

Present Value and Predictable Returns (1)

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Outline

- Market efficiency
 - ▶ Joint hypothesis problem
 - ▶ Literature classification
- Autocorrelations of stock returns
 - ▶ Variance ratio statistic
 - ▶ Empirical evidence

Market Efficiency

Fama (1970): “Prices fully reflect all available information”.

Malkiel (1992, *New Palgrave Dictionary of Money and Finance*): “A capital market is said to be efficient if it fully and correctly reveals all available information in determining security prices. Formally, the market is said to be efficient with respect to some information set, ϕ , if security prices would be unaffected by revealing that information to all participants. Moreover, efficiency with respect to an information set, ϕ , implies that it is impossible to make economic profits by trading on the basis of ϕ .”

Note contrast between price metric and return metric.

The Joint Hypothesis Problem

"It is impossible to make economic profits" implies

$$R_{i,t+1} = \Theta_{it} + U_{i,t+1}.$$

- Θ_{it} is the equilibrium return on asset i generated by some economic model.
- $U_{i,t+1}$ is a fair game with respect to the information set at t .
- Given the economic model, market efficiency is equivalent to rational expectations.
- The *joint hypothesis problem* is that market efficiency is not testable except in combination with a model of expected returns.
- Is the reverse true?

Classification of the Market Efficiency Literature

What information set?

- *Weak form efficiency*. Past returns.
- *Semi-strong form efficiency*. Past publicly available information, e.g. stock splits, dividends, earnings.
- *Strong form efficiency*. Past information, even if only available to insiders.

Classification of the Market Efficiency Literature

What economic model?

- *Cross-sectional.* Average returns over t and consider various i .
 - ▶ Tests of the CAPM can be thought of as joint tests of the CAPM and market efficiency.
- *Time-series.* Fix i , model returns over t .
 - ▶ Simplest model is $\Theta_{it} = \Theta$, a constant.
 - ▶ Early literature relied on this, but evidence for return predictability has stimulated the development of equilibrium models with time-varying expected returns.
 - ▶ Much of this work concentrates on the behavior of an aggregate stock index.
- *Panel.* Model both cross-sectional and time-series variation jointly.
 - ▶ This is where the literature is moving.

Classification of the Market Efficiency Literature

What data frequency?

- High frequency predictability, e.g. from market illiquidity (bid-ask bounce), or sluggish reaction to information, or disposition-effect trading by individual investors.
 - ▶ Comparatively easy to detect if present.
 - ▶ Hard to explain using a risk-based model.
 - ▶ Has small effects on prices.
 - ▶ Can disappear quickly once detected by arbitrageurs.
- Low frequency predictability, e.g. from gradually changing risk or risk aversion, or slow changes in sentiment of irrational investors.
 - ▶ Long time series are needed to detect this.
 - ▶ There may be several plausible explanations.
 - ▶ Potentially large effects on prices.
 - ▶ Hard to arbitrage away.

Famous Quotes on Market Efficiency

Samuelson "micro efficiency, macro inefficiency".

Michael Jensen (1978): "There is no other proposition in economics which has more solid evidence supporting it than the Efficient Markets Hypothesis".

Robert Shiller (1984): "Returns on speculative assets are nearly unforecastable; this fact is the basis of the most important argument in the oral tradition against a role for mass psychology in speculative markets. One form of this argument claims that because real returns are nearly unforecastable, the real price of stocks is close to the intrinsic value, that is, the present value with constant discount rate of optimally forecasted future real dividends. This argument... is one of the most remarkable errors in the history of economic thought".

Autocorrelations of Stock Returns

- If expected returns are constant, returns should have zero autocorrelations.
- Asymptotic standard error for a single autocorrelation is $1/\sqrt{T}$ under null of iid returns.
- Problem: plausible alternative models have small autocorrelations which cannot easily be detected.
- Under null of iid returns, different autocorrelations are uncorrelated with one another. How to gain power by combining them?
- Box-Pierce Q statistic:

$$Q_K = T \sum_{k=1}^K \hat{\rho}_k^2 \sim \chi_K^2$$

But this does not look at the signs of the autocorrelations.

