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High Inflation: Low Default Risk and Low Equity Valuations

Harjoat S. Bhamra
Imperial College Business School, CEPR, NIESR, and CFM, UK

Christian Dorion
HEC Montreal and CDI Research Fellow, Canada

Alexandre Jeanneret
UNSW Business School, Australia

Michael Weber
Booth School of Business, University of Chicago, CEPR, and NBER, USA

We develop an asset pricing model with endogenous corporate policies that explains how inflation jointly affects real asset prices and corporate default risk. Our model includes two empirically founded nominal rigidities: fixed nominal debt coupons (sticky leverage) and sticky cash flows. These two frictions result in lower real equity prices and credit spreads when expected inflation rises. A decrease in expected inflation has opposite effects, with even larger magnitudes. In the cross-section, the model predicts that the negative impact of higher expected inflation on real equity values is stronger for low leverage firms. We find empirical support for the model's predictions. (*JEL* E44, G12, G32, G33)

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Corporate default risk falls during times of higher expected inflation. But so do firms' equity values, despite lower bankruptcy risk. Figure 1 documents these two empirical facts for the United States over the period 1970Q2–2019Q4, after orthogonalizing expected inflation with respect to real economic conditions. Panel A illustrates the strong negative relationship between expected inflation and the number of quarterly defaults in the U.S., whereas panel B shows a similar negative relationship between expected inflation and the price-dividend ratio. In this paper, we explain how shareholders can rationally value equity less favorably during periods of higher expected inflation, despite facing lower bankruptcy risk. We propose a theory that reconciles this apparent contradiction and provide novel evidence that these relationships are robust features of the data.[1]

Existing theories have overlooked the connection between these two empirical relationships and only examined them separately. One branch of the literature focuses on the link between expected inflation and default risk, but yields counterfactual implications for equity valuation. In Bhamra, Fisher, and Kuehn (2011), Kang and Pflueger (2015), and Gomes, Jermann, and Schmid (2016), higher expected inflation increases both the nominal risk-free rate and the expected growth rate of a firm's nominal cash flows. Both effects reduce firms' indebtedness and default risk, but these models predict a counterfactual increase in equity prices. Another branch of the literature investigates the link between expected inflation and equity values, but this literature remains silent on implications for default risk (see, e.g., Modigliani and Cohn (1979), Feldstein et al. (1980), Ritter and Warr (2002), Sharpe (2002), and Campbell and Vuolteenaho (2004)).[2] A common explanation for the link between inflation and equity prices is money illusion: investors discount real cash flows with nominal discount rates.[3] In contrast to the existing literature, we propose a unified treatment of the empirical facts we illustrate in Figure 1.

We build on Bhamra, Kuehn, and Strebulaev (2010a,b) and Chen (2010) and construct an asset-pricing model with fluctuating levels of expected inflation to explain these apparently contradictory observations.[4] Our framework provides

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[1] We show the relationships displayed in Figure 1 are not an artifact of firm aggregation: we find that the *same sets* of firms experience a decrease in default risk and equity valuation when expected inflation increases. Furthermore, firm-level regressions reveal that equity valuation and default risk jointly decrease with expected inflation after controlling for firm characteristics and variations in aggregate financial/economic conditions.

[2] Additional contributions to this literature are Lintner (1975), Bodie (1976), Fama and Schwert (1977), Miller, Jeffrey, and Mandelker (1976), Nelson (1976), Fama (1981), Schwert (1981), Geske and Roll (1983), Gultekin (1983), Solnik (1983), Pindyck et al. (1984), Kaul (1987), Pearce and Roley (1988), Kaul and Seyhun (1990), Boudoukh and Richardson (1993), and Bekaert and Wang (2010).

[3] Alternative explanations are the nonneutrality of inflation and the existence of an inflation risk premium. We will describe the relevant literature in more detail below.

[4] Bhamra, Kuehn, and Strebulaev (2010a,b) and Chen (2010) analyze firms' capital-structure and default decisions, as well as levered asset prices, in a consumption-based model with changing macroeconomic conditions. Our key

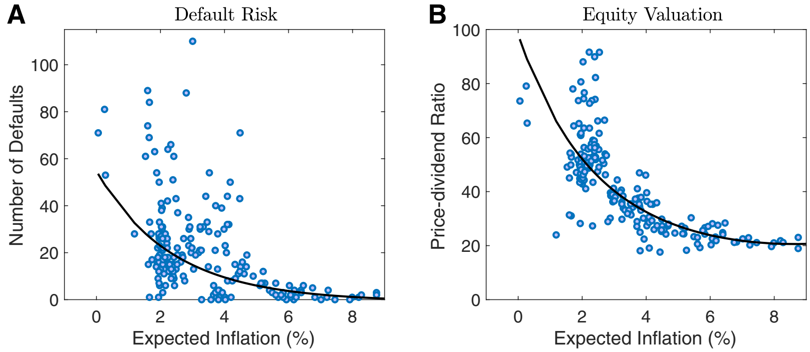

Figure 1
Default risk, equity valuation, and expected inflation in the United States
This figure illustrates the relationship between default risk, equity valuation, and expected inflation. Panel A reports the number of quarterly defaults of firms domiciled in the United States with debt rated by Moody's. Default data are from the Moody's Default and Recovery Database. Panel B displays the price-dividend ratio, computed as the value-weighted CRSP price index in the last month of the quarter divided by the sum of dividends paid in the last 12 months. Expected inflation is the one-year-ahead inflation forecast from the Survey of Professional Forecasters, which is orthogonalized with respect to real economic conditions, as measured by real consumption growth, NBER recessions, and a dummy for the Great Recession. The sample spans the period 1970Q2–2019Q4.

predictions on default risk and equity values from a corporate finance perspective, whereby firms' financing and default policies are endogenous. Firms issue nominal debt and equity, which are priced by a representative agent with Epstein-Zin-Weil preferences. The economy switches randomly between expansion and recession, creating intertemporal macroeconomic risk. A two-state Markov regime-switching model with parameter estimates based on quarterly U.S. consumption data over the period 1970Q2–2019Q4 determines the switches between real states. We introduce three expected inflation states (low, moderate, and high) via a second Markov regime-switching process that matches the one-year mean inflation forecast from the Survey of Professional Forecasters. We refer to fluctuations in the expected inflation rate as *inflation risk*, which is distinct from real macroeconomic risk. We consider both correlated and uncorrelated real macroeconomic risk and inflation risk regimes. Furthermore, we can allow for a time-varying correlation between shocks to consumption growth and inflation, consistent with the evidence (see Bilal (2017), Boons et al. (2020) and Campbell, Pflueger, and Viceira (2020)).

We impose two key frictions in our model, both of which act as nominal rigidities. First, firms keep their nominal debt coupons fixed. This *stickiness of leverage* means changes in expected inflation affect real asset prices via shifts in the real values of debt coupons. Second, price rigidity in the goods market

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modeling contribution relative to the above papers is the introduction of a new state variable (stochastic expected inflation) and two specific nominal rigidities (sticky leverage and sticky cash flows). Understanding how these two nominal rigidities affect the way expected inflation affects endogenous corporate financial policies and real asset prices forms the novel theoretical core of this paper.

implies sticky nominal cash flow growth in the short run, and so expected nominal cash flow growth changes less than one-for-one with changes in expected inflation. We denote this friction as *sticky cash flows* and we find strong empirical support for this nominal rigidity in U.S. data. Our assumption is consistent with the evidence on the stickiness of output prices (see, e.g., Nakamura and Steinsson (2008), Gorodnichenko and Weber (2016)), Pasten, Schoenle, and Weber (2019) and D'Acunto et al. (2018) and nominal rigidities are also central in explaining the real effects of large-scale asset purchase programs (Elenev (2019)).[5]

We show these two empirically motivated nominal frictions are sufficient to explain the stylized facts in Figure 1. Our model predicts an individual firm experiences both lower credit risk and lower equity valuation during periods of higher expected inflation. In addition, we extend our analysis to an economy of firms, whose distribution of leverage ratios is structurally similar to that in the data. We show the negative impact of expected inflation on equity valuation and default risk continues to hold–and thus does not cancel out–when aggregating over a cross-section of firms.

Each friction plays a distinct role in driving our theoretical results. The sticky leverage nominal rigidity is the key driver of the result that an increase in expected inflation reduces credit risk: an increase in expected inflation increases firm performance in nominal terms, or alternatively reduces the real debt coupon, which decreases the default probability. The sticky cash flow rigidity, however, determines how changes in expected inflation affect equity valuation, and does so via two distinct effects. First, a higher nominal cash flow growth rate caused by a rise in expected inflation increases the equity value. Second, firm cash flows are discounted at a higher nominal risk-free rate, which decreases the equity value. The latter discount rate effect dominates the former cash flow effect, because the nominal risk-free rate varies one-for-one with expected inflation, whereas the nominal cash flow growth rate varies less than one-for-one with expected inflation. Hence, equity value decrease with expected inflation, because of sticky cash flows.

The model also generates the convexity in the relations, depicted in Figure 1. A decrease in expected inflation increases the value of equity, and it appears natural to assume an increase in expected inflation of the same size will result in an equal-sized decrease of equity values. But such an analysis is incomplete, because it ignores how the present value of firm cash flows depends nonlinearly on the nominal risk-free rate, and thus on the level of expected inflation, via

[5] Nominal price rigidities are the leading explanation of the real effects of monetary policy. We show in the Internet Appendix that sticky cash flows arise endogenously in a continuous-time New Keynesian model with aggregate risk, where firms have monopoly power and adjust their prices subject to quadratic costs as in Rotemberg (1982). Also, menu-cost models with fixed costs generate a band of inaction, rationalizing price nonadjustment to shocks (see, e.g., Mankiw (1985) and Ball and Mankiw (1994)).

nominal discounting.[6] The relation between equity valuation and expected inflation is thus asymmetric, and low expected inflation is not the mirror image of high expected inflation. Lower expected inflation increases equity prices more than higher expected inflation depresses them, which implies the presence of fluctuations in expected inflation increases equity valuation on average.[7] Hence, the presence of inflation risk has a positive–and not a negative–effect on real asset values. Our paper thus contributes to understanding the impact of inflation risk on asset pricing and in showing that the existence of inflation fluctuations can be economically beneficial to investors.

At first glance, the sticky leverage assumption may appear to drive the model's results for credit risk while the sticky cash flow assumption drives the equity valuation results. If the two assumptions operated independently, it could call into question the rationale behind studying how expected inflation affects both equity valuation and credit risk. However, the sticky leverage assumption does affect equity valuation; that is, in the cross-section, the impact of expected inflation on equity values varies with firm leverage, because changes in expected inflation affect asset prices through two opposing channels: discounting and default risk. First, higher expected inflation decreases the value of equity through sticky cash flows, i.e., nominal cash flow growth does not increase one-for-one with expected inflation, while the nominal risk-free rate does. This discounting effect is independent of leverage. Second, default risk decreases when expected inflation goes up, and this relationship strengthens with leverage. The reduction in default risk partially offsets the decrease in equity valuation, especially for more highly levered firms. The model thus predicts equity prices of more highly levered firms are less sensitive to changes in expected inflation than those of less-levered firms, because of sticky leverage.

We provide a detailed empirical investigation of the impact of expected inflation on both equity valuation and default risk. Our empirical analysis has two aims. First, we test the cross-sectional prediction that financial leverage reduces the sensitivity of equity values to expected inflation. Second, we verify that the negative and asymmetric relations are robust at the firm level. We use CRSP-Compustat merged data from April 1972 to December 2019 and exploit two firm-level measures of equity valuation: the market-to-book (M/B) ratio and the price-dividend ratio.[8] We compute a firm's financial distress risk and its implied physical default probability following Campbell, Hilscher, and Szilagyi (2008). A portfolio analysis with firms sorted on their financial leverage ratios shows that default risk and equity valuation decrease with the level of

[6] This prediction arises although default probabilities are convex in the distance-to-default, which implies that an increase in default risk depresses the value of equity more than a decrease in default risk of the same size. But we show this effect is not sufficient to offset the asymmetry arising from nominal discounting.

[7] To reach this conclusion, we compare the model's prediction with that of an hypothetical economy with expected inflation set at its unconditional mean.

[8] The availability of forecasts for inflation determines the starting point of the sample.

expected inflation, for both low- and high-leverage firms. The reduction in equity valuation is, however, stronger for less-levered firms, which means that higher default risk reduces, rather than exacerbates, the sensitivity of equity prices to changes in nominal conditions. The validation of this cross-sectional prediction provides support for our model.

A potential concern is that variations in expected inflation reflect changes in economic or financial conditions, and that the resultant changes in default risk and equity valuation at the portfolio level are due to grouping heterogeneous firms. We address these issues by running firm-level regressions with 798,288 firm-quarter observations and a rich set of financial, macroeconomic, and firm-level controls. We find that the negative and asymmetric impact of expected inflation on a firm's equity valuation and default risk is highly statistically significant, and the results remain robust to different samples of firms and subperiods. The results continue to hold when we condition on firms that remain in our sample throughout the period, which ensures a firm-selection effect does not explain our findings. Furthermore, consistent with our model's predictions, the negative relation between expected inflation and equity values strengthens for firms with lower leverage or with more cash flow stickiness, using the frequency of price adjustments from Pasten, Schoenle, and Weber (2017). Our empirical analysis thus provides robust support that U.S. firms display lower equity values, despite lower default risk, when expected inflation increases and that the sensitivity of a firm's equity value to expected inflation is decreasing in leverage and increasing in price stickiness.

Our paper makes several contributions. First, we build a model of multiple firms issuing debt and equity with the option to default, in which expected inflation affects firms' asset prices because of sticky leverage and sticky cash flows. We explain the negative relation between equity valuation and expected inflation with sticky cash flows. Our model generates the negative impact of expected inflation on default risk through sticky leverage, which induces variations in real leverage. Second, we find that equity prices and default risk are more sensitive to a change in expected inflation when expected inflation is currently low than when it is high, which suggests a fundamental asymmetry in the effects of inflation risk. This asymmetry is important in light of the extremely low inflation levels we have observed during and after the Great Recession. Third, in the cross-section, we show equity prices vary more with expected inflation for firms with less leverage and stickier cash flows. Finally, we empirically validate all these predictions at the firm level, which provides new evidence regarding the joint response of equity valuation and default risk to variations in expected inflation.

Existing studies going back to Fama (1981) provide explanations for the negative relation between equity valuation and expected inflation, based on the idea that inflation is nonneutral because it has a negative effect on real growth.[9] Agents demand a positive inflation risk premium, which reduces equity prices (e.g., Eraker, Shaliastovich, and Wang (2015)). Our model shows that sticky leverage combined with sticky cash flows is sufficient to generate the relations between expected inflation, equity valuation, and default risk we observe in the data. We can thus obtain negative relations between equity valuation and expected inflation without any inflation risk premium.

We also explore the impact of a nonzero correlation between real and nominal conditions, based on the evidence of an unconditionally small but strongly time-varying inflation risk premium (Boons et al., 2020).[10] We uncover two new results. First, when the unconditional inflation risk premium becomes sufficiently large, our model no longer generates the relationship between equity values and expected inflation shown in Figure 1. Our model in tandem with the data therefore places an upper bound on the unconditional inflation risk premium. Second, with significant time variation in the correlation between shocks to consumption growth and inflation, within our model, equity values and credit spreads still decrease with expected inflation. Therefore, an unconditionally small, but time-varying inflation risk premium is consistent with the data.

To further assess the theoretical underpinnings of our model, we confront it with the empirical data on the term structure of equity yields and credit spreads. Empirically, we find the level of equity yields is increasing with expected inflation, in particular at the short end of the term structure.[11] Furthermore, we find the slope of the equity yield term-structure is downward sloping when expected inflation is high and upward sloping when expected inflation is medium or low. Our model is able to generate both these features of the data, because of cash flow stickiness. We also find the level of finite-maturity credit spreads is decreasing with expected inflation,[12] thus complementing our empirical findings that financial distress risk and physical default probabilities decrease with expected inflation. The difference in spreads is particularly high in the medium and long end of the term structure. Our model-implied

[9] Other studies theoretically exploring the interaction between inflation and equity returns include Day (1984), Stulz (1986), Wachter (2006), Gabaix (2008), Hess and Lee (1999), Chen (2010), Bansal and Shaliastovich (2013), and Gomes, Jermann, and Schmid (2016).

[10] While Piazzesi and Schneider (2006) shows inflation predicts consumption growth negatively, Boons et al. (2020) suggest the relation is time-varying. This finding is consistent with the evidence inflation periods do not always reflect a bad state of the economy. See, for example, Bekaert and Wang (2010), David and Veronesi (2013), and Campbell, Sunderam, and Viceira (2017).

[11] We use model-implied data from Giglio, Kelly, and Kozak (2021) that matches the available empirical data from Bansal, Miller, and Yaron (2017) and Van Binsbergen and Koijen (2017), but goes further back in time and includes the 1970's high inflation period.

[12] Following Chordia et al. (2017), we combine different bond data sets to construct the corporate credit spreads over the period 1974Q3–2019Q4: the Lehman Brothers Fixed Income Database, TRACE, Mergent FISD/NAIC, and Datastream.

finite-maturity credit spreads are able to reproduce this feature of the data, because of sticky leverage.

This paper contributes to the literature exploring empirically the relation between inflation and equity returns. Chen, Roll, and Ross (1986) and Ang, Briere, and Signori (2012) find inflation risk is priced in the cross-section of U.S. equity returns, whereas Boons et al. (2020) show the inflation risk premium varies over time, conditional on the relation between inflation and the real economy. We provide a complementary approach to understanding the impact of expected inflation on equity values, which hinges on cash flow stickiness. Whereas Weber (2015) shows how inflation risk affects equity returns via a sticky-price channel, we combine the idea of *sticky cash flows* with *sticky leverage*. Finally, Kang and Pflueger (2015), which studies how inflation risk affects corporate bond prices, is another closely related paper. Our paper complements this study by jointly studying expected inflation, default risk, and equity prices in a unified framework. Furthermore, we provide novel evidence and a theoretical explanation for the asymmetric relation between asset prices and expected inflation.

1. Intuition from a Simple Model

In this section, we consider a simple, static model with exogenous financing and default policies. We develop intuition for the negative impact of expected inflation on equity valuation and credit risk. We also discuss why equity prices and credit risk are more sensitive to a decrease in expected inflation than to an increase in expected inflation, that is, why the relations are asymmetric. The Internet Appendix IA.A provides details on derivations and proofs.

1.1 Economy

To value nominal asset prices, we specify a price index P_t that satisfies

$$\frac{dP_t}{P_t}=\mu_P dt, \tag{1}$$

where μ_P is expected inflation, which is constant.[13] We assume the price index is locally risk free. Therefore, the nominal risk-free rate is equal to the real interest rate r plus expected inflation μ_P, that is $r^{\$}=r+\mu_P$.

Consider a firm with time t nominal cash flow X_t. Under the risk-neutral probability measure $\mathbb{Q}$, the dynamics of X_t are given by

$$\frac{dX_t}{X_t}=\widehat{\mu}_X dt+\sigma_X dW_t^{\mathbb{Q}}, \tag{2}$$

[13] In the simple model of this section, there are no shocks to inflation, so realized inflation and expected inflation are the same. In the full model of Section 2, we introduce shocks to inflation, such that realized inflation and expected inflation are no longer equal.

Table 1
Estimation of cash flow stickiness

Dependent variable: Expected profit growth

	(1)	(2)	(3)	(4)
Expected inflation	0.373**	0.383**	0.409**	0.407**
	(0.176)	(0.173)	(0.171)	(0.164)
Expected GDP growth	3.806***	4.057***	4.262***	4.264***
	(0.283)	(0.320)	(0.313)	(0.309)
Consumption growth		−0.225	0.009	0.011
		(0.166)	(0.167)	(0.177)
Industrial production growth			−0.198***	−0.197***
			(0.058)	(0.062)
NBER recession				0.076
				(1.222)
Constant	−4.408***	−4.447***	−5.363***	−5.382***
	(0.970)	(0.965)	(0.942)	(1.004)
No. obs.	199	198	198	198
R^2	57.8%	58.2%	60.6%	60.6%

This table reports estimates of the degree of cash flow stickiness, as determined by the sensitivity of expected cash flow growth to expected inflation. Expected cash flow growth is measured as the mean forecast for the one-year-ahead corporate profit growth rate, while expected inflation is measured as the mean forecast for 1-year-ahead inflation. All growth rates are annualized. We report standard errors corrected for heteroscedasticity and serial correlation in parentheses. Forecast data are obtained from the Survey of Professional Forecasters provided by the Federal Reserve Bank of Philadelphia. The control variables are retrieved from the Federal Reserve of St. Louis. The sample period is 1970Q2–2019Q4. *p < .1; **p < .05; ***p < .01.

where $W_t^{\mathbb{Q}}$ is a standard Brownian motion under $\mathbb{Q}$. The nominal cash-flow growth volatility σ_X equals real cash-flow growth volatility, as the price index is locally risk free. Expected nominal cash-flow growth is the sum of real expected cash-flow growth $\widehat{\mu}_Y$ and a multiple φ of expected inflation μ_P, that is, $\widehat{\mu}_X = \widehat{\mu}_Y + \varphi\mu_P$, where φ captures the sensitivity of nominal cash-flow growth to expected inflation. Cash flows are sticky when $\varphi < 1$. In Section IA.O of the Internet Appendix, we provide a model to show that sticky cash flows can arise endogenously when firms with monopoly power optimally adjust prices subject to menu costs.

