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Nominal Rigidities and the Term Structures of Equity and Bond Returns

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Abstract

We present a production economy with nominal price rigidities that explains several asset pricing facts, including a downward-sloping term structure of the equity premium, upward-sloping term structures of nominal and real interest rates, and the cyclical variation of the term structures. In the model, after a productivity shock a countercyclical labor share exacerbates the procyclicality of dividends, and hence their riskiness, and generates countercyclical inflation. The dividend share gradually increases after a negative productivity shock as the price level increases sluggishly, so the payoffs of short-duration dividend claims (bonds) are more (less) procyclical than the payoffs of long-duration claims (bonds). A slow-moving external habit then produces large and countercyclical prices for these risks as well as high risk premia at very long horizons. In bad times, the slope of equity (bond) yields for the observable maturities becomes more negative (more positive), but risk premia also increase at longer horizons, and market equity premia end up increasing by more than short-run equity premia. The simultaneous presence of market and home consumption habits allows for uniting habits and a production economy without compromising the model's ability to fit macroeconomic variables. The central bank's anti-inflationary stance plays a key role in shaping equity and bond prices.

JEL classification: E43; E44; G12.

Keywords: Structural term structure modeling, Equity and bond yields, Habit formation, Nominal rigidities, Macro-finance separation.

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1. Introduction

Recent evidence shows that discount rates of financial claims differ across maturities as well as across asset classes. In particular, the maturity structure and time variation of equity and bond risk premia contain rich information to understand investors' marginal utility of wealth and their expectations about future macroeconomic variables. The expected returns of nominal and real bonds increase with the maturity on average, while claims to short-term dividends have higher excess returns than the aggregate stock market, implying a term structure of the equity premium that is downward-sloping on average over the observable maturities (Binsbergen et al., 2012). Such a slope characterizes the term structures of both one-period equity returns and yields, which differ however in their cyclicalities. During recessions, the term structure of equity yields becomes more negatively sloped (Binsbergen et al., 2013), while the term structure of one-period equity returns becomes less so, as the equity premium can increase by more than short-duration equity premia (Gormsen, 2021). Finally, at the bottom of stock market recessions, the term structure of bond yields becomes steeper, as it predicts higher future growth and rates (an observation that goes back to at least Estrella and Hardouvelis, 1991). A general-equilibrium explanation of the forces driving such features of equity and bond prices is still missing.

Our first contribution is to offer an explanation of the macroeconomic forces that drive these empirical features of equity and bond markets. We present a New Keynesian model with habit formation that relies on *two key ingredients*. The first ingredient, a textbook *sticky-price production economy*, provides a familiar model of output and inflation that matches standard macroeconomic data and rationalizes the payoffs of nominal bonds (inverse inflation) and dividends as a levered version of consumption. The second ingredient, *slow-moving external habit formation* à la Campbell and Cochrane (1999), generates realistically large and time-varying discount rates.

Our second contribution is to illustrate how to unite nonlinear consumption habits and a production economy without compromising the model's ability to fit macroeconomic variables—a challenge documented by Lettau and Uhlig (2000) and Rudebusch and Swanson (2008). We avoid that difficulty by including a *second* habit in effective leisure, or home consumption. Intuitively, after a bad productivity shock, both market and home consumption drop close to their habit levels, with offsetting effects on the labor choice, thereby neutralizing the undesirable effect of habits on production. In fact, we show how one can approximately preserve a macroeconomist's preferred model of quantities, in this case of the New Keynesian production economy, while using nonlinear habits to produce realistic asset prices. This *macro-finance separation* result—whereby the states that drive variation in discount rates beyond the usual CRRA preferences do not drive consumption, hours, and inflation—implies that habits do not affect the well-known properties of quantities in the macro model. It also follows that we can effectively inspect the mechanism by considering in isolation the role of the two ingredients.

Our first ingredient, the production economy with sticky prices, provides a macroeconomic model that matches the observed volatility and autocorrelation of cash flows (consumption growth, dividend growth, and inflation). Because of the approximate macro-finance separation,

the model’s quantity and inflation implications and responses to a productivity shock are standard. The central mechanism relies on nominal rigidities that produce countercyclical labor shares after a productivity shock, which imply procyclical corporate profits and countercyclical inflation. Therefore, dividend claims and nominal bonds pay off badly in a downturn when marginal utility is high, and are therefore risky investments. However, since the labor share is stationary, and hence it mean reverts, the payoffs of long-duration dividend strips (nominal bonds) are less (more) procyclical: corporate profits and the price level increase after a bad transitory shock as more and more firms are able to adjust their prices to mark them up over marginal costs.