Variance Ratio Statistic

- Variance ratio statistic can be interpreted as a weighted average of autocorrelations, preserving the information in the signs.

$$\widehat{V}(K) = \frac{\widehat{\text{Var}}(r_{t+1} + \dots + r_{t+K})}{K\widehat{\text{Var}}(r_{t+1})} = 1 + 2 \sum_{j=1}^{K-1} \left(1 - \frac{j}{K}\right) \widehat{\rho}_k.$$

- Asymptotically, the variance of this statistic under the iid null is

$$\text{Var}(\widehat{V}(K)) = \frac{4}{T} \sum_{j=1}^{K-1} \left(1 - \frac{j}{K}\right)^2 = \frac{2(2K-1)(K-1)}{3KT}.$$

As K increases, this approaches $4K/3T$.

Variance Ratio Statistic

- Asymptotic distribution can be generalized when $K \rightarrow \infty$, $T \rightarrow \infty$, and $K/T \rightarrow 0$. Even with serially correlated, heteroskedastic, and nonnormal returns, we then have

$$\text{Var}(\hat{V}(K)) = \frac{4KV(K)^2}{3T}.$$

Note that this is larger when the true $V(K)$ is large.

- A related approach is to regress the K -period return on the lagged K -period return:

$$\beta(K) = \frac{V(2K)}{V(K)} - 1.$$

Empirical Results on Stock Return Autocorrelations

Frequency	Individual stocks	Stock indexes
High (daily)		
Medium (monthly)		
Low (annual)		

