Research School of Finance, Actuarial Studies and Statistics
2018 Summer Camp

Day 1: Monday, 26th November

9:30 am **Bus Departs ANU for Peppers Craigieburn**

12.00 pm **Lunch**

1.00 pm **Welcome Message (*Belmore Room*)**

1:10 pm **Combined Session 1 (*Belmore Room*)**
50 min presentation plus 10 min Q&A

Speaker: David Reeb (NUS)
Presentation Title: Dissecting Innovation

2.10 pm **Afternoon Tea (*Alexander Room*)**

2.30 pm **Parallel Session 1**

Finance Session (*Belmore Room*)
ANU session. 6 papers, each gets 4 slides, 10 mins to present + 5 mins questions

- *The BOJ Large-scale Purchases of Equity Index ETFs: Float Reduction and its Impact on Market Frictions*, by Takeshi Yamada
- *Broker network structure and stock liquidity*, by Geoff Warren and Wai-Man (Raymond) Liu
- *Category thinking in financial market*, by Xin Liu
- *Media Exposure and Stock Market Participation*, by Kun Li
- *Shareholder litigation risk and listing gap*, by Nhan Le
- *The Decline of Too Big To Fail* by Antje Berndt

Actuarial Studies Session (*Minters 1910*)
40 mins presentation plus 5 mins Q&A

Presenter: Benjamin Avanzi (UNSW)
Paper Title: Modelling insurance claim counts and reporting delays with Cox processes

Presenter: Aaron Bruhn (ANU)
Paper Title: Teaching ethics and professionalism in university actuarial education

Statistics Session (*Fitzroy Room*)
40 mins presentation plus 5 mins Q&A

Presenter: Guangming Pan (NTU)
Paper Title: PCA under large dimension

Presenter: Boris Buckmann (ANU)
Paper Title: Modelling of electricity prices using nearly alpha-stable processes

4:30 pm **Accommodation Check-in and Free Time**

6:30 pm **Dinner (*Restaurant*)**

After Dinner **Trivia Night (*Belmore Room*)**

Day 2: Tuesday, 27th November

8.00 am **Breakfast (*Restaurant*)**

9.00 am **Combined Session 2 (*Belmore Room*)**
50 mins presentation plus 10 min Q&A

Speaker: Rong Chen (Rutgers)
Presentation Title: New Approaches to Analyzing Modern Time Series

10.00 am **Morning Tea (*Alexander Room*)**

10.30 am **Parallel Session 2**

Finance Session (*Belmore Room*)
30 mins presentation, 10 min discussion plus 5 min Q&A

Presenter: Ali Akyol (U Melbourne)
Paper Title: How Does the Market React When Shareholders Lose Power?
Discussant: Lei Zhang (U Queensland)

Presenter: Olesya Grishchenko (FRB)
Paper Title: Gauging the Sentiment of Federal Open Market Committee Communications through the Eyes of the Financial Press
Discussant: Stephen Brown (Monash)

Actuarial Studies Session (*Minters 1910*)
40 mins presentation plus 5 mins Q&A

Presenter: Rui Zhou (Melbourne)
Paper Title: Evaluating Effectiveness of Rainfall Index Insurance

Presenter: Wai-Man (Raymond) Liu (ANU)
Paper Title: End of life care in Residential Aged Care Facilities: Present and Future

Statistics Session (*Fitzroy Room*)
40 mins presentation plus 5 mins Q&A

Presenter: Jingyuan Chang (Southwestern University of Finance and Economics)
Paper Title: High-dimensional statistical inferences with over-identification: confidence set estimation and specification test

Presenter: Robert Clark (ANU)
Paper Title: Sample Design for Analysis

12.00 pm **Lunch (*Restaurant*)**

1.00 pm **Parallel Session 3**

Finance Session (*Belmore Room*) **30 mins presentation, 10 mins discussion plus 5 min Q&A**	**Actuarial Studies Session (*Minters 1910*)** **40 mins presentation plus 5 mins Q&A**	**Statistics Session (*Fitzroy Room*)** **40 mins presentation plus 5 mins Q&A**
Presenter: Elisabeth Kempf (Chicago) *Paper Title*: Partisan Professionals: Evidence from Credit Rating Analysts *Discussant*: Carola Frydman (Northwestern)	*Presenter*: Jeff Gebler (Milliman) *Paper Title*: Portfolio formulation for Superannuation Funds under real-world objectives	*Presenter*: Garvesh Raskutti (U Wisconsin–Madison) *Paper Title*: Estimation and testing for time series network models
Presenter: Le Zhang (ANU) *Paper Title*: Political connection and peers *Discussant*: Bruce Grundy (Melbourne)	*Presenter*: Jananie William (ANU) *Paper Title*: Gender disparities in retirement: lifetime aged pension liabilities using stochastic mortality assumptions with case studies illustrating policy options	*Presenter*: Kevin Lu (ANU) *Paper Title*: Dependence Modelling with Weak Subordination of Lévy Processes

