Empirical Asset Pricing Models

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Data, Empirical Verification, and Model Search

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PREFACE

This book discusses several issues concerning the construction of empirical asset pricing models, including: (1) the setting of essential properties in asset pricing models of stock returns, (2) the statistical inferences that can be applied to verify the necessary properties of empirical asset pricing models, and (3) the model search approach where any model can be considered as only a tentative approximation for asset returns given their time-changing nature.

The main aim of the book is to verify that statistical inferences and time series analysis for asset returns should not be confined to the verification of certain structures or variables based simply on statistical significance alone. These statistical verifications can only be meaningful if the intent or hypothesis for the model is related to the properties developed in the theoretical setting of asset pricing models where systematic components of asset returns are considered.

Blaming the existing models for their deficiency or lack of forecasting superiority is not necessarily a solid way to refute the theories. In fact, unless we have some solid understanding of the ultimate mechanism of stock returns, it is premature to claim the depletion of current existing theories based only on predictability or forecasting. A rigorous justification must originate from more profound alternatives that may belittle the currently existing theoretical framework. Profitability (through forecasting, for instance) can't even be a unique determinant for the validity of empirical models on asset returns.

Speculative profits (through forecasting) may result from technical analysis where no theoretical background of financial economics (or anything

else) is discussed at all. Superiority in forecasting with certain proposed models or mechanisms may prevail with short-term horizons among different data sets. Yet, it is not surprising to find that this advantage quickly resolves over time which entails the needs to update and modify the presumed models continuously. Thanks to their properties, this is precisely why financial markets are sufficiently interesting to attract enormous resources in exploring the quintessence of their evolving mechanism. What is really essential for empiricists is how to accommodate this possibly time-changing nature of stock returns, and to strive for the pricing kernels with meaningful interpretation of them.

Part I of this book covers the essential properties of theoretical asset pricing models, especially when linear (factor-pricing) models are of interest. Since the focus of the book is on empirical asset pricing models, only discrete-time models are discussed. From the theoretical issues, the conventional specification tests are also discussed with their possible implications for the models of interest. This leads to the discussion of model searching with various model selection criteria where emphases are mainly of reduction of dimensionality and predictability.

Given the pitfalls of these model selection criteria, Part II provides an alternative methodology where various justifications of the cross-sectional properties of stock returns is emphasized and additional model searching is devised with the specification tests provided. Hence the aim of this book is to reconsider the necessary cautions involved in the analyses of empirical asset pricing models and to provide some alternatives. The book may be used as a technical reference for researchers, graduate students, and professionals who are interested in exploring the possible alternatives that may provide more tractable methods for empirical asset pricing models for various applications in the future.

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Introduction

Ever since the pioneering work of the capital asset pricing model, theoretical and empirical discussion on the pricing kernel of asset returns has been huge in the financial economics literature. Although many alternative methodologies and theories have been devised, the difficulty in empirical application of asset pricing models still remains unresolved in many areas such as model instability over different time horizons, variable selection on proxies for factors, and (possibly) applicable robust statistical inferences. It is likely that we will discover that an empirical asset pricing model, once selected, can only apply to a certain time period before the model validity quickly disappears when an extended time horizon or data set is considered.

Unfortunately, this phenomenon seems to prevail in many data sets (domestic or foreign) that are applied. The disappointing results in turn lead to the pervasive discontent with the theoretical foundation of asset pricing models. Emphasis on (time series) predictability becomes the norm for model validity for empirical asset pricing models. With the keen demand for validating empirical asset pricing models, statistical verification (with predictability and specification tests) when certain proxies or variables of interest are used becomes the mainstream for financial time series modeling on asset returns.

Essentially, emphases in finding the common features or characters of asset returns (in an attempt to reduce the dimensionality, for instance) through statistical significance should be dealt with using additional caution since these features, once identified, may only prevail tentatively (or contempornaeously) over the selected time horizon.

Part I surveys (a) the quintessential issues of asset pricing models as the pricing kernels for asset returns and (b) the conventional specification tests that consider the possible reduction of dimensionality with statistical significance, which leads to (c) the importance of model searching for the normal (or expected) returns where model selection criteria are applied. Although various specification tests or model selection criteria have been developed for empirical asset pricing models, few of them emphasize the prerequisite that these included variables (in empirical asset pricing models) should satisfy the systematic properties of pricing kernels such as non-diversifiability so that the separation between normal (or expected) returns and abnormal returns or idiosyncratic risks can be well stated.

In essence, empirical asset pricing models must fulfill a set of more restrictive conditions whereas statistical significance in explanatory power (such as p-value) on certain (pre-)selected variables can only be considered as exploratory. After all, as the purpose of empirical asset pricing models is to identify the intrinsic structure that governs the (possibly time-changing) core or pricing kernel of asset returns, statistical inference of the significance of certain variables or structures is not entirely sufficient.

Developments on the conventional studies in testing empirical asset pricing models focus mainly on asymptotic arguments of time series data. However, for the validity of any empirical asset pricing model, the focus should be on whether the set of selected variables or proxies by which one attempts to explain the pricing kernel of asset returns constitutes the cross-sectional (asymptotic) commonality among the asset returns or not. It appears, if experience in empirical finance is applied, that identification of some statistically significant explanatory variables for asset returns is not too difficult to provide.

