A guide to our US Treasury yield curve modeling

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Warning: this paper is intended for market participants (fund managers and traders). For a detailed academic presentation of the factors that determine the yield curve and the implications for yield curve modeling, see Davanne (2021). For a related academic discussion on asset pricing inefficiencies and the source of market volatility, see Davanne (2023).

Important note (October 2023): This presentation of our yield curve modelling was written before the strong US monetary tightening of 2022-2023. Risk premia increased sharply during this period. It is too early to know whether this is just a temporary blip, or a radical new structural change after more than 20 years of excess demand for US Treasuries (see our recent analysis on www.riskpremium.com)

Summary

The behavior of financial markets is difficult to understand. Prices seem often disconnected from what the academic pricing theory seems to suggest. Moreover, there are regularly some large daily changes in asset prices without any significant economic news.

This is particularly true of the US Treasuries market. As early as 2005, Alan Greenspan qualified the low level of long-term rates of "conundrum". Since that time, US long-term rates have more frequently surprised investors on the downside than on the upside. Traders and fund managers have frequently lost money taking short positions in this market. Indeed, this has been the case several times in the course of 2021, with the activation of stop-loss orders contributing to this key market's volatility.

In this note, on both a theoretical and empirical basis, we explain what drives the US Treasuries yield curve and why market participants have faced so many "conundrums" over the last twenty years, and particularly in 2021.

Everyone knows that expectations about the future US monetary policy play a key role in this market. But there is a clear underestimation of the symmetrical role played by expectations about future risk premia. Thanks to our modelling of the US Treasury yield curve, we document the history of these expected risk premia and discuss how the constant underestimation of the strength of the demand for US Treasuries explains until recently the somewhat strange behavior of this key market.

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Introduction

Understanding the US Treasuries yield curve is very important. This is obvious for traders and fund managers specialized in this large asset class, but the behavior of US yields is closely monitored by all market participants. Changes in the prices of US Treasuries have often strong direct and indirect impacts on the prices of other assets.

The direct impact results from the key role of US Treasuries as the risk-free reference, at least as far as dollar assets are concerned. All other assets are priced relative to US Treasuries.

The indirect impact results from the information that the US Treasuries are assumed to provide. Many investors and central bankers believe that the shape of the yield curve reveals information on the most likely future scenario for economic growth and inflation. Thus, when the US Treasuries yield curve moves, some investors may alter their fundamental macroeconomic scenario. For example, when the yield curve flattens, people often fear that this may be the sign of a forthcoming economic slowdown and are tempted to sell equities as a result. In this kind of situation, paradoxically, the indirect impact of lower long-term rates may be a weaker stock market.

Thus, it is important to understand the US yield curve. Yet, it is far from being a straightforward exercise! Over the last twenty years, US Treasuries have often had a strange behavior. Contrary to the analysis of many market participants, surprises have not started with the direct intervention of the Fed (Quantitative Easing) after the 2008-2009 financial crisis. As early as 2005, Alan Greenspan had some good reasons to qualify the low level of long-term rates of "conundrum".

The purpose of this paper is to explain what drives the US Treasuries yield curve from a theoretical perspective (Section 1/) and to show how empirically a model based on these premises help to explain the behavior of this key market over the last 30 years (Section 2/). We'll insist on the importance to understand correctly how risk premia are determined.

1/ Expectations regarding monetary policy and risk premia: the 8 key factors driving the US Treasuries yield curve.

The first well-known observation is that the yield curve reflects expectations regarding monetary policy in the future. In a world without risk premia, the expected return on a monetary fund should be equal to the return provided by a long-term bond hold until maturity. Thus, long-term rates are basically equal to the average expected short rates over the life of the bonds, plus a risk premia correction.

Any yield curve reflects an implicit path for monetary policy in the future. Unfortunately, this implicit path is very hard to extract due to the complex risk premia also embedded in the curve.

A first key question is how many variables or factors are needed to describe this implicit path for short-term rates? This question is related to the complexity of the monetary policy process. When short rates are not at their long-term equilibrium, how complex can be the expected returning path to this equilibrium?

In a simple two-factor world, expectations could be described by only two variables: the current short rate and the expected equilibrium rate. The process of convergence would always follow the same path. Obviously, this is not a realistic hypothesis. Sometimes investors expect a quick convergence and sometimes investors expect that short rates will stay for a long-time away from the equilibrium, or even diverge more before finally converging. Thus, to describe expectations correctly, at least three factors are needed.