Strong evidence exists supporting the notion of sticky cash flows (see, e.g., Nakamura and Steinsson (2008) and Gorodnichenko and Weber (2016)), which we confirm by estimating the parameter φ with U.S. data. We regress the consensus forecast for the growth rate of corporate profits over the next 12 months on the consensus forecast for inflation over the same period, using data from the Survey of Professional Forecasters. The estimate of φ is 0.407 in column (4) of Table 1, which controls for variations in real macroeconomic conditions. This estimate is significantly lower than 1 (t-stat of 2.48), which indicates that the relation between expected nominal cash flow growth and expected inflation is less than one-for-one. Hence, cash flows are sticky with respect to changes in nominal conditions.

The firm issues equity and a bond. The corporate bond pays out a fixed nominal coupon of c dollars per unit of time until default which occurs at the first passage time $\tau_D = \inf_{t>0}\{X_t \leq X_D\}$, for some fixed default threshold X_D.

The debt coupon is constant in nominal terms, that is, leverage is sticky. The firm has no residual value when default occurs and there are no taxes.[14]

Consider first the case of a bond with no default risk. The nominal price of this bond is given by

$$B^{\$}_{f,t} = \frac{c}{r+\mu_P}, \tag{3}$$

from which we can immediately obtain the real bond price $B_{f,t} = B^{\$}_{f,t}/P_t$. Sticky leverage implies that both the real and nominal prices of a bond without default risk are decreasing in expected inflation, simply because the real value of the nominal coupon decrease with expected inflation. We report this relation in panel A of Figure 2, using three levels of expected inflation: low ($\mu_P = 1\%$), moderate ($\mu_P = 3\%$), and high ($\mu_P = 5\%$).

A corporate bond subject to default risk has a different exposure to expected inflation. The nominal price of such a bond is equal to

$$B^{\$}_t = B^{\$}_{f,t}\left[1 - q^{\$}_{D,t}(\mu_P)\right], \tag{4}$$

where the term $0 < q^{\$}_{D,t}(\mu_P) < 1$ is the Arrow-Debreu default claim, that is, the date t price of the security that pays out one dollar at the time of default. An increase in expected inflation improves firm performance in nominal terms, which decreases the Arrow-Debreu default claim (for any value of $\varphi > 0$). This effect originates from the nominal debt coupons that are constant and, thus, not adjusted with expected inflation.[15] This is a direct consequence of the stickiness of leverage, as in Bhamra, Fisher, and Kuehn (2011), Kang and Pflueger (2015), and Gomes, Jermann, and Schmid (2016).

A change in expected inflation now has two opposing effects on corporate debt valuation (both present because of sticky leverage): both the present value of the nominal coupons, $B^{\$}_{f,t}$, and the Arrow-Debreu default claim, $q^{\$}_{D,t}(\mu_P)$, decrease with expected inflation. The pricing of default risk dampens the price sensitivity of a risky corporate bond to expected inflation, relative to that of a risk-free bond (panel A). The yield of a risky corporate bond ($y^{\$} = c/B^{\$}_t$) then moves less than one-for-one with expected inflation, whereas the nominal risk-free rate ($r^{\$} = c/B^{\$}_{f,t}$) moves one-for-one with expected inflation (panel B). The credit spread, which is defined as the nominal yield of the corporate bond minus the nominal risk-free rate

$$cs_t = y^{\$} - r^{\$} = \frac{c}{B^{\$}_t} - \frac{c}{B^{\$}_{f,t}}, \tag{5}$$

[14] We relax these assumptions in the full model (Section 2).

[15] Without leverage stickiness, the firm would optimally increase the level of the nominal debt coupon to offset the decrease in default risk when expected inflation increases.

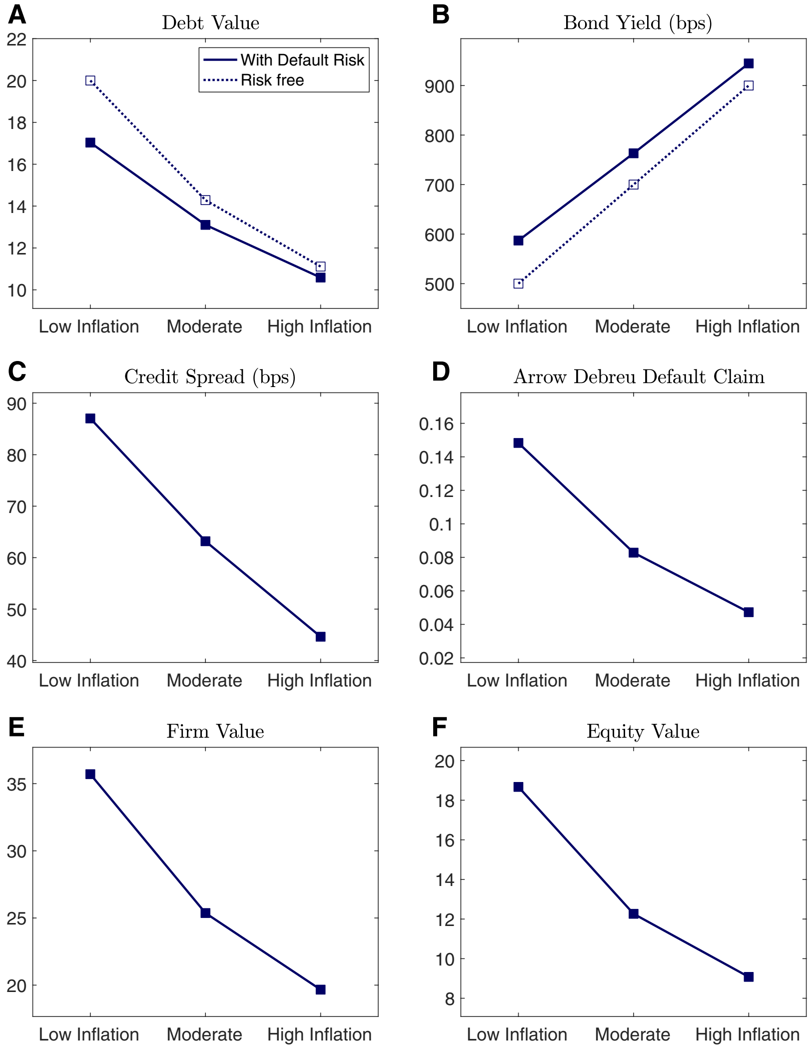

Figure 2
Expected inflation and asset prices: Simple model
The figure illustrates the impact of inflation on debt value (panel A), bond yield (panel B), credit spread (panel C), Arrow-Debreu default price (panel D), firm value (panel E), and equity value (panel F). The expected inflation rate is either low (1%), moderate (3%), or high (5%). Predictions are obtained with the static corporate finance model with exogenous capital structure and default policies discussed in Section 1. We set the parameter values to $\widehat{\mu}_Y=2\%$, $\sigma_Y=15\%$, $X_D=0.5$, $X_0=1$, $c=1$, $\varphi=0.407$, and $r=4\%$.

thus decreases with expected inflation, because of sticky leverage (panel C).[16,17] Without sticky leverage, the corporate bond subject to default risk

[16] See Internet Appendix IA.A for a proof.

[17] We can directly interpret the predictions on the credit spread as predictions on default risk, because the bond has no value in default.

displays a similar sensitivity to expected inflation as the risk-free counterpart, thereby turning off the negative exposure of credit risk to expected inflation.

With sticky leverage, the relation between the credit spread and expected inflation is not only negative but also convex, as expected inflation affects default risk nonlinearly via the Arrow-Debreu default claim (panel D).[18] Intuitively, an increase in expected inflation decreases default risk more when default risk is currently high, which is when expected inflation is low.

We turn now to equity valuation. The nominal value of equity is given by the nominal firm value less the nominal bond value

$$S_t^{\$} = V_t^{\$} - B_t^{\$}, \tag{6}$$

with

$$V_t^{\$} = \frac{X_t - X_D q_{D,t}^{\$}}{r^{\$} - \widehat{\mu}_X} = \frac{X_t - X_D q_{D,t}^{\$}}{r - \widehat{\mu}_Y + (1-\varphi)\mu_P}, \tag{7}$$

where $V_t^{\$}$ is the present value of the firm's cash flows up until default. Observe that $V_t^{\$}$ is decreasing with expected inflation when $\varphi < 1$ (panel E), and so the equity value, $S_t^{\$}$, is also decreasing with expected inflation when cash flows are sticky (panel F).

The sticky cash flows assumption implies that expected inflation affects equity valuation through two distinct channels. First, higher expected inflation increases the nominal cash flow growth rate, which increases equity valuation. Second, firm cash flows are discounted at a higher nominal risk-free rate, which decreases equity valuation. The latter effect dominates the former because the nominal risk-free rate varies one-for-one with expected inflation, whereas the nominal cash flow growth rate varies less than one-for-one with expected inflation when $\varphi < 1$. Hence, equity valuation decreases with expected inflation, and this relation arises from sticky cash flows. A change in the nominal risk-free rate affects equity values non-linearly via nominal discounting, which implies that the impact of changes in expected inflation on equity value is stronger when expected inflation is lower. Hence, the relation between equity valuation and expected inflation is negative and asymmetric.

In sum, Figure 2 shows that equity values and credit risk are both negatively related to expected inflation. Hence, a firm displays lower equity prices and, at the same time, faces lower credit spreads (or default risk) when expected inflation increases. Furthermore, a change from moderate to low expected inflation has a greater impact than a change from moderate to high expected inflation, although we consider symmetric variations in expected inflation. Hence, low expected inflation is not the mirror image of high expected inflation.

18 The Arrow-Debreu default claim satisfies $q_{D,t}^{\$}(\mu_P) = e^{-a(\mu_P)(x_t - x_D)}$, with $x_t = \ln X_t$ and $x_D = \ln X_D$. Note that $x_t - x_D$ is the distance-to-default in logarithms and so $a(\mu_P)$ acts as a discount rate, which is increasing in expected inflation. For a given distance-to-default, the relation between the Arrow-Debreu default claim $q_{D,t}^{\$}(\mu_P)$ and expected inflation μ_P is negative and convex, as verified in Internet Appendix IA.A.

This analysis demonstrates that firms can have lower levered equity valuations *and* lower default risk when expected inflation increases. This simple model assumes no arbitrage and does not make specific assumptions about preferences. The two critical features driving both relations are sticky cash flows, for which we find strong support in the data, and sticky leverage, which is an empirically grounded friction in the corporate debt market. Based on these insights, we now consider a dynamic version of the model with endogenous corporate policies to study how fluctuations in expected inflation jointly affect equity valuation and credit risk in a richer environment.

2. Model

This section presents a dynamic asset-pricing model with firms facing real and nominal risk. We first define aggregate consumption and inflation and derive the real and nominal stochastic discount factors, using an Epstein-Zin-Weil representative agent. We then derive the asset values of firms, which issue nominal debt and equity, and describe their optimal financing and default decisions.

2.1 Aggregate economic variables

We now specify the joint dynamics of aggregate consumption and inflation. Aggregate consumption at time t is denoted by C_t and the time t level of the price index by P_t, where

$$\frac{dC_t}{C_t} = \mu_{C,t} dt + \sigma_{C,t} dZ_t, \tag{8}$$

$$\frac{dP_t}{P_t} = \mu_{P,t} dt + \sigma_{P,t} dZ_{P,t}, \tag{9}$$

and Z_t and $Z_{P,t}$ are standard Brownian motions under the physical probability measure $\mathbb{P}$ such that $E_t[dZ_{P,t} dZ_t] = \rho_{PC,t}$.

The conditional first and second moments of aggregate consumption growth, $\mu_{C,t}$, $\sigma_{C,t}$, conditional expected inflation, $\mu_{P,t}$ together with the volatility $\sigma_{P,t}$ and the correlation between shocks to consumption growth and the price index, $\rho_{PC,t}$ are all stochastic.[19]

[19] See, for example, Boons et al. (2020), who document a small negative unconditional correlation between expected consumption growth and expected inflation in addition to a time-varying correlation, the latter being the focus of their analysis.

We use a six state Markov chain to describe the joint real-nominal state of the economy. The current state of the Markov chain is denoted by s_t, which switches randomly between the six states described in the table below.

	s_t	g_t	$\sigma_{C,t}$	$\mu_{P,t}$	$\rho_{PC,t}$
Recession & Low Expected Inflation (RL)	1	$\mu_{C,R}$	$\sigma_{C,R}$	$\mu_{P,L}$	$\rho_{PC,RL}$
Recession & Moderate Expected Inflation (RM)	2	$\mu_{C,R}$	$\sigma_{C,R}$	$\mu_{P,M}$	$\rho_{PC,RM}$
Recession & High Expected Inflation (RH)	3	$\mu_{C,R}$	$\sigma_{C,R}$	$\mu_{P,H}$	$\rho_{PC,RH}$
Expansion & Low Expected Inflation (EL)	4	$\mu_{C,E}$	$\sigma_{C,E}$	$\mu_{P,L}$	$\rho_{PC,EL}$
Expansion & Moderate Expected Inflation (EM)	5	$\mu_{C,E}$	$\sigma_{C,E}$	$\mu_{P,M}$	$\rho_{PC,EM}$
Expansion & High Expected Inflation (EH)	6	$\mu_{C,E}$	$\sigma_{C,E}$	$\mu_{P,H}$	$\rho_{PC,EH}$

(10)

We have $\mu_{C,R} < \mu_{C,E}$ and $\sigma_{C,R} > \sigma_{C,E}$ to ensure the mean and volatility of consumption growth are procyclical and countercyclical, respectively. Also, $\mu_{P,L} < \mu_{P,M} < \mu_{P,H}$, to be consistent with the labelling described in the above table.

We allow for correlation between real and nominal states, because expected inflation can change at the same time as the moments of real consumption growth. The physical probability of the joint real-nominal state switching from s_{t-} to s_t, where $s_t \neq s_{t-}$ within a time interval of length dt is given by $\lambda_{s_{t-},s_t} dt$, where λ_{s_{t-},s_t} is the physical intensity of switching from state s_{t-} to s_t. Since the Markov chain has $N=6$ states, there are $N(N-1)=30$ such physical intensities λ_{ij}, where $i \neq j$ and $i, j \in \{1,\ldots,6\}$. In the special case of independent real and nominal regimes, the 6×6 intensity matrix arises from two nested intensity matrices, associated with a two-regime real Markov chain and a three-regime nominal chain. As such, the probability of switching from a nominal regime to another becomes independent of the current real state.

2.2 Representative agent and stochastic discount factors

The representative agent has the continuous-time analog of Epstein-Zin-Weil preferences.[20] The real stochastic discount factor (SDF) at time t, π_t, depends on the state of the real economy and is given by (see Internet Appendix IA.B for the derivation)

$$\pi_t = \left(\beta e^{-\beta t}\right)^{\frac{1-\gamma}{1-\frac{1}{\psi}}} C_t^{-\gamma} \left(p_{C,t} e^{\int_0^t p_{C,u}^{-1} du}\right)^{-\frac{\gamma-\frac{1}{\psi}}{1-\frac{1}{\psi}}}, \tag{11}$$

where β is the rate of time preference, γ is the coefficient of relative risk aversion (RRA), and ψ is the elasticity of intertemporal substitution under certainty (EIS). The date t value of the claim to aggregate consumption per unit

20 The continuous-time version of the recursive preferences introduced by Epstein and Zin (1989) and Weil (1989) is known as stochastic differential utility, and is derived in Duffie and Epstein (1992). Schroder and Skiadas (1999) provide a proof of existence and uniqueness for the finite-horizon case.

of time is denoted by $p_{C,t}$.[21] This price-consumption ratio depends on the state of the economy, denoted by s_t:

$$p_{C,t} = p_{C,i}\,, \text{if } s_t = i. \tag{12}$$

The real stochastic discount factor at date-t, π_t, evolves as follows

$$\left.\frac{d\pi_t}{\pi_t}\right|_{s_{t-}=i, s_t=j} = -r_i dt - \gamma\sigma_{C,i} dZ_t + \sum_{j\neq i}(\omega_{ij}-1)dN^P_{ij,t},\, i,j\in\{1,\dots,N\},\, j\neq i, \tag{13}$$

where r_i is the equilibrium real risk-free interest rate in state $i\in\{1,\dots,N\}$ and $N^P_{s_{t-},s_t,t}$ is a compensated Poisson process given by

$$dN^P_{s_{t-},s_t,t} = dN_{s_{t-},s_t,t} - \sum_{k\neq s_{t-}} \lambda_{s_{t-},k} dt,\, s_{t-}, s_t \in\{1,\dots,N\}, \tag{14}$$

where $N_{s_{t-},s_t,t}$ is a Poisson process that jumps up by one when the state of the economy switches; that is, $N_{s_{t-},s_t,t} = 1$ if $s_t \neq s_{t-}$. The real interest rates are identical to those of Bhamra, Kuehn, and Strebulaev (2010a) and Bhamra, Kuehn, and Strebulaev (2010b), and given in Internet Appendix IA.B.

Two distinct types of risk are priced. First, the increment in the standard Brownian motion, i.e. dZ_t, represents small but frequent changes in unexpected consumption growth, and $\gamma\sigma_{C,i}$ is the associated price of risk. Second, the increment in the compensated Poisson process, that is $dN^P_{s_{t-},s_t,t}$ is a martingale (under the physical measure $\mathbb{P}$) representing the risk that the state of the economy changes, and the associated price of risk is $\omega_{s_{t-},s_t} - 1$. If the state of the economy moves from i to j, that is, if $s_{t-} = i$ and $s_t = j$, then $\omega_{ij} = \omega_j/\omega_i = \left(p_{C,j}/p_{C,i}\right)^{-\frac{\gamma-\frac{1}{\psi}}{1-\frac{1}{\psi}}}$, where the $N-1$ constants, $\omega_1,\dots,\omega_{N-1}$ are determined by a system of $N-1$ nonlinear algebraic equations (see Equation IA.60 of the Internet Appendix IA.D). Observe that if $p_{C,j} < p_{C,i}$, then $\omega_{ij} > 1$, and so the real SDF increases because the price-consumption ratio falls – we interpret the change in state from i to j as a negative shock to the economy.

In general, a change in expected inflation triggers a jump in the real SDF. Changes in nominal conditions are priced positively (negatively) when a rise in expected inflation is associated with better (worse) real economic conditions. Our framework also nests the special case in which changes in real and nominal regimes are independent: transitions between nominal states are then unpriced and the price of risk $\omega_{ij} - 1$ associated with strictly nominal transitions is zero.

The pricing of securities is based on the risk-neutral switching probabilities per unit of time (that is, transition intensities), $\hat{\lambda}_{s_{t-},s_t}$, which are related to the physical switching probabilities, λ_{s_{t-},s_t}, via

$$\hat{\lambda}_{s_{t-},s_t} = \omega_{s_{t-},s_t}\lambda_{s_{t-},s_t},\, s_{t-} \neq s_t, \tag{15}$$

where $\omega_{s_{t-},s_t} = 1$ if $s_{t-} = s_t$.

[21] The price-consumption ratios for each real state are derived from a coupled system of nonlinear algebraic equations given in Equation IA.45 of the Internet Appendix.

Hence, under Epstein-Zin-Weil preferences, ω_{s_{t-},s_t} acts as a distortion factor, distorting physical transition intensities. The representative agent cares about future consumption growth and prefers early resolution of intertemporal risk ($\gamma > 1/\psi$) so $\omega_{s_t,s_{t-}} > 1$ when s_t is a worse state than s_{t-}, which implies the risk-neutral probability per unit of time of the economy worsening is higher than the physical probability.

Financial securities have nominal prices, which requires us to consider a nominal stochastic discount factor for asset pricing. The date t nominal SDF, denoted by $\pi_t^{\$}$, is defined as

$$\pi_t^{\$} = \frac{\pi_t}{P_t}, \tag{16}$$

whose dynamics satisfy

$$\left.\frac{d\pi_t^{\$}}{\pi_t^{\$}}\right|_{s_{t-}=i,s_t=j} = -r_i^{\$}dt - \gamma\sigma_{C,i}dZ_t + \sum_{j\neq i}(\omega_{ij}-1)dN_{ij,t}^{P} \tag{17}$$

and $r_i^{\$}$ is the nominal interest rate in state i, given by

$$r_i^{\$} = r_i + \mu_{P,i} - \gamma\rho_{PC,i}\sigma_{P,i}\sigma_{C,i} - \sigma_{P,i}^2. \tag{18}$$

The nominal interest rate depends on both real and nominal states and can thus takes six different values; it changes when the conditional moments of consumption growth change and also when expected inflation changes. The nominal risk-free rate is lowest during the recession/low-inflation state and highest during the expansion/high-inflation state.

2.3 Firm cash flows

The date-t level of the real cash flow of an individual firm is denoted by Y_t and evolves under the physical probability measure $\mathbb{P}$ according to the process

$$\frac{dY_t}{Y_t} = \mu_{Y,t}dt + \sigma_{Y,t}dW_t. \tag{19}$$

Real cash flows have a conditional expected growth rate $\mu_{Y,t}$ and a conditional volatility $\sigma_{Y,t}$. Both moments are identical across firms. Increments in the standard Brownian motion W (under $\mathbb{P}$) represent frequent but small shocks to the firm's cash flow growth. We assume cash flow shocks are independent across firms and from shocks to consumption growth.[22] Consequently, systematic risk in real cash flows is exclusively originating from low-frequency but severe changes in economic conditions. The expected growth rate is higher in expansions than in recessions, whereas the conditional volatility is lower in expansions than in recessions.

22 We ignore a non-zero correlation between real cash flows and consumption, because the asset-pricing and corporate financing implications are negligible. See, for example, Bhamra, Kuehn, and Strebulaev (2010a,b).