2.30 pm **Afternoon Tea *(Alexander Room)***

3.00 pm **Free Time**
(*Optional: Golf, bush walking or wine tour departing approximately 2:45PM*)

7:00 pm **Dinner (*Restaurant*)**

Day 3: Wednesday, 28th November

8.00am **Breakfast (*Restaurant*) and Checkout**

9:00am **Combined Session 3 *(Belmore Room)***
50 mins presentation plus 10 mins Q&A

Speaker: Mogens Steffenson (U Copenhagen)
Presentation Title: Consumption-Investment-Insurance Problems

10:00 am **Morning Tea (*Alexander Room)***

10:30am **Parallel Session 4**

Finance Session (*Belmore Room*)
30 mins presentation, 10 mins discussion plus 5 min Q&A

Presenter: Dan Li (CUHK, Shenzhen)
Paper Title: Does Stock Market Liquidity Affect Real and Accrual-Based Earnings Management?
Discussant: Jianxin Wang (UTS)

Presenter: Shikha Jaiswal (UNSW)
Paper Title: Connections and Conflicts of Interest: Investment Consultants' Recommendations or Do Funds Mask Distribution fees as Brokerage Commissions?
Discussant: John Wei (HK Poly)

Actuarial Studies Session (*Minters 1910*)
40 mins presentation plus 5 mins Q&A

Presenter: Greg Taylor (UNSW)
Paper Title: The long road to enlightenment. Loss reserving models from the past, with some speculation on the future

Presenter: Tim Higgins (ANU)
Paper Title: Using copulas for the projection of lifetime income

Statistics Session (*Fitzroy Room*)
40 mins presentation plus 5 mins Q&A

Presenter: Pauline O'Shaughnessy (UOW)
Paper Title: The Role of Statistics in Data Masking: Case study for Smart Electricity Meters

Presenter: Lingbing Feng (JiangXi University of Finance and Economics)
Paper Title: Analysis on China's air pollution data based on multivariate functional clustering methods

12:00pm **Lunch (*Restaurant*)**

1.15 pm **Bus Departs for Canberra**

PAPERS TITLES AND ABSTRACTS

FINANCE

Dissecting Innovation

David Reeb (NUS)

Abstract: Owing to the lack of theoretical guidance, the flourishing, cross-disciplinary literature on innovation generates a large set of determinants of corporate innovation. Surprisingly but understandably, these determinants are not used as a common set of control variables. Leveraging thirty-five previously proposed innovation covariates, we propose a data-driven approach to variable selection to establish a minimum set of common controls. We find that seven variables provide material, independent information about patents and citations. We also evaluate common econometric techniques, such as firm fixed-effects, that are used in lieu of including previously identified innovation covariates and offer guidance for testing the exclusion restriction. Relative to making each researcher pick and choose their control variables, our analysis provides a disciplined approach to incorporating previously identified innovation covariates.

How Does the Market React When Shareholders Lose Power?

Ali Akyol (Melbourne)
Discussant: Lei Zhang (U Queensland)

Abstract: Using the decision made by a corporate vote tabulating firm that limits shareholder power, I examine how the market views shareholder proposals and, in general, whether shareholder empowerment creates value. I find that the overall market reaction to the decision made by the vote tabulating firm was positive, suggesting that the market viewed the limiting of shareholder power favorably. I also find that the type of a proposal as well as its sponsor matters. The market's reaction was negative for better performing firms, for firms that were targets of proxy fights, and for firms that had proposals sponsored by hedge funds. On the other hand, the market's reaction for firms with social responsibility proposals and for firms with proposals submitted by individual investors was positive. My results suggest that it is important to understand how shareholders get involved in corporate affairs to correctly gauge the benefits and costs of shareholder empowerment.