Our second ingredient, the slow-moving external habit formation, then magnifies these cash flow risks into large and countercyclical risk premia. Moreover, for sufficiently long durations, the model’s discount rate does more than simply amplify risk premia; all claims are risky in the very long run. In fact, in a downturn, habits make prices drop more the longer the claim’s duration, because people will slowly get used to the lower consumption level, so people will want to anticipate consumption and will require compensation for shifting resources in the future, even if the shock to consumption is permanent. Because of this *habit effect*, we produce a term structure of the equity premium that is U-shaped—with a negative slope in the short to medium run, driven by the cyclicalities of dividends, and a positive slope for longer maturities, driven by the habit effect. By the same habit effect, our model produces a positively sloped term structure of real rates, thereby avoiding a real bond premium puzzle (Backus et al., 1989), while the cyclicalities of inflation implies a positive inflation risk premium at all horizons, and hence a positively sloped nominal term structure.

The nonlinear habits also generate the cyclicalities of the term structures documented in the data. In bad times, as consumption falls close to habits and dividends drop, risk premia increase and future dividends are expected to recover; hence, the slope of equity yields for the observable maturities becomes more negative, but risk premia also increase for longer horizons and, consequently, market equity premia turn out to increase by more than short-run equity premia in the model. At the same time, inflation is expected to increase sluggishly, and hence the slope of bond yields becomes more positive.

This paper offers a structural story that captures several of the empirical properties of equity and bond prices that so far only the descriptive, no-arbitrage models of Lettau and Wachter (2007, 2011) and Gormsen (2021) have tried to capture. The model fits the listed term structural facts despite being parameterized to match macroeconomic quantities. Furthermore, our framework preserves the main achievements of Campbell and Cochrane (1999), including a solution to the average equity premium and the risk-free rate puzzles, long-horizon predictability of excess stock returns, and the countercyclical variation of stock market returns and volatility. All these phenomena arise naturally as we unite slow-moving countercyclical discount rates and New Keynesian cash flows.

The choice of external habits to explain the term structure evidence may seem surprising at first, as some authors document the challenges of the habit framework in producing a downward-sloping term structure (e.g., Binsbergen et al., 2012), even though they are naturally consistent with the countercyclicalities of one-period equity term premia (Gormsen, 2021) due to the habit effect at very long horizons. Those results, however, are derived in

endowment economies with random-walk dividend streams. Once we inject a mean-reverting component into dividends, as endogenously generated by the production economy, we depart from those benchmark models. In particular, by using the model to make the properties of cash flows match their volatility and autocorrelation in the data, we are able to naturally generate a downward and procyclical slope at the observable end of the term structure of equity yields while preserving the property of habits that generates countercyclical one-period equity term premia.

Furthermore, the results in [Gormsen \(2021\)](#) rule out Epstein-Zin preferences as an obvious ingredient. In fact, the habit effect at long horizons is preserved in the production economy. In contrast, with Epstein-Zin preferences, the ingredients necessary for flipping the sign of the slope of the equity term structure will tend to operate also at long horizons. Indeed, [Gormsen](#) shows how recent examples in [Hasler and Marfè \(2016\)](#) and [Ai et al. \(2018\)](#), who are able to generate a downward-sloping equity term structure by changing the cash flow process, display as a consequence the wrong cyclicity of the term structure of equity premia. The extension of those setups to a nominal production economy, therefore, seems to be a challenging avenue.

Even though we operate under approximate macro-finance separation, the nonlinearity of habits still calls for an accurate nonlinear solution method. In particular, we solve the model by a global solution spanned by a basis of high-order polynomials and confirm that macro-finance separation holds almost exactly. Furthermore, while we focus on evidence that goes back to the 1980s or early 1990s, and while the facts we are after have also been documented in periods where the federal funds rate was not constrained by the zero lower bound on the nominal interest rate, we also solve the model subject to a zero-lower-bound constraint. Our results remain similar.

Our emphasis is on the effect of productivity shocks in our simple framework, which, as we show, goes a long way in explaining several asset pricing facts. A full-fledged model would include more shocks, including demand shocks, to capture more comprehensively the data. For example, as argued by [Campbell et al. \(2020\)](#), the presence of a mix of demand and supply shocks can capture changing correlation patterns between consumption and inflation and between stock and bond returns. Therefore, we extend our model to include demand shocks and parameterize their size to match the observed correlation between consumption growth and inflation, which is too low in a model with only productivity shocks. In line with the evidence in [Campbell et al.](#), we find that the model can easily produce decade-long spells with negative correlations between stock and bond returns. In this context, while the presence of demand shocks partly offsets the term structural properties generated by supply shocks, the properties of interest remain consistent with the data. That is, the model augmented with demand shocks displays a similar cash flow mean reversion and similar slopes of the term structures of the equity premium and interest rates, although flatter than in the baseline model. The cyclicity of the term structure of equity is likewise preserved when we add demand shocks.

Finally, we use our setup to quantify the role played by nominal rigidities and monetary policy in shaping asset returns. Indeed, since we captured several stylized facts of equity and bond markets in a New Keynesian model, it follows that the degree of nominal price