Which factors are relevant for asset prices?

Much research effort has focused on developing estimation methodologies and models aiming to identify the relevant factors for pricing the cross-section of stock returns, meaning the change in average returns across different stocks. Traditional asset pricing models with many factors can no longer cope with the dimensionality of present-day problems. Moreover, relying on misleading results could end in disastrous financial consequences. Professor Francesco Audrino at the University of St. Gallen and Swiss Finance Institute, Switzerland, is using methods developed by the machine learning community to overcome this problem. He demonstrates the suitability of Lasso-type methods for predicting the cross-section of returns and reveal how the true firm characteristics driving these forecasts are determined.

Innovation and financial liberalisation have led asset prices to be important factors in propelling economic variation and influencing the strength and stability of financial systems. Investors and policymakers, together with public and private institutions, rely on being able to understand the behaviour of asset prices for their financial economic success. The accurate identification of common factors, or characteristics, influencing joint asset price dynamics enables investors to design profitable trading strategies for the timely exploitation of investment opportunities and enables them to assess the risk associated with portfolio allocations. Furthermore, it helps policymakers to keep the health of the global financial system under control and implement actions to correct distortions if required.

It is therefore unsurprising that much research effort has focused on developing estimation methodologies and models aiming to identify the relevant factors for pricing the cross-section of stock returns. During the past decade, both improvements in technology and the convenience of large data sources have transformed the landscape of suitable methods available for dealing with these asset pricing tasks. Most of the asset pricing models with many factors traditionally used in the literature, however, cannot cope with the dimensionality of present-day problems where policymakers and investors are challenged with identifying the main factors, or firm characteristics, from several hundred proposed factors. This is referred to as the factor zoo – a term coined in 2011 by Professor John Cochrane of the University of Chicago in his presidential address to the American Finance Association. Moreover, relying on misleading results could result in disastrous financial consequences.

Researchers are now looking to other fields for inspiration. Professor Francesco Audrino from the University of St. Gallen and Swiss Finance Institute, Switzerland, is using methods developed by the machine learning community to overcome this problem. In his empirical study, Audrino uses simulation to investigate the selection of firm characteristics for prediction. He analyses the predictive performance of a range of methodologies using the US cross-section of stock returns spanning more than four decades.

OVERCOMING THE HIGH VARIANCE PROBLEM

Economists and financiers are regularly challenged with predicting targets, selecting variables, and estimating coefficients. Estimates are typically acquired using ordinary least squares (a method for estimating the coefficients of linear regression equations describing the relationship between independent and dependent variables) and often involve a large variance. It follows that decisions surrounding the relevance of coefficients are accompanied with a high degree of uncertainty.

Asset price dynamics influence the strength and stability of financial systems.

Audrino describes how machine learning offers alternative methods that allow a small bias in order to reduce the variance incurred in estimating linear models. These include the Lasso (least absolute shrinkage and selection operator) method. Reducing the effects of sampling variation is known as shrinkage. The Lasso method selects and regularises variables to improve both the accuracy and interpretation of the ensuing statistical model. A modified model, the adaptive Lasso, maintains the advantages of absolute shrinkage under less stringent conditions.

PREDICTING CROSS-SECTION OF RETURNS

The comparison of a particular company with its industry peers is known as cross-sectional analysis. This analysis involves the examination of cross-sectional returns to find out how the average returns vary across different portfolios. Audrino examines various Lasso and factor models to establish whether he can improve on the predictive accuracy of ordinary least squares in the selection of pertinent firm characteristics to forecast the future cross-section of stock returns. Employing these shrinkage methods for predicting stock returns allows the researcher to examine which characteristics contain true predictive information for the cross-section of expected returns.

Using simulated data, Audrino analysed the methods' properties to verify that the results are reliable and accurate in an artificial setting. Machine learning techniques are highly sophisticated and usually rely on many tuning parameters, so they can be unstable, and their results can be difficult to estimate. This verification process allowed Audrino to understand any deficiencies that appear as well as interpreting the outcomes of the analysis correctly.