Gauging the Sentiment of Federal Open Market Committee Communications through the Eyes of the Financial Press

Olesya V. Grishchenko (FRB)
Discussant: Steven Brown (Monash)

Abstract: Using articles in the financial press, we use natural language processing to construct an index of the perceived sentiment of FOMC communications around FOMC meetings. Using changes in our index around each FOMC meeting between May 1999 to June 2017 as a measure of monetary policy surprises, we find that changes in market-perceived FOMC sentiment explain movements in asset prices during narrow FOMC event windows. We also document that most of this explanatory power appears to be driven by the sample prior to the zero lower bound period. We compare our results with sentiment indexes constructed using other methodologies in the literature and find that our index has higher explanatory power for movements in various financial asset prices around FOMC meetings, even when we control for financial market-based measures of monetary policy surprises. Through a series of robustness checks, we show that our results are robust to several alternative specifications of our index.

Partisan Professionals: Evidence from Credit Rating Analysts

Elisabeth Kempf (Chicago)

Discussant: Carola Frydman (Northwestern)

Abstract: Partisan bias affects the decisions of financial analysts. Using a novel hand-collected dataset that links credit rating analysts to party affiliations from voter records, we show that analysts who do not support the President's party are more likely to downgrade firms. Our identification approach compares analysts with different party affiliations covering the same firm at the same point in time, ensuring that differences in firm fundamentals cannot explain the results. The effect is more pronounced in periods of increased partisan conflict and during election quarters. Overall, our results suggest that partisan bias and political polarization may have adverse effects on the U.S. economy.

Political connection and peers

Le Zhang (ANU)

Discussant: Bruce Grundy (Melbourne)

Abstract: We examine the mechanisms between political connections and firm value and performance by studying how the political connections affect connected firms and their peers. Following the announcement of anticorruption investigations, we find that industry peers of firms connected to investigated officials decrease in value but not performance, despite connected firms' significant deterioration of value and performance. These results are consistent with an increase in political uncertainty. Interestingly, we document evidence of a transfer of reduced effective tax rates away from connected firms to firms headquartered in the same city, mitigating the negative impact of the increase in political uncertainty.

Does Stock Market Liquidity Affect Real and Accrual-Based Earnings Management?

Dan Li (CUHK, Shenzhen)

Discussant: Jianxin Wang (UTS)

Abstract: In this paper, we study the effect of stock market liquidity on earnings management. Using a sample of U.S. public firms over the time period from 1993 to 2013, we show that firms with more liquid stocks have lower level of both real activities and accrual-based earnings management. The results are robust to the use of various measures of liquidity. We address the endogeneity problem by using several sources of exogenous shocks to stock liquidity, i.e. Decimalization regulation and pilot program before Decimalization. After establishing the causal effect of stock liquidity on earnings management, we further find that stock liquidity curbs earnings management by mitigating the information asymmetry between managers and shareholders and facilitating governance by large institutional investors.

Connections and Conflicts of Interest: Investment Consultants' Recommendations or Do Funds Mask Distribution fees as Brokerage Commissions?

Shikha Jaiswal (UNSW)
Discussant: John Wei (HK Poly)

Abstract: Plan sponsors rely on investment consultants' recommendations for hiring money managers to manage their plan funds. Often these investment consultants have their own investment management firms, or have business connections with investment managers, creating a conflict of interest. I find strong evidence that consultants bias hiring decisions towards their connected managers: a direct connection to a consultant increases a manager's odds of being hired by 637%, while an indirect connection increases the odds by 301%. The hiring decisions are less sensitive to past performance and management fee when connected managers are hired. I further find that, post hiring, the funds managed by the connected managers underperform significantly relative to the funds managed by the unconnected managers.

Consumption-Investment-Insurance Problems

Mogens Steffensen (U Copenhagen)

Abstract: We consider generalizations of the classical continuous-time consumption-investment problem with fixed time horizon. The generalizations include uncertain lifetime with access to life insurance and events like disability or unemployment with access to insurance, correspondingly. We discuss how frictions in the market can solve the so-called life insurance and life annuity puzzles. We also discuss the separation of risk aversion (aversion towards consumption uncertainty) and elasticity of intertemporal substitution (aversion towards consumption variability over time) with and without presence of insurable life events. This relates to so-called recursive utility. Aversion towards consumption variability in different states of the lifecycle model can explain the observed hump-shaped pattern of consumption, even among patient consumers paying a fair price for insurance. All works and results can be seen as input to better product advice and better product design of life insurance and pension savings products.