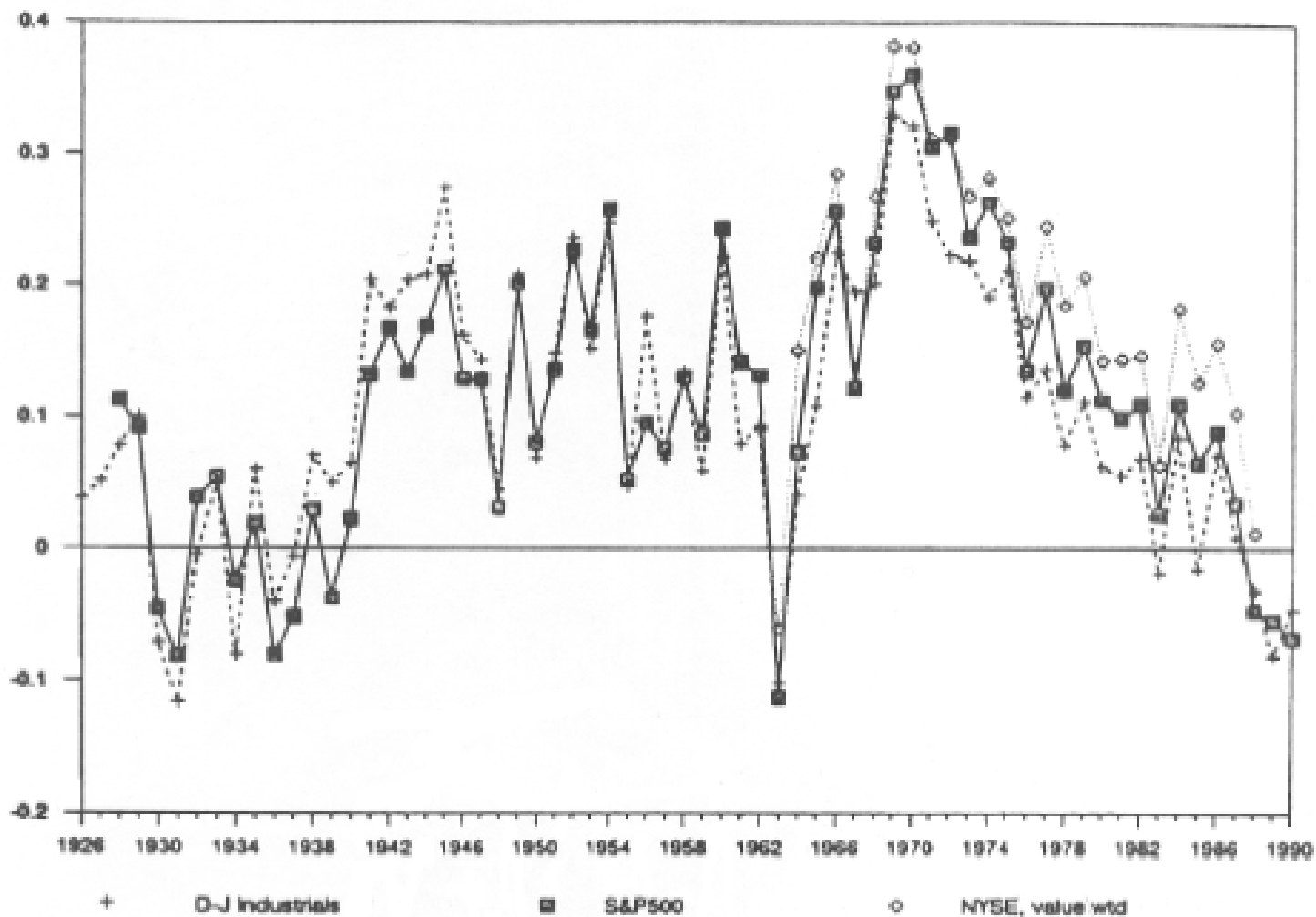


FIGURE 3
Autocorrelation of daily returns on stock indices.

Kenneth Froot and Andre Perold, "New Trading Practices and Short-Run Market Efficiency", *Journal of Futures Markets* 15, October 1995, 731-766.

Empirical Results on Stock Return Autocorrelations

Frequency	Individual stocks	Stock indexes
High (daily)	Negative	Positive $\rightarrow 0$
Medium (monthly)		
Low (annual)		

Empirical Results on Stock Return Autocorrelations

Frequency	Individual stocks	Stock indexes
High (daily)	Negative	Positive $\rightarrow 0$
Medium (monthly)	Positive, tiny (momentum)	Positive, small
Low (annual)		

Table 2

Variance ratios for U.S. monthly data, 1926–1985.

Calculations are based on the monthly returns for the value-weighted and equal-weighted NYSE portfolios, as reported in the CRSP monthly returns file. The variance-ratio statistic is defined as $VR(k) = (12/k) * \text{var}(R^k) / \text{var}(R^{12})$, where R^j denotes returns over a j -period measurement interval. Values in parentheses are Monte Carlo estimates of the standard error of the variance ratio, based on 25,000 replications under the null hypothesis of serially independent returns. Each variance ratio is corrected for small-sample bias by dividing by the mean value from Monte Carlo experiments under the null hypothesis of no serial correlation.

Data series	Annual return standard deviation	Return measurement interval							
		1 month	24 months	36 months	48 months	60 months	72 months	84 months	96 months
Value-weighted real returns	20.6%	0.797 (0.150)	0.973 (0.108)	0.873 (0.177)	0.747 (0.232)	0.667 (0.278)	0.610 (0.320)	0.565 (0.358)	0.575 (0.394)
Value-weighted excess returns	20.7%	0.764 (0.150)	1.036 (0.108)	0.989 (0.177)	0.917 (0.232)	0.855 (0.278)	0.781 (0.320)	0.689 (0.358)	0.677 (0.394)
Equal-weighted real returns	29.6%	0.809 (0.150)	0.963 (0.108)	0.835 (0.177)	0.745 (0.232)	0.642 (0.278)	0.522 (0.320)	0.400 (0.358)	0.353 (0.394)
Equal-weighted excess returns	29.6%	0.785 (0.150)	1.010 (0.108)	0.925 (0.177)	0.878 (0.232)	0.786 (0.278)	0.649 (0.320)	0.487 (0.358)	0.425 (0.394)

Empirical Results on Stock Return Autocorrelations

Frequency	Individual stocks	Stock indexes
High (daily)	Negative	Positive \rightarrow 0
Medium (monthly)	Positive, tiny	Positive, small
Low (annual)	Negative (value)	Negative (mean-reversion)