For example, if we know the current short rate, the equilibrium short rate, and the short rate expected in one year, we are starting to have a pretty good view of the convergence process expected by investors. But is it enough? The answer is a clear no. There is more complexity than that in short rate expectations. Rates can stay at the one-year expected level for a while, especially when they are stuck around 0, or they can converge quickly at the one-year plus horizon. Indeed, if one looks at the available surveys of investors' expectations, one can see that knowing the expected equilibrium short rate and the short rate expected at the one-year horizon does not allow to estimate precisely the short rate expected in the medium term, let's say at the three years horizon.

To understand the current yield curve or forecast its shape in the future, we need (at least) four key variables regarding monetary policy:

- The current rate.
- The expected equilibrium short rate.
- The short rate expected in one year.
- The short rate expected in three years.

Let's now turn our attention to risk premia.

There is an abundant academic literature showing that risk premia vary over time. But there is often a lot of ambiguity about what we call "risk premia"!

The first fundamental risk premia to consider are **the current tactical or short-term risk premia**. How much excess returns investors require to hold bonds at a few weeks or few months horizon (i.e. the investors' tactical horizon)? These short-term risk premia are related to the current risks (and notably to the current correlation between the return on bonds and the return on equities: we'll come back to this issue later).

These tactical risk premia fluctuate widely around their expected equilibrium, as short rates do. And obviously, bond prices depend a lot on future risk premia expected by investors, as they depend on future expected short rates. If tactical risk premia are low, for example due to Quantitative Easing (QE), but investors expect them to climb back in the future, rational investors will expect bond yield to rise in the future, and obviously this pushes higher the long-term yields as soon as today. **There should be no doubt that bonds prices reflect future expected risk premia exactly as they reflect future expected short-term rates.**

As we have just emphasized with the short rates, it is very clear that the expected convergence path for risk premia also varies over time. Here again, we are not in a simple two-factor world where it would be enough to know the current tactical risk premia and their expected equilibrium to extract all the risk premia expected by investors at the future intermediate horizons. Sometimes, investors are very confident that risk premia will go back rapidly to the "normal" or equilibrium level. Sometimes, they believe that current distortions, like QE, will last for a while. In all markets, the changes of view on the speed of convergence towards equilibrium play a major role to explain the price dynamic.

Thus, to understand the yield curve, we also need an indication on the expected risk premia in the medium-term, let's say in 3 years. But again, is it enough? We have argued that for short rates, three factors were not sufficient to understand the yield curve and that expected path towards equilibrium could be rather complex. However, investors don't spend as much time studying the dynamic of tactical risk premia required by investors (maybe they should…) as they spend trying to second guess the decisions of the Fed in the coming months and years. Thus, we believe that the risk premia path embedded in the US Treasuries yield curve is much less complex than the short-rate path. Three factors seem enough: if we want to describe the expected path of 10-year Treasuries tactical risk premia, we

probably need to know only the current short-term risk premium, its expected equilibrium in the long-term and its expected level in 3 years.

Thus, on top of the four key variables related to monetary policy expectations, we need at least three other key variables to understand the observed yield curves:

- The current short-term risk premium required on 10-year US Treasuries.
- The expected long-term equilibrium for this tactical risk premium.
- An indication on the speed of the expected convergence process: the expected tactical risk premium on these 10-year notes at the three-year horizon.

Obviously, all investors don't have the same tactical horizon. Some traders have a very short horizon, but most fund managers don't base their decisions on daily or weekly forecasts. **In all that follows, our short-term/tactical risk premia will be the expected excess returns (annualized) at the three months horizon.**

We could stop here if there was a simple and robust relation between the tactical risk premia on bonds of various durations. For example, if the risk premia were strictly proportional to bonds' duration, knowing the current and future expected tactical risk premia on 10-year bonds would directly lead to the tactical risk premia on all other bonds (the tactical risk premium on a one-year discount bond would be one-tenth of the tactical risk premium on a 10-year discount bond). Thus, the US Treasuries yield curve would simply be the product of our seven key variables, four related to the expected monetary policy in the future and only three needed to describe the expected dynamic of the risk premia.

Unfortunately, there is some strong empirical evidence that risk premia on US Treasuries are not strictly proportional to duration. In general, the tactical risk premium on a one-year bond is significantly larger than one-tenth of the risk premium on a 10-year (zero-coupon) bond. But this hierarchy sometimes changes: there are situations where the risk premium on short-term bonds becomes abnormally low.

A key observation is that the short and the long end of the US yield curve are not subject to the same risks. The price of short-term treasuries is mainly influenced by monetary policy decisions: prices fall when the Fed raise rates (or is expected to raise rates). Long-term rates are also influenced by monetary policy decisions (or rather expectations regarding monetary policy) but depends also in a very significant way from changes in risk premia (actual and expected). Without any expected change in monetary policy, the price of long-term bonds may fall if the risk premia required by investors increase.