Modelling insurance claim counts and reporting delays with Cox processes

Benjamin Avanzi (UNSW)

Abstract: The accurate estimation of the outstanding liabilities of an insurance company is an essential task. This is to meet regulatory requirements, but also to achieve efficient internal capital management. Over the recent years, there has been increasing interest in the utilisation of insurance data at a more granular level, and to model claims using stochastic processes. So far, this so-called 'micro-level' approach has largely focused on the Poisson process. Our presentation is based on Avanzi et al. (2016b, 2017), which introduce a multivariate Cox process approach to model the arrival process and reporting pattern of insurance claims. This allows for overdispersion and serial dependency in claim counts, which are typical features in real insurance data. We explicitly consider risk exposure and reporting delays, and show how to use our model to predict the numbers of Incurred-But-Not-Reported (IBNR) claims. We will focus on shot noise processes, and introduce dependencies using either common shocks, or L´evy copulas (see, e.g., Avanzi et al., 2011, 2016a). We develop a Reversible Jump Markov Chain Monte Carlo (RJMCMC) filtering algorithm to estimate the unobservable intensity of the Cox process, and use an EM algorithm for parameter estimation and prediction. The model is calibrated and illustrated using real data from the AUSI data set. The AUSI dataset was developed as part of a Linkage Project grant awarded by the Australian Research Council (ARC) for a project titled Modelling claim dependencies for the general insurance industry with economic capital in view: an innovative approach with stochastic processes. Its name is an acronym combining of the names of the project partners (Allianz Australia Insurance Ltd, UNSW Australia, Suncorp Metway Ltd, and Insurance Australia Group Ltd).

Teaching ethics and professionalism in university actuarial education

Aaron Bruhn (ANU)

Abstract: The teaching of professionalism and ethics can present challenges within the University environment. This is due to many students not having a hands-on familiarity with real life challenges in the workplace; not yet being immersed in the nuances of professional rights and responsibilities; and often a perception that such issues can be 'dry' and an afterthought to the belief that technical skills alone are sufficient to succeed as an actuary. This talk briefly outlines a few approaches adopted within the actuarial studies program at the Australian National University, that endeavour to overcome the above challenges.

Evaluating Effectiveness of Rainfall Index Insurance
Rui Zhou (Melbourne)

Abstract: Rainfall index insurance, whose payouts are determined by a transparent rainfall index rather than actual crop yield of any producer, circumvents problems of adverse selection and moral hazard. We derive an optimal insurance portfolio that minimizes the income variance for a crop producer and examine the reduction of crop yield uncertainty using rainfall index insurances. We illustrate our approach with the corn yield in Illinois east crop reporting district and weather data of a city in the same district. Our analysis shows that corn yield in this district is negatively influenced by excessive precipitation in May and drought in June, July, and August. Rainfall index insurance portfolio can reduce the income variance by up to 51.84%. The optimal insurance portfolio obtained provides insights on the practical development of rainfall insurance for corn producers, from the selection of triggering index to the demand of the insurance.

Portfolio formulation for Superannuation Funds under real-world objectives
Jeff Gebler (Milliman)

Abstract: The purpose of superannuation is to provide an income in retirement. However, the superannuation industry has to date viewed superannuation as an investment problem with solutions posed by investment professionals. Portfolio construction frameworks commonly used in superannuation funds do not reflect the objectives of the end users. Metrics typically used for setting and communicating asset allocations include expected real annual returns or the likelihood of negative returns every 20 years. These metrics are investment concepts divorced from retirement objectives and will not answer questions such as “will I be able to retire comfortably?

The long road to enlightenment. Loss reserving models from the past, with some speculation on the future
Greg Taylor (UNSW)

Abstract: This address canvasses the history of loss reserving, commencing with the chain ladder and its derivatives. These early approaches were not models in the generally accepted sense. Their subsequent development into genuine stochastic models is considered. Their limitations are also considered, along with various extensions aiming to mitigate those limitations. The progression to more mainstream statistical methods is followed, and then the modern era progression to granular models and machine learning. Some conjectures on the future are offered.

