Good afternoon everyone. I am Andy. I am happy standing here to share with you our paper. The Shiller P/E and Macroeconomic conditions. First of all, what is Shiller P/E. Shiller P/E is introduced by Robert Shiller and John Campbell. And in fact, John is a doctoral student of Robert Shiller. It’s called cyclically adjusted price to earnings ratio (CAPE) or Shiller PE.

What’s the difference between Shiller PE ratio and normal P to E?

Next, I am going to talk about macroeconomic conditions. How do inflation and real interest rates affect stock price? Many investors, commentators, and policymakers seem to believe that rock- bottom levels of inflation and real interest rates provide the best economic conditions for stock prices to rise. Their logic is straightforward. Consider the textbook valuation formula relating the current price of a

stock or portfolio, *Pt*, to the sum of discounted expected future dividends, *Dt*: Given that the discount rate, *rt*→*t*, is the sum of expected inflation, real interest rates, and an equity risk premium, it seems obvious that a reduction in any of those three variables should reduce the discount rate and consequently raise stock prices. In this reasoning, the relationship between stock prices and either inflation or real interest rates is *monotonically inverse*.

Yet this straightforward logic is not supported by the data. In the messy real world, market participants appear to value stocks based on the rule that: The levels of inflation and of real interest rates have to be “just right” to sustain high valuations. When either deviates from its “sweet spot”—*in either direction*—valuations tend to fall. The relationship between stock prices and inflation, and between stock prices and real interest rates, can be simplistically described as a mountain. It peaks at medium levels of inflation and real interest rates and slopes downward from that point in any direction.

How can we explain this mountain-shaped relationship? Where does the logic described above break down? To answer these questions, notice that the relationship is monotonic only if all other variables remain constant when the inflation rate or real interest rate changes. It turns out that cash flows, and risk premiums exhibit nonlinear and nonmonotonic interrelationships with inflation and real interest rates.

For instance, using data starting in 1871, we consider a monthly regression of three-year nominal earnings growth (∆*Et*→*t*36) on concurrent three-year inflation rates. This is the regression result. But tt gets even more interesting when we include the square of those same inflation rates.

According to the logic presented earlier, very low inflation rates would drive the discount rate down and stock prices up. However, this regression shows that the growth rate in profits falls even faster, given the highly negative quadratic term. At times of very low—even negative—inflation rates, market participants evidently should worry about the economy and reduce their expectations of *real* earnings growth. The negative quadratic term creates a mountain-like relationship between earnings growth—the numerator in Equation 1—and inflation rates, influencing stock prices to display a similar relationship with inflation rates.

Similar arguments can be made about real interest rates. A prolonged period of low real interest rates may suggest a market expectation of slow macroeconomic growth, or increased fear, which might require a higher equity risk premium, hence lower valuations.5 For instance, consider a forecasting regression of future three-year inflation volatility (), a measure of *t*→*t*36 price uncertainty, on current real yields (*yt*) and the square of current real yields:

According to the logic presented earlier, very low real interest rates would drive the discount rate down and stock prices up. However, the strongly positive quadratic term shows that abnormally low (or high) real interest rates tend to indicate higher uncertainty in prices. It seems reasonable that market participants actually increase the discount rate—reduce the valuation multiples—as inflation volatility rises, causing stock prices to go down and not up. The positive quadratic term creates a U-shaped relationship between inflation volatility and real interest rates, again influencing stock prices to display a mountain-like relationship with real interest rates.

In this study, we formalize the mountain-shaped relationship between the stock market valuation and inflation rates and real yields. For the details of our model. I will hand over to Jiaqi. Let’s welcome.

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One of the most common misattributions in finance is Ben Graham’s almost certainly apocryphal remark that “in the short run the market is a voting machine and in the long run it is a weighing machine.”1 The history of financial analysis is, in part, a quest for metrics that can help us better predict the voting and more accurately gauge the weight (i.e., fair value) of an investment. Robert Shiller and John Campbell introduced one of the most powerful measures of value when they developed the cyclically adjusted price/earnings ratio (CAPE) or Shiller P/E.2 The Shiller P/E divides the current real price of a broad market index by a 10-year average of its inflation-adjusted earnings. Peak earnings no longer create an illusion of low P/E ratios; trough earnings no longer create artificially elevated P/E ratios. The Shiller P/E is a powerful predictor for long-horizon capital market returns all over the world. This result is expected, as long as markets exhibit long-horizon mean reversion toward the historical average for the Shiller P/E ratio.

The Shiller P/E is a much less powerful predictor of short-term returns. Can we fix this? Building on the work of Leibowitz and Bova [2007], we find that the average Shiller P/E ratio (hereafter, the “P/E”) varies with both real interest rates and inflation. Moderate levels of inflation and real interest rates

coincide with the highest average valuation multiples. Unusually high or low real yields—or inflation rates—tend to coincide with much lower average valuation multiples, creating a valuation “mountain.” This relationship spans the developed world.

