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# Volatility and Return Predictability

## 1. Introduction

Most early studies on market efficiency tested whether price changes can be predicted by using past returns. Later, empirical tests expanded to other predictive variables, including interest rates, default spreads, dividend yield, book-to-market ratio, and the earnings-price ratio. Those financial ratios have become important instruments in predicting stock returns and have several common features.

We examine the predictability of excess return from various perspectives in order to understand whether stock returns can be forecast by financial ratios, or other predictors. Why is the excess return predictability so important? Investors or householders make the decisions of allocating their wealth between consumption and investment, maximizing lifetime utilities and hedging consumption risks. Dynamic assets allocation is thus related to households' risk aversion preference, stochastic discount factor, and inter-temporal consumption substitution. The inter-temporal consumption decision is very complex, especially when householders can use simple methods or predictors to help them solve the decision problem. They are glad to apply those rules to achieve their rational investment and consumption goals. Return predictability has two-folded implications for assets pricing and market inefficiency. Economic agents can assess the real price of risky assets by using observable variables and hedge the consumption risks in a complete insurance market. The price of risk is time-varying because the forecastability of stock price can change. In other words, excluding white noise shock the predictable components of return news or discount rate news can be found from historical data or technical analysis, implying the market would not be efficient.

If excess returns can be predicted, then what is the appropriate predictor on returns? Financial ratios such as dividend yield, dividend-price ratio, earning-pricing ratio, book-to-market ratio, and so on, are common predicting variables in single- or multi-factors regression models that explain the long horizon risk premium and cross-sectional equity premium. As Cochrane (1999) remarks on the predictability of excess returns, one of the "new facts in finance" is that the dividend ratios predict long-run dividend growth or stock returns, which holds empirically only over 5–10 years horizons.

Financial ratio is an easily available instrument employed by several return predictability papers. Based on the firm's risk characters and common price of risk, financial ratio provides a unified valuation way for householders to forecast the excess return, regardless of news from dividend or discount factor.

News about dividends, similar to the "Bad Beta" defined by Campbell and Vuolteenaho(2004), is related to changes in the expected cash flow and highly positively correlated with the level of current wealth and labor income. News about the discount factor, namely "Good Beta", can be seen in the reverse way. Dividend news enhances the wealth effect continuously. To smooth the effects of consumption uncertainty, householders require more risk compensation on intensive wealth changes caused by risky asset payments. "Bad Beta" is in the same direction as business cycle. That is, when economy is booming, dividend news improves on the value of householder's original assets. On the contrary, people lose large money in recession. "Bad Beta" goes against consumption smoothing and increases the volatility of non-labor income.

Financial ratios have the advantage of simplicity. Economic agents can exploit the firm's financial data to forecast the rational excess return, but financial ratios lead to complications in wrong investment decision. Financial ratios mix changes in cash-flow expectations (i.e., cash-flow news) with changes in discount rates (i.e., expected-return news). Householders decompose an individual firm's stock return into cash-flow news and expected-return news with much difficultly. Therefore, investors can not exactly tell what kind of news is really related to stock returns.

Investors can predict long-run excess return easily if financial ratios really have predicting power. Cochrane (2005) surveys the related literature and concludes that, in general, dividend ratios are statistically significant predictors, especially for annual equity premium. However, financial ratios may lose their predicting power without differentiating between dividend news and discount factor news. Specifically, for the long-horizon return forecastability, if bad beta and good beta is co-integrated it is hard for investors to know where the influence comes from. When investors use high financial ratios as predictors, they may expect high-priced stock to pay high cash flows and thus require lower rate of return. However, high dividends may be caused by high risks.

The alternatives depend on the dissolution of news. To solve the problem of co-integration on cash-flow news and expected-return news (bad beta and good beta), vector autoregressive model is used for finding the long-run stationary relationship between the two components of firm-level stock returns and the predictability of excess return. Those new disintegration approaches provide more detailed information about excess return than the financial ratio approaches. Many studies find that cash-flow news is the main element driving the firm-level stock returns and the variance of cash flow news is more important than that of expected return news. This finding implies that investors care more about cash flow news than discount factor news and over-emphasize on the cash flow from dividends while neglecting the good beta effect.

Consumption-based capital asset pricing theory (CCAPM, see Breeden (1979)) is therefore advanced to explain the return predictability, as the previous theories on the firm- level stock returns lack of intuition about investor's life-time consumption and investment decisions. Consumers are aware of the consumption utility, asset returns and risks, especially during economy recession. The consumption-based model exploits the idea of envelope theorem that, at the optimal point, one marginal dollar saved is just as good as one marginal dollar spent, so the marginal utility of consumption equals the marginal value of wealth. Based on consumption smoothing, assets must offer high returns if they pay off well in "good times" and pay off badly in "bad times", as measured by the aggregate consumption growth.