Thus, the risks do not have exactly the same origin – monetary policy surprises versus changing risk premia - and it should not be surprising that risk premia along the yield curve are not the same per unit of volatility. A key observation is that, in general, markets for risky assets dislike very much the unexpected increases in the risk-free rates, i.e., in the official rates controlled by central banks. As William M. Martin, former chairman of the board of the Fed, famously said in the 50s, the role of the Fed is "*to order the punch bowl to be removed just when the party is really warming up*"[1]. In the same speech to a group of investment bankers, he also said that "*those who have the task of making such policy don't expect you to applaud*". As a result, it is not surprising that investors require in normal time a specific risk premium at the short end of the yield curve to be exposed to unwelcome central banks' surprises.

[1] Address before the New York Group of the Investment Bankers Association of America, October 19, 1955.

The difficulty is that this specific "monetary policy risk premium" is unlikely to be stable over time. Indeed, the traditional view – a looser monetary policy is good for markets and a tighter one is bad - has been challenged over the last two decades by the introduction of the "Greenspan/Bernanke/Yellen/Powell puts": when stock markets fall sharply, the US central bank may react quickly to stop the rout. As a result, when this "put" seems active, holding short duration bonds can be especially effective in protecting the investors' portfolios. The correlation between short-duration bonds and equities becomes the opposite of the natural one implied by William M. Martin.

It is why in order to understand the observed yield curve, one also needs some information on this specific monetary policy risk premium. What is its current level? Are we still in the "normal" situation where investors fear the impact of a possible Fed tightening and require a specific risk premium on bonds of short duration? To take into account the fact that the "monetary policy risk premium" varies over time we have introduced another key variable: the current tactical risk premium on one-year US notes[2].

We believe that the role of these 8 key variables – four related to monetary policy (current and expected) and four related to risk pricing (current and expected) - is very strongly supported by the economic theory. Let's turn our attention to the empirical evidence.

2/ Modeling and revisiting the US Treasuries yield curve over three decades.

Let's start by explaining how it is possible to extract these 8 key variables from the available information.

The first step is to establish the relationship between the observed rates on bonds of various durations and our key variables (i.e., finding what the technical jargon calls the "factor loadings"). As by design our key variables cover all what we need to understand bonds prices, it is not very difficult to establish these "factor loadings"[3].

In theory, once these factor loadings are known, one only needs to take 8 rates on the yield curve and by a simple matrix inversion, extract what are the underlying 8 key variables consistent with these 8 observable rates. Yet, in practice, the extraction process is more complicated than that.

The problem is what Duffee (2011) rightly called the "hidden factors" problem. A change of expected risk premia will produce a shift in the yield curve that will look exactly (or almost exactly) as the result of changing expectations regarding monetary policy. We don't easily observe 8 factors in the yield curve (all published papers use between 3 and 5 factors), but that does not mean that factors spotted by economic theory don't exist. They are simply not apparent.

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[2] We have also assumed that when the specific monetary risk premium is different from its normal level, investors expect a smooth return to normality over the long-term.

[3] Yet, there is a key problem of interpolation: current bond prices depend on expected short rates at all horizons and expected risk premia at all horizons on bonds of all durations. One needs to assume an interpolation mechanism that establish a link between all these variables (an infinite number!) and our 8 key variables based on a few key specific horizons (current, one-year and three-year ahead, long-term equilibrium) and two specific maturities (one and 10-year bonds). We have done that in a way that respect the no-arbitrage constraint: the interpolation mechanism is such that it is not possible to make risk-free profits by playing some bonds against others (see Davanne (2021a), for a first-generation version of the model where the specific "monetary policy risk premium" is assumed to be constant). The methodology we use is original, but our model belongs to the general class of essential affine model discussed by Duffee (2002).

This is a very important point: there is no hope of understanding well the yield curve without the help of outside information. The same yield curve may result from very different sets of expectations regarding the future monetary policy or the expected dynamic of risk premia[4].

It is why, as in numerous academic papers, we also add the result of investors surveys to extract our 8 key variables. More precisely, we use the Consensus Economics monthly surveys and the quarterly Surveys of Professional Forecasters (managed by the Philadelphia Fed). These surveys inform on investors' expectations for both short-term and long-term rates at various horizons. Thus, they give some rich information on the returns and risk premia expected on bonds at various horizons.

Using a standard statistical procedure (a Kalman filter), it is possible to extract our 8 key variables from the joint information provided by the yield curve (Current Fed funds rates, 6-month rate, one-year rate, 2-year rate, 5-year rate and 10-year) and the answers to these surveys.