The difficulty, however, is whether these identified variables or proxies truthfully reveal the essential (cross-sectional) commonality of asset returns or not. What is misleading in many empirical findings is that the essence of asset pricing models as pricing kernels was sacrificed when statistical verification of the significance and predictability of explanatory variables in the presumed models is advocated through time series data.

Notice that this empirical verification (of predictability) is mostly (if not all) based on known or collected time series data. As a matter of fact in empirical finance, even if the verification is carried out through out-of-sample time series data, these data are usually known in advance. In other words, the models are fitted with a given training sample of presumed time horizon. And then, time series forecastability is verified with the

left-over data in the data set which the modeler has already obtained. The major dilemma lies in the trade-offs as to whether the model specification on empirical asset pricing models is to find something that may help to describe the (short-run) dynamics of asset returns or to identify the quintessence of pricing kernels when short-run predictability could be sacrificed.

Although these trade-offs are not immediately clear-cut, given the notorious time-changing nature of financial markets, it is unlikely that there exists an omnipotent model that encompasses all others across all time horizons. To the best that can be shown, the winning model (through statistical verification or otherwise) only represents a tentative explanation or approximation for the underlying pricing kernel of asset returns. Time changes everything.

Hence, even with the contemporaneous model that encompasses all other competitive alternatives, the empirical result only shows the current notion for the underlying determinant of asset returns. What is more critical, however, is whether the tentative model obtained helps us understand more about the pricing kernel of the asset returns or not. And perhaps more essentially, it helps us to modify diligently the model(s) for different time horizons or data sets.

In Chap. 1 of Part I, the discussions focus on the conventional linear models for asset returns. Given the enormous volume of literature on asset pricing models, this book only surveys and develops the discussions on parametric model building and variable selection. The recent developments on semi-parametric (factor) modeling for asset pricing are also briefly discussed.

Starting from the capital asset pricing model (CAPM), the methods for reduction of dimensionality are covered where factor-pricing models are typical examples. It is not too difficult to find that the empiricist in applied finance may criticize these models as somewhat useless in the usage of profit-taking transactions. Nonetheless, from the perspectives of the financial economist, this is precisely the result of a properly working market mechanism where the advantage in any attempt at speculative opportunity should quickly resolve to zero. Does this mean that these theories are all useless in empirical application? We can only be sure if we have some better theories to explain the mechanism of capital markets and the ultimate determinants for pricing kernels of stock returns.

Although many alternative approaches such as the nonlinearity and behavioral assumptions are developed, the question to ask is "Are these

alternative approaches good enough to substitute for the original models we have?" or "Are they competitive enough to provide better insights for the pricing mechanism of stock returns?" Up to the current date, these known alternatives (or models), although rigorous and promising, remain as supplementaries, but they are inadequate as substitutes for existing theories on the pricing kernels of stock returns.

For empirical asset pricing models, the basic criteria for model building are: (1) the procedures for identifying a (or a group of) proper model(s) should be easy to implement in statistical inferences (or with other analytical tools); (2) these candidate models must have well-established theoretical foundations to support the findings; and (3) they provide further directions to cope with the developing status of information and model searching.

Chapter 2 in Part I, for instance, will discuss the methodologies that are currently applied in empirical asset pricing models on asset returns. The chapter includes up-to-date coverage on theoretical setting and model specification tests developed for empirical asset pricing models. However, it is not difficult (in empirical application) to find that these identified, presumed to be economic, variables may not necessarily provide better specification and forecasts than the application of simple time series modeling of asset returns. Chapter 3 in Part I surveys the model selection criteria in determining the number of factors of asset returns. Chapter 4 in Part II discussed alternative methods for detecting hidden systematic factors without assuming that there exists a correct factor structure. Chapter 5 considers model search in empirical asset pricing models.

As such, the search for empirical asset pricing models cannot be succinctly accomplished with the in-sample statistical inferences over some limited time horizons or data sets. Various model specification tests have been developed toward robust methods in (dynamic) asset pricing models. However, it seems that most analyses emphasize the asymptotic properties from time series perspectives. One possible reason for this is that the shadow of forecastability still plays an essential role in the robustness of empirical asset pricing models. Nevertheless, what is essential in such models is the strength of (cross-sectional) coherence or association for these identified economic variables/factors that possibly describes the intrinsic mechanism or pricing kernel of asset returns.

Given the evolving nature of these pricing kernels, forecastability of presumed models over an out-of-sample time horizon is usually limited. Instead, tractability is the goal for empirical asset pricing models: that

model specification should emphasize the capability and properties of the underlying intrinsic mechanism of asset returns (or so-called pricing kernels) to administer and accommodate the model search when various available information is applied. The interest of study should be on what method (or methods) is (are) to apply in the search for empirical asset pricing models which is often perceived as evolving through time where many data sets have been applied to trace them. Hence, a model search for empirical asset pricing models should focus on the fundamental properties that any pricing kernel (based on any available information) should prevail in addition to the statistical significance of certain (economic) variables identified or their forecastability.

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