Return predictability may not truly exist, especially when the methodology of the empirical test is not reasonable. This arises when, for example, spurious regression exists between stock return and predictors, the asymptotic t-statistics in long-horizon regressions do not converge to well-defined distributions, OLS estimator is not consistent, or the determination coefficient $R^2$ is an insufficient measure of the goodness of fit.

In order to correct for the bias of test statistics, specifically for the persistence of the predictor, new approaches are developed to revise drawbacks of traditional *t*- test.

More efficient methodology of in-sample tests such as Bonferroni *Q*-test for return predictability leads to valid inference regardless of the degree of persistence of the predictor variable. This test methodology also avoids the problem of conventional *t*-statistic that arises when the innovations of stock returns and predictors are persistent. Bonferroni *Q*-test does not need to be recomputed for each sample size because the asymptotic distribution of this statistics does not depend on the sample size. It also provides large sample justification. Therefore, we are free of the sample size restriction and can get more consistent results.

Out-of-sample tests differ from the in-sample tests in that forecasting regressions are estimated only with then-available data: both the "conditional dividend-ratio model" (the prevailing forecasting regressions or unobservable variable) and the "unconditional historical equity premium model" (the prevailing simple moving average or observable variable) are estimated as rolling forecasts to predict one year ahead equity premium.

The consistency property of asymptotic distribution is very important for return predictability in the long horizon when there is no simulation evidence for a rescaled t-statistic or local-to-unity asymptotic approach, which has been applied successfully to approximate the finite sample behavior of persistent time series in the unit-root testing literature.

## 2. Is Financial Ratio an Appropriate Predictor?

The financial ratios as predictive variables have several common features. First, the ratios measure stock prices relative to fundamentals. The ratios are positively related to expected returns because of using stock price as the denominator. When stocks are overpriced, investors expect low future stock returns, so the ratios are low. According to the rational pricing theory, the ratios are low when discount rates are low, and vice versa. The financial ratios predict returns because they capture information about the risk premium. Second, the financial ratios also share similar time series properties. At a monthly frequency, they have high autocorrelations close to one and most of their movement is caused by price changes in the denominator. These financial properties have important implications for tests of return predictability.

Lewellen (2004) studies whether dividend yield can predict aggregate stock returns over short horizons by regressing monthly returns on lagged dividend yield in order to avoid the complications arising from overlapping returns. He shows that dividend yield predicts market returns during the period 1946–2000, as well as in various sub-samples. He also finds that the book-to-market and the earnings-price ratios predict returns during the shorter sample 1963–2000.

Lewellen focuses mainly on dividend yield because many previous studies examined the predicting role of this variable. Fama and French (1988) use different definitions of returns (equal-weighted vs. value-weighted, and real vs. nominal) and find that dividend yield predicts monthly NYSE returns from 1941–1986, with *t*-statistics ranging from 2.20 and 3.21.

However, traditional predictive regressions can be severely biased toward the existence of predictability. Some other studies replicate the Fama and French tests, while using bootstrapping simulations to correct for the small sample bias, find that dividend yield has undecided forecasting power for excess return as the estimated p-value of dividend yield lies between 0.03 and 0.33.

Lewellen's study is based on the small-sample distribution of Stambaugh(1999), which assumes that dividend yield follows a first-order autoregressive (AR1) process when deriving the exact small-sample distribution of the slope estimate. Though Stambaugh provides a generally appropriate way for the bias correction and reports a one sided p-value of 0.15 when NYSE returns are regressed on dividend yield over the period 1952–1996, Lewellen improves upon the predictive ability of dividend yield by setting autoregressive process of dividend yield in some substantially understated circumstances. Lewellen finds that the slope in a predictive regression is strongly correlated with the dividend yield's sample autocorrelation, so the information conveyed in the autocorrelation helps produce more powerful tests of return predictability. Condisering this finding helps us figure out two effects: (1) the slope estimate is often larger than the standard bias-adjusted estimate, and (2) the variance of the estimate is much lower. In conjunction, the two effects can raise the power of the *t*-tests in empirical research.