Because firms issue nominal securities and pay nominal taxes, investors care about the dynamics of nominal cash flows. The firm's nominal date t cash flow level is then given by X_t, where

$$X_t \equiv Y_t P_t^{\varphi}, \tag{20}$$

which thus satisfies

$$\frac{dX_t}{X_t} = \mu_{Y,t} + \varphi\left(\mu_{P,t} + \rho_{PY,t}\sigma_{Y,t}\sigma_{P,t}\right)dt + \sigma_{Y,t}dW_t + \varphi\sigma_{P,t}dZ_{P,t}. \tag{21}$$

If we assume that shocks to real cash flow growth and inflation are uncorrelated, that is $\rho_{PY,t} = 0$, then the above expression reduces to

$$\frac{dX_t}{X_t} = \mu_{X,t}dt + \sigma_{Y,t}dW_t + \varphi\sigma_{P,t}dZ_{P,t}, \tag{22}$$

where

$$\mu_{X,t} = \mu_{Y,t} + \varphi\mu_{P,t} \tag{23}$$

and the volatility of nominal cash flow growth is given by

$$\sigma_{X,t} = \sqrt{\sigma_{Y,t}^2 + \varphi^2\sigma_{P,t}^2}. \tag{24}$$

The sticky cash flow parameter, φ, captures the extent to which changes in inflation expectations affect the firm's cash flow growth rate.

Overall, firms exhibit heterogeneity in their cash flows due to firm-specific shocks but, at the same time, all firms have identical conditional moments for the cash flow growth rate.

3. Asset Prices and Corporate Financing Decisions

In this section, we derive asset prices together with optimal default and capital-structure decisions.

3.1 Nominal debt and leverage stickiness

Firms pay taxes on nominal cash flows X_t and issue debt to shield profits from taxes. Each firm has a debt contract that is characterized by a constant and perpetual nominal debt coupon c. Leverage is sticky because the coupon is fixed in nominal terms. Hence, when the nominal state changes, the real coupon changes, which affects asset valuations. Consequently, sticky leverage acts as a nominal rigidity. In other words, firms cannot adjust the nominal quantity of debt to news about the inflation state.

3.2 Liquidation value

A firm is liquidated when its nominal cash flows reach a state-dependent boundary $X_{D,i}$, which equityholders select to maximize equity value.

The nominal asset value at the time of liquidation, denoted by $A^{\$}_{i,t}$ in state $i \in \{1,\dots,N\}$, corresponds to the present value of the after-tax nominal unlevered cash flows:

$$A^{\$}_{i,t} = (1-\eta) X_t \frac{1}{r_{A,i}}, \tag{25}$$

where η is the corporate tax rate and $\frac{1}{r_{A,i}}$ is defined by

$$\frac{1}{r_{A,i}} = E_t\left[\int_t^{\infty} \frac{\pi^{\$}_u}{\pi^{\$}_t} \frac{X_u}{X_t} du \middle| s_t = i\right]. \tag{26}$$

The value of $r_{A,i} = v^{-1}_{A,i}$ is given by the reciprocal of the i'th element of the vector $V_A = \left[v_{A,1},\dots,v_{A,N}\right]^{\top}$ where

$$V_A = (R_A - \widehat{\Lambda})^{-1} 1_{N\times 1}. \tag{27}$$

$1_{N\times 1}$ is a $N \times 1$ vector of ones, R_A is the following $N \times N$ diagonal matrix

$$R_A = \mathrm{diag}(r^{\$}_1 - \mu_{X,1},\dots,r^{\$}_N - \mu_{X,N}), \tag{28}$$

and $\widehat{\Lambda}$ is the $N \times N$ risk-neutral generator matrix of the Markov chain characterizing the real and nominal states of the economy, defined by

$$[\widehat{\Lambda}]_{ij} = \widehat{\lambda}_{ij},\ i, j \in \{1,\dots,N\},\ j \neq i, \tag{29}$$

$$[\widehat{\Lambda}]_{ii} = -\sum_{j\neq i} \widehat{\lambda}_{ij},\ i \in \{1,\dots,N\}. \tag{30}$$

We can interpret $r_{A,i}$ as the discount rate for a perpetuity with stochastic expected growth rate $\mu_{X,t}$, which is currently equal to $\mu_{X,i}$. If the economy stays in state i forever, the discount rate reduces to the standard expression $r_{A,i} = r^{\$}_i - \mu_{X,i}$. In general, however, the economy can change state, and so the discount rate depends on the risk-neutral generator matrix of the Markov chain governing the economy's transitions. The presence of the risk-neutral generator matrix, as opposed to the physical generator matrix, incorporates the pricing of risk.

3.3 Arrow-Debreu default claims

Default risk is central to firm valuation. We now express the value of a firm's assets as a function of a set of Arrow-Debreu default claims. We define an Arrow-Debreu default claim as an asset that pays out $1 if default occurs in state j and the current state is i. We denote the nominal price of such a security by $q^{\$}_{D,ij,t}$, which satisfies (see Internet Appendix IA.H)

$$q^{\$}_{D,ij,t} = E_t\left[\frac{\pi^{\$}_{\tau_D}}{\pi^{\$}_t} I_{\{s_{\tau_D}=j\}}\middle| s_t = i\right], \tag{31}$$

where τ_D is the time at which default occurs and $I_{\{s_{\tau_D}=j\}}$ is an the indicator function that equals 1, if default occurs in state j, and zero otherwise.

When valuing assets that depend on the level of cash flows at the time of default, X_{τ_D}, we have to consider additional Arrow-Debreu securities, because our economy features "deep defaults." These defaults can occur when the state of the economy jumps from its current state to a worse state. Default boundaries are countercyclical and can suddenly move upward when the economy deteriorates. In such a situation, a fraction of firms may immediately default upon a change in state. Consider a firm that has a nominal cash flow level of \$10 while the default boundary is \$8. If the economy suddenly deteriorates by moving into a new state where the default boundary is \$11, the firm will immediately default. In fact, all firms with a nominal cash flow level below \$11 would default, thereby creating a default cluster. More formally, we can consider a firm with a nominal cash flow level X_{τ_D-}, at time τ_D-, which is the time just before default, where X_{τ_D-} is below the new state's default boundary, $X_{D,j}$. This firm will default as soon as the economy enters the new state, and so $X_{\tau_D-} = X_{\tau_D} < X_{D,j}$ ($X_{\tau_D-} = X_{\tau_D}$ because X is a continuous process). Hence, it is not necessarily the case that at default a firm's cash flow level is at the default boundary. Consequently, to value securities that depend on a firm's cash flows, we need a modified set of Arrow-Debreu default claims. We derive them in Internet Appendix IA.I.

This second type of Arrow-Debreu default claims pay out $\frac{X_{\tau_D}}{X_{D,j}}$ at default if default occurs in state j and the current state is i. The date-t nominal price of this security is denoted by $\tilde{q}^{\$}_{D,ij,t}$, where

$$\tilde{q}^{\$}_{D,ij,t} = E_t\left[\frac{\pi^{\$}_{\tau_D}}{\pi^{\$}_t} \frac{X_{\tau_D}}{X_{D,j}} I_{\{s_{\tau_D}=j\}}\middle| s_t = i\right]. \tag{32}$$

Overall, $N^2 = 36$ Arrow-Debreu default prices exist for each type, because $N = 6$ states characterize the aggregate economy.

3.4 Corporate bond value

A firm that issues debt promises to pay the nominal coupon c per unit of time. If the firm defaults, debtholders recover a fraction of the after-tax unlevered asset value of the firm, whereas the remaining fraction is lost due to liquidation costs. We denote the state-dependent recovery rate by α_j if default occurs in state j. Hence, the time t nominal value of corporate debt, conditional on the current state being i, is given by

$$B_{i,t}^{\$}=cE_t\left[\int_t^{\tau_D}\frac{\pi_u^{\$}}{\pi_t^{\$}}du\right]+E_t\left[\frac{\pi_{\tau_D}^{\$}}{\pi_t^{\$}}\alpha_{s_{\tau_D}}A_{s_{\tau_D}}^{\$}(X_{\tau_D})du\right]. \tag{33}$$

The above expression is simply the present value of future coupon flows up until some random default time, τ_D, plus the present value of the unlevered firm assets net of liquidation costs. We can rewrite the above expression as

$$B_{i,t}^{\$}=c\left(\frac{1}{r_{P,i}^{\$}}-\sum_{j=1}^{N}q_{D,ij,t}^{\$}\frac{1}{r_{P,j}^{\$}}\right)+\sum_{j=1}^{N}\alpha_jA_j^{\$}(X_{D,j})\tilde{q}_{D,ij,t}^{\$}, \tag{34}$$

where $r_{P,i}^{\$}$ is the nominal discount rate for a perpetuity paying a flow of \$1, conditional on the current state being i. Observe that

$$\frac{1}{r_{P,i}^{\$}}=E_t\left[\int_t^{\infty}\frac{\pi_u^{\$}}{\pi_t^{\$}}du|s_t=i\right]. \tag{35}$$

To gain intuition for the corporate bond price in Equation (34), note that $c\frac{1}{r_{P,i}^{\$}}$ is the present value in nominal terms of a default-free bond paying a coupon flow of c dollars in perpetuity. The expression $c\sum_{j=1}^{N}q_{D,1,ij}^{\$}\frac{1}{r_{P,j}^{\$}}$ is the present value of coupons lost because of the possibility of default, and $\sum_{j=1}^{N}\alpha_jA_j^{\$}(X_{D,j})\tilde{q}_{D,ij,t}^{\$}$ is the present value of the assets recovered.

The nominal discount rate for a constant nominal perpetuity, $r_{P,i}^{\$}$, is given by $r_{P,i}^{\$}=v_{B,i}^{-1}$, where $v_{B,i}$ is the i-th element of the vector $V_B=[v_{B,1},...,v_{B,6}]'$,

$$V_B=(R^{\$}-\widehat{\Lambda})^{-1}1_{N\times 1}, \tag{36}$$

and $R^{\$}$ represents the $N\times N$ diagonal matrix such that $R_{ii}^{\$}=r_i^{\$}$. Therefore, $r_{P,i}^{\$}$ accounts for the possibility that the nominal risk-free rate takes different future values as macroeconomic fundamentals and expected inflation fluctuate over time.

3.5 Equity value

Shareholders are entitled to the firm's cash flows net of taxes and debt servicing as long as the firm does not default. When the firm is in default, which occurs at some random time τ_D, shareholders recover nothing and lose their rights to any future cash flows. The nominal value of equity at date t, conditional on the current state i, is then given by

$$S_{i,t}^{\$}=(1-\eta)E_t\left[\int_t^{\tau_D}\frac{\pi_u^{\$}}{\pi_t^{\$}}(X_u-c)du\middle|s_t=i\right] \tag{37}$$

$$=A_i^{\$}(X_t)-(1-\eta)\frac{c}{r_{P,i}^{\$}}-\sum_{j=1}^{N}\left(A_j^{\$}(X_{D,j})\tilde{q}_{D,ij,t}^{\$}-(1-\eta)q_{D,ij,t}^{\$}\frac{c}{r_{P,j}^{\$}}\right). \tag{38}$$

The first two terms of Equation (38) represent the present value of cash flows net of coupon payments in the absence of default, whereas the summation term captures the present value of the net cash flows that shareholders lose in the case of default.

The equity risk premium in state-i is given by

$$\mu^{\$}_{R,i} - r^{\$}_{i} = \sum_{j \neq i} (1-\omega_{ij}) \frac{S^{\$}_{j,t} - S^{\$}_{i,t}}{S^{\$}_{i,t}} \lambda_{ij} + \varphi \frac{X_t}{S^{\$}_{i,t}} \frac{\partial S^{\$}_{i,t}}{\partial X_t} \left(\gamma \rho_{PC,i} \sigma_{P,i} \sigma_{C,i} + \sigma^2_{P,i} \right),$$
$$i, j \in \{1, \ldots, N\}. \tag{39}$$

Changes in nominal conditions affect the equity risk premium through two distinct channels: i) the correlation between real and nominal regimes generates a risk premium shown in the first component of Equation (39) via a jump in the SDF; ii) the correlation between shocks to consumption and inflation, $\rho_{PC,i}$, generates an additional risk premium (second component of Equation (39)). The portion of the equity risk premium induced by the pricing of random changes in nominal conditions is the inflation risk premium.

3.6 Default and capital structure decisions

Shareholders maximize the value of their default option by choosing when to default. The state-contingent endogenous default boundary X_{D,s_t} depends on the current real and nominal states of the economy, that is, $s_t \in \{1, \ldots, N\}$. Expected inflation matters for default decisions because a change in the nominal cash flow growth is not offset by a change in the nominal coupon rate; that is, leverage is sticky. Hence, equityholders are entitled to smaller expected future cash flows when expected inflation is low than when expected inflation is high.

The default boundaries satisfy the following $N=6$ standard smooth-pasting conditions

$$\left. \frac{\partial S^{\$}_{s_t}(X)}{\partial X} \right|_{X = X_{D,s_t}} = 0, \; s_t \in \{1, \ldots, N\}. \tag{40}$$

Shareholders also choose the optimal nominal coupon to maximize firm value at time 0 by balancing marginal tax benefits from debt against marginal expected distress costs. Two features are noteworthy. First, as is standard in the capital structure literature (Leland, 1994), by maximizing firm value, shareholders internalize debtholders' value at time 0. However, in choosing default times, they ignore the considerations of debtholders. This feature creates the usual conflict of interest between equity- and debtholders. Second, the optimal coupon depends on the state of the economy at date 0. We denote the time 0 coupon by c_{s_0}, where, to emphasize this dependence, s_0 is the date 0 state of the economy. Shareholders choose the coupon to maximize date 0 firm value $F^{\$}_{s_0,0} = B^{\$}_{s_0,0} + S^{\$}_{s_0,0}$

$$c_{s_0} = \arg\max_{c} F^{\$}_{s_0,0}(c). \tag{41}$$

We obtain the optimal default and capital-structure decisions numerically by maximizing Equation (41) subject to the conditions in Equation (40). As a result, the optimal default boundaries depend on the debt policy, which the initial financing state determines. Hence, if the economy is in state i, the default boundary for nominal cash flows is given by $X_{D,i}(c_{s_0})$, where i denotes the dependence on the current state and c_{s_0} the dependence on the optimal coupon chosen in the initial state.

4. Theoretical Predictions

This section discusses how changes in expected inflation affect corporate asset prices and default risk.

4.1 Calibration

We calibrate the model to the U.S. economy over the period 1970Q2–2019Q4. The real states (R and E) are characterized by the conditional moments of quarterly real per capita consumption expenditures and real earnings growth. For the nominal regimes (L, M, and H), we use the quarterly mean of the one-year-ahead inflation forecasts from the Survey of Professional Forecasters, as reported by the Federal Reserve Bank of Philadelphia. We set the unconditional probabilities of being in the low (L) or high (H) expected-inflation regimes to be 25%. The sensitivity of nominal cash-flow growth to expected inflation is set to $\varphi = 0.407$, using the empirical estimate reported in Table 1.

In the core of our analysis, we intentionally consider a restricted version of the model in which inflation risk is absent from the stochastic discount factor, such that the inflation risk premium does not drive any of our predictions. In this benchmark case, no inflation risk premium exists, because (a) expected consumption growth and expected inflation change independently (because of the way the Markov chain governing the state of the economy s_t is specified) and (b) shocks to consumption growth and expected inflation are uncorrelated. We thus analyze how higher expected inflation can negatively affect equity prices although inflation risk remains unpriced. We relax the assumption of uncorrelated real and nominal conditions in Section 4.7. Appendix A provides additional details on the calibration, while Table 2 summarizes the parameter values.

Table 3 reports the firm-level predictions in the case of independent real and nominal regimes and a zero correlation between shocks to consumption growth and inflation. Unconditionally, the firm-level risk premium is 4.57%, while the credit spread is 154 bps with a leverage ratio of 37.8%. These model-implied moments are consistent with their empirical counterparts for an average Baa firm, which displays an average leverage ratio of 43.28% and a bond spread of 158 bps (Huang and Huang, 2012). Similarly, Kang and Pflueger (2015) report a leverage ratio of 41% and a credit spread of 153 bps.

Table 2
Model calibration

	Unconditional	Conditional State 1 R & L	State 2 R & M	State 3 R & H	State 4 E & L	State 5 E & M	State 6 E & H
A: Economic environment							
Stationary probability		3.27	6.54	3.27	21.74	43.45	21.73
Consumption growth rate	1.66	−1.85	−1.85	−1.85	2.19	2.19	2.19
Consumption growth volatility	1.06	1.52	1.52	1.52	0.99	0.99	0.99
Expected inflation	3.46	1.78	3.46	5.15	1.78	3.46	5.15
Inflation volatility	0.87	0.81	0.69	1.29	0.81	0.69	1.29
Real interest rate	4.06	3.77	3.77	3.77	4.10	4.10	4.10
Nominal interest rate	7.52	5.54	7.23	8.91	5.87	7.56	9.24
Risk-free discount rate	7.44	6.33	7.57	8.19	6.35	7.60	8.22
Cash flow discount rate	4.08	4.63	5.38	5.70	3.43	3.98	4.23
B: Firm characteristics							
Real cash flow growth rate	3.72	−24.33	−24.33	−24.33	7.94	7.94	7.94
Nominal cash flow growth rate	5.13	−23.61	−22.92	−22.23	8.66	9.35	10.04
Inflation passthrough	0.407	0.407	0.407	0.407	0.407	0.407	0.407
Real cash flow volatility	25.93	29.59	29.59	29.59	25.38	25.38	25.38
Recovery rate	35.00	20.00	35.00	50.00	20.00	35.00	50.00
Tax rate	15.00	15.00	15.00	15.00	15.00	15.00	15.00

This table presents the parameter values of the model. Panel A reports the conditional moments of the economic environment. Panel B reports the conditional firm characteristics. We calibrate the model to the aggregate U.S. economy using real consumption data (nondurable goods plus service consumption expenditures). Expected inflation is measured as the mean forecast for one-year-ahead inflation. The moments of cash flows are estimated using Robert J. Shiller's aggregate earnings data. The personal consumption expenditure chain-type price index is used to deflate nominal earnings. Each column displays the predictions for a specific state of the economy: the expected inflation rate can be low (L), moderate (M), or high (H), whereas the real economy can be in recession (R) or in expansion (E). The table also reports the unconditional predictions for a weighted average of these states. We retrieve the consumption data from the Bureau of Economic Analysis, while the forecast data are obtained from the Survey of Professional Forecasters provided by the Federal Reserve Bank of Philadelphia. All estimates are in percentage points and annualized when applicable. The sample period is 1970Q2–2019Q4. The calibration is detailed in Section 4.1.

4.2 Expected inflation, equity valuation, and default risk

Equity valuation decreases with the level of expected inflation (see solid line in panel A of Figure 3). Two opposing effects of an increase in expected inflation on equity valuation exist: a discounting channel, which reduces equity values via an increase in the nominal risk-free rate; and a cash flow channel, which increases equity values via an increase in nominal cash flow growth. The discounting channel dominates the cash flow channel, because of the sticky cash flow assumption. The reason is that the nominal risk-free rate changes one-for-one with expected inflation ($r_t^{\$} = r_t + \mu_{P,t} - \sigma_{P,t}^2$, when $\rho_{PC,t} = 0$), whereas the expected nominal cash flow growth rate changes less than one-for-one with expected inflation ($\mu_{X,t} = \mu_{Y,t} + \varphi\mu_{P,t}$) when cash flows are sticky ($\varphi < 1$).

We now explain why the sticky leverage assumption implies that an increase in expected inflation reduces credit spreads (see solid line in panel B of Figure 3). A rise in expected inflation decreases the real value of debt coupons, because coupons are set in nominal terms; that is, leverage is sticky. The fall in real coupon value creates a reduction in default risk and, thus, in credit spreads. Stickiness in leverage is the central driver of the negative relation between expected inflation and credit spreads, following the work of

Table 3
Firm policies and asset prices

		Conditional					
	Unconditional	State 1 R & L	State 2 R & M	State 3 R & H	State 4 E & L	State 5 E & M	State 6 E & H
Stationary probability		0.0327	0.0654	0.0327	0.2174	0.4345	0.2173
A: Corporate policies							
Default boundaries (coupon: 0.7290)		0.2371	0.2475	0.2490	0.2018	0.2104	0.2115
B: Asset pricing quantities							
Equity value	13.63	10.17	8.76	8.33	16.18	13.94	13.23
Debt value	8.16	8.33	7.42	7.02	9.24	8.10	7.60
Market leverage (%)	37.76	45.02	45.86	45.73	36.34	36.74	36.48
Equity risk premium (%)	4.57	18.37	18.40	18.29	2.50	2.50	2.50
Credit spreads (bps)	154.31	242.70	225.72	218.43	154.61	140.72	136.76

This table presents the predictions of the model regarding endogenous firm policies and asset valuation. Panel A reports the coupon and the conditional default boundaries. The capital structure is chosen optimally in the state of expansion with moderate inflation. Panel B reports the conditional asset pricing quantities for the economy. Each column displays the predictions for a specific state of the economy: the expected inflation rate can be low (L), moderate (M), or high (H), whereas the real economy can be in recession (R) or in expansion (E). The table also reports the unconditional predictions for a weighted average of these states. Market leverage is the ratio of the market value of debt to the sum of the market values of debt and equity. The parameter values of the model are reported in Table 2 and discussed in Section 4.1.

Bhamra, Fisher, and Kuehn (2011), Kang and Pflueger (2015), and Gomes, Jermann, and Schmid (2016).[23]

Importantly, when it comes to equity valuations, the default risk channel is not strong enough to fully counteract the discounting channel: equity valuations still fall as expected inflation rises. Naturally, this effect is muted for higher leverage firms, leading to the cross-sectional implications described in Section 4.6.