End of life care in Residential Aged Care Facilities: Present and Future
Wai-Man (Raymond) Liu (ANU)

Gender disparities in retirement: lifetime aged pension liabilities using stochastic mortality assumptions with case studies illustrating policy options
Jananie William (ANU)

Using copulas for the projection of lifetime income
Tim Higgins (ANU)

STATISTICS

New Approaches to Analyzing Modern Time Series

Rong Chen (Rutgers)

Abstract: The BIGDATA era, many new forms of data have become available and useful in various important applications. When these data are observed over time, they form new types of time series that require new statistical models and analytical tools in order to extract useful information, discovery important dynamics and make predictions. In this talk we present new developments in analyzing matrix time series, dynamic traffic networks, functional time series and compositional time series, with applications ranging from economics, finance, international trade, electricity loading and others. We will also briefly discuss approaches on modeling other forms of time series, including text time series, dynamic social network and tensor time series.

PCA under large dimension

Guangming Pan (NTU)

Abstract: The talk is about the spiked eigenvalues of sample covariance matrices under the large dimension. It is often the case that the population eigenvalues are significantly bigger than the remaining population eigenvalues. We will discuss the asymptotic distribution of the largest spiked eigenvalues and the asymptotic properties of the eigenvectors. The joint distribution of the largest eigenvalue and the linear spectral statistics will be explored as well.

Modelling of electricity prices using nearly alpha-stable processes

Boris Buckmann (ANU)
joint and ongoing work with Professor Gernot Mueller (U Augsburg)

Abstract: Time series models are used to describe various quantitative phenomena in nature, engineering and economics. The main idea is that a diving stationary noise could be detected after disentangling of various deterministic patterns such as trend or seasonality. Being an emerging markets, electricity market tend to be in non-stationary phenomena. Their trading systems are adapted regularly and are subject to change as are the strategies of their traders. Hanging in a highly sensitive balance between demand and supply, sudden demand failure (e.g. failure of a power plant) creates positive spikes of electricity prices, while negative prices occur when the demand is unexpectedly low in comparison to the current electricity production. The price returns to a mean level determined by a well-working supply and a demand-as-predicted. To the dynamics of electricity prices, Benth, Klueppelberg Mueller and Voss (2014) proposed a three-component additive model, consisting of a deterministic trend and seasonality function, a CARMA process driven by a stable Levy process for the spikes, and an additional normal inverse Gaussian process. Mueller and Seibert (2016) developed a Bayesian estimation procedure to conduct a rolling window analysis for electricity price data taken from the European Energy Exchange EEX. The estimates of the stability parameter increased from about 1.50 in 2007 to about 1.75 nowadays while the skewness parameter changed its sign from positive to negative. In present talk we define a new class of driving noise processes NASA (nearly alpha-stable additive) processes a class of additive processes, which behave locally similar to stable processes, but allow the stable parameters to vary over time. This class captures the time-changing behaviour regarding spikes and skewness. Under mild conditions, the NASA processes have similar convergence properties as stable processes, while being semimartingales. We estimate a NASA processes with smoothly changing parameters which is the most relevant one for practical applications in the analysis of EEX electricity prices.

High-dimensional statistical inferences with over-identification: confidence set estimation and specification test

Jingyuan Chang (Southwestern University of Finance and Economics)

Abstract: Over-identification is a signature feature of the influential Generalized Method of Moments (Hansen, 1982) that flexibly allows more moment conditions than the model parameters. Investigating over-identification together with high-dimensional statistical problems is challenging and remains less explored. In this paper, we study two high-dimensional statistical problems with over-identification. The first one concerns statistical inferences associated with multiple components of the high-dimensional model parameters, and the second one is on developing a specification test for assessing the validity of the over-identified moment conditions. For the first problem, we propose to construct a new set of estimating functions such that the impact from estimating the nuisance parameters becomes asymptotically negligible. Based on the new construction, a confidence set is estimated using empirical likelihood (EL) for the specified components of the model parameters. For the second problem, we propose a test statistic as the maximum of the marginal EL ratios respectively calculated from individual components of the high-dimensional moment conditions. Our theoretical analysis establishes the validity of the proposed procedures, accommodating exponentially growing data dimensionality, and our numerical examples demonstrate good performance and potential practical benefits of our proposed methods with high-dimensional problems.

Sample Design for Analysis

Robert Clark (ANU)
Joint work with David Steel, University of Wollongong

Abstract: Many surveys and observational studies are conducted to support regression and other analyses. However, most sample design methods are aimed at the calculation of descriptive statistics such as means, totals and proportions. This talk will present some new general results on sample design for regression analysis, assuming weighted regression. Unlike existing methods, we allow the design variables to be related to the dependent variable of interest, the covariates of interest, or both. The special case of multivariate normality provides some insights into what optimal sample designs should look like. Simulations are used to explore more complex problems and some practical guidelines are proposed.