Dividend yield appears to be good instrument for predicting returns without adjusting traditional testing statistics by a wide margin. Dividend yield leads to the significant testing result because the sample autocorrelation of dividend yield is strongly correlated with the slope in a predictive regression and its lower estimated variance. However, using the highly autocorrelated divided yield may get caught in a data snooping trap. What is the proper lagged value of the autocorrelation of divided yield? Due to the restriction of an observable finite sample, people use many kinds of methods to predict the unobservable expected return, such as the known parameter bootstrapping simulation. However, lengthening the sampling period of the regression may cause an overlapping problem. Though we may want to obtain consistent and robust results by increasing the sample size, unrepresentative finite sample cannot increase the testing power.

Furthermore, investors may misuse the rational pricing relationship between dividend and discount factor. They may believe that cash-flow news is able to capture information about the risk premium while neglecting the discount factor news. Investment inertia makes people wrongly believe that pervious returns will be sustained when they predict the dividend or growth rate of cash flow continuously.

High dividends are not necessarily accompanied by high discount rates. The puzzle about value and growth stocks is a good example against investors' belief. A value stock is one whose cash flow per share (or less reliably, the book value) is high relative to its stock price. The value-growth stocks approach conforms to the rational pricing viewpoint, but when the cash flow and discount factor have an unstable relationship in the long run, serious predicting bias occurs.

Vuolteenaho (2002) use a vector autoregressive model to study individual firm's stock returns from a large firm-level data, considering both cash-flow news and expected-return news when testing whether positive cash-flow news is associated with an increase or decrease in expected returns. He estimates the importance of these two sources of stock-return variation for individual firms, using market-adjusted log stock returns, log book-to-market values, and log ROE's as the predictors.

Vuolteenaho designs a "short VAR" method in which only one-period lagged value of each predictor is used to forecast the state vector progression. The short VAR approach for the long-run relationship between excess return and various predictors can avoid the persistence problem in the regressions.

He finds that returns are high when past one-year return, the book-to-market ratio, and the profitability are high. Expected profitability is high when past stock return and past profitability are high and the book-to-market ratio is low. The expected future book-to-market ratio is mostly affected by the past book-to-market ratio. An important result is that unexpected profitability co-varies positively with the stock return, with a correlation coefficient of about 0.3 for the smallest stocks. This finding explains both co-movement between cash flow news and the discount factor and previous evidence of market over- or under-reaction to news about future cash flows.

To learn about the sources of stock return variation, Vuolteenaho also investigates the variance decomposition of market-adjusted returns sorted on firm size (proxied by the market capitalization of equity). By this analysis he finds that both cash flow news and expected return news variance decrease in firm size and the ratio of expected return news to total return variance is also higher for smaller firms. Campbell and Shiller (1988) argue that the expected return news variance dominates the cash flow news variance in the postwar period by using the aggregate return variance decomposition. Vuolteenaho repeats the firm-level return variance decomposition of Campbell and Shiller. He shows that the variance of cash flow news is twice that of expected return news for firm-level excess returns and the cash flow news variance is only three-quarters of the expected-return-news variance for equal-weighted stock returns. It appears that even if people distinguishes between bad beta and good beta, firm-specific cash flow information dominates the systematic expected return information in most situations. Financial ratios can be directly applied in return forecasting by using Vuolteenaho's results. However, some studies argue that, seeing the evidence of investment heterogeneity across asset holders and non–asset holders, financial ratios in the firm-level as a return predictor are short of micro-foundation in individual choices.

There is no theoretical ground to expect investors that do not hold a given asset to adjust their consumption growth rate in response to predictable changes in the return of the asset. In particular, if the consumption growth of non-asset holders does not co-move with predictable asset return changes at all, then return predictors based on the consumption of all households will be substantially biased.

## 3. Consumption-Based Asset Pricing and Return Predictability

We want to understand the relationship between predictive variables and consumption decision. Consumption-based asset pricing theory differs from firm-level stock return with regard to the issue of return predictability. The purpose of investment is not only to advance the dynamic wealth for satisfying individual's consumption needs but also to hedge the consumption uncertainty in the future.

The idea of limited participation in asset markets is explored by Mankiw and Zeldes (1991) in an effort to explain the relationship between consumption and asset returns. They estimate unconditional pricing equations for stockholders and non-stockholders using data from the Panel Study of Income Dynamics (PSID). Their finding shows that there is a large difference in the relative risk aversion estimates across the two groups, although the estimate remains as high as 35 for the richest group of stockholders.

Vissing-Jorgensen (1999) uses the bootstrapping method to show that the standard errors of risk aversion estimates based on unconditional Euler equations are very large, especially when one uses a relatively short time period. This suggests that extra information about predictable movements in expected consumption growth rates and expected asset returns is valuable for improving the precision of the estimates in return predictability regressions.