Thus, we may interpret the observed yield curves in terms of expected monetary policy and expected risk premia with a detail never produced before.

Let's discuss a bit the discovery we made regarding the dynamic of risk premia. The following graph shows our estimates for tactical risk premia on 10-year Treasuries. As explained previously, three horizons should be considered: the current tactical risk premium, the equilibrium risk premium and, to assess the convergence speed, the tactical risk premium apparently expected by markets' participants in the medium term (three years).

In this graph, the risk premium is annualized: a tactical risk premium of 4% means that investors on average expect an excess return of 1% over the coming three months, relative to a "safe" monetary instrument.

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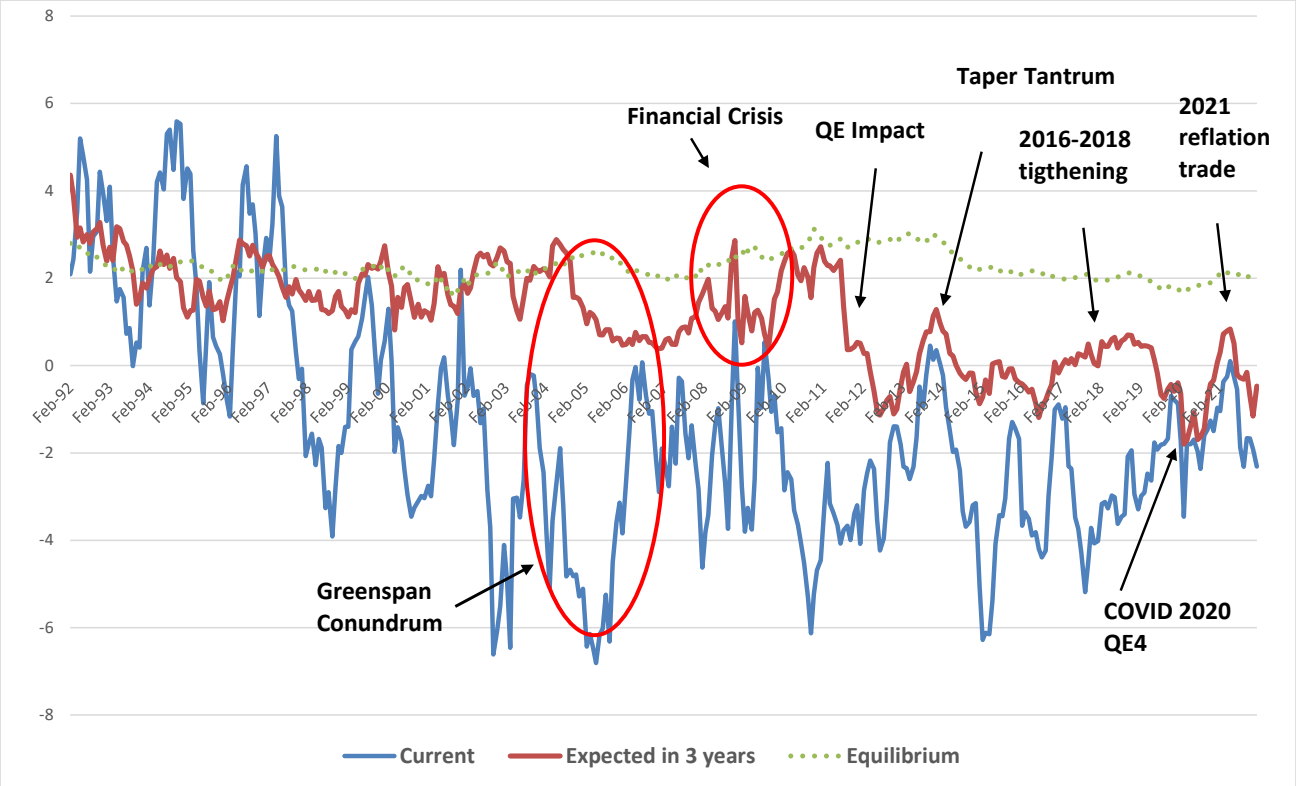
[4] For those interested in this important issue and the role played by only three factors (the "level", the "slope" and the "convexity") in the academic literature, we can be a bit more specific about why most of our 8 factors are hidden. All these factors have a rather smooth impact along the yield curve: thus, the factors loadings along the yield curve can be reasonably approximated by a polynomial of degree 2. Let's assume that the impact of a change of factor i on the rate of maturity T can be approximated by $a_i + b_i T + c_i T^2$. All factors have a specific signature on the yield curve as the parameters a_i, b_i, c_i are specific to the factor i. Yet, the cumulative impact of our 8 factors will systematically lead to a yield curve that will be of the form $R_T = \alpha + \beta T + \gamma T^2$, with α, β and γ changing over time. Thus, the yield curve will also always look like a polynomial of degree 2 and only 3 factors ("level", "slope" and "convexity") will be observable! Crump and Gospodinov (2019) arrived broadly to the same conclusion in a more formal discussion of the traditional factor analysis of the yield curve: "*At the heart of this "identification" problem lies the extreme cross-sectional dependence across maturities that produces a polynomial pattern in the eigenvectors of the covariance and correlation matrices of these processes*". This problem of identification is not specific to yield curve modelling as pointed out by Rebonato (2018): "*So, yes, the yield curve changes are well described by changes in levels, slope and curvature, but so are many other quantities that have nothing to do with yields. Indeed, in 30-plus years of working with principal components with a variety of data derived from sources as unrelated as neutron scattering and yield curves, I do not recall a single case in which I have not found a level/slope/curvature pattern for the first principal components, at least when all the variables have been positively correlated. Which simply suggests we are mainly observing a mathematical fact, rather than a sign from an higher being.*" Maybe this mathematical fact is that all smooth functions can be well approximated by a polynomial of degree 2.