We find that the equity risk premium remains similar across nominal states and, as a result, is not driving our main finding regarding the negative relation between expected inflation and equity valuation. In the absence of correlation between real and nominal conditions, any link between the equity risk premium and nominal conditions results from the effect of nominal conditions on leverage. Corporate bond prices actually fall with expected inflation (see solid line in panel C) together with equity values, so leverage is stable across nominal states (see solid line in panel D). The equity risk premium therefore does not vary materially with expected inflation (see panel B of Table 3) in the baseline calibration. We investigate the effect of a nonzero correlation in Section 4.7.

4.3 Varying cash flow stickiness

The degree of cash flow stickiness shapes the relations between equity valuation and expected inflation, and between credit risk and expected inflation. We find that the negative relation between expected inflation and equity values

23 Shareholders' option value of defaulting, as captured by the level of the optimal default boundaries, also varies with expected inflation. An increase in expected inflation translates into a higher default boundary, but this effect on default risk remains modest.

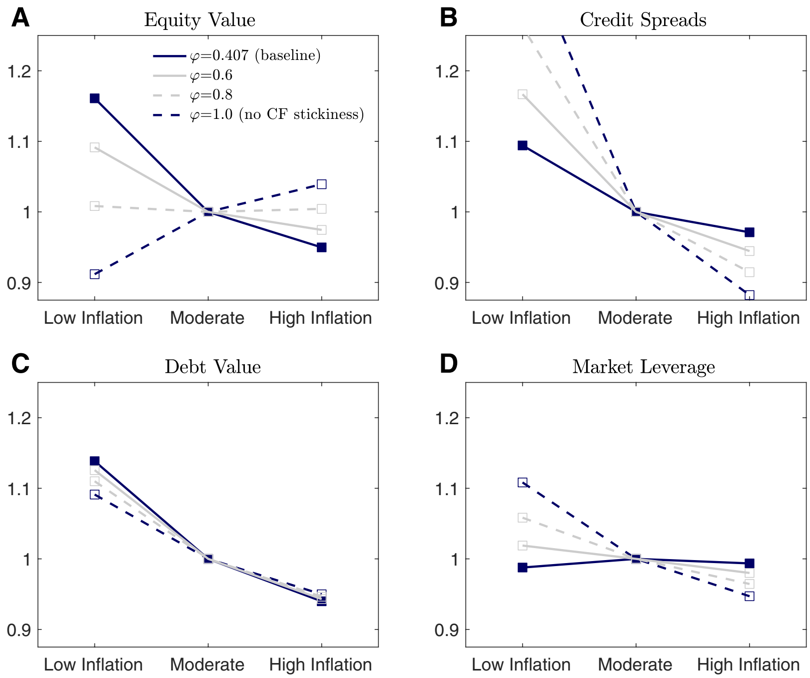

Figure 3
Expected inflation and asset prices: Full model
The figure illustrates the impact of expected inflation on equity value (panel A), credit spread (panel B), debt value (panel C), and market leverage (panel D). Each panel reports the predictions for different nominal conditions: low, moderate, and high expected inflation. Predictions for the full model (sticky cash flows, $\varphi = 0.407$) are compared to the predictions of a model without sticky cash flows ($\varphi = 1$). Light-gray lines report the predictions when φ equals 0.6 and 0.8. All values are normalized to unity in the moderate expected inflation state. The baseline firm has the corporate policies presented in Table 3. The parameter values of the model are reported in Table 2 and discussed in Section 4.1.

strengthens for firms with more cash flow stickiness (see panel A of Figure 3). As a counterfactual, turning off cash flow stickiness completely in the model ($\varphi = 1$) inverts the relation between equity prices and expected inflation: equity prices rise with expected inflation, at odds with our motivating empirical evidence (Figure 1). The intuition is straightforward: the discount rate is canceled out by the cash flow effect, and so, the only way expected inflation affects equity valuation is through the default risk channel. Without cash flow stickiness, higher expected inflation lowers default risk, which then increases equity values and reduces the equity risk premium (see panel A of Table 4).

In contrast with equity valuation, the negative relation between credit spreads and expected inflation weakens for firms with more cash flow stickiness. This illustrates the tension inherent in using sticky cash flows to generate a joint decrease in equity valuation and default risk when expected inflation increases. Our model shows that, with reasonable degrees of cash flow and leverage stickiness, equity valuation and default risk jointly decrease with expected

Table 4
Conditional equity risk premium under different model specifications

	Unc.	RL	RM	RH	EL	EM	EH
A: No IRP							
Sticky cash flows	4.57	18.37	18.40	18.29	2.50	2.50	2.50
No stickiness	4.98	21.88	20.08	19.32	2.79	2.64	2.60
B: Nonzero shock correlation							
Sticky cash flows	4.58	18.37	18.38	18.31	2.53	2.51	2.48
No stickiness	4.98	21.87	19.97	19.37	2.87	2.65	2.55
C: Nonzero regime correlation							
IRP 25 bps	4.82	20.87	19.38	17.73	2.84	2.54	2.64
IRP 50 bps	5.07	23.67	20.40	17.27	3.21	2.58	2.77
IRP 75 bps	5.32	26.79	21.42	16.90	3.63	2.62	2.90
IRP 100 bps	5.57	29.94	22.31	16.63	4.05	2.66	3.02
IRP 125 bps	5.82	33.22	23.09	16.42	4.46	2.70	3.12

This table reports the conditional equity risk premium (in %) under alternative model specifications. Panel A reports the equity risk premium for our baseline model with and without sticky cash flows. Panel B reports the predictions of a model with correlated consumption and inflation shocks (shock correlation). Panel C reports the predictions of a model with correlated expected consumption growth and expected inflation (regime correlation). Each line of panel C captures a different degree of regime correlation, which implies different levels of inflation risk premium (IRP). Each column reports model predictions for a different current state of the economy. The expected inflation rate can be low (L), moderate (M), or high (H), whereas the real economy can be in recession (R) or in expansion (E). The parameter values of the model are reported in Table 2 and discussed in Section 4.1.

inflation. Thus far, these relations have only been studied separately in the existing literature.

4.4 Low versus high expected inflation: Asymmetry

Our model uncovers another new prediction: the relation between equity valuation and expected inflation is asymmetric, as illustrated by Figure 3, which implies that higher expected inflation is not the mirror image of lower expected inflation. Specifically, equity valuation increases by 16.1% (from 13.94 to 16.18) when the economy switches from moderate to low expected inflation, whereas it decreases by only 5.1% (from 13.94 to 13.23) when expected inflation switches from moderate to high expected inflation, as reported in Table 3.[24] The impact of a decrease in expected inflation on equity prices is therefore stronger than the impact of an increase in expected inflation, although both states are equally likely.

The reason underlying this result is the convexity of equity values with respect to expected inflation, which exists because of sticky cash flows. Importantly, a change in expected inflation has stronger effects on equity valuation when the denominator in the traditional Gordon growth formula is small, that is, when expected inflation, the real risk-free rate, or both are small. This prediction arises although default probabilities are convex in the distance-to-default, which implies that an increase in default risk depresses the value of equity more than a decrease in default risk of the same size. We find this latter effect is not sufficient to offset the asymmetry arising from nominal discounting.

24 We consider a firm being in the expansion state, but the message is qualitatively similar when considering the recession state.

Table 5
Firm policies and asset prices: constant inflation

		Conditional	
	Unconditional	State 2 R & M	State 5 E & M
Stationary probability		0.1308	0.8692
A: Corporate policies			
Default boundaries (Coupon: 0.7146)		0.2416	0.2054
B: Asset pricing quantities			
Equity value	13.56	8.99	14.25
Debt value	7.97	7.39	8.06
Market leverage (%)	37.29	45.11	36.12
Equity risk premium (%)	4.54	18.20	2.48
Credit spreads (bps)	148.92	221.06	138.06

This table presents the predictions of the model without fluctuating nominal conditions. Expected inflation is constant and set to its unconditional mean over the sample period, which corresponds to the moderate expected inflation state (M). Panel A reports the coupon and the conditional default boundaries. The capital structure is chosen optimally in the state of expansion. Panel B reports the conditional asset pricing quantities for the economy. Each column displays the predictions for a specific state of the economy, which can be in recession (R) or in expansion (E). The table also reports the unconditional predictions for a weighted average of these states. Market leverage is the ratio of the market value of debt to the sum of the market values of debt and equity. The parameter values of the model are reported in Table 2 and discussed in Section 4.1.

Two direct implications of this asymmetry exist. First, when moving out of a low inflation environment, the initial increase in expected inflation has a more negative impact on asset prices than subsequent increases. Second, the presence of inflation risk increases unconditional asset valuations. Given the convex relation between equity value and expected inflation, the average equity value across the low and high expected inflation states is higher than the equity value during an average expected inflation state. Following the same reasoning, inflation risk increases debt and firm valuation, on average.

To quantify the role of inflation risk, we compare the results of the full model (Table 3) with the case in which we switch off variations in the nominal state (Table 5). In this latter specification, the expected inflation rate is set at its unconditional mean, which corresponds to the "moderate inflation" regime. Table 6 indicates that inflation risk increases asset valuations, on average, adding up to 0.47% of equity value and 1.2% of total firm value. This prediction translates, using a simple back-of-the-envelope calculation, into an increase in aggregate firm valuation of approximately US$1.13 trillion, given a total market capitalization of public U.S. companies of US$37.7 trillion (as of December 2019) and a leverage ratio of 40%. The existence of inflation fluctuations therefore has economically important asset pricing implications for investors.

4.5 Representative firm versus aggregation of firms

The results discussed so far are for a single firm with optimal capital structure. In the real world, firms' leverage ratios frequently deviate from their optimal levels. These deviations are not symmetric and do not cancel each other in the cross-section. We now verify that our predictions continue to hold for a distribution of firms. For this exercise, we consider an economy of 1000 firms, with optimal policies reported in Table 3. We specify a cross-section of firms

Table 6
Asset pricing implications of nominal risk

		Conditional					
	Unconditional	State 1 R & L	State 2 R & M	State 3 R & H	State 4 E & L	State 5 E & M	State 6 E & H
Change in stationary probability		0.0327	0.0654	0.0327	0.2174	0.4345	0.2173
Change in equity value	0.47	13.15	−2.61	−7.30	13.53	−2.21	−7.14
Change in debt value	2.44	12.73	0.40	−4.93	14.60	0.48	−5.66
Change in firm value	1.20	12.96	−1.25	−6.23	13.92	−1.24	−6.61
Change in market leverage (%)	1.25	−0.20	1.67	1.39	0.60	1.74	1.01
Change in equity risk premium (%)	0.04	0.17	0.20	0.09	0.02	0.02	0.01
Change in credit spreads (bps)	5.39	21.64	4.66	−2.63	16.55	2.65	−1.30

This table presents the impact of nominal risk on asset prices. It reports differences in asset pricing predictions between a model with fluctuating expected inflation and a model with constant expected inflation. In the latter case, the expected inflation rate is constant and set to its unconditional mean (i.e., moderate inflation state), and the model predictions are those of Table 5. The differences in asset values are in relative terms (%). The differences in leverage and equity risk premium are in percentage points, while the difference in credit spreads are in basis points. Each column reports model predictions for a different current state of the economy. The expected inflation rate can be low (L), moderate (M), or high (H), whereas the real economy can be in recession (R) or in expansion (E). The parameter values of the model are reported in Table 2 and discussed in Section 4.1.

that differ in their distance-to-default, such that the distribution of leverage ratios is structurally similar to that in the data.

Figure 4 shows that the impact of expected inflation on equity valuation and credit spreads does not depend on whether we consider an individual firm or an economy of firms. The results are moreover similar if we aggregate firms using an equally weighted (panels A and B) or a value-weighted (panels C and D) approach, which indicates that small, risky firms are not driving the relations. The joint relations between equity valuations, default risk, and expected inflation are thus robust, as these relations do not vanish when aggregating a large cross-section of firms.

4.6 Cross-sectional predictions

Leverage plays a central role in the model, so we can expect equity valuations and credit spreads of low and high-leverage firms to be differentially exposed to variations in expected inflation. In our analysis, firms with higher leverage are those with lower cash flow levels (and thus lower distance-to-default) than firms with lower leverage.

Insightful cross-sectional predictions arise because changes in expected inflation affect asset prices through two opposing channels: discounting and default risk. First, higher expected inflation decreases the value of equity through sticky cash flows; that is, nominal cash flow growth does not vary one-for-one with expected inflation, while the nominal risk-free rate does. This discounting effect is independent of leverage. Second, default risk decreases when expected inflation goes up, and this relationship strengthens with leverage. The reduction in default risk partially offsets the decrease in equity valuation, especially for more highly levered firms. The model thus predicts that equity prices of firms with higher leverage are less sensitive to changes in expected inflation than firms with lower leverage.

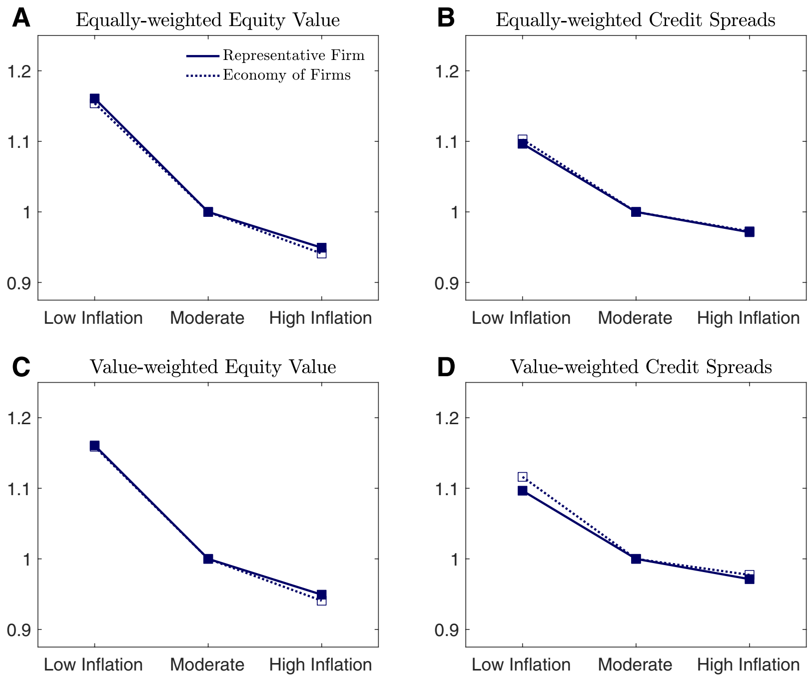

Figure 4
Expected inflation and asset prices: Economy of firms
The figure illustrates the impact of expected inflation on asset valuation for an economy of firms. Predictions are reported for equity values (panels A and C) and credit spreads (panels B and D). Each panel reports the predictions for different nominal conditions: low, moderate, and high expected inflation. Predictions for a representative firm are compared to the predictions for an economy of 1000 firms that differ in their leverage ratios. All values are normalized to unity in the moderate expected inflation state. All firms have initially the corporate policies presented in Table 3. The parameter values of the model are reported in Table 2 and discussed in Section 4.1.

We illustrate the impact of leverage on the sensitivity of equity values with respect to changes in expected inflation in Table 7. We report equity prices by nominal conditions for firms with low versus high financial leverage, with ratios of 35% and 55%, respectively. An increase in expected inflation (from L to H) generates a greater fall in equity valuation (3.86 vs 1.78) for less-levered firms than for more-levered firms. Hence, higher leverage reduces–rather than exacerbates–the sensitivity of equity valuation to changes in nominal conditions. Consistent with this mechanism, Table 7 shows that credit risk is more sensitive to expected inflation for firms with higher leverage: an increase in expected inflation (from L to H) generates a stronger fall in credit spreads (24.44 vs. 15.60 bps) for more-levered firms than for less-levered firms.

4.7 The inflation risk premium

We now relax the assumption of independent real-nominal conditions, based on findings in Boons et al. (2020), who document an unconditionally small

Table 7
Cross-sectional predictions

	Equity		Credit spread	
Expected inflation	Low leverage	High leverage	Low leverage	High leverage
L	21.18	9.74	130.33	231.76
M	18.26	8.37	117.96	214.36
H	17.32	7.96	114.73	207.32
H-L	−3.86	−1.78	−15.60	−24.44
Double difference		2.08		−8.84

This table presents the cross-sectional impact of nominal risk by market leverage. The table reports asset pricing predictions for firms that differ in their levels of cash flow, which generates cross-sectional differences in market leverage. Predictions are reported across nominal conditions for a firm with low (35%) and high (55%) leverage. The expected inflation rate can be low (L), moderate (M), or high (H), while the real economy is set at its unconditional state. The table also displays the difference in results between the high (H) and the low (L) expected inflation state, as well as the double difference. The parameter values of the model are reported in Table 2 and discussed in Section 4.1.

but strongly time-varying inflation risk premium. First, we consider a time-varying correlation between shocks to consumption growth and shocks to inflation, denoted by $\rho_{PC,t}$ (*shock correlation*). Second, we allow for a nonzero correlation between expected consumption growth, $\mu_{C,t}$, and expected inflation, $\mu_{P,t}$ (*regime correlation*), by allowing both to switch at the same time.

We uncover two new results. First, accounting for significant time variation in the consumption-inflation correlation has no impact on our main model predictions: equity values and credit spreads still decrease with respect to expected inflation. Second, a large unconditional inflation risk premium does not generate the relationship between equity values and expected inflation we document in Figure 1, suggesting that the unconditional inflation risk premium cannot be too large.

Table 4 reports the results regarding the equity risk premium, which we discuss in detail within Appendix B. Panel B presents the predictions when we introduce a time-varying *shock correlation*, $\rho_{PC,t}$. Panel C considers different levels of the unconditional inflation risk premium (IRP), arising for different calibrations of the *regime correlation*. We will summarize the main findings below.

With a *shock correlation*, equity values and credit spreads continue to decrease when expected inflation increases (see Figure B.1 in the Appendix), as was the case for zero correlation (see Figure 3). However, the equity risk premium now decreases with expected inflation, because the shock correlation decreases with expected inflation: the correlation between consumption and inflation shocks is 51.6% when expected inflation is low, −3.7% when expected inflation is moderate, and −24.2% when expected inflation is high.[25] A negative consumption-inflation correlation in times of higher expected inflation implies nominal cash flows become less correlated with consumption, thereby reducing the equity risk premium. The covariance between shocks to consumption

25 Our calibrated consumption-inflation correlation is unconditionally small, although highly time varying, consistent with the findings of Bilal (2017), Boons et al. (2020) and Campbell, Pflueger, and Viceira (2020), among others.

growth and inflation is, however, small, because consumption growth and inflation are not very volatile, and so the inflation risk premium remains modest. Introducing a correlation between shocks to consumption growth and inflation therefore does not change our model's predictions.

When we allow for *regime correlation*, the equity risk premium is higher in the low inflation regime than in the high inflation regime. In addition, the relationship between equity valuation and expected inflation is no longer convex and loses its monotonicity for an unconditional inflation risk premium of 0.5% or more (see Figure B.2 in the Appendix). This result implies that (a) there is an upper bound on the *unconditional* inflation risk premium of around 0.25% per annum, and (b) any significant inflation risk premium beyond this magnitude must be time varying. This finding is consistent with the empirical evidence suggesting that, over the last 50 years, the inflation risk premium has switched sign and is unconditionally close to zero (Boons et al., 2020).

In sum, our analysis suggests the inflation risk premium can be time varying, but cannot be too high unconditionally. These findings provide further support for our baseline model. In addition, we find that the equity risk premium is highest when expected inflation is low in both of these alternative cases. Hence, introducing an inflation risk premium cannot rationalize the finding that equity valuation *decreases* with expected inflation, as suggested by Figure 1.

4.8 Equity and credit spread term structures

We now explore the model's implications for the term structures of equity yields and credit spreads.[26] We construct the term structure of earnings yields, where payoffs are affected by default risk. The date t nominal value of the unlevered equity strip paying off X_T at time T, conditional on being in state i is denoted by $S^{\$}_{i,T-t}$. Therefore, we have

$$S^{\$}_{i,T-t} = (1-\eta) E_t \left[\frac{\pi^{\$}_T}{\pi^{\$}_t} X_T I_{\{\tau_D \geq T\}} \right] \tag{42}$$

$$= (1-\eta) X_t e^{-y^{\$}_{i,T-t}(T-t)}, \tag{43}$$

where $I_{\{\tau_D \geq T\}}$ is an indicator function that equals one if the firm does not default before time T, and zero otherwise. The implied earnings yield, denoted by $y^{\$}_{i,T-t}$ with time horizon $T-t$, is then equal to

$$y^{\$}_{i,T-t} = -\frac{1}{T-t} \ln \frac{E_t \left[\frac{\pi^{\$}_T}{\pi^{\$}_t} X_T I_{\{\tau_D \geq T\}} \right]}{X_t}. \tag{44}$$

To the best of our knowledge, no closed-form solutions can be obtained for the finite-maturity expectations in (44). We thus rely on Monte Carlo simulations to compute these expectations (see Appendix C).

[26] We use the terms equity yields and earnings yields interchangeably.

We now describe the model-implied term structure of earnings yields. Figure 5 shows the term structure of earnings yields conditional on real (panel A) and nominal (panel B) states. In the baseline calibration with sticky cash flows, we uncover three predictions: First, the term structure is upward sloping in expansions and downward sloping in recessions, as documented in Bansal et al. (2021) and Giglio, Kelly, and Kozak (2021). Second, earnings yields increase with expected inflation, and the effect is strongest for short maturities. Third, except in the very short run, we obtain a downward-sloping term structure in the high inflation state (H) and an upward- sloping term structure in the lower inflation states (M and L). These results imply a convergence in earnings yields across nominal states as the horizon increases. In a counterfactual exercise, we compare the above results with the case of zero cash flow stickiness ($\varphi = 1$) in Figure 6. In the model without cash flow stickiness, we observe much less variation in the conditional term structure of earnings yields with respect to expected inflation and the ordering of states changes. Indeed, when expected inflation goes up, earnings yields become (modestly) lower.