Vissing-Jorgensen (2002) focuses on the effect of limited participation on the estimate of intertemporal elasticity of substitution (IES) instead of on the risk aversion. He emphasizes that the difference in IES estimates across asset holders and non–asset holders should not be seen as evidence of heterogeneity in the IES across households. Since the same asset return cannot be expected to hold for non-asset holders, IES estimates for asset holders are not consistent estimates for the non-asset holders. In fact, IES may be similar for asset holders and non-asset holders.

The elasticity of the marginal rate of substitution between inter-temporal consumption (IES) is one of the major determinants in households' inter-temporal consumption choices. The IES can be defined as the ratio of current-period consumption to the certainty equivalent of future consumption under the assumption that asset returns and next period consumption are joint log-normal distribution conditional on information known in this period.

Confirming this point of view, Vissing-Jorgensen uses micro data from the U.S. Consumer Expenditure Survey (CEX) to show that limited asset market participation is critical for obtaining consistent estimates of the IES only if the household holds a nonzero position (positive or negative) in the asset. This result implies that the consumption of non-asset holders in Euler equation estimations will lead to inconsistent estimates of the IES. Therefore, different values of the IES across heterogeneous investors under limited asset market participation suggest that people could adjust their consumption growth rate in response to predictable changes in the asset returns.

Bansal and Yaron(2004) employs the standard Epstein and Zin (1989) preference framework, which allows for separation between the inter-temporal elasticity of substitution (IES) and risk aversion, to model consumption and dividend growth rates as containing (1) a small long-run predictable component, and (2) fluctuating economic uncertainty (consumption volatility). They show that this specification for consumption and dividends is consistent with observed annual consumption and dividend data. When the IES is larger than 1, people require large equity risk premium because they fear that a reduction in economic growth expectations or a rise in economic uncertainty would lower asset prices. They modify the degree of persistence in expected growth rate news that affects the volatility of the price-dividend ratio and the risk premium, because the persistence in expected dividend growth rates is an important source of volatility in the price-dividend ratios.

Their results show that risks related to varying growth prospects and economic uncertainty can be characterized by the significantly negative correlation between consumption volatility and future price-dividend ratios. This explains many of the observed results in asset market data.

Therefore, the inter-temporal elasticity of substitution can help us understand the long-run predictable relationship between expected dividend growth and consumption risk. Can we divide the inter-temporal consumption into different generations?

Consider the assumption of overlapping generations (OLG) described by Constantinides, Donaldson and Mehra (2002). When investors are young, they cannot raise their consumptions to the optimal level due to borrowing constraints, even though there is a higher equity premium for long-run risky assets. News from excess return predictability is related to the life-cycle feature of equity as an asset for different aged investor, with the desirability of the equity asset depending on the correlation between consumption and equity income. If equity pays off in states of high marginal utility of consumption, it will command a higher price and consequently a lower rate of return. Since the marginal utility of consumption varies inversely with consumption, equity will command a low rate of return if it pays off in states when consumption is low.

Young investors have an incentive to smooth their consumption by borrowing and investing in a high return stock to hedge their labor income risks. Middle-aged investors with stable wage income want to buy stocks that have a high correlation between equity yields and consumption, preparing for the retirement life.

Overlapping generations differentiate consumption market segments and describe the substitution of risk premium across different generations. It gives a portrayal of the life-cycle behavior of consumption and investment. However, dynamic optimization of consumption and wealth allocation cannot be simply divided into young, middle-aged, and grey-haired periods. Besides, individual's fortune does not necessarily evolve with the supposed life-cycle pattern. Even if in the same generation, people still have different level of wealth.

The aggregation consumption-wealth ratio is close to dynamic optimization of consumption and investment and modifies the problem in the OLG model. The aggregation consumption-wealth ratio can be seen as an important predictor for estimating both the real and excess stock return.

Lettaua and Ludvigson (2001, 2004), based on the consumption capital asset pricing model, provide another aggregation predictor of excess returns. They find that returns on aggregate stock market indexes in excess of a short-term interest rate are highly forecastable over long horizons. They link consumption, aggregate wealth, and expected returns and connect aggregate consumption and dividend payments from aggregate wealth to the expected future growth rates of income flows from aggregate wealth. Because some components of consumption-wealth ratio cannot be easy to observable, we need to divide this ratio into three parts such as consumption, holding assets, and the labor income.

Those predictive variables are shown to have more fluctuations on predicting future stock returns at short and intermediate horizons than the dividend yield, the dividend payout ratio, and several other popular forecasting variables in long run. These results imply that stock returns should be forecasted by macroeconomic business cycle variables at cyclical frequencies.