Figure 1: Tactical risk premia on 10-year US Treasuries (annualized).



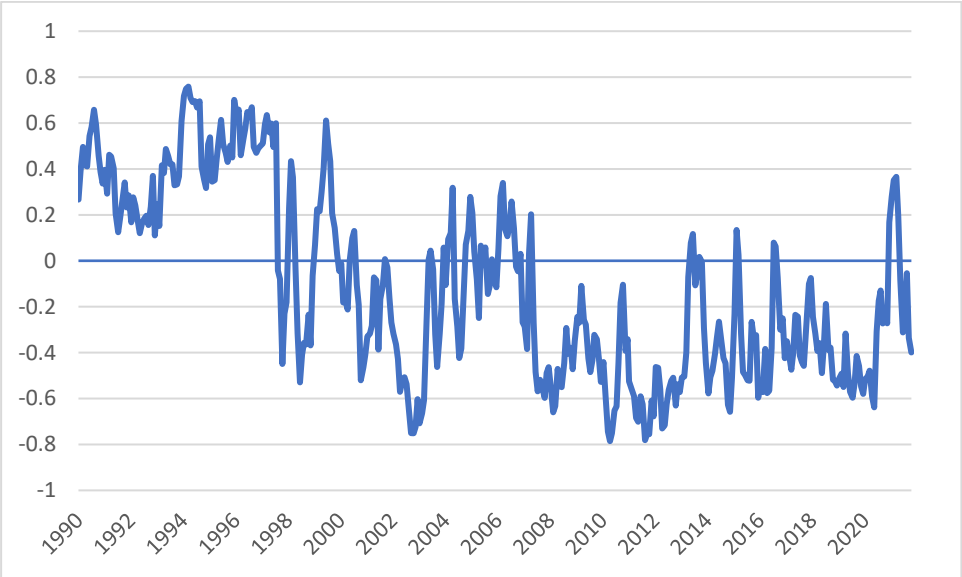
There are two striking results about the current tactical risk premia (lower line in blue).

Firstly, while the current risk premium was on average positive in the 90s, it turned progressively negative in the following decade. This observation may surprise many readers. There is a common view that long term bonds are riskier than T-bills since their prices are very volatile. Investors are often supposed to require some form of compensation to bear this short-term volatility risk. This no longer seems to be the case since the late 1990s: according to surveys, investors are generally pessimistic about the likely returns of Treasuries at horizons of three months or one year.

There are two reasons while it should not be that surprising.

- As demonstrated in the Capital Asset Pricing Model, for short term investors risk premia depend a lot on the correlations between various asset classes' returns. A volatile asset may benefit from a negative risk premium if it is negatively correlated to other assets and offer as a result some form of insurance to investors. And, indeed, we have observed a structural break in the 90s in the correlation between US Treasuries and US equities (see figure 2). Since the end 90s, holding long-term US Treasuries has provided a form of protection to equities investors. This negative β goes a long way to explain the observed negative risk premia. What are the reasons of this remarkable change of correlations? This is a complex question, but it is clear that the nature of risks born by investors have changed. The last two decades have been characterized by less worries about inflation and a lot of financial instability. As a result, US Treasuries have benefited from this safe haven status with rising prices when equities fall.