We then explore predictions on the term structure of corporate credit spreads in panels C and D of Figure 5. We focus on the credit spreads of finite-maturity consol bonds, which we derive in Internet Appendix IA.I. We find credit spreads are higher in recessions and in the low inflation state for any maturity. The credit spreads display a hump shape, that is, an upward-sloping term structure in the short term but downward-sloping term structure for longer horizons. Furthermore, the difference between credit spreads in high vs. low expected inflation states is stable over time due to sticky leverage.[27] In the model, firms do not adjust their capital structure as nominal conditions vary, which increases their default risk in times of lower expected inflation. This finding is consistent with the empirical evidence that firms tend to adjust their capital structure conservatively (Graham, 2000), which suggests that sticky leverage is a reasonable friction in our model.

4.9 Summary of theoretical predictions

We show that a rational model can explain why shareholders value stocks less favorably when default risk decreases, that is, in times of higher expected inflation. The asset pricing implications of expected inflation do not vanish when shareholders optimally adjust the firm's capital structure and the timing of default to the presence of inflation risk. In addition, we find these relations hold in the case of endogenous corporate policies, both for a representative firm and for a cross-section of firms, over different horizons, and when accounting for macroeconomic risk or the correlation between real and nominal conditions.

[27] The patterns of the credit spread term structure are similar with (Figure 5) and without (Figure 6) cash-flow stickiness, given that the primary channel behind the relation between credit spreads and expected inflation is not cash-flow stickiness but sticky leverage.

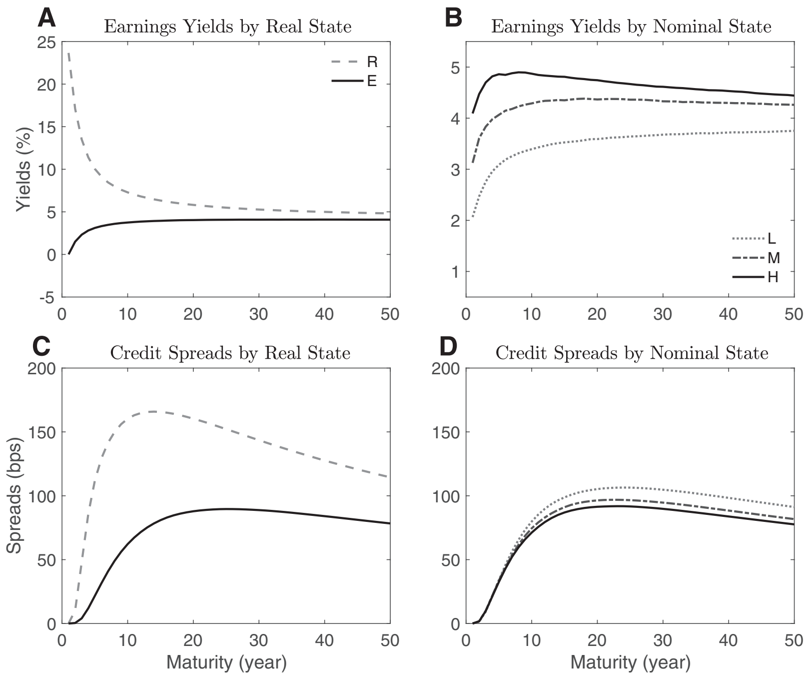

Figure 5
Term structure of equity yields and credit spreads, with sticky cash flows
The figure illustrates the term structure of equity yields (top panels) and credit spreads (bottom panels) in a model with sticky cash flows ($\varphi=0.407$). The left panels report predictions by real conditions, while the right panels report predictions by nominal conditions. We construct the term structure of earnings yields from the nominal value of the unlevered equity strip for different maturities, while the term structure of credit spreads is for finite-maturity consol bonds. Results are based on Monte Carlo simulations; Appendix C provides the details. The firm initially has the corporate policies presented in Table 3. The parameter values of the model are reported in Table 2 and discussed in Section 4.1.

Our theory highlights the minimum set of frictions that are necessary to explain the seemingly conflicting relations between default risk, equity valuation, and expected inflation in an asset pricing model with optimal corporate financing decisions. The key channel for the relation between default risk and expected inflation is the presence of sticky leverage, whereas sticky cash flows drive the negative relation between equity valuation and expected inflation.[28] Therefore, we find that both sticky cash flows and sticky leverage, which are plausible channels, help us understand how expected inflation jointly affects equity valuation and default risk.

28 Alternatively, investors may discount real cash flows with nominal discount rates, which induces real equity valuations to decrease with expected inflation. In this paper, we assume that the agent is fully rational and thus does not suffer from any type of money illusion. Accounting for this behavioral channel would merely reinforce the quantitative predictions of this paper.

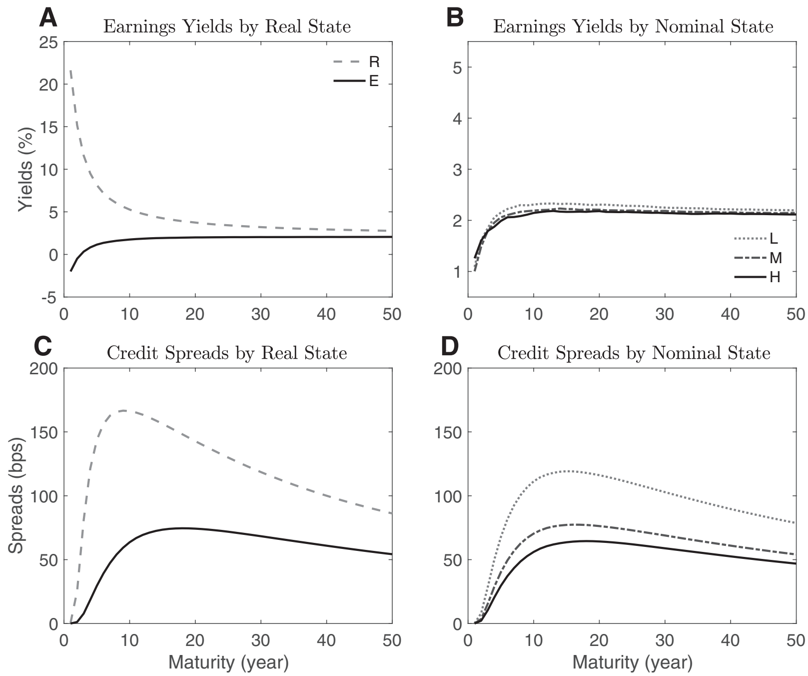

Figure 6
Term structure of equity yields and credit spreads, without sticky cash flows
The figure illustrates the term structure of equity yields (top panels) and credit spreads (bottom panels) in a model without sticky cash flows ($\varphi = 1$). The left panels report predictions by real conditions, while the right panels report predictions by nominal conditions. We construct the term structure of earnings yields from the nominal value of the unlevered equity strip for different maturities, while the term structure of credit spreads is for finite-maturity consol bonds. Results are based on Monte Carlo simulations; Appendix C provides the details.

5. Empirical Analysis

This section has four aims. First, we provide robust evidence for the empirical relations that arise in our theoretical model: equity valuation and default risk jointly decrease with expected inflation. Second, we verify that these relations are asymmetric. Third, we test our theoretical cross-sectional predictions that the relation between equity valuation and expected inflation is stronger for firms with less leverage and with more sticky cash flows. Fourth, we show that the term structures of equity yields and credit spreads are consistent with our model's predictions.

5.1 Data

Our empirical analysis is based on the following data. Expected inflation is the year-on-year expected gross domestic product (GDP) deflator inflation from the Federal Reserve Bank of Philadelphia's Survey of Professional Forecasters. We consider two measures of equity valuation: the firm's market-to-book (M/B) equity ratio and the price-dividend ratio. Default risk is measured by a firm's financial-distress risk, following Campbell, Hilscher, and Szilagyi

Table 8
Descriptive statistics

	Mean	SD	25% perc	Median	75% perc
Expected inflation (%)	3.634	1.865	2.207	3.055	4.410
Price-dividend ratio	72.621	60.624	23.958	40.000	72.807
Market-book ratio	3.080	1.655	0.956	1.428	2.271
Distress risk	−7.867	0.718	−8.266	−7.855	−7.383
Default probability (bps)	4.561	0.376	2.570	3.875	6.211
Market leverage	0.258	0.231	0.112	0.278	0.484
Net income to total assets (%)	0.761	1.024	0.260	0.800	1.296
Excess return (%)	3.721	35.122	−15.171	1.993	20.696
Return volatility (%)	27.127	19.366	23.956	29.133	40.237
Size to market	−8.605	2.636	−11.198	−9.102	−7.298
Short-term assets to total	0.054	0.071	0.015	0.037	0.083
log(Share price)	0.554	2.701	0.451	1.268	3.139
Investment (%)	1.844	6.079	−0.702	1.542	4.341
Profitability	0.133	10.800	0.004	0.051	0.085
log(Size)	7.047	1.965	4.704	6.198	7.637
IP growth (%)	1.817	4.278	0.497	2.659	4.707
S&P return (%)	9.732	15.787	1.388	10.926	19.345
Yield curve (%)	1.274	1.477	0.250	1.290	2.260
Frequency of price adjustment	0.323	0.191	0.163	0.253	0.486
N	798,288	798,288	798,288	798,288	798,288

This table reports the summary statistics of the main variables. Financial variables at the firm level are value-weighted. Expected inflation is from the Survey of Professional Forecasters from the Federal Reserve Bank of Philadelphia. The default probability is the marginal probability of bankruptcy or failure over the next quarter, which is computed as in Campbell, Hilscher, and Szilagyi (2008). Section 5.1 provides details on the computation of the firm variables. N is the number of observations. The sample period is 1972Q2–2019Q4.

(2008), which corresponds to the logarithm of the marginal probability of bankruptcy or failure over the next quarter. Appendix D provides details on the computation of these measures. Accounting variables are from Compustat Fundamental Quarterly data, whereas stock price variables are from CRSP. The data set spans from April 1972 to December 2019. Table 8 displays the summary statistics.

5.2 Relations between equity valuation, default risk, and expected inflation

We first compute the average price-dividend ratios, market-to-book ratios, and default risk for each of the six states in the model. Table 9 reports the results. Expansions (E) and recessions (R) are determined by the median real GDP growth. Low (L) and high (H) expected inflation states are determined by the bottom and top quartiles of expected inflation; the moderate (M) state spans the interquartile range. The results show that both price-dividend ratios and market-book ratios decrease as expected inflation goes up, while distress risk and implied default probabilities fall. Also, price-dividend ratios and market-book ratios are lower in economic downturns, while distress risk and default probabilities are higher. Equity valuation thus decrease with expected inflation even though default risk falls, in line with the model predictions.

We then analyze the relation between equity valuations and default risk with expected inflation. Figure 7 displays the results for the price-dividend ratio (top panels), the market-to-book ratio (middle panels), and the implied bankruptcy

Table 9
Conditional equity valuation and default risk

	State 1 R & L	State 2 R & M	State 3 R & H	State 4 E & L	State 5 E & M	State 6 E & H
P/D ratio	68.85	58.32	30.60	76.69	59.76	38.92
M/B ratio	2.13	1.86	1.05	2.44	1.84	1.23
Distress risk	−7.59	−7.80	−8.14	−7.61	−7.94	−8.29
Default probability (bps)	5.07	4.10	2.92	4.95	3.55	2.52

This table reports average price-dividend ratios, market-to-book ratios, and default risk by state. Reported estimates of distress risk are computed as in Campbell, Hilscher, and Szilagyi (2008). The default probability is the marginal probability of bankruptcy or failure over the next quarter (reported in bps), whereas the distress risk measure corresponds to the logarithm of the default probability. Expansions (E) and recessions (R) are determined by the median real GDP growth. Low (L) and high (H) expected inflation states are determined by the bottom and top quartile of expected inflation; the moderate (M) state spans the interquartile range. Expected inflation is from the Survey of Professional Forecasters from the Federal Reserve Bank of Philadelphia. The sample period is 1972Q2–2019Q4.

probability (bottom panels). The panels plot the (value-weighted) averages of these firm characteristics against the level of expected inflation observed in the corresponding quarter. We disentangle the relations by level of financial leverage, which we define as long-term debt and debt in current liabilities over the sum of the numerator and stockholders' equity. The left panels report portfolios of firms with below-median leverage, whereas the right panels report firms with above-median leverage. Each panel uses a quadratic regression to fit the data.

This graphical analysis suggests the price-dividend ratio, the market-to-book ratio, and the bankruptcy probability are all negatively related to the level of expected inflation. Importantly, each portfolio contains the same set of firms, thereby indicating a decrease in expected inflation simultaneously increases *both* a firm's equity valuation and its default risk. Furthermore, as our model predicts, the relations based on equity valuation appear to be stronger for low-leverage firms, whereas the relation based on default risk appears to be stronger for high-leverage firms.

5.3 Portfolio sorts

As a formal test of these cross-sectional relations, we now exploit portfolio double sorts. We first sort all firms into two portfolios based on their financial leverage. We then create three equal-sized portfolios depending on the level of expected inflation.

Table 10 reports the results. Panel A shows, using conditional double sorts, that both equity valuation and default risk decrease in expected inflation. The high expected inflation-minus-low expected inflation estimates are all negative and statistically significant within each leverage sort. In terms of magnitude, firms with low (high) leverage display an average price-dividend ratio of 97.1 (58.9) when expected inflation is low and 46.2 (24.8) when expected inflation is high. The market-to-book ratios are 3.78 (2.08) and 1.87 (0.95), respectively. These differences are economically large. Furthermore, the double differences

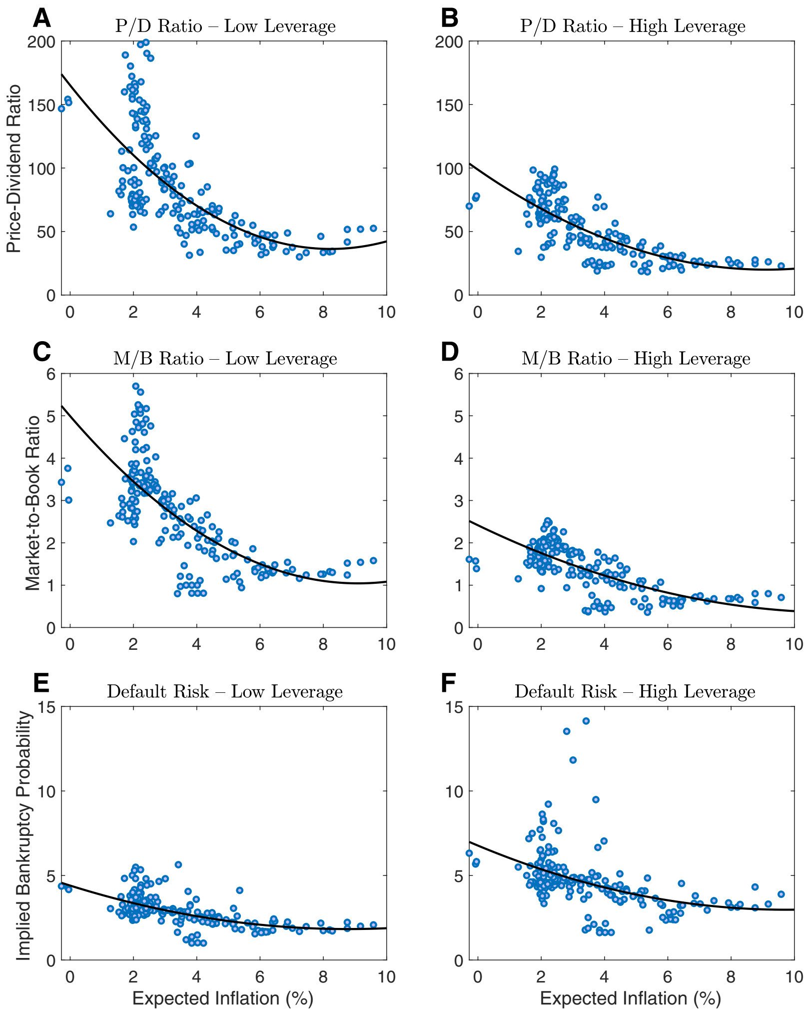

Figure 7
Equity valuation, default risk, and expected inflation: By leverage
This figure plots the relations between expected inflation and the price-dividend ratios (top panels), the market-to-book ratios (middle panels), and default risk (bottom panels). We report the relations by levels of market leverage. The left panels show portfolios of firms with below-median leverage, whereas the right panels report firms with above-median leverage. Each observation represents the value-weighted average of the valuation metric across firms for a given level of expected inflation. Expected inflation is the one-year-ahead inflation forecast from the Survey of Professional Forecasters, which is orthogonalized with respect to real consumption growth, NBER recessions, and a dummy for the Great Recession. Default risk is the marginal probability of bankruptcy or failure over the next quarter (reported in bps), which is computed as in Campbell, Hilscher, and Szilagyi (2008). Section 5.1 provides additional details on the data. The sample period is 1972Q2–2019Q4.

by leverage ratios (that is, the difference between estimates of the high expected inflation minus low expected inflation estimates across high- and low-leverage firms) are also highly statistically significant.[29] These tests show that these relation between equity valuation and expected inflation is negative and stronger for firms with lower levels of financial leverage, consistent with our theory.

The conditional double sorts also indicate that the negative relation between distress risk and expected inflation is weakly stronger for high-leverage firms than for low-leverage firms. Both the sign and the (low) magnitude of this difference are consistent with the cross-sectional prediction of our model. Panel B of Table 10 confirms these results when we perform unconditional double sorts.

5.4 Firm-level regressions

We now show that these negative relations are robust features of the data and, in particular, hold at the individual firm level. To this end, we examine how valuation ratios and default risk at the firm level vary with expected inflation, while keeping constant other firm characteristics and aggregate economic conditions.

Our main regression specification is as follows:

$$S_{i,j,t} = \delta_P \mu_{P,t} + \mathbf{X}'_{i,j,t}\delta_{C_1} + \mathbf{Y}'_t \delta_{C_2} + \gamma_j + \epsilon_{i,j,t}, \tag{45}$$

where $S_{i,j,t}$ denotes the equity valuation for firm i in industry j at quarter t, measured as the price-dividend ratio or the market-to-book ratio. In the analysis of default risk, $S_{i,j,t}$ captures firm i's default probability computed in quarter t. Keeping the same notation as in the model, $\mu_{P,t}$ reflects expected inflation in quarter t. We denote the vectors of firm and global characteristics that we use as control variables by $\mathbf{X}_{i,j,t}$ and $\mathbf{Y}_t$, respectively. We include industry fixed effects (γ_j) to control for time-invariant differences across industry groups and cluster standard errors at the quarter level to allow for correlations in error terms of unknown form across firms in a given quarter.

Equity valuations and default probabilities vary with firm characteristics; therefore, accounting for such drivers is critical. Following Fama and French (2015), we consider the level of investment, profitability, and firm size as firm-level controls (see Appendix D for details on the variable definitions). We also include the year-on-year growth rate of U.S. industrial production, a recession indicator based on the NBER business-cycle dates, the trailing 1-year return of the S&P 500 index, and the slope of the yield curve measured by the yield spread between the 10-year Treasury note and the three-month Treasury bill, because these factors help predict U.S. defaults.[30] We also control for the recent period of unconventional monetary policies by including a dummy variable that is equal to 1 over the 2008Q1–2019Q4 period, and zero otherwise. These data are from the Federal Reserve Bank of St. Louis.

[29] We bootstrap the double difference to calculate standard errors.

[30] See, for example, Das et al. (2007), Duffie, Saita, and Wang (2007), Campbell, Hilscher, and Szilagyi (2008), Duffie et al. (2009), Giesecke et al. (2011), and Azizpour, Giesecke, and Schwenkler (2018).

Table 10
Equity valuation and default risk by expected inflation and leverage

Expected inflation	No. obs	P/D ratio: Low leverage (1)	P/D ratio: High leverage (2)	M/B ratio: Low leverage (3)	M/B ratio: High leverage (4)	Low leverage (5): Distress risk	Low leverage (5): Default prob.	High leverage (6): Distress risk	High leverage (6): Default prob.
				A. Conditional double sorts					
L	190	97.08	58.89	3.78	2.08	−7.78	4.16	−7.53	5.39
		(1.72)	(0.90)	(0.05)	(0.02)	(0.02)		(0.02)	
M	189	92.23	53.36	3.61	1.88	−8.06	3.14	−7.68	4.62
		(1.66)	(1.03)	(0.05)	(0.09)	(0.01)		(0.02)	
H	189	46.18	24.81	1.87	0.95	−8.43	2.17	−7.99	3.40
		(0.98)	(0.56)	(0.04)	(0.02)	(0.01)		(0.02)	
H-L		−50.90	−34.08	−1.91	−1.13	−0.65		−0.46	
		(3.22)	(1.21)	(0.07)	(0.04)	(0.05)		(0.03)	
Double difference			19.37		0.93			0.21	
			(0.12)		(0.04)			(0.01)	
				B. Unconditional double sorts					
L	190	90.94	58.29	3.76	1.81	−8.01	3.32	−7.58	5.10
		(1.76)	(0.86)	(0.05)	(0.02)	(0.01)		(0.02)	
M	189	90.48	51.12	3.72	1.76	−8.08	3.09	−7.61	4.96
		(1.66)	(0.99)	(0.08)	(0.02)	(0.02)		(0.02)	
H	189	49.22	26.43	1.99	1.00	−8.49	2.05	−8.02	3.28
		(0.82)	(0.47)	(0.03)	(0.01)	(0.02)		(0.02)	
H-L		−41.72	−31.87	−1.76	−0.81	−0.48		−0.44	
		(2.37)	(1.23)	(0.06)	(0.05)	(0.09)		(0.05)	
Double difference			11.23		0.92			0.04	
			(0.14)		(0.05)			(0.01)	

This table reports double sorts of price-dividend ratios in columns 1 and 2, market-to-book ratios in columns 3 and 4 and default risk in columns 5 and 6 by firm market leverage and level of expected inflation. Panel A reports conditional double sorts, whereas panel B reports unconditional double sorts. We value-weight variables at the portfolio level. Expected inflation is from the Survey of Professional Forecasters from the Federal Reserve Bank of Philadelphia. Reported estimates of default risk are computed as in Campbell, Hilscher, and Szilagyi (2008). The default probability is the marginal probability of bankruptcy or failure over the next quarter (reported in bps), whereas the distress risk measure corresponds to the logarithm of the default probability. We bootstrap standard errors for the double differences. Section 5.1 provides additional details on the data. The sample period is 1972Q2–2019Q4.