This new approach helps investors investigate the linkages between macroeconomics and financial markets by noting that aggregate consumption, asset holdings, and labor income share a common long-term trend, but may deviate substantially from one another in the short run. The roles of these temporary deviations from the common trend in consumption, asset holdings, and labor income explain most variations when predicting stock market fluctuations.

The question is, why the main variable described by the consumption-wealth ratio can forecast asset returns? Consider the case that agent wants to eliminate the volatility of consumption and hedge the uncertainty in future. First, an agent will take into account of pervious period budget restrictions when choosing the consumption level and allocate the rest of wealth in different assets for risk-aversion reasons. At the same time the agent also determines labor time in the accumulation equation (dynamic budget restriction) to get stable salary income while optimizing his continuous time consumption, investment and labor decisions, so as to maximize lifetime utilities of consumption and leisure.

In addition, human capital factor can improve the consumption-based assets pricing model without strong explanation of assets return from empirical evidence.

Particularly, human capital provides almost a fraction of two-thirds of fund source of the agent when deciding his consumption level.

Piazzesi, Schneider, and Tuzel (2004) and Yogo (2003) show that if households cannot separate nondurable consumption and housing services in their utility function then extra new risk of rental price shocks and consumption basket composition shocks would increase for households. Households require more risk premium if returns and rental price growth are positively correlated.

Lustig and Van Nieuwerburgh(2004), following the study of Lettau and Ludvigson(2001), study the durable asset effects in aggregate wealth and aggregate consumption growth. Durable assets such as housing collateral provide powerful reason for consumption-based CAPM to survive, which considers only aggregate consumption growth risk and has been rejected by Hansen and Singleton's (1983). They find that housing collateral assets play an important role in influencing the conditional distribution of consumption growth and assets return because collateral assets represents a large proportion of households' wealth.

There are two ways to see this point of views. One is *the ratio of housing wealth to human wealth*. Another is *the housing collateral ratio*. If those ratios decrease then household's idiosyncratic risk changes upward and increases the conditional market price of risk. Households would require more returns on equity to compensate for their exposure of risk. Hence, the asset price will move downward.

Lustig and Van Nieuwerburgh (2004) use three different measures for the aggregate stock of housing collateral：(1) The value of outstanding mortgages, (2) The value of residential real estate (structures and land), and (3) The value of residential fixed assets (structures). According to those mesaures, the housing collateral ratio is measured as the deviation from the co-integration relationship between the value of the aggregate housing stock and the aggregate labor income.

Their prediction models are confirmed by the U.S. stock return data over time and in the cross-section. For time-series data, when the housing collateral ratio is low, investors demand larger risk compensation because the housing collateral ratio predicts higher aggregate stock returns.

The collateral model can explain up to 80% of the variability in assets' annual returns. They thus conclude that assets returns are more correlated with aggregate consumption growth shocks when collateral is at a deeply discount.

The interesting thing is that reduction in the housing collateral value will strength more sensitivity of aggregate consumption growth shocks and the dispersion of consumption growth across households. Furthermore, it raises the market price of aggregate risk.

For the cross-section data, they find two important results about value premium (return on value stock greater than growth stock). First, value stocks have higher Sharpe ratio than growth stocks. Because value stocks are more risky, their return are more correlated with aggregate consumption growth shock if collateral ratio is low. Second, the term structure of value premium generates a downward slope correlation with consumption growth in short horizons rather than long ones. Therefore, we can predict that value premium occurs in cross-sectional data and the slope of the term structure about value premium would increase if the collateral ratio changes from low to high.

Furthermore, in order to find the kernel pricing factor to improve the consumption CAPM, the model of housing markets that transfers variation in the amount of housing collateral to total wealth incorporates the state-contingent borrowing constraints for the linkage between housing collateral ratio and the prediction of asset pricing.

For simplicity, they assume that there exists an efficient rental markets or spot market for housing services. This means that ownership and consumption of housing are completely separated. They also calibrate the persistence of the consumption/housing expenditure ratio to the data. Variation in the expenditure ratio changes the value of housing relative to the value of other non-durable consumption.

Two channels produce the time variation in the conditional market price of risk, at different frequencies. One is that a decrease in the housing collateral ratio has adverse effects on the risk diversification that enable households to insulate their consumption from labor income shocks. It makes households demand a higher price to bear risk in times with low housing collateral. It is also the source of low-frequency variation in the market price of risk. The other is that households are more exposed to binding collateral constraints when there is more cross-sectional dispersion of labor income shocks. This is the source of high-frequency variation in the market price of risk. After a negative aggregate consumption growth shock, the conditional market price of risk drops when the next low aggregate consumption growth shock arrives.