Figure 2: Correlation between the price of the 10-year US Notes and the S&P500 (rolling period of three months).



- But investors are not all short-term investors mainly concerned by volatility and correlations and the strength of the demand for US Treasuries has other complementary explanations. There are many long-term investors, like pension funds, managing their "strategic" portfolios with a long-term horizon. For them, as long as there is little risk of inflation, long-term bonds may be less risky than monetary instruments. A highly rated long-term bond guarantees a fixed payment to the long-term buy and hold investors, while investing in monetary instruments may be extraordinary risky from a long-term perspective as short-term rates vary widely. And the last three decades have seen many structural changes leading to a higher demand for safe bonds coming from long-term investors (the increase in pension saving, the credibility of central banks in the fight against inflation, the more stringent regulations of institutional investors…).

Overall, what we see in figure 1, is the consequence of a rising demand of safe long-term Treasuries meeting a limited supply. And it seems clear that the gap between supply and demand did not appear with Quantitative Easing in the aftermath of the 2008-2009 financial crisis but was already present before. Indeed, the negative tactical risk premium on US Treasuries reached its maximum in 2005 when Alan Greenspan famously mentioned the existence of a bond "conundrum".

The second striking result visible in figure 1 is the volatility of the short-term tactical risk premia. A limited part of this volatility may be due to measurement errors, as our estimates rely a lot on the available investors' surveys. But we believe that most of this volatility is real and explained by two fundamental mechanisms.

- As already explained, correlations play a very important part as investors like the assets that are negatively correlated to the rest of their portfolios. One can note in figure 2 that there was not only a structural break in the correlation between US Treasuries and equities in the late 90, one can also observe a lot of volatility in this correlation before and after this break.
- Moreover, one has also to consider the strong constraints faced by traders and fund managers in how they can manage their tactical positions. A fundamental mechanism in real life investing, absent from most academic papers, is the existence of the "stop-loss" constraint. Most investors must close tactical positions that have produced losses above their risk budget.

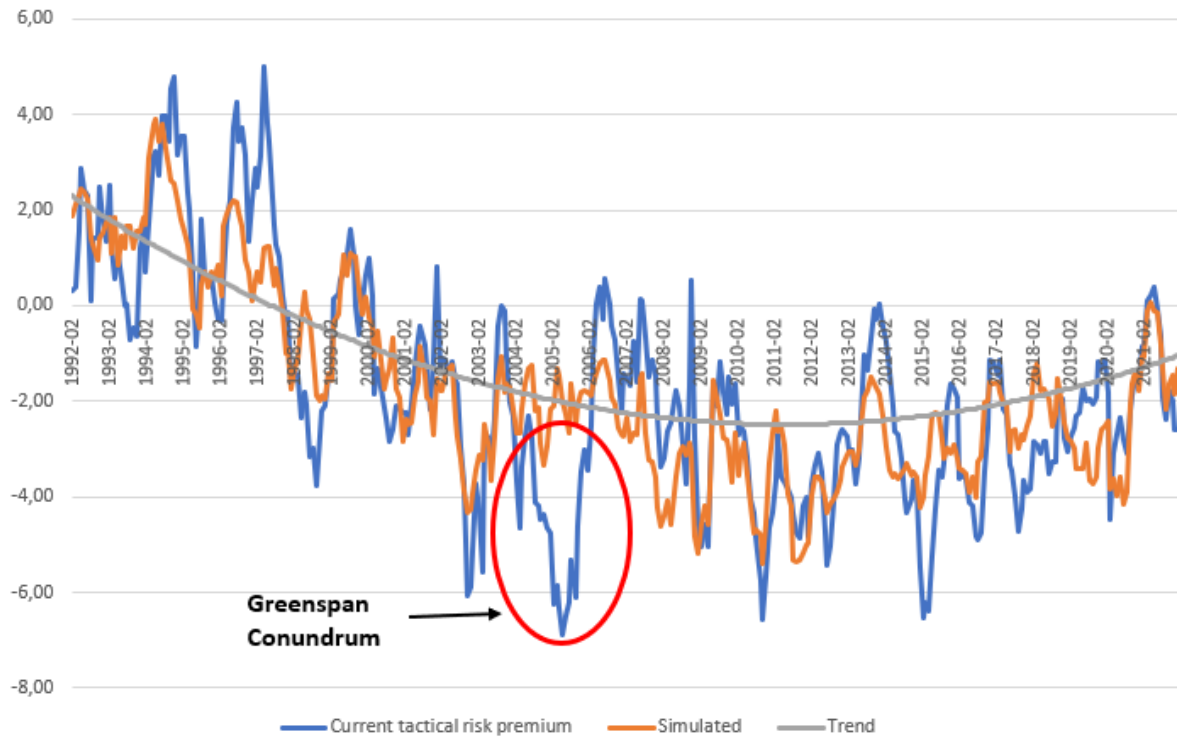
This has strong implications for the dynamic of tactical risk premia: an asset that has suffered some significant losses in the recent past should probably offer some higher risk premia to keep investors on board. Thus, one can assume that some of the volatility of the tactical risk premia can be explained by the recent behavior of the US Treasuries market.