Table 11
Regressions on expected inflation

	P/D ratio (1)	M/B ratio (2)	Default risk (3)	P/D ratio (4)	M/B ratio (5)	Default risk (6)
Expected inflation (μ_P)	−9.27	−0.14	−0.14	−9.90	−0.14	−0.18
	(0.52)	(0.01)	(0.01)	(0.51)	(0.00)	(0.01)
Investment	101.69	1.68	−0.77	107.26	1.69	−0.62
	(2.56)	(0.05)	(0.05)	(3.21)	(0.05)	(0.05)
Profitability	0.00	0.00	0.00	−0.01	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
log(Size)	3.44	0.25	−0.06	3.67	0.23	−0.04
	(0.17)	(0.00)	(0.00)	(0.22)	(0.01)	(0.00)
IP growth	30.96	−0.11	−0.82	8.85	0.16	−0.51
	(8.69)	(0.15)	(0.22)	(10.53)	(0.16)	(0.24)
S&P return	18.66	0.37	−0.10	12.18	0.42	0.07
	(2.81)	(0.05)	(0.06)	(3.18)	(0.05)	(0.06)
Yield curve	−1.40	−0.06	−0.07	−2.03	−0.05	−0.07
	(0.29)	(0.00)	(0.01)	(0.30)	(0.00)	(0.01)
Leverage	−35.37	−1.91	1.56	−35.55	−1.80	1.50
	(0.76)	(0.03)	(0.02)	(0.83)	(0.02)	(0.01)
Recession	2.61	0.02	0.17	1.18	0.05	0.13
	(1.76)	(0.03)	(0.03)	(2.23)	(0.03)	(0.04)
$\text{Dummy}_{post\ 2008}$	−16.32	−0.23	0.05			
	(1.07)	(0.02)	(0.02)			
Industry FE	X	X	X	X	X	X
No. obs.	798,288	798,288	798,288	592,819	592,819	592,819
R^2	16.71%	32.53%	49.34%	19.78%	35.95%	46.50%

This table reports regressions of price-dividend ratios, market-to-book ratios and default risk on expected inflation, firm characteristics, and macro aggregates. Expected inflation is from the Survey of Professional Forecasters from the Federal Reserve Bank of Philadelphia. Default risk is the level of distress risk computed as in Campbell, Hilscher, and Szilagyi (2008), which corresponds to the logarithm of the marginal probability of bankruptcy or failure over the next quarter. Section 5.1 provides additional details on the data. The sample period is 1972Q2–2019Q4 in columns 1–3 and 1972Q2–2007Q4 in columns 4–6. We report standard errors in parentheses. Standard errors are clustered at the quarter level and all specifications include industry fixed effects at the Fama and French 17 industry classification.

Table 11 reports the regression results. We see in columns 1–2 that expected inflation is a strong driver of the price-dividend ratio and the market-to-book ratio, beyond the information contained in firm fundamentals and economic/financial conditions. A one-standard-deviation decrease in expected inflation (1.865) increases the price-dividend ratio by 17.29, which is economically sizable. Column 3 reports similar results for the level of distress risk. Results are also similar if we end the sample in 2007 in columns 4–6 ensuring that the decade of low inflation after the Global Financial Crisis does not drive our results.

We now turn to another central prediction of the model: a decrease in expected inflation has a stronger impact on equity valuation and default risk than an increase in expected inflation. The following analysis tests for such asymmetry in the data. To investigate a potential nonlinearity in the relation between the valuation ratios (or default risk) and expected inflation, we interact expected inflation with a dummy variable, $\mathcal{D}_{L,M}$, that takes the value of 1 when expected inflation is below the 75^{th} percentile. This choice follows from our calibration, in which high expected inflation corresponds to the top quartile.

Table 12
Regressions on expected inflation: Convexity

	P/D ratio (1)	M/B ratio (2)	Default risk (3)	P/D ratio (4)	M/B ratio (5)	Default risk (6)
Expected inflation (μ_P)	−2.65	−0.08	−0.10	−4.18	−0.09	−0.01
	(0.55)	(0.01)	(0.01)	(0.38)	(0.01)	(0.02)
$\mu_P \times \mathcal{D}_{L,M}$	−12.50	−0.11	−0.08	−12.74	−0.13	−0.13
	(0.73)	(0.01)	(0.02)	(0.91)	(0.02)	(0.01)
Investment	101.02	1.68	−0.77	106.92	1.70	−0.62
	(2.55)	(0.05)	(0.05)	(3.08)	(0.04)	(0.05)
Profitability	0.00	0.00	0.00	0.19	0.01	0.00
	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)
log(Size)	3.21	0.25	−0.06	3.38	0.23	−0.04
	(0.16)	(0.00)	(0.00)	(0.22)	(0.01)	(0.00)
IP growth	51.99	0.08	−0.68	26.45	0.41	−0.24
	(6.00)	(0.14)	(0.22)	(6.37)	(0.13)	(0.23)
S&P return	17.34	0.36	−0.11	15.78	0.46	0.04
	(2.02)	(0.04)	(0.06)	(2.17)	(0.05)	(0.06)
Yield curve	−0.05	−0.05	−0.06	−0.50	−0.03	−0.06
	(0.21)	(0.00)	(0.01)	(0.21)	(0.00)	(0.01)
Leverage	−35.19	−1.91	1.57	−35.44	−1.79	1.51
	(0.77)	(0.03)	(0.02)	(0.84)	(0.02)	(0.01)
Recession	1.94	0.02	0.17	0.03	0.05	0.14
	(1.23)	(0.02)	(0.03)	(0.02)	(0.02)	(0.04)
$\text{Dummy}_{post\ 2008}$	−22.70	−0.29	0.01			
	(0.91)	(0.02)	(0.03)			
Industry FE	X	X	X	X	X	X
No. obs	798,288	798,288	798,288	592,966	592,966	592,966
R^2	17.33%	32.60%	49.52%	20.62%	36.08%	47.04%

This table reports regressions of price-dividend ratios, market-to-book ratios and default risk on expected inflation, including an interaction term capturing the asymmetry in the relations. Expected inflation is from the Survey of Professional Forecasters from the Federal Reserve Bank of Philadelphia. $\mathcal{D}_{L,M}$ denotes a dummy variable that equals 1 when expected inflation is below the third quartile. Default risk is the level of distress risk computed as in Campbell, Hilscher, and Szilagyi (2008), which corresponds to the logarithm of the marginal probability of bankruptcy or failure over the next quarter. Section 5.1 provides additional details on the data. The sample period is 1972Q2–2019Q4 in columns 1–3 and 1972Q2–2007Q4 in columns 4–6. We report standard errors in parentheses. Standard errors are clustered at the quarter level and all specifications include industry fixed effects at the Fama and French 17 industry classification.

Table 12 show the relation between equity valuations and expected inflation is stronger when expected inflation is lower. The difference in the sensitivity to expected inflation is economically and statistically significant. The total effect of expected inflation on the price-dividend ratio is -15.15 when expected inflation is below the 75^{th} percentile, whereas it is only -2.65 for expected inflation in the top quartile. The same result holds for distress risk. The empirical support for such asymmetry confirms that an increase in expected inflation is not the mirror image of a decrease in expected inflation.

5.5 Cross-sectional analysis

We now use our regression-based analysis to test two key cross-sectional predictions of the model. First, we verify that the effect of expected inflation on the price-dividend ratio is weaker for high leverage firms. Columns 1–3 of Table 13 introduce an interaction term between expected inflation and firm leverage that confirms our theoretical prediction. In particular, the impact of expected inflation is statistically weaker for firms with higher leverage, controlling for expected drivers of financial leverage such as firm performance and aggregate economic/financial conditions.

Second, we verify the prediction that the relation between equity valuation and expected inflation becomes weaker when prices are less sticky. Columns 4–7 of Table 13 introduce an interaction between expected inflation and the frequency of price adjustments from Pasten, Schoenle, and Weber (2017). A higher frequency of price adjustments implies less sticky output prices, which we interpret as a lower degree of cash flow stickiness through the lens of our model. The interaction term is positive and statistically significant. The relation between the price-dividend ratio and expected inflation thus becomes weaker with a higher frequency of price adjustments, that is when prices are less sticky. The same result obtains for the relation between market-to-book ratio and expected inflation.[31] We can conclude that the strong negative relation between equity valuation and expected inflation observed in the data reflects a high degree of cash flow stickiness. This finding provides further support to our model.

5.6 Robustness analysis

In this section, we report several alternative tests to probe the robustness of our empirical findings. We first address the potential concern that variations in expected inflation reflect changes in economic or financial conditions, in particular given the low inflation levels observed during and after the Great Recession. It is therefore critical to exploit a measure of expected inflation that is independent of the business cycle. To this end, we first orthogonalize the level of expected inflation with respect to the NBER recession indicator and reproduce our portfolio analysis of Table 10 with this orthogonalized measure. Table 14 displays the results. Alternatively, Table 15 focuses on the 1972Q2–2007Q4 period to ensure that observations during and subsequent to the Great Recession do not drive the relation between expected inflation and equity valuation or default risk. In both analyses, the results continue to hold with the same economic magnitude and statistical significance.

We go through the same exercise for the firm-level regressions, which all control for indicators of NBER recession and post-2007 years. Columns 4–6 of Tables 11 and 12 repeat the baseline analysis of columns 1–3 but for the 1972Q2–2007Q4 period, thereby excluding observations during which equity valuation and default risk are most sensitive to expected inflation. The relations continue to be negative and asymmetric. Furthermore, our rich set of financial, macroeconomic, and firm-level controls allows us to disentangle the impact of

[31] By contrast, the relation between default risk and expected inflation becomes only marginally weaker with a higher frequency of price adjustments. To see that, a one-standard-deviation increase in the frequency of price adjustments reduces the impact of expected inflation on default risk from -0.184 ($=-0.19+0.03\times0.32$) to -0.178 [$=-0.19+0.03\times(0.32+0.19)$]. This change is economically negligible.

Table 13
Regressions on expected inflation: Interactions with leverage and price stickiness

	P/D ratio (1)	M/B ratio (2)	Default risk (3)	P/D ratio (4)	M/B ratio (5)	Default risk (6)
Expected inflation (μ_P)	−11.65	−0.25	−0.16	−11.96	−0.30	−0.19
	(0.41)	(0.01)	(0.01)	(0.60)	(0.01)	(0.01)
$\mu_P \times$ leverage	7.95	0.30	0.02			
	(0.47)	(0.01)	(0.00)			
$\mu_P \times$ FPA				4.57	0.41	0.04
				(0.57)	(0.02)	(0.01)
Investment	102.53	1.70	−0.66	112.36	1.79	−0.72
	(2.60)	(0.05)	(0.06)	(2.77)	(0.05)	(0.08)
Profitability	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
log(Size)	3.36	0.25	−0.07	3.95	0.26	−0.07
	(0.17)	(0.00)	(0.00)	(0.15)	(0.00)	(0.00)
IP growth	32.07	−0.10	−0.95	38.92	−0.23	0.42
	(8.45)	(0.14)	(0.19)	(9.70)	(0.19)	(0.22)
S&P return	16.91	0.36	−0.22	17.12	0.36	0.13
	(2.73)	(0.05)	(0.05)	(2.54)	(0.05)	(0.05)
Yield curve	−1.29	−0.06	−0.07	−0.25	−0.06	−0.06
	(0.28)	(0.00)	(0.01)	(0.29)	(0.00)	(0.01)
Leverage	−64.27	−3.01	2.29	−44.71	−1.97	3.95
	(2.00)	(0.06)	(0.01)	(0.92)	(0.02)	(0.02)
Recession	2.28	0.03	0.18	3.61	0.03	0.05
	(1.71)	(0.03)	(0.03)	(1.50)	(0.03)	(0.03)
$\text{Dummy}_{post\ 2008}$	−16.73	−0.26	0.00	0.92	−0.31	0.13
	(1.01)	(0.02)	(0.02)	(0.20)	(0.02)	(0.01)
FPA				−16.37	−1.82	0.91
				(2.57)	(0.09)	(0.04)
Industry FE	X	X	X	X	X	X
No. obs.	798,288	798,288	798,288	445,728	445,728	445,728
R^2	17.04%	33.16%	50.56%	15.27%	32.44%	41.63%

This table reports regressions of price-dividend ratios, market-to-book ratios and default risk on expected inflation by leverage and price stickiness. Expected inflation is from the Survey of Professional Forecasters from the Federal Reserve Bank of Philadelphia. Default risk is the level of distress risk computed as in Campbell, Hilscher, and Szilagyi (2008), which corresponds to the logarithm of the marginal probability of bankruptcy or failure over the next quarter. Columns 1–3 add interaction terms between expected inflation and leverage, while columns 4–6 add interaction terms between expected inflation and the frequency of price adjustment (FPA) from Pasten, Schoenle, and Weber (2017). Higher frequencies imply lower price stickiness. Section 5.1 provides additional details on the data. The sample period is 1972Q2–2019Q4. We report standard errors in parentheses. Standard errors are clustered at the quarter level and all specifications include industry fixed effects at the Fama and French 17 industry classification.

nominal and real conditions. Hence, we can rule out the concern that a high or a low inflation environment reflects a bad state of the economy, thereby driving equity valuation and default risk.

Our robustness analysis also considers alternative samples. First, we compare the findings with and without financial firms and utilities in Table 16, because they operate in regulated markets or have special capital structures. Second, columns 1–3 of Table 17 exclude all tech firms, which tend to display relatively high equity valuations. The results remain similar in all of these cases.

Furthermore, we address the concern that the high levels of expected inflation in the 1970s may be a driver of our results. We thus exclude the pre-1980 period and report the results in columns 4–6 of Table 17. This analysis shows

Table 14
Equity valuation and default risk by orthogonalized expected inflation

Expected inflation	No. obs	P/D ratio Low leverage (1)	P/D ratio High leverage (2)	M/B ratio Low leverage (3)	M/B ratio High leverage (4)	Low leverage (5) Distress risk	Low leverage (5) Default prob.	High leverage (6) Distress risk	High leverage (6) Default prob.
				A. Conditional double sorts					
L	190	93.67	59.22	3.87	1.91	−7.92	3.63	−7.58	5.11
		(1.72)	(0.91)	(0.06)	(0.02)	(0.02)		(0.02)	
M	189	89.93	53.19	3.53	1.86	−8.07	3.13	−7.67	4.64
		(1.63)	(0.99)	(0.05)	(0.09)	(0.01)		(0.03)	
H	189	45.99	24.66	1.86	0.95	−8.43	2.19	−7.98	3.43
		(0.96)	(0.55)	(0.04)	(0.02)	(0.01)		(0.02)	
H-L		−47.68	−34.56	−2.00	−0.97	−0.51		−0.40	
		(3.95)	(1.33)	(0.12)	(0.06)	(0.03)		(0.03)	
Double difference			16.93		1.12			0.12	
			(0.09)		(0.03)			(0.01)	
				B. Unconditional double sorts					
L	190	89.59	58.21	3.78	1.83	−8.00	3.35	−7.59	5.08
		(1.73)	(0.87)	(0.05)	(0.02)	(0.01)		(0.02)	
M	189	81.99	51.28	3.69	1.75	−8.09	3.08	−7.61	4.96
		(1.49)	(0.98)	(0.08)	(0.02)	(0.02)		(0.02)	
H	189	49.08	26.37	2.00	1.00	−8.47	2.10	−8.01	3.31
		(0.80)	(0.46)	(0.03)	(0.01)	(0.02)		(0.02)	
H-L		−40.51	−31.85	−1.79	−0.82	−0.47		−0.43	
		(4.21)	(1.89)	(0.12)	(0.06)	(0.06)		(0.04)	
Double difference			10.21		0.96			0.05	
			(0.12)		(0.04)			(0.01)	

This table reproduces Table 10 when the level of expected inflation is orthogonalized with respect to NBER recessions. We present double sorts of price-dividend ratios in columns 1 and 2, market-to-book ratios in columns 3 and 4 and default risk in columns 5 and 6 by firm market leverage and level of expected inflation. Panel A reports conditional double sorts, while panel B reports unconditional double sorts. We value-weight variables at the portfolio level. Expected inflation is from the Survey of Professional Forecasters from the Federal Reserve Bank of Philadelphia and orthogonolized with respect to NBER recessions. Reported estimates of default risk are computed as in Campbell, Hilscher, and Szilagyi (2008). The default probability is the marginal probability of bankruptcy or failure over the next quarter (reported in bps), whereas the distress risk measure corresponds to the logarithm of the default probability. We bootstrap standard errors for the double differences. We bootstrap standard errors for the double differences. Section 5.1 provides additional details on the data. The sample period is 1972Q2–2019Q4.

that our findings are not driven by the changes in equity valuation and default risk as a consequence of the large variations in expected inflation during this period. Expected inflation decreased substantially over time and at the same time valuation ratios have, on average, increased. To ensure that such a secular trend does not drive our baseline results, Table 18 directly controls for a linear time trend. The results remain qualitatively similar, that is, equity valuations decrease in expected inflation even after controlling for a time trend.

Finally, we verify that the results are not driven by the time-varying comovement between stocks and bonds. Over the last few decades, the correlation between stocks and bonds has switched signs (Bilal, 2017, Campbell, Pflueger, and Viceira, 2020, Boons et al., 2020), which might affect the relation between expected inflation, equity valuations, and default risk. Table 19 shows that the empirical effect of expected inflation on equity valuation and default risk is negative and statistically significant in periods of negative and positive stock-bond correlation, which we compute using the unsmoothed

Table 15
Equity valuation and default risk by expected inflation and leverage (1970–2007)

Expected inflation	No. obs.	P/D ratio Low leverage (1)	P/D ratio High leverage (2)	M/B ratio Low leverage (3)	M/B ratio High leverage (4)	Distress risk Low leverage (5)	Default prob. Low leverage (5)	Distress risk High leverage (6)	Default prob. High leverage (6)
A. Conditional double sorts									
L	138	130.15	72.69	4.66	2.35	−7.91	3.65	−7.56	5.22
		(1.58)	(0.96)	(0.08)	(0.04)	(0.02)		(0.03)	
M	135	72.62	41.25	3.21	1.59	−8.21	2.71	−7.73	4.39
		(1.14)	(0.93)	(0.05)	(0.03)	(0.02)		(0.02)	
H	138	44.08	23.15	1.79	0.90	−8.47	2.10	−7.96	3.49
		(0.86)	(0.55)	(0.03)	(0.02)	(0.02)		(0.02)	
H-L		−86.07	−49.54	−2.87	−1.45	−0.55		−0.40	
		(1.82)	(0.71)	(0.10)	(0.03)	(0.03)		(0.03)	
Double difference			31.73		1.26			0.09	
			(0.03)		(0.00)			(0.00)	
B. Unconditional double sorts									
L	138	121.99	68.83	4.40	2.21	−7.90	3.72	−7.50	5.55
		(1.43)	(1.02)	(0.08)	(0.03)	(0.02)		(0.03)	
M	135	72.38	41.02	3.19	1.58	−8.21	2.72	−7.73	4.40
		(1.13)	(0.91)	(0.04)	(0.03)	(0.02)		(0.02)	
H	138	48.68	26.77	2.02	1.03	−8.56	1.92	−8.07	3.13
		(0.93)	(0.64)	(0.04)	(0.02)	(0.02)		(0.02)	
H-L		−73.31	−42.06	−2.37	−1.18	−0.66		−0.57	
		(1.68)	(0.76)	(0.10)	(0.03)	(0.03)		(0.02)	
Double difference			27.27		1.07			0.02	
			(0.03)		(0.00)			(0.00)	

This table reports double sorts of price-dividend ratios in columns 1 and 2, market-to-book ratios in columns 3 and 4 and default risk in columns 5 and 6 by firm market leverage and level of expected inflation. Panel A reports conditional double sorts, while Panel B reports unconditional double sorts. We value-weight variables at the portfolio level. Expected inflation is from the Survey of Professional Forecasters from the Federal Reserve Bank of Philadelphia. Reported estimates of default risk are computed as in Campbell, Hilscher, and Szilagyi (2008). The default probability is the marginal probability of bankruptcy or failure over the next quarter (reported in bps), whereas the distress risk measure corresponds to the logarithm of the default probability. We bootstrap standard errors for the double differences. Section 5.1 provides additional details on the data. The sample period is 1972Q2–2007Q4.

correlation of Campbell, Pflueger, and Viceira (2020). Interestingly, the relations become steeper in times of positive stock-bond correlation, that is, when an increase in expected inflation reduces consumption growth and is thus viewed as bad news.

