Normal tempered stable distribution, Levy process.

JEL classification : C15, C22, G13, G17

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A Gaussian Kusuoka approximation and application to deep learning-based numerical method for high-dimensional PDEs

Toshihiro Yamada[*,1]

We show a new second order Gaussian Kusuoka approximation without solving randomized ODEs. The proposed approximation based on operator splitting and Stratonovich calculus provides a simple algorithm with polynomials of Brownian motion. As applications, deep learning-based numerical schemes are introduced for high-dimensional linear and nonlinear PDEs which can be implemented without suffering from the curse of dimensionality. Numerical examples for 100-dimensional models in financial mathematics are shown to demonstrate the validity.

This talk is partially based on a joint work with Riu Naito.

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Time Stepwise Local Volatility

Hyuncheul Lim,[*,1]

We propose a path integral method to construct a time stepwise local volatility for the stock index market under Dupire's model. Our method is focused on the pricing with the Monte Carlo method and taking the idea in "P. Carr and L. Wu. Static hedging of standard options. Journal of Financial Econometrics, 12:1–44, 2014". We solve the problem of randomness of Monte Carlo method by applying numerical integration. We reconstruct this task as a matrix equation. Our method provides the analytic Jacobian and Hessian required by the nonlinear optimization solver, resulting in stable and fast calculations.

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Exact simulation of multivariate Hawkes process with jump-diffusion CIR intensity

Kazuhiro Yasuda[*,1]

In this presentation, we consider exact simulation algorithm for multivariate Hawkes process with jump-diffusion CIR intensity. Hawkes process is a self-exciting point process and was introduced by A. G. Hawkes in 1971. Since then, it has been widely applied in several fields: seismic events, epidemic, access number of web pages and so on. Recently, Hawkes process and its extended processes have been applied in finance and insurance problems like high-frequency trading, chain bankruptcy and generalization of the Cramer-Lundberg model. Here we consider an extended multivariate Hawkes process which has the jump-diffusion CIR intensity and provide its exact simulation algorithm which generates an unbiased sample path on computational simulation. Finally, we show accuracy of our algorithm through numerical simulation.

This is a joint work with T. Yoshida (Hosei university).

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Computation of the Greeks for complicated options

Tomonori Nakatsu[*,1]

The Greeks are defined by the sensitivities of the price of derivatives with respect to the change of market parameters. In the Black-Scholes model, many closed form representations of the greeks are well known, but the problem is not easy in general models. In this talk, we first show how to compute the vega(sensitivity with respect to the change of volatility) for options depending on the maximum of the price of underlying asset in a general model. Then, we show a formula to compute the delta(sensitivity with respect to the change of the underlying price) for options depending on stopping times. Finally, some formulas for the delta and vega for options depending on the maximum of the underlying price are shown in a more general model.

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Market liquidity, domestic funding liquidity, and stock price synchronicity

Jinyoung Yu,[*,1]   **Doojin Ryu**[2]

This study examines the role of local funding liquidity, beyond that of international funding liquidity, in shaping equity market liquidity. While the improvement in either domestic or international funding supply generally increases stock market trading volume, the effect of local funding liquidity is only significant for the firms with highly systematic or idiosyncratic stock return dynamics. Among investor types, domestic individuals ' trading for idiosyncratic firms substantially increases as local funding supply becomes abundant, providing evidence against the relative synchronicity hypothesis.

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Non-zero-sum optimal stopping game with continuous versus periodic observations

Kazutoshi Yamazaki*,[1]

We introduce a new non-zero-sum optimal stopping game with asymmetric information. Given a stochastic process modelling the value of an asset, one player has full access to the information and observes the process completely while the other player can access it only periodically at independent Poisson arrival times. The first one to stop receives a reward, while the other one gets nothing. The reward function is different for each player. We study how each player balances the maximisation of gains against the maximisation of the likelihood of stopping before the opponent. Under the setting driven by a L vy process with positive jumps, we explicitly construct a Nash equilibrium with values of the game written in terms of the scale function. Numerical illustrations with put-option payoffs are also provided to study the behaviours of the players' strategies as well as the quantification of the value of information.

Joint work with J. L. Perez (CIMAT) and N. Rodosthenous (Queen Mary, University of London).

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Physical ETFs and Synthetic ETFs, What is Really Good?: Compensation channel of Synthetic ETFs

Jinhwan Kim,[*,1]   **Hoon Cho,**[2]   **Sangik Seok**[3]

This study examines the compensation channels of synthetic ETFs, which have additional risks compared to physical ETFs, in an efficient market. We analyze the difference in systematic liquidity risk between synthetic ETFs and physical ETFs using the liquidity-adjusted capital asset pricing model (LCAPM). Our findings suggest that synthetic ETFs have a larger liquidity risk than physical ETFs, and there is an additional risk premium. In addition, we analyze the tracking performance of ETFs by type, and find that synthetic ETFs have lower tracking error. In particular, synthetic ETFs' superiority in tracking performance is more prominent in the liquidity shock period than in the normal period. In summary, synthetic ETFs have significant compensation channels for additional risk in return and tracking performance.

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