An implication of Lustig and Van Nieuwerburgh's (2004) research is that housing collateral generates great current wealth effect more than inter-temporal substitution effect for households. Therefore, it can explain most cross-sectional value premium because housing collateral can substitute for equity assets by households to reduce temporal consumption shock or labor income shock (unemployment or a cut-down in the salary). In household's viewpoint, housing collateral is a better instrument than stocks for hedging the short run uncertainty, especially for temporary large fund demand.

During the low collateral ratio period, this function cannot work very well, because households face strict borrowing constraints and low consumption level, their margin utilities of consumption become higher and risk premium also increases. Therefore, households transfer their saving to equity market and require more risk premium or price of market risk to eliminate their incremental consumption shock (idiosyncratic risk), thereby raising the asset return.

However, the properties of housing investment decision are very different from the investment choice in equity. First, it requires a large amount of fund or a high proportion of household's income persistently. Households can hardly switch the investment position to match the cycle of housing assets. They can only use the housing mortgages to hedge the consumption and labor income shocks. Hence, short run interest and long run spread, for example, are more important factors for collateral models. This also provides new explanations for why interest rate can predict the equity return. Second, the price of housing collateral market is more rigid than stock market, this means that there is a lager persistence effect in housing collateral, and the value of housing is unlike that of stocks with opportunity of growth usually, so it will keep the previous situation for a long time in its business cycle and change slowly over time. The persistence enhances the correlation between consumption growth shock and dividend growth shock and increases the risk to the households; hence, households need more equity premium to compensate for their risk.

In the case of permanent shock (e.g. health care of cancer) that causes a decrease in value, households will smooth their labor income and variability of housing value to match the individual permanent consumption shocks and less fund are invested in equity. Hence, housing collateral has low explanatory power for the time-series data.

Lettau and Ludvigson (2005) trace to the fundamental cause of the return predictability and try to explain these questions:

(1) Large predictable movements in dividends are not apparent in U.S. stock market data. In particular, the log dividend-price ratio does not have important long horizon forecasting power for the growth in dividend payments.

(2) Returns on aggregate stock market indexes in excess of a short-term interest rate are highly predictable over long horizons. The log dividend-price ratio is extremely persistent and forecasts excess returns over horizons of many years.

(3) Variance decompositions of dividend-price ratios show that changing forecasts of future excess returns comprise almost all of the variation in dividend-price ratios.

They find that the market risk premium and expected dividend growth may be better than the log divided-price ratio alone as a predictive variable for stock return, because the variations of dividend forecasts are found to co-vary with changing forecasts of excess stock returns at business cycle frequencies. This is important as positively correlated fluctuations in expected dividend growth and expected returns have offsetting effects on the log dividend–price ratio.

However, several new studies argue that the log dividend–price ratio does not have important long horizon forecasting power for the growth in dividend payments, because the log dividend–price ratio is extremely persistent and forecasts excess returns over horizons of many years.

## 4. Spurious Return Predictability and Faulty Test Methods

Lagged variables are often used to predict the stock returns. For the same reason, lagged variables as predictors exhibit persistence easily. Many papers that focus on the issues of data mining and spurious regression recognize the consequence of persistence. Spurious regression generates a misleading relationship between excess return and predictors. The main reason that lead to the spurious regression bias is unobservable expected return. It is fine for asset pricing regressions to use real rates of return as the dependent variables, which are not highly persistent. However, asset returns are expected returns plus unpredictable noise. If the expected returns are persistent, there is the risk of a spurious relationship between the excess return (dependent) and predictors (independent variables) that are highly auto-correlated lagged variables.

When there is no persistence in the true expected return, the spurious regression phenomenon is not an issue. It is true even when the measured predictor is highly persistent. This implies that spurious regression is not a problem from testing the null hypothesis that expected stock returns are unpredictable, even if a highly auto-correlated lagged variable is used. The problem of spurious regression for stock returns gets worse as the autocorrelation in the expected return increases, and as the fraction of the stock return variance attributed to the conditional mean increases.

Data mining, in the form of searching through the data for high R-square predictors, results in regressions whose apparent explanatory power occurs by chance. Manipulation of data snooping pervert the result of return predictability tests similarly, regardless of the validity of specific instruments identified in the literature, such as the term spread, the book-to-market ratio, and the dividend yield. Data mining often results from a small sample. It can be easy to get the faulty inference in time-series data by using the conventional student-t test because the t-statistics in long-horizon regressions do not converge to well-defined distributions. Moreover, the ordinary least squares estimator is not consistent and the R-square is not an adequate measure of the goodness of fit. We now discuss the significant properties in the tendency of long-horizon regressions that are not found in previous short-term approaches.