5.7 Equity and credit spread term structures

Nominal price stickiness in output markets can temporarily generate sticky cash flows but this effect is likely of moderate persistence. To study these implications, we explore the equity and credit spread term structures in the data and compare them to the model predictions.[32] We empirically analyze the conditional term structure of forward equity yields, using the model-implied data from Giglio, Kelly, and Kozak (2021). The term structures of forward equity yields conditional on real and nominal states are displayed in panels A and B of Figure 8. As in Giglio, Kelly, and Kozak (2021), the term structure is

32 We thank the editor and two referees for motivating this analysis.

Table 16
Regressions on expected inflation: Convexity, excluding finance and utilities

	P/D ratio (1)	M/B ratio (2)	Default risk (3)	P/D ratio (4)	M/B ratio (5)	Default risk (6)
Expected inflation (μ_P)	−3.75	−0.10	−0.11	−5.25	−0.10	−0.01
	(0.70)	(0.01)	(0.01)	(0.48)	(0.01)	(0.02)
$\mu_P \times \mathcal{D}_{L,M}$	−15.25	−0.05	−0.08	−18.62	−0.08	−0.14
	(0.96)	(0.02)	(0.02)	(0.87)	(0.02)	(0.01)
Investment	119.98	1.75	−0.83	122.42	1.81	−0.67
	(3.31)	(0.05)	(0.05)	(3.89)	(0.05)	(0.05)
Profitability	0.00	0.00	0.00	0.16	0.01	0.00
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
log(Size)	3.30	0.33	−0.05	2.93	0.28	−0.03
	(0.19)	(0.01)	(0.00)	(0.25)	(0.01)	(0.00)
IP growth	54.80	0.41	−0.69	27.31	0.64	−0.47
	(6.80)	(0.20)	(0.22)	(7.74)	(0.15)	(0.24)
S&P return	19.96	0.49	−0.15	20.52	0.58	0.00
	(2.58)	(0.06)	(0.06)	(2.75)	(0.06)	(0.06)
Yield curve	−0.37	−0.07	−0.06	−0.58	−0.04	−0.06
	(0.27)	(0.01)	(0.01)	(0.28)	(0.01)	(0.01)
Leverage	−33.21	−2.39	2.12	−34.90	−2.32	2.09
	(0.96)	(0.04)	(0.02)	(1.02)	(0.04)	(0.01)
Recession	2.69	−0.06	0.18	−0.34	0.08	0.17
	(1.59)	(0.03)	(0.03)	(1.43)	(0.02)	(0.03)
$\text{Dummy}_{post\ 2008}$	−31.19	0.01	−0.03			
	(1.16)	(0.04)	(0.02)			
Industry FE	X	X	X	X	X	X
No. obs	464,322	464,322	464,322	356,938	356,938	356,938
R^2	15.75%	34.70%	48.65%	19.01%	38.40%	48.31%

This table reports regressions of price-dividend ratios, market-to-book ratios and default risk on expected inflation excluding firms operating in the Finance and Utilities sectors. Expected inflation is from the Survey of Professional Forecasters from the Federal Reserve Bank of Philadelphia. $\mathcal{D}_{L,M}$ denotes a dummy variable that equals one when expected inflation is below the third quartile. Default risk is the level of distress risk computed as in Campbell, Hilscher, and Szilagyi (2008), which corresponds to the logarithm of the marginal probability of bankruptcy or failure over the next quarter. Section 5.1 provides additional details on the data. The sample period is 1972Q2–2019Q4 in columns 1–3 and 1972Q2–2007Q4 in columns 4–6. We report standard errors in parentheses. Standard errors are clustered at the quarter level and all specifications include industry fixed effects at the Fama & French 17 industry classification.

upward sloping in expansions and downward sloping in recessions. We provide evidence that the slope also varies strongly with expected inflation. Panel B of Figure 8 shows the slope of the term structure of equity yields is positive for states of low and moderate inflation, but turns negative for states of high inflation. The difference in the slope slowly compresses as the time horizon increases. Furthermore, the equity yields always increase with the level of expected inflation for any maturity, thereby providing further support for one of the key empirical results we address with our model: equity valuation decreases with expected inflation. These findings are all consistent with the predictions of our model with sticky cash flows.

We then estimate the average credit spreads by maturity using an extensive data set of 20,068 corporate bonds issued by 2,123 firms, spanning the period

Table 17
Regressions on expected inflation: Convexity, no tech or pre-1980

	P/D ratio	M/B ratio	Default risk	P/D ratio	M/B ratio	Default risk
	(1)	(2)	(3)	(4)	(5)	(6)
Expected inflation (μ_P)	−2.61	−0.09	−0.10	−2.20	−0.11	−0.13
	(0.55)	(0.01)	(0.01)	(0.53)	(0.01)	(0.02)
$\mu_P \times \mathcal{D}_{L,M}$	−12.58	−0.08	−0.08	−13.00	−0.05	−0.05
	(0.72)	(0.01)	(0.02)	(0.69)	(0.02)	(0.02)
Investment	100.56	1.67	−0.76	112.61	1.82	−0.84
	(2.57)	(0.05)	(0.05)	(2.29)	(0.05)	(0.04)
Profitability	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
log(Size)	3.16	0.26	−0.06	3.38	0.27	−0.07
	(0.16)	(0.00)	(0.00)	(0.18)	(0.00)	(0.00)
IP growth	51.13	0.25	−0.68	72.62	0.33	−0.16
	(5.98)	(0.16)	(0.22)	(7.70)	(0.20)	(0.26)
S&P return	17.16	0.35	−0.11	15.79	0.27	−0.19
	(2.01)	(0.05)	(0.06)	(2.12)	(0.05)	(0.06)
Yield curve	0.00	−0.06	−0.06	0.47	−0.07	−0.06
	(0.22)	(0.01)	(0.01)	(0.24)	(0.01)	(0.01)
Leverage	−34.79	−1.91	1.56	−38.90	−2.05	1.58
	(0.77)	(0.03)	(0.02)	(0.77)	(0.03)	(0.02)
Recession	1.98	−0.02	0.16	3.35	−0.06	0.17
	(1.24)	(0.02)	(0.03)	(1.58)	(0.03)	(0.04)
$\text{Dummy}_{post\ 2008}$	−22.70	−0.16	0.03	−23.13	−0.16	0.04
	(0.87)	(0.02)	(0.02)	(0.86)	(0.02)	(0.02)
Industry FE	X	X	X	X	X	X
No. obs.	702,000	702,000	702,000	694,460	694,460	694,460
R^2	17.35%	32.34%	49.65%	14.82%	30.14%	47.40%

This table reports regressions of price-dividend ratios, market-to-book ratios and default risk on expected inflation using different samples. Expected inflation is from the Survey of Professional Forecasters from the Federal Reserve Bank of Philadelphia. $\mathcal{D}_{L,M}$ denotes a dummy variable that equals 1 when expected inflation is below the third quartile. Default risk is the level of distress risk computed as in Campbell, Hilscher, and Szilagyi (2008), which corresponds to the logarithm of the marginal probability of bankruptcy or failure over the next quarter. Section 5.1 provides additional details on the data. The sample period is 1972Q2–2019Q4 in columns 1–3 but excludes all tech firms, while it is 1980Q1–2019Q4 in columns 4–6. We report standard errors in parentheses. Standard errors are clustered at the quarter level and all specifications include industry fixed effects at the Fama and French 17 industry classification.

matching the equity yield sample.[33] Panels C and D of Figure 8 show the value-weighted results conditional on real and nominal states, respectively. As illustrated in panel C, credit spreads display a hump shape, that is, an upward-sloping term structure in the short term but a downward-sloping term structure for longer horizons, that is similar to the model-implied patterns reported in Figure 5. Credit spreads are also higher during periods of lower inflation for any maturity, confirming the main results of our paper that default risk increases with lower expected inflation. These plots provide further evidence on the negative relation between expected inflation and default risk, as measured by the implied default probability in our main empirical analysis. The difference between the credit spreads in high vs. low expected inflation is persistent over time, which

[33] Appendix D describes the construction of the corporate credit spreads by maturity and describes the bond data.

Table 18
Regressions on expected inflation: With time trend

	P/D ratio	M/B ratio	Default risk	P/D ratio	M/B ratio	Default risk
	(1)	(2)	(3)	(4)	(5)	(6)
Expected inflation (μ_P)	−3.40	−0.07	−0.12	−2.48	−0.07	−0.07
	(0.41)	(0.01)	(0.02)	(0.43)	(0.01)	(0.01)
Investment	105.42	1.73	−0.75	113.80	1.77	−0.54
	(2.35)	(0.04)	(0.05)	(2.66)	(0.04)	(0.05)
Profitability	0.00	0.00	0.00	0.18	0.01	0.00
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
log(Size)	2.91	0.25	−0.06	3.00	0.23	−0.05
	(0.17)	(0.00)	(0.00)	(0.23)	(0.01)	(0.00)
IP growth	38.56	−0.01	−0.79	18.96	0.37	0.11
	(6.58)	(0.13)	(0.22)	(9.38)	(0.20)	(0.26)
S&P return	23.71	0.44	−0.08	20.96	0.51	0.10
	(1.88)	(0.04)	(0.06)	(2.36)	(0.05)	(0.06)
Yield curve	0.88	−0.03	−0.06	0.63	−0.02	−0.04
	(0.21)	(0.00)	(0.01)	(0.20)	(0.00)	(0.01)
Leverage	−33.85	−1.90	1.57	−33.50	−1.78	1.53
	(0.77)	(0.03)	(0.02)	(0.85)	(0.02)	(0.01)
Recession	4.42	0.05	0.18	0.77	0.05	0.08
	(1.51)	(0.02)	(0.03)	(1.57)	(0.02)	(0.03)
$\text{Dummy}_{post\ 2008}$	−32.00	−0.43	−0.02			
	(1.23)	(0.02)	(0.04)			
Industry FE	X	X	X	X	X	X
Time trend	X	X	X	X	X	X
No. obs	798,288	798,288	798,288	592,819	592,819	592,819
R^2	17.36%	32.67%	49.43%	20.71%	36.08%	47.66%

This table reports regressions of price-dividend ratios, market-to-book ratios and default risk on expected inflation, controlling for a linear time trend. Expected inflation is from the Survey of Professional Forecasters from the Federal Reserve Bank of Philadelphia. Default risk is the level of distress risk computed as in Campbell, Hilscher, and Szilagyi (2008), which corresponds to the logarithm of the marginal probability of bankruptcy or failure over the next quarter. Section 5.1 provides additional details on the data. The sample period is 1972Q2–2019Q4 in columns 1–3 and 1972Q2–2007Q4 in columns 4–6. We report standard errors in parentheses. Standard errors are clustered at the quarter level and all specifications include industry fixed effects at the Fama and French 17 industry classification.

implies moderate convergence across nominal states in the long run. Again, the predictions of our model are consistent with this new set of observations.

Overall, one may expect that price rigidity in the goods market implies sticky nominal cash flow growth in the short run. Whether the price rigidity is transitory or not should be reflected in the response of the term structure of equity yields. Similarly, any expected adjustment in firms' capital structure should be reflected in the term structure of credit spreads. Our analysis suggests the difference in term structures across nominal conditions remains of the expected sign and stays large for a relatively long horizon, consistent with the size of the frictions (the degree of cash flow and leverage stickiness) we assume theoretically.

5.8 Summary

Our empirical investigation of the impact of expected inflation on equity valuation and default risk highlights several findings. First, we document that the relations are robust feature of the data and, in particular, hold for individual

Table 19
Regressions on expected inflation: Split by stock-bond correlation

	Negative stock-bond correlation			Positive stock-bond correlation		
	P/D ratio (1)	M/B ratio (2)	Default risk (3)	P/D ratio (4)	M/B ratio (5)	Default risk (6)
Expected inflation (μ_P)	−7.23	−0.06	−0.11	−8.29	−0.14	−0.19
	(2.60)	(0.02)	(0.04)	(0.58)	(0.01)	(0.01)
Investment	99.97	1.60	−0.66	103.13	1.80	−0.61
	(3.64)	(0.07)	(0.10)	(3.47)	(0.06)	(0.07)
Profitability	0.00	0.00	0.00	0.17	0.01	0.00
	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)
log(Size)	4.93	0.29	−0.10	1.84	0.21	−0.04
	(0.20)	(0.01)	(0.00)	(0.23)	(0.01)	(0.00)
IP growth	52.54	−1.33	−0.24	41.20	0.62	1.39
	(10.94)	(0.31)	(0.33)	(8.58)	(0.22)	(0.38)
S&P return	25.19	0.46	0.38	17.91	0.44	0.30
	(2.72)	(0.07)	(0.08)	(3.60)	(0.07)	(0.09)
Yield curve	3.21	−0.06	−0.06	−2.94	−0.05	−0.05
	(0.44)	(0.01)	(0.01)	(0.33)	(0.01)	(0.01)
Leverage	−42.14	−2.17	4.94	−31.37	−1.75	4.68
	(1.18)	(0.05)	(0.02)	(0.84)	(0.03)	(0.02)
Recession	−24.36	−0.03	0.02	0.09	0.02	0.05
	(0.90)	(0.03)	(0.04)	(2.91)	(0.04)	(0.06)
$\text{Dummy}_{post\ 2008}$	6.97	−0.30	0.16	−10.85	0.00	0.02
	(1.66)	(0.02)	(0.02)	(1.55)	(0.05)	(0.04)
Industry FE	X	X	X	X	X	X
No. obs.	330,374	330,374	330,374	467,914	467,914	467,914
R^2	13.28%	28.77%	41.55%	19.67%	35.67%	38.68%

This table reports regressions of price-dividend ratios, market-to-book ratios and default risk on expected inflation by stock-bond correlation. Expected inflation is from the Survey of Professional Forecasters from the Federal Reserve Bank of Philadelphia. Default risk is the level of distress risk computed as in Campbell, Hilscher, and Szilagyi (2008), which corresponds to the logarithm of the marginal probability of bankruptcy or failure over the next quarter. Columns 1–3 focus on periods with negative stock-bond correlations, while columns 4–6 focus on periods with positive stock-bond correlations. We calculate the unsmoothed stock-bond correlation as in Campbell, Pflueger, and Viceira (2020). Section 5.1 provides additional details on the data. The sample period is 1972Q2–2019Q4. We report standard errors in parentheses. Standard errors are clustered at the quarter level and all specifications include industry fixed effects at the Fama and French 17 industry classification.

firms. Firm-level regressions reveal equity valuation and default risk jointly decrease with expected inflation, even after controlling for firm characteristics or for variations in aggregate financial, economic, and monetary conditions. Second, the relations are asymmetric, that is, a decrease in expected inflation has a stronger impact on a firm's default risk and equity valuation when expected inflation is low than when it is high. Third, we validate the cross-sectional prediction of our theory that the relation between equity valuation and expected inflation is stronger for less levered firms. Leverage thus reduces, rather than exacerbates, the sensitivity of equity valuations to changes in nominal conditions. Hence, our analysis provides novel empirical evidence that the relations are negative and asymmetric at the firm level, and vary with financial leverage. Fourth, we show firms with less sticky output prices are less sensitive to movements in expected inflation. Finally, we find our model implies term structures of equity yields and credit spreads that closely match those observed in the data, thereby lending further support for the model.

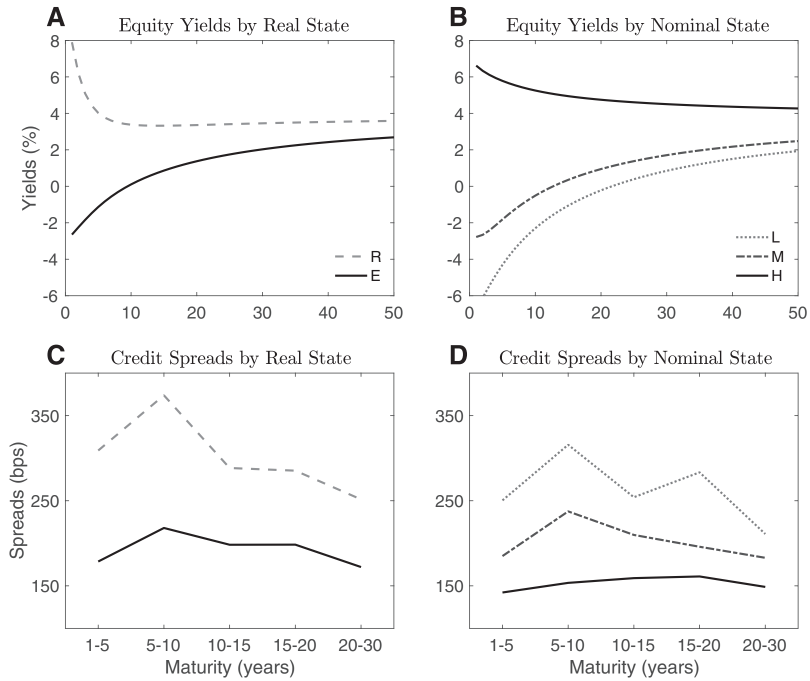

Figure 8
Term structure of equity yields and credit spreads: Data
The figure illustrates the term structure of equity yields (top panels) and credit spreads (bottom panels). The left panels report results by real conditions, while the right panels report results by nominal conditions. Expansions (E) and recessions (R) are determined by NBER-dated recessions. Low (L) and high (H) expected inflation states are determined by the bottom and top quartile of expected inflation; the moderate (M) state spans the interquartile range. Expected inflation is via the Survey of Professional Forecasters via the Federal Reserve Bank of Philadelphia. Equity yields data are from Giglio, Kelly, and Kozak (2021). Credit spreads data are described in Appendix D. The sample period is 1974Q3–2019Q4.

6. Conclusion

Default risk decreases in times of higher expected inflation, despite a fall in equity valuations. Our empirical contribution is to provide new evidence that these relations are robust features of the data, not only at the market level but also for individual firms. In particular, we show these relations are asymmetric and vary with firm leverage. Our theoretical contribution is to develop a model which jointly rationalizes these stylized patterns in the data. In the model, inflation risk affects real asset prices via two empirically grounded nominal frictions: sticky leverage and sticky cash flows. Two key mechanisms are at play. First, long-term nominal debt coupons are fixed, but expected inflation varies. This stickiness in leverage makes expected future real debt coupons dependent on future expected inflation, ensuring that inflation risk affects real corporate bond values and hence default risk. Second, the expected cash flow growth rate is less sensitive to variations in expected inflation than the nominal risk-free rate. This stickiness in cash flows makes equity prices decreasing in the nominal risk-free rate and hence in expected inflation.

Our model thus implies that higher expected inflation simultaneously decreases default risk and real asset values. Importantly, the relations are asymmetric, as a decrease in expected inflation increases real equity values by more than an increase in expected inflation of equal size decreases them. The effect on equity prices is also stronger for firms with less leverage. Hence, leverage dampens rather than exacerbates the sensitivity of equity valuation to inflation expectations. We find support for the model predictions in the data, lending credence to the idea that sticky leverage and sticky cash flows are important channels for understanding the impact of inflation risk on real asset values and corporate default risk.

Appendix

A. Calibration

This appendix provides details on the calibration of the model. We distinguish between two distinct cases: with and without correlated real-nominal conditions.

We calibrate the model to the U.S. economy over the period 1970Q2–2019Q4.[34] The real states (R & E) are characterized by the conditional moments of quarterly real per capita consumption expenditures and real earnings growth.[35]

We obtain data on real per capita personal consumption expenditures and the corresponding price index from the Federal Reserve Bank of St. Louis (FRED). Nominal earnings for S&P 500 constituents, obtained from Robert J. Shiller's website, are deflated using the aforementioned price index.[36] NBER-based recession indicators, also obtained from FRED, are used to determine (a) the long-run probability of being in recession / expansion and (b) the moments of real consumption and earnings within those real regimes.

Regarding the nominal regimes (L, M, and H), we use the quarterly mean of the one-year-ahead inflation forecasts from the Survey of Professional Forecasters, as reported by the Federal Reserve Bank of Philadelphia. Moments of inflation in the low (L) expected inflation regime are obtained from the lowest quartile in the data. Expected inflation in the moderate (M) regime is set to the unconditional mean. We then determine the high (H) expected inflation level such that the unconditional expected inflation in the calibration matches that in the data. Our calibration imposes a symmetry in the unconditional probabilities of being in the low (L) or high (H) expected-inflation regimes by setting them both to 25%. This choice ensures that any asymmetry in the response of asset prices to expected inflation is not driven by the calibration.

In the full model, expected inflation is nonneutral. With a correlation between real and nominal conditions, investors demand an inflation risk premium that affects equity valuation. In the core of our analysis, we intentionally consider a restricted version of the model in which inflation risk is absent from the stochastic discount factor, such that the inflation risk premium does not drive any of our predictions. In this benchmark case, no inflation risk premium exists, because (a) expected consumption growth and expected inflation change independently (because of the way the Markov

[34] The availability of the data on expected inflation determines our start date.

[35] Following Bhamra, Kuehn, and Strebulaev (2010a,b), we account for an additional 22.58% of firm-specific volatility. The total cash-flow volatility is thus approximately 26% for our benchmark firm, which is the average volatility of firms with outstanding rated corporate debt.

[36] Real earning shocks are winsorized at the 1st and 99th percentiles.

chain governing the state of the economy s_t is specified) and (b) shocks to consumption growth and expected inflation are uncorrelated, that is $Cov_t\left(\frac{dC_t}{C_t},\frac{dP_t}{dP_t}\right)=\rho_{CP,t}\sigma_{C,t}\sigma_{P,t}dt=0$, because $\rho_{CP,t}dt=E_t[dZ_{P,t}dZ_t]=0$. We thus analyze how higher expected inflation can negatively affect equity prices although inflation risk remains unpriced. In this baseline calibration, the 2×2 real transition matrix and the 3×3 nominal transition matrix are obtained separately, and are interacted to obtain the 6×6 chain for the model.