We have tested these hypotheses with a simple model where the observed tactical risk premia are explained by three simple variables:

- A quadratic trend to reflect the progressive transition, completed in the late 90s, from structurally positive tactical risk premia to structurally negative risk premia.
- The volatile correlation between 10-year US notes and the S&P500 index, as shown in figure 2.
- The recent performance of the 10-year notes, measured by its performance over the last 6 months compared to the performance of "risk-free" short-term T-bills.

Despite the extreme simplicity of this equation to describe the complexity of the process producing tactical risk premia, this simple model explains the large majority of the observed volatility. **The tactical risk premium required on bonds augments significantly when i/ the return on bonds and equities are positively correlated, ii/ the recent performance of the bond market has been bad** (i.e., long-term rates have been recently on a rising trend). Figure 3 shows how the model fits the tactical risk premia, and the role played by the quadratic trend.

Figure 3: "Observed" and simulated tactical risk premia (annualized).

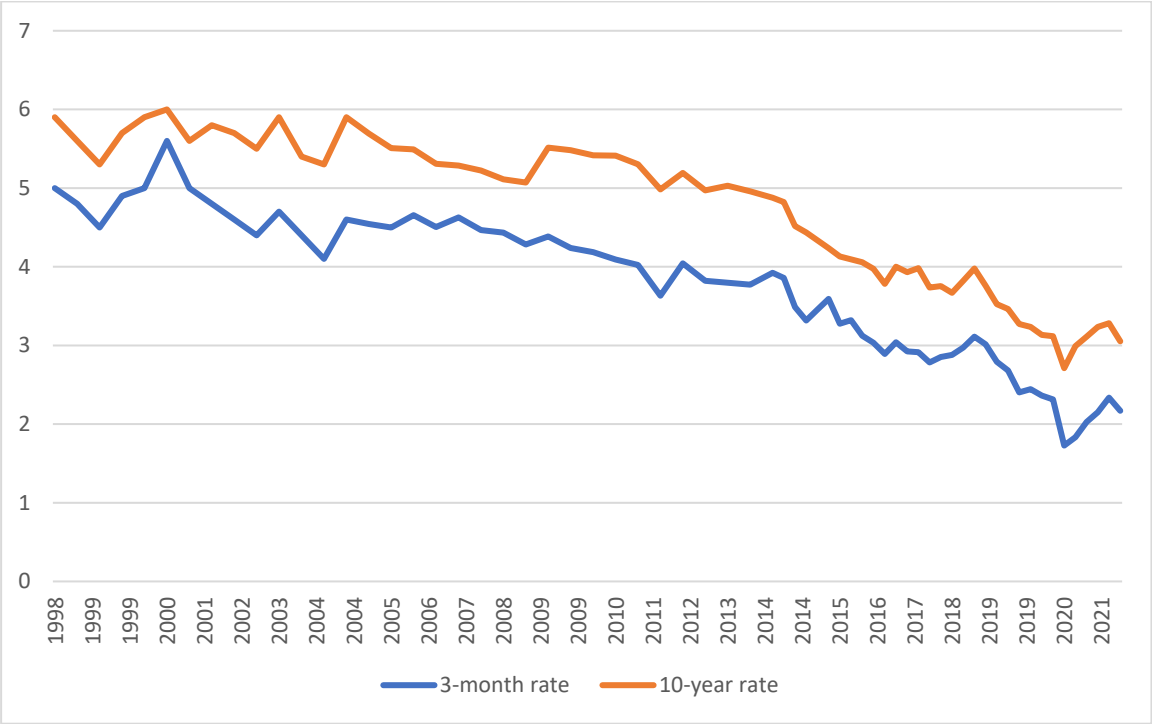


This high volatility of the current tactical risk premia contrasts sharply with the remarkable stability of the tactical risk premia investors have considered as normal in the long term (green curve in figure 1). Investors seem to consider that the normal risk premium on a 10-year bond relative to a "safe"

monetary instrument is slightly above 2% per annum, and they don't seem to have changed much their view on that matter since the 90s.