Valkanov(2003) focuses on asymptotic arguments to show that the t-statistics in long-horizon regressions do not converge to well-defined distributions. Therefore, OLS estimator is not consistent and the $R^2$ is an inadequate measure of the goodness of fit. Even though stock returns are not highly auto-correlated, there is a spurious regression bias in predictive regressions for stock returns.

Return predictability of financial ratios in the long run may be an invalid cause of the fault predictability when measured in-sample from the t-statistic and the $R^2$ : Both of these statistics increase with the horizon (the overlap or size distortions). Campbell and Yogo(2005) describe that conventional tests of the predictability of stock returns may be incorrect, that is, rejecting the null too frequently, when the predictor variable is persistent and its innovations are highly correlated with returns. They use a pretest to check whether the conventional *t*-test may leads to invalid inference and develop more efficiency Bonferroni *Q*-test for return predictability based on *local-to-unity asymptotic* that leads to valid inference regardless of the degree of persistence in the predictor variable.

The Bonferroni *Q*-test has two parameters: $\beta_0$, the value of null hypothesis (if $\beta_0$ =0 then Bonferroni *Q*-test become traditional t-test), and $\rho$ , which measures the persistence of predictor, conditional on the infeasible uniformly most powerful (UMP) test. The Bonferroni *Q*-test has three desirable properties for empirical tests. First, the test can be implemented with standard regression methods, and inference can be made through an intuitive graphic output. Second, the test is asymptotically valid under fairly general assumptions on the dynamics of the predictor variable (i.e., a finite-order auto-regression with the largest root less than, equal to, or even greater than one) and on the distribution of the innovations (i.e., even heteroskedastic). Finally, the test is more efficient than previously proposed tests in the sense of Pitman efficiency (i.e., requires fewer observations for inference at the same level of power).

Even if the predictor variable is stationary, first-order asymptotic may be a poor approximation in finite samples when $\rho$ is close to one, and inference based on first-order asymptotic may therefore be invalid due to *size distortions.* There are two approaches to solve this problem：The first approach is the *exact finite-sample theory under the assumption of normality*. The second approach is *local-to-unity asymptotic*, which has been applied successfully to approximate the finite sample behavior of persistent time series in the unit root testing literature.

*Local-to-unity asymptotic* is the asymptotic distribution of test statistics and does not depend on the sample size, so the critical values of the relevant test statistics do not have to be recomputed for each sample size. It also provides the large-sample justification for our methods in empirically realistic settings that allow for short-run dynamics in the predictor variable and heteroskedasticity in the innovations.

Campbell and Yogo (2005) analyze the finite sample for four tests of predictability: the conventional *t*-test, the Bonferroni *t*-test, the Bonferroni *Q*-test and the sup-bound $Q$-test. The conventional $t$-test has large size distortions; the rejection probability is 27.2% when there are 250 observations and parameter $\rho$= 0.992 is the unknown degree of persistence in the predictor. The finite-sample rejection rate of the Bonferroni $t$-test is no greater than 6.5% for all values of $\rho$ and $\delta$ considered. The Bonferroni $Q$-test has a finite-sample rejection rate no greater than 6.4% for all levels of $\rho$ and $\delta$ considered, as long as sample size is at least 100. The sup-bound $Q$-test is the most powerful test if $\rho$=1. However, undersizing translates into loss of power.

So far, we know the conventional $t$-test, with its largest rejection range, rejects the null hypothesis too easily and misleads the conclusion about the forecasting power of a predictor. Sup-bound $Q$-test has a restriction in the unit-root situation.

Campbell and Yogo (2005) use the Pitman efficiency to compare power gains between the Bonferroni $Q$-test and Bonferroni $t$-test. Pitman efficiency is the ratio of the sample sizes at which two tests achieve the same level of power (e.g.50%) along a sequence of local alternatives. They conclude that the Bonferroni $Q$-test under *local-to-unity asymptotic* has important power advantages in finite sample size over the other feasible tests. Especially when the predictor variable is highly persistent, and it has much better power than the sup-bound $Q$-test when the predictor variable is less persistent.