We relax the assumption of uncorrelated real and nominal conditions in Section 4.7 and adjust the calibration accordingly. Accounting for a correlation between real and nominal variables within our model can be done two ways: (a) allowing for a nonzero *shock correlation*, whereby *shocks* to consumption growth and *shocks* to inflation exhibit an instantaneous correlation ρ_{CP,s_t} that varies with the current state of the economy, s_t; (b) allowing for *regime correlation* by relaxing the assumption that the real and nominal Markov chains are independent, thereby introducing a correlation between *expected* consumption growth and *expected* inflation.

In the case of nonzero *shock correlation*, we obtain the state-dependent values of ρ_{CP,s_t} from the estimation of the Markov-regime switching model. We find that the correlation between shocks to inflation and consumption growth ρ_{CP,s_t} is -26.9% in RL, -61% in RM, 6.1% in RH, 63.4% in EL, 4.9% in EM, and -28.8% in EH.

In the case of *regime correlation*, we consider various calibrations that generate different unconditional levels of inflation risk premium, computed as the difference between the equity risk premium of the full model and the equity risk premium in the model with independent regimes. In each case, we directly estimate the 6×6 transition matrix, effectively adding 7 degrees of freedom to the estimation.[37] Importantly, none of these calibrations leads to a statistically significantly better fit to the macro data than the case of independent regimes. A log-likelihood ratio test of the nested setup – with independent regimes – against an estimation allowing for regime correlation yields a p-value of at least 98.4% across the different calibrations. While it is difficult to distinguish econometrically between these alternative specifications based on macro data, the asset pricing implications across them are very different. We find that only a specification with low unconditional correlation between real and nominal regimes can generate the relations between equity valuation, credit risk, and expected inflation that we observe in the data.

The remaining parameters of the model are as follows. The sensitivity of nominal cash-flow growth to expected inflation is set to $\varphi=0.407$, using the empirical estimate reported in Table 1. The corporate tax rate is set to $\eta=15\%$. Following Chen (2010) and Bhamra, Kuehn, and Strebulaev (2010a,b), we consider a state-dependent liquidation value in default, with $\alpha_L=20\%$, $\alpha_M=35\%$, and $\alpha_H=50\%$. We normalize the initial value of the cash flow to $X_0=1$. Preferences involve a risk aversion of $\gamma=10$, an elasticity of intertemporal substitution (EIS) of $\psi=2$, and a subjective time discount rate of $\beta=0.035$ per annum. Table 2 summarizes the model calibration.

B. Inflation Risk Premium

The core results of the paper are based on a calibration that intentionally abstracts from a correlation between real and nominal variables. Our aim is to provide an explanation of the negative relation between equity valuation and expected inflation without relying on an inflation risk premium, thereby complementing existing work (e.g., Eraker, Shaliastovich, and Wang (2015)).

In this appendix, we account for a time-varying, nonzero correlation and investigate how the resulting inflation risk premium affects the results. Appendix A describes how we can do so by

[37] Technically, a free 6×6 intensity matrix has 25 parameters, one of which is constrained by the unconditional inflation risk premium target. In an unrestricted estimation, we find that 11 of these parameters are virtually zero. We thus rerun the estimation with 13 free parameters. Under the independence assumption, we interact (a) a nested real intensity matrix with two free parameters and (b) a nested nominal matrix with four free parameters after setting the insignificant ones to zero. Thus, under the independence assumption, we have six free parameters.

allowing for either a *shock correlation* or a *regime correlation*. Here, we discuss the results from both approaches.

B.1 Shock correlation

We first introduce a time-varying correlation between shocks to inflation and consumption growth. We obtain the state-dependent values of ρ_{CP,s_t} from the estimation of the Markov-regime switching model. We find that ρ_{CP,s_t} ranges between -0.61 in state RM and 0.63 in state EL, thereby generating substantial time variation in the correlation between consumption growth and inflation. Specifically, the correlation is -24.2% when expected inflation is high (H), -3.7% when expected inflation is moderate (M), and 51.6% when expected inflation is low (L).[38]

Figure B.1 shows that the relations between expected inflation and the main output of the model remain very close to the baseline calibration (with $\rho_{CP,s_t} \equiv 0$). This analysis shows that accounting for a correlation between shocks to inflation and consumption growth has no impact on our model predictions, because the resultant inflation risk premium is small in all states, even when the correlation ρ_{CP,s_t} becomes sizable.

To see that, panel B of Table 4 presents the predictions on the equity risk premium in the case of a non-zero *shock correlation*, ρ_{CP,s_t}. The equity risk premium becomes weakly decreasing in expected inflation. To understand how the inflation risk premium varies with expected inflation, recall that the correlation is positive in state L (51.6%) and negative in state H (-24.2%), consistent with the evidence that the sign switched from negative before 2000 to positive since the early 2000s (Boons et al., 2020). While an inflation shock in state H is typically viewed as bad news (inflation correlates negatively with consumption), the negative correlation also reduces the systematic risk exposure of shareholders. Effectively, nominal cash flows become less correlated with consumption in state H than in state L, thereby reducing the levered equity risk premium. Observe that this effect is small, however, because the term $\varphi\gamma\sigma_{P,t}\sigma_{C,i}\rho_{PC,i}$ in (39) is quantitatively negligible, given that the product of inflation volatility ($\sigma_{P,t}$) and consumption growth volatility ($\sigma_{C,i}$) is economically small. As a result, the inflation risk premium and thus the equity risk premium decrease, but modestly, with expected inflation.

In summary, accounting for a *shock correlation* in the model does not materially affect the relationships between price-dividend ratios, credit spreads and expected inflation. The reason is that the covariance between shocks to consumption growth and inflation is economically modest, although strongly time-varying.

B.2 Regime correlation

We then allow for a *regime* correlation. The conditional moments of aggregate consumption growth inflation now evolve jointly; that is, the real dynamics and inflation dynamics are not independent. Changes in expected inflation can then be correlated with shocks to the real SDF. The log likelihood function in our estimation does not change appreciably as the dependence between real and nominal regimes varies, so we can explore different calibrations. In each scenario, we compute the inflation risk premium as the difference between the equity risk premium of the full model and the equity risk premium of the nested model with independent regimes.

Figure B.2 shows how the inflation risk premium affects the relationship between the model-implied valuations and expected inflation. Our results regarding the negative impact of expected inflation on both equity valuation and credit risk continue to hold with regime correlation, as long as the *unconditional* inflation risk premium is small – around 0.25% per annum.

We can see, however, that for an unconditional inflation risk premium of 0.5% or above, the relationship between equity values and expected inflation is no longer convex and loses its

38 In line with Bilal (2017), Boons et al. (2020), or Campbell, Pflueger, and Viceira (2020), we find that the correlation between consumption growth and inflation has turned from negative in the 1970-80s (mostly characterized by the H regime) to positive in recent years, which have been characterized by a period of low expected inflation (L regime).

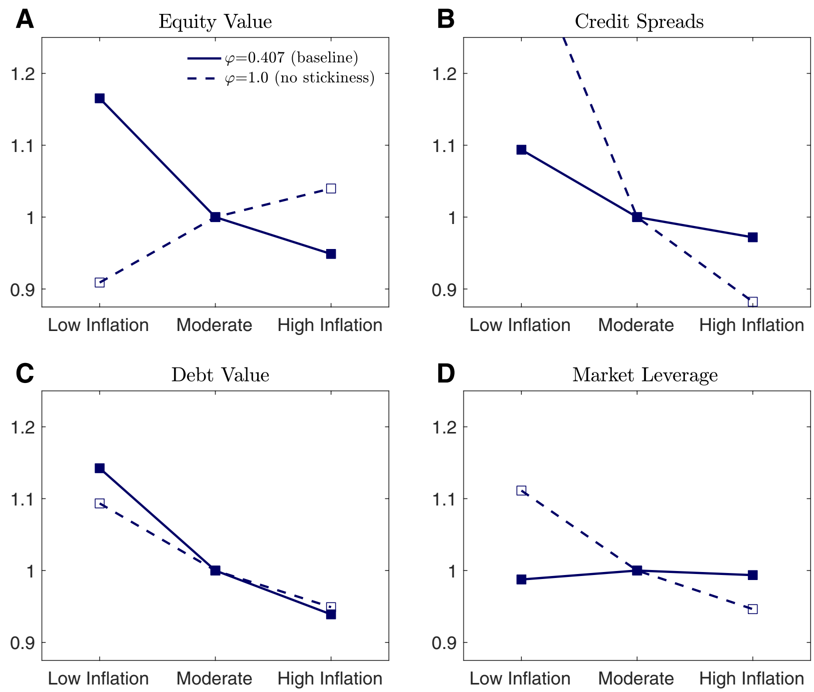

Figure B.1
Expected inflation and asset prices – Correlated consumption and inflation shocks
The figure illustrates the impact of expected inflation on asset valuation in the case of conditional correlations between consumption and inflation shocks (shock correlation). Predictions are reported for equity value (panel A), credit spread (panel B), debt value (panel C), and market leverage (panel D). Each panel reports the predictions for different nominal conditions: low, moderate, and high expected inflation. Predictions for the baseline model with sticky cash flows ($\varphi = 0.407$) are compared to the predictions of a model without sticky cash flows ($\varphi = 1$). All values are normalized to unity in the moderate expected inflation state. Panel B truncates extreme values for improved visibility. Firms have endogenous corporate policies. The parameter values of the model are reported in Table 2 and discussed in Section 4.1.

monotonicity. The relationship between credit spreads and expected inflation retains its convexity, but loses its monotonicity. Based on our model, the negative relation between expected inflation and both equity valuation and credit risk implies that (a) there is an upper bound on the *unconditional* inflation risk premium of around 0.25% per annum, and (b) any significant inflation risk premium beyond this must be time varying, lending further support to the findings in Boons et al. (2020) and Campbell, Pflueger, and Viceira (2020), among others. Their evidence suggests that, over the last 50 years, the inflation risk premium has switched sign and is unconditionally close to zero.

Panel C of Table 4 considers different levels of the unconditional inflation risk premium, arising from different correlation structures between real and nominal states. The equity risk premium is now clearly higher in state L than in state H. The model can generate substantial *conditional* inflation risk premiums via correlated regimes; this is a direct consequence of the impact of a regime switch being persistent and, thus, having a much greater impact on the pricing kernel that transitory shocks.

Overall, we find that the equity risk premium tends to decrease with expected inflation in these two cases: (1) with correlated inflation-consumption shocks and (2) with correlated real

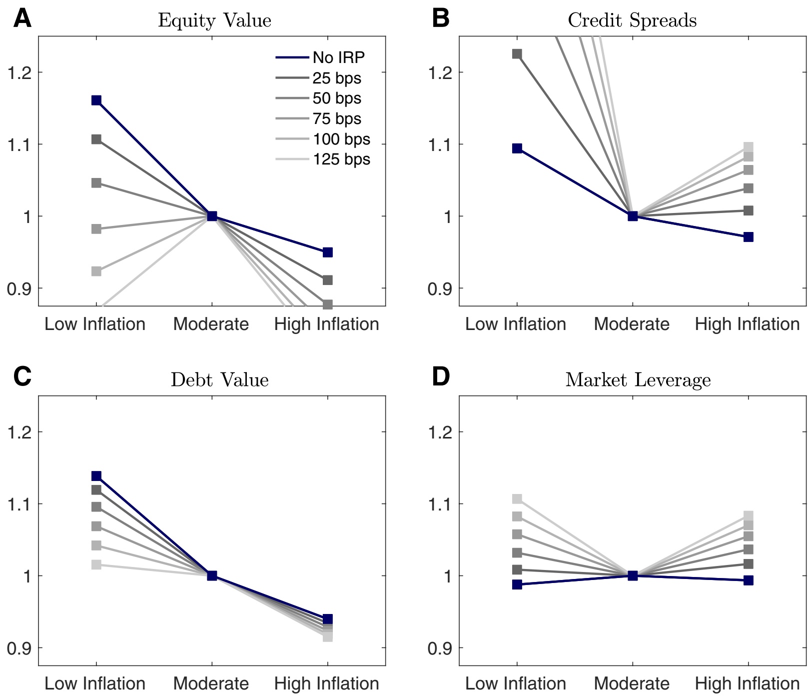

Figure B.2
Expected inflation and asset prices – Correlated real and nominal regimes
The figure illustrates the impact of expected inflation on asset valuation when real and nominal regimes are correlated (regime correlation). The results compare calibrations for different regime correlations generating different levels of inflation risk premium (IRP). The solid line captures the baseline case of independent real and nominal regimes (also reported in Figure 3), while the gray lines reflect unconditional levels of inflation risk premium ranging between 25 and 125 bps. Predictions are reported for equity value (panel A), credit spread (panel B), debt value (panel C), and market leverage (panel D). Each panel reports the predictions for different nominal conditions: low, moderate, and high expected inflation. All values are normalized to unity in the moderate expected inflation state. Panel B truncates extreme values for improved visibility. All firms have endogenous corporate policies. The parameter values of the model are reported in Table 2 and discussed in Section 4.1.

and nominal states. Hence, introducing an inflation risk premium cannot rationalize the negative relation between equity valuation and expected inflation observed in the data.

C. Term Structure Analysis: Monte Carlo Simulation

This appendix describes the Monte Carlo simulation we use to construct the term structures of equity yields, credit spreads, and nominal bond yields. Our model allows for closed-form solution for most perpetual claims (e.g., debt, equity), but several finite-maturity claims cannot be obtained in closed form, and so, we use the following simulation procedure.

For each of our 6 regimes, we simulate 20,000 paths, over 200 quarters, of the Markov chain and Brownian motions for the consumption C_t and price index P_t that characterize the evolution of the economy, starting in a given regime. For each of these paths, we consider a firm starting with

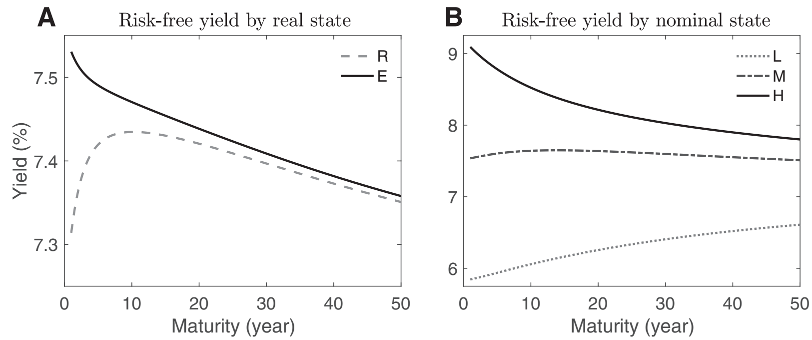

Figure C.1
Term structure of risk-free nominal yield
The figure illustrates the term structure of the risk-free nominal yield. The left panel reports predictions by real conditions, while the right panel reports predictions by nominal conditions. The parameter values of the model are reported in Table 2 and discussed in Section 4.1.

the optimal corporate policies presented in Table 3, but experiencing 10,000 different streams of idiosyncratic cash flow shocks.[39]

The firm defaults when its cash flow X_t crosses the default boundary $X_{D,j}$ corresponding to the ongoing regime j in a given time period; a defaulted firm ceases to generate any cash flow.

In total, the simulation involves 240 billion ($6\times200\times20,000\times10,000$) different realizations of cash flows and, thus, asset prices, which we use to generate the term structure of nominal equity yields and the term structure of nominal corporate credit spreads. We discuss our results in Section 4.8.

We also explore the term structure of nominal risk-free bond yields in Figure C.1. The nominal bond yield increases with expected inflation. The difference between states is especially strong in the short end of the term structure and decreases with the bond maturity. The resultant upward-sloping term structure in state L and downward-sloping term structure in state H reflects the transitory nature of expected inflation implied by our calibration.

D. Data Description

This appendix describes the data used in our empirical analysis, presented in Section 5.

D.1 Valuation ratios

Market-to-book ratio (MB) is computed as ME/BE. Book equity (BE) is shareholders' equity ($SEQQ+CEQQ+PSTKQ$ or ATQ - LTQ), plus balance sheet deferred taxes and investment tax credit ($TXDITCQ$) if available, minus the book value of preferred stock ($PSTKQ$) as in Weber (2018). Market capitalization (ME) is the product of quarter-end price (PRC) and share outstanding ($Shrout$).

The price-dividend ratio is computed as the share price divided by the sum of dividend payments over the last 12 months. We construct dividend payments using cum-dividend return and ex-dividend returns, as in Beeler and Campbell (2012).

39 The expectations we compute depend both on trajectories of the pricing kernel and on the cash flow stream associated with realizations of the pricing kernel. It is thus important to simulate a large number of both paths. The chosen methodology allows for straightforward parallelization of the simulation procedure.

D.2 Default risk

We follow Campbell, Hilscher, and Szilagyi (2008) to calculate financial distress risk (FR) as the logit transformed bankruptcy probability, while excluding leverage in the measurement. FR is then calculated as

$$FR = -9.16 - 20.26 * NIMTAVG - 7.13 * EXRETAVG + 1.41 * SIGMA$$

$$-0.045 * RSIZE - 2.13 * CASHMTA + 0.075 * MB - 0.058 * PRICE,$$

where

$$NIMTAVG_t = \sum_{i=0}^{3} \frac{1-\phi^3}{1-\phi^{12}} (\phi^{3(i-1)} NITMA_{t-3i})$$

$$EXRETAVG_t = \sum_{i=0}^{11} \frac{1-\phi}{1-\phi^{12}} (\phi^{i-1} EXRET_{t-i})$$

$NIMTA$ and $EXRET$ are net income over total assets (NIQ/ATQ) and the log of gross excess returns over the value-weighted S&P500 returns, respectively. $SIGMA$ is the square root of the annualized sum of squared stock returns over a 3-month period. $RSIZE$ is the log of firm's market equity over the total valuation of all firms in the S&P500. $CASHMTA$ is cash and short-term investments over total assets ($CHEQ/ATQ$). MB is the market-to-book value of equity. $PRICE$ is the log of price per share. The associated 1-quarter bankruptcy probability for firm i at time t is then

$$P_{t-1}(Y_{i,t} = 1) = \frac{1}{1 + exp(-FR_{i,t-1})}.$$

D.3 Leverage, investment and profitability

Market leverage is the sum of long term debt and debt in current liabilities over the sum of of debt and market capitalization ($(DLCQ + DLTTQ)/(DLCQ + DLTTQ + ME)$) as in Freyberger, Neuhierl, and Weber (2020).

Investment and profitability are calculated following Fama and French (2015) as revenues minus cost of goods sold, minus selling, general, and administrative expenses, minus interest expense all divided by book equity ($IBQ - COGSQ - XSGAQ - XINTQ)/BE$ and the percentage change in total asset.

D.4 Credit spreads

For our term structure analysis of credit spreads, we exploit a comprehensive data set combining corporate bond data from four distinct sources: (1) the Lehman Brothers Fixed Income Database, which covers the period 1973-1998; (2) the cleaned Enhanced TRACE data provided by WRDS, spanning the period 2002-2019; (3) the Mergent FISD/NAIC data, which comprises transaction level data for all trades in publicly traded bonds issued by life, property, and casualty insurance companies and health maintenance companies (HMOs) over the period 1994-2016; and, (4) the Datastream database covering the period 1990-2019. We follow Chordia et al. (2017) to deal with overlapping observations and prioritize the different sources using the order above. We filter bonds using the following rules:

- Bond Type: We only include corporate bonds which are classified as US Corporate Debentures ('CDEB'), US Corporate MTN ('CMTN') or US Corporate MTN Zero ('CMTZ').
- Public Firm: We exclude bonds that are not listed, or traded in the US public market, this includes bonds issued via private placement, bonds issued under the 144A rule and bond issuers not in the jurisdiction of the United States.

- Bond Coupon: We exclude bonds with a variable coupon ("V"), that is, we only include bonds with a fixed ("F") or zero coupon ("Z").
- Convertible: We exclude all convertible bonds.
- Asset-Backed: We exclude all asset-backed bonds.
- Yankee bonds: We exclude all Yankee bonds (a debt obligation issued by a foreign entity, such as a government or company, which is traded in the United States and denominated in U.S. dollars).
- Foreign currency: We only include U.S.-denominated bonds
- Embedded options: We exclude putable bonds but include callable bonds.
- Security level: We exclude all junior bonds, this includes "Junior", "Junior Subordinate" and "Subordinate" bonds.
- Rating: We exclude bonds which are "Unrated".

We then apply these additional filters: (a) we remove observations if a corporate bonds monthly price is less than $1 or above $1000 and if the bonds time to maturity is less than 12 months, as in Bai, Bali, and Wen (2019), and (b) to address the issue of stale prices, we follow Chordia et al. (2017) and exclude prices that do not change for more than 3 months. The final sample comprises 20,068 corporate bonds issued by 2,123 firms. We focus on the period 1974Q3–2019Q4 to match the equity yield sample.

We compute the average credit spread of each firm's outstanding bonds over a given quarter. We then construct a quarterly value-weighted average credit spread by maturity bucket. The credit spread of an individual bond is computed as the difference between the yield of the bond and the associated yield of the Treasury curve at the same maturity. We use the Benchmark Treasury rates from Datastream for maturities of 3, 5, 7, 10, and 30 years, and then use a linear interpolation scheme to estimate the entire yield curve, following Duffee (1998) and Collin-Dufresne, Goldstein, and Martin (2001) among others.

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