This is a key observation, and it is important to understand the piece of data that support this conclusion. There are clues pointing in that direction both in the yield curve and in investors surveys. In the yield curve, the slope of the forward rates at a very long horizon (more than 10 years) is directly related to the "normal" risk premia expected in the long term and it has always been compatible with an equilibrium risk premium around 2% for 10-year bonds (see Davanne (2021a for an analysis of the information in (and not in) long-term forward rates). As far as surveys are concerned, Figure 4 shows how the consensus for 10-year rates and 3-month T-bills at the 6-10 years horizon has changed since the late 90s (Consensus Economics survey). We can see that the expected spread at the long-term equilibrium is pretty stable around 1%. This spread of 1% is broadly in line with a risk premium around 2% for 10-year notes[5].

Figure 4: Expected long-term equilibrium for 10-year and 3-month rates (forecasts at the 6-10 years horizon).



Source: Consensus Economics. The surveys are semestrial from 1998 to 2014 and quarterly since that date.

In other words, long-term Treasuries are generally priced on the wrong assumption that there is no structural gap between a very strong demand and a limited supply. **Despite more than twenty years of negative tactical risk premia, investors have always considered during that time that this situation was transitory and that sooner or later, investors would again require some "normal" positive risk premia.**

[5] The spread between 10-year rates and short rates is not the risk premium on a 10-year rate. The spread reflects the average excess return provided by the 10-year note until redemption. But its maturity declines progressively towards 0, thus this average excess return is close to half the risk premium required on a constant maturity 10-year note.

However, the expected speed of convergence towards "normality" has varied a lot over time. This can be seen Figure 1 looking at the tactical risk premia expected at the three-year horizon (red line). We can identify four different periods:

- **Until 2003, investors were confident that the return towards significantly positive risk premia would be quick.** Tactical risk premia priced at the three-year horizon were around 2%, pretty close to the expected long-term equilibrium.
- But the surprising strength of the demand for US Treasuries, and the low level of long-term rates, started to be noted in 2004-2005. Alan Greenspan observed that "*For the moment, the broadly unanticipated behavior of world bond markets remains a conundrum. Bond price movements may be a short-term aberration, but it will be some time before we are able to better judge the forces underlying recent experience*"[6]. Investors implicitly conclude (wrongly?) that there was no new paradigm: they did not change their estimate for the equilibrium risk premia in the long-term. But they indeed took a cautious view of the convergence process: the expected tactical risk premium at the three-year horizon fell for a while at a relatively low level.
- In its first stage, the financial crisis put an end to this process of recognizing the strength of demand for US Treasuries. In an uncertain context, long term rates become again priced on the assumption that tactical risk premia on 10-year bonds would converge quickly towards 2%. As a result, the yield curve became quite steep: in 2009, 10-year rates were at 3.3% on average when the 3-month T-bills rates were at only 0.2%.
- **Everything changed in 2011-2012 with new powerful rounds of QE** ("QE2" in November 2010 and "QE3" in September 2012). QE cut the supply of US Treasuries available for the private sector and pushed even more the current tactical risk premia into negative territory. But its main impact on long-term rates was psychological, playing through changing expectations: it provided a justification to challenge the traditional view that "normal" bonds risk premia are necessarily positive. Suddenly, thanks to central banks' interventions, the "this time is different" cautiously assumed by Alan Greenspan in 2005 became credible. As a result, expected risk premia at the 3-year horizon collapsed (and the long-term rates with them). Since that time, they have been on average slightly negative. But, in some way, many markets' participants are still prisoner of the view that "lower for longer" does not mean "forever": the yield curve still prices in the long term a recovery of risk premia on 10-year bonds towards 2%. And as QE is seen (wrongly) as the main reason why rates are so low, each time there are reasons to expect a normalization of US monetary policy in the not-too-distant future, expected risk premia in the medium term move sharply higher. It was the case in 2013 ("the Taper Tantrum" episode), in 2016-2018 (rising Fed Funds) and in the spring of 2021 (peak of the "reflation trade"). Yet, each time these increased in risk premia proved to be short-lived.

It will be fascinating to use the indicators we provide to follow the end of this story… Will the increased supply of US Treasuries in the future due to Quantitative Tightening (i.e. the Fed reducing its balance sheet) lead to higher short term tactical risk premia, with perhaps a return to positive? Will investors continue for a while to consider that in the long run the normal risk premium on 10-year treasuries is around 2% (probably…)? Will changing views on the convergence path towards these 2% continue to introduce a lot of volatility for long-term rates (probably…)?

[6] February 17, 2005, testimony before the Committee on Banking, Housing, and Urban Affairs of the U.S. Senate.

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