Applying the more strict Bonferroni $Q$-test in empirical tests, Campbell and Yogo show that dividend price ratio ($d - p$) has return predictability for annual data and the earnings-price ratio ($e - p$) also can predict returns at all frequencies. This finding is different from Campbell and Shiller (1988) and Fama and French (1988), which finid that regressing long-horizon returns on financial ratios at lower frequencies has a smaller autoregressive root. Unlike short-horizon returns, long-horizon returns can be predicted using dividend yields or dividend-price ratios. Campbell and Yogo's study includes only NYSE firms and a long run estimation window to predict stock returns. Unfortunately, the study does not eliminate the persistence because the effective sample size shrinks as one increases the overlapping horizon of the regression.

The Bonferroni $Q$-test seems to be most powerful in annually return prediction, in spite of the fact that annual horizons have been generally thought to have the least statistical problems and the best or close to best performance. However, reducing the persistence in predictor at lower overlapping frequencies may lose the short run properties in excess return. We suspect that the effective finite sample size of dividend price ratio in annual data is not enough to represent the characteristics of population, due to *local-to-unity asymptotic* in finite sample performance. For the prediction on different horizons (monthly, quarterly, multi yearly), do we find the Bonferroni $Q$-test to outperform other methods in forecasting dividend-price ratio model at a halfway statistically significant manner?

The recursive residuals approach is one in which the reasonable testing about the out-of-sample can avoid the data-mining problem and requires a larger estimated interval of the predictive variables. If the confidence interval of predictor becomes large then it is not easy to reject the null hypothesis: the predictor has significant forecasting power for stock return. This out-of-sample approach could measure the predictive ability of the forecasting variables in models on equity premium and long-term stock returns.

Goyal and Welch (2003) employ the recursive residuals approach and find that dividend ratios ( dividend yields ) have no predictability not only after 1990 but also in prior periods. They also show that an increasing persistence of dividend price ratio will induce the dividend ratios to have lower predictability for equity premium. Dividend ratios only have power for forecasting the long-run dividend growth or stock return over 5 to 10 years.

Goyal and Welch's study shows that dividend ratios' presumed forecastability of the equity premium is an illusion, even before the 1990s. Despite good in-sample predictive ability for annual equity premium prior to 1990, they show that dividend ratios have poor out-of-sample forecasting ability. Therefore, dividend ratios cannot have robust out-of-sample predictive ability in the standard financial ratio models in any way.

The reason is that data-snooped estimate of the changes in the dividend-ratio coefficients would have to look nice to make the dividend ratio a useful variable. A theory predicting future equity premium in the long run with lagged dividend ratios would have to predict the slowly increasing coefficients until mid-1975, followed by slowly decreasing coefficients thereafter, and finally sharply increasing coefficients in the post-1999 period.

Here we are interested in investigation the reason for the discrepancy between in-sample and out-of sample performance. According to Campbell and Shiller (1988), changes in the dividend processes themselves could have needed a non-stationary dividend ratio coefficient in explaining the risk premium. The Campbell and Shiller theory (1988) may be used to instrument the dividend-ratio market premium forecasting coefficients with their own time-varying auto-regression coefficient estimates. Unfortunately, despite a good theoretical justification, the instruments cannot do better than the dividend ratios, casting even more doubt on the theory of dividend ratios as useful stock market predictors. This leaves us with the puzzle as to what dividend-price ratios really predict.

## 5. **Conclusion**

We have reviewed and analyzed the important studies over the past few years, and shown that generally, financial ratios are statistically significant predictors in long-horizon return predictability.

Even though financial ratios as predictors might lose accuracy when not distinguishing between cash-flow news and discount factor news, using financial rations are acceptable since cash-flow news is more important than expected-return news. With a high financial ratio, investors can expect high payments consistently, and require lower rate of return.

We should note the important result that expected-return variation still has an economically significant impact on firm-level stock prices and household's consumption uncertainty. When the volatility of expected-return variation increases, not only the significance level of test statistic is reduced but also the household's inter-temporal consumption and investment decision is affected.

We have also discussed some important issues on spurious regression, data mining and persistence in long-run regression and inference of testing. Those problems arise from using finite lagged and highly autocorrelated observable variables to predict unobservable expected return, thus causing the biased statistical inference. Several papers try to cope with those problems by using various new methods, including vector auto-regression of long-run co-integration variables, to avoid the spurious relationship between stock return and predictors. Other alternatives include searching for new powerful predictor such as housing collateral ratio to explain the return predictability.

In the early literature the financial ratios were thought to be a good predictor of dividend growth rate, but in recent years the ratios' predicting ability has shifted towards its own future value (higher autoregressive root of dividend price ratio) rather than one-year-ahead dividend growth rates. As the self-predictive properties of the dividend yield are dominant, it can be concluded that, for most of the sample period, the predictability of stock returns over annual horizons is weak.

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