METHODS FOR ASSET PRICING FACTOR ZOO

The second phase of this investigation involved the application of the methods to a large dataset made up of cross-section of US stock returns together with 62 published firm characteristics covering the period from 1974 to 2020. Audrino limited his selection and prediction procedure based on a multivariate regression consistent with the original models used in the literature. Rather than relying on multivariate regression, he employed the adaptive Lasso method.

To find out if Lasso-type linear methods can improve the predictive accuracy in the selection of relevant firm characteristics for predicting future cross-sections of stock returns, Audrino performed an extensive Monte Carlo simulation – a technique that predicts the possible outcomes of uncertain events that analyses past data to predict a range of future outcomes supported by a choice of action. He compared the models' accuracy based on their ability to select the actual firm characteristic that was informative for prediction and on their overall predictive performance.

The main firm characteristic for prediction was price information, whereas the characteristic selected most often was short-term reversal.

Audrino used simulated data to verify that his method produces reliable results.

Investors and policymakers, together with public and private institutions, rely on being able to understand the behaviour of asset prices for their financial economic success.

WHICH FACTORS ARE RELEVANT FOR ASSET PRICES?

Both the Lasso and the adaptive Lasso methods generated better predictive results than their classical alternatives. Further analysis of the results revealed several advantages in using the adaptive Lasso rather than the Lasso in the selection of the true set of firm characteristics. The adaptive Lasso selected 21 relevant US firm characteristics, whereas the Lasso selected 47 factors. On the other hand, Lasso-type predictions were better in cases where the main aim was predictive accuracy. The main firm characteristic for prediction was price information, whereas the characteristic selected most often was short-term reversal. When compared with ordinary least squares, the adaptive Lasso was superior at reducing type II error ratios (when a false negative occurs, for example, not rejecting the target hypothesis when it is actually false) and at controlling firm characteristics that were likely to be affected by publication bias.

LINEAR METHODS FOR SMALL AND MICRO-CAPITALISED STOCKS

The empirical analysis also demonstrates that small-capitalised stocks can be reliably predicted using shrinkage models based on a rich 'zoo' of firm characteristics. This study concurs with previous literature that the use of linear methods for prediction is primarily limited to small and micro-capitalised stocks. In contrast, large-capitalised stocks are not predictable with these linear methods. This means that measuring the predictive differences between the various linear methods is an arduous task due to the lack of predictability of large-capitalised stocks.

Small-capitalised stocks can be reliably predicted using shrinkage models based on a rich 'zoo' of firm characteristics.

Audrino demonstrates the suitability of Lasso-type methods for predicting differences in expected cross-sectional returns. He also reveals how the true firm characteristics driving these forecasts are determined, as well as discussing their comparison with traditional approaches. Together with their empirical evaluation, the simulation study elucidates the properties of the methods. His research also contributes to several threads within the literature. In analysing the suitability of Lasso-type methods for the selection of relevant firm characteristics for the estimation and prediction of expected cross-sectional stock returns, it contributes to the asset pricing literature. This is evident through the reviews of the various estimation methods, research questions and the introduction of firm characteristics in relation to asset pricing. This study also links to the literature surrounding the properties of shrinkage approaches within financial settings. Moreover, it demonstrates how the desire to improve the predictability of ordinary least squares estimates and avoid the limitation of traditional selection and regression inspired the development of the Lasso-type asset pricing models.

Behind the Research

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Research Objectives

Professor Audrino analyses the predictive performance of different machine learning based asset pricing models.

Detail

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Bio

Francesco Audrino is Professor of Statistics at the University of St. Gallen. He has been the academic director of the PhD programme in Economics and Finance since 2011. His research lies at the intersection between computational statistics and financial econometrics. Audrino is the author of many publications in statistics, econometrics, and finance.

Collaborators

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References

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Personal Response

What has been the most rewarding outcome of your research to date?

"Starting in the early 2000s, my contributions to the literature were among the first pioneering studies investigating the suitability of methods coming from statistical learning for concrete financial applications. It is extremely rewarding to see how nowadays a large body of methods dealing with the same questions is related directly or indirectly to the results of my studies and that methods coming from the machine learning community are becoming a standard also in economics and finance. Lasso-type asset pricing models are one example of this phenomenon. All this means that my innovative research agenda had a lot of potential as I suspected."