Suppose we measure the abnormal P/E by comparing the current P/E with a condi- tional normal P/E adjusted to reflect current inflation and real yields. If P/E mean reverts toward levels suggested by macroeconomic conditions, rather than toward long-term averages, the conditional abnormal P/E may be a better predictor of short-term market returns. We find this to be the case, to an extent that is statistically significant and economically meaningful. P/E is an excellent predictor of long-term returns over spans of 3 to 10 years (and even better over longer spans). P/E, relative to a normal P/E that is conditioned to reflect current inflation and real yields, proves to be the better predictor of shorter-term returns of one month to one year.

What levels of inflation and real interest rates are more favorable to stock markets? Many investors, commentators, and policymakers seem to believe that rock- bottom levels of inflation and real interest rates provide the best economic conditions for stock prices to soar. Their logic is straightforward. Consider the textbook valuation formula relating the current price of a

stock or portfolio, *Pt*, to the sum of discounted expected future dividends, *Dt*:

Given that the discount rate, *rt*→*t*, is the sum of expected inflation, real interest rates, and an equity risk premium, it seems obvious that a reduction in any of those three variables should reduce the discount rate and consequently raise stock prices. In this reasoning, the relationship between stock prices and either inflation or real interest rates is *monotonically inverse*.

Yet this straightforward logic is not supported by the data. In the messy real world, market participants appear to value stocks based on the Goldilocks principle: The levels of inflation and of real interest rates have to be “just right” to sustain high valuations. When either devi- ates from its “sweet spot”—*in either direction*—valuations tend to fall. The relationship between stock prices and inflation, and between stock prices and real interest rates, can be simplistically described as a mountain. It peaks at medium levels of inflation and real interest rates and slopes downward from that point in any direction.

How can we explain this mountain-shaped relationship? Where does the logic described above break down? To answer these questions, notice that the relationship is monotonic only if all other variables remain constant when the inflation rate or real interest rate changes. It turns out that cash flows, and risk premiums exhibit nonlinear and nonmonotonic interrelationships with inflation and real interest rates.

For instance, using data starting in 1871, we consider a monthly regression of three-year nominal earnings growth (∆*Et*→*t*36) on concurrent three-year inflation rates ().3 We find that they are interconnected in a *t*→*t*36

manner that is not helpful to the conventional narrative:

According to the logic presented earlier, very low inflation rates would drive the discount rate down and stock prices up. However, this regression shows that the growth rate in profits falls even faster, given the highly negative quadratic term. At times of very low—even negative—inf lation rates, market participants evidently should worry about the economy and reduce their expectations of *real* earnings growth. The negative qua- dratic term creates a mountain-like relationship between earnings growth—the numerator in Equation 1—and inf lation rates, inf luencing stock prices to display a sim- ilar relationship with inflation rates.

Similar arguments can be made about real interest rates. A prolonged period of low real interest rates may suggest a market expectation of slow macroeconomic growth, or increased fear, which might require a higher equity risk premium, hence lower valuations.5 For instance, consider a forecasting regression of future three-year inflation volatility (), a measure of *t*→*t*36 price uncertainty, on current real yields (*yt*) and the square of current real yields:

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In this study, we formalize the mountain-shaped relationship between the stock market valuation and inflation rates and real yields. Under the right conditions—that is, moderate levels of inflation and real yields—the market P/E empirically tends to reside well above the unconditional long-term historical average of 16.7. In contrast, when either the inflation rate or the real yield is at an extreme, we observe a markedly lower valuation.

We define a continuous nonlinear Gaussian model to estimate the normal P/E ratio—hence, the short- term P/E mean-reversion target, given the inflation rate and the real yield.6 It is widely accepted that the deviation of the current stock market valuation from its long-term unconditional average is a good predictor of the long-horizon (10-year) return. Our model of a short-term mean-reversion target significantly enhances the predictability of stock market returns at short hori- zons (1 year or less). Our observations are robust within the U.S. market as well as across the global developed markets.

**LITERATURE REVIEW AND OUR CONTRIBUTIONS**

The relationship between stock prices and nom- inal or real interest rates is well understood. Leibowitz and Bova [2007, p. 84], for instance, introduce the “intriguing conjecture that P/E in the U.S. market may decline in times of both significantly lower, as well as significantly higher, real interest rates.” We extend their study in two directions before turning to the core goal of improving the efficacy of P/E as a predictor of shorter- term market returns.

First, we show that the same nonmonotonic, mountain-shaped relationship between P/E and real interest rates also holds between P/E and inflation. Second, we show that this relationship is found not only in the U.S. market but also in a sample including numerous developed markets. We then create a bell- shaped “mountain” that describes this relationship, and finally test the markets’ tendency to mean revert toward this new variable normal P/E, conditioned on current inflation and real interest rates, as a predictor of future returns.