Estimation and testing for time series network models

Garvesh Raskutti (U Wisconsin–Madison)

Abstract: Estimating networks from multi-variate time series data is an important problem that arises in many applications including computational neuroscience, social network analysis, and many others. Prior approaches either do not scale to multiple time series or rely on very restrictive parametric assumptions in order to guarantee mixing. In addition to estimation, determining suitable confidence intervals for the presence or absence of edges is of great importance. In this talk, I address these challenges through a series of approaches. In particular, I first provide estimation error guarantees for both parametric and non-parametric network estimation schemes. Then I provide a hypothesis testing framework which allows the construction of confidence intervals for the presence of network edges using the de-biasing technique developed for confidence intervals in high-dimensional statistics. Our approaches are validated on a number of real data examples including Chicago crime data, multi-variate news data and spike train data.

Dependence Modelling with Weak Subordination of Lévy Processes

Kevin Lu (ANU)
Joint work with Boris Buchmann and Dilip Madan

Abstract: Lévy processes are often used to model random phenomena that exhibit stationary and independent increments. Strong subordination is the operation that evaluates a Lévy process at a subordinator, creating a time-changed process. A prominent example is Madan and Seneta's variance-gamma process, which has been applied to model stock prices in finance. In the multivariate setting, unless the subordinate has independent components or the subordinator has indistinguishable components, strong subordination may not produce a Lévy process. We discuss weak subordination, which extends strong subordination and allows for dependence across multiple components to be parsimoniously modelled while remaining in the class of Lévy processes. Weak subordination is applied to extend the class of variance generalised gamma convolutions. We focus on the particular example of the weak variance-alpha-gamma process, formed by weakly subordinating Brownian motion, possibly with dependent components unlike strong subordination, with an alpha-gamma process. We show that this process can be used to model broader dependence structures than the variance-alpha-gamma process, where strong subordination is used instead. We outline a method for simulating such processes and compare three parameter estimation methods: method of moments, maximum likelihood and digital moment estimation, and discuss conditions for Fourier invertibility.

The Role of Statistics in Data Masking: Case study for Smart Electricity Meters

Pauline O'Shaughnessy (UOW)

Abstract: Given the rapid growth in big data analysis as a tool for commercial insight, many organisations often outsource the analyses of the data they collect in-house to a third-party firm specialising in data analysis. In other cases, institutions may acquire external data of customers of other institutions, for example in the area of fraud detection in the finance sector. Situations as such often present a potential for breaching of privacy. Whilst the rise of big data has created an entirely new industry in the past few decades, the handling of sensitive data presents a privacy concern for individuals. This is indeed a challenge for businesses desiring insights from data: how can a firm meet its need for accurate and meaningful analysis while protecting individual's need for privacy? We use `smart meter' as an example. Smart meter is an emerging technology in the energy industry that records time-series electricity consumption data. Such time-series data provides a high-resolution view of individual dwelling's demand, providing observers opportunity to obtain sensitive information regarding the dwelling, including the number of occupants and their daily schedule. One way to simultaneously ensure individual privacy and control the quality of analysis is data masking. As its name suggests, data masking is a technique, which masks the original value of the data while still keeps the desirable statistical properties. We will illustrate two data masking techniques, i.e., the differential privacy method and the multiplicative noise method.

Analysis on China's air pollution data based on multivariate functional clustering methods

Lingbing Feng (JiangXi University of Finance and Economics)

Abstract: This work investigates the spatio-temporal patterns of the China's atmospheric environment. We extend a method based on the functional discriminative latent mixture (DLM) model to a multivariate case to solve the functional clustering problem. This method focuses on the most discriminative functional subspace linked to the original functional data by maximizing the between-class variance while minimizing the within-class variance of a lower-dimensional discriminative subspace. We apply this method to cluster the mass concentrations of six main atmospheric pollutants across 364 cities in China in 2016. We discover significant characteristics of locally spatial distribution in the clustering results and visualizations of the structure of the orientation matrix, and we can gain more insight into the discriminative latent subspace and temporal patterns of each functional variable from the projected data in clusters. In addition, we perform variable selection based on the multivariate functional DLM model on the same atmospheric pollutants to improve the efficiency of interpretation.