This article contrasts with the literature on what is commonly referred to as the inflation or money illu- sion. Modigliani and Cohn [1979], Ritter and Warr [2002], Asness [2003], and Campbell and Vuolteenaho [2004], among others, argue that investors extrapolate *past* trends in nominal cash flow growth when forming their expectations about *future* nominal growth, failing to adjust them for changes in inflation. As a conse- quence, in times of low inf lation their cash f low growth assumptions are too high, resulting in inflated P/E; and in times of high inf lation, their cash f low growth assumptions are too low, resulting in depressed P/E.

This “inflation illusion,” or “money illusion,” generates long periods of a negative relationship between P/E and inf lation. If cash f low growth expectations were cor- rectly adjusted for inflation, P/E should not move as much with inf lation.

A clear example of the inflation illusion took place during the late 1990s and early 2000s when a rule of thumb dubbed the “Fed model” became pundits’ pre- ferred argument to justify extremely high stock prices (debunked by Asness [2003]).7 According to this simple rule, one need only compare the stock market earnings yield (E/P) with nominal interest rates to know whether stocks are fairly priced: Buy when E/P is above nominal interest rates and sell when it is below them. Because nominal interest rates were relatively low during that time, and inflation expectations have historically been the major driver of nominal interest rates, supporters of the Fed model failed to lower their nominal cash flow growth expectations. Using low nominal interest rates to discount those prospective cash flows resulted in high P/E.

We are not proponents of this simple trading rule. Yields, growth rates, and inflation are intertwined with nonlinear connections that make the Fed model an exer- cise in folly. We propose a more sophisticated model to assess market levels and forecast returns.

A growing literature shows that stock market return forecasts can be significantly improved by deviating from static mean-reversion targets. The most common approach, exemplified by Lettau and Van Nieuwerburgh [2008] and Pettenuzzo and Timmermann [2011], is to assume that the markets suffer structural breaks and thus mean-reversion targets are dependent on some unob- servable state of the economy that needs to be inferred using advanced econometric techniques. We adopt a more direct and practical approach: Because P/E declines when either the inflation rate or the real yield deviates from moderate levels, conditioning P/E on inf lation and real yield forms a sensible short-term mean-reversion target. We define a three-dimensional parametrized continuous bell curve to model the relationship between the expected P/E and both the inflation and the real yield. The difference between the observed and mod- eled P/E is more powerfully—and significantly—related to near-term future stock market returns than a simple P/E relationship. We hope that this work stimulates fur- ther research into the linkage between macroeconomic conditions and equilibrium valuation levels and that our

parametrized Gaussian model helps others extract more statistical significance from these linkages.

**PRACTICAL IMPLICATIONS**

Leibowitz and Bova [2007] framed their analysis within the practical considerations of pension funding ratios. When real interest rates rise, the value of pension funds’ liabilities decreases in the same proportion that the value of their assets decreases. When real interest rates fall, however, the value of pension fund liabilities and fixed-income assets increases, but the value of equity assets decreases. This perverse relationship between stock prices and interest rates can create a stark and economically important mismatch between the value of assets and liabilities.

In the wake of the financial crisis of 2008 and the ensuing Great Recession, it is more important to grasp the relationship between interest rates and stock prices. Slow to no macroeconomic growth, accompanied by high unemployment, has driven central banks in many devel- oped countries (including the United States, Japan, the Eurozone, and the United Kingdom) to cut interest rates to near-zero and even negative rates, and to engage in assorted forms of unconventional monetary policy. In par- ticular, varieties of quantitative easing—buying long-term government or asset-backed bonds with the goal of low- ering long-term interest rates—became a common remedy in the medicine cabinet of many central banks. Where these policies have led to negative real interest rates, we should understand the implications for market valuation.

In the words of former Fed chairman Ben Bernanke [2010],

This approach [quantitative easing] eased finan- cial conditions in the past and, so far, looks to be effective again. *Stock prices rose* and long-term interest rates fell when investors began to antici- pate the most recent action... And *higher stock prices* will boost consumer wealth and help increase confidence, which can also spur spending.8 (emphasis added)

As the evidence we present suggests, reducing inf la- tion or real interest rates can be helpful to market valua- tions, to a point. But beyond a certain threshold, it may cause the opposite of the intended effect on stock markets: in the long run, valuation multiples could actually fall.

At the time of this writing, the P/E of the U.S. stock market has stayed above 24 for almost three years. Our model indicates the U.S. market is expensive—priced to offer anemic real returns, or worse, if the P/E reverts toward historical norms. That said, the Fed has done an admirable job in keeping the inflation rate (and, to a lesser extent, real interest rates) at levels that are favorable to stock prices. From these “Goldilocks” conditions, any positive shock to inflation and further reduction in real yield could be the catalyst for a serious reversal.