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Government debt and risk premia☆

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ABSTRACT

Risk premia increase with government debt. Debt-to-GDP ratios positively predict stock returns at short and long horizons in the U.S. and other advanced economies. Higher debt is also associated with higher bond premia and lower risk-free rates. Major government debt theories (liquidity, safety, crowding out) either do not address or are inconsistent with these findings. New evidence suggests that the increased risk premia provide compensation for larger fiscal risk; during periods of elevated debt, fiscal policy becomes more uncertain and less effective and can lead to debt crises. I quantify these mechanisms in an equilibrium model.

1. Introduction

The U.S. economy has experienced a drastic increase in government debt during the COVID-19 pandemic, with the debt-to-GDP ratio reaching a historical high of approximately 100% in 2020. Policymakers and investors have been concerned about unsustainable debt levels and massive uncertainty over the future path of fiscal policy. This paper reveals a new consequence of government debt: risk premia increase with debt. Higher debt-to-GDP ratios are associated with larger equity premia, larger bond risk premia, and lower risk-free rates. Risk considerations add an important aspect to the debate on deficit reduction and debt sustainability. During periods of high debt, the large risk premium is a significant cost to the economy that can impact corporate financing and reduce capital formation and economic growth.

Evaluations of fiscal policy often ignore asset market data. However, forward-looking asset prices are informative about the intertemporal marginal rate of substitution, which is crucial for any intertemporal policy. Given the new asset pricing facts, we can infer the dynamics of fiscal policy based on a structural model in which agents rationally price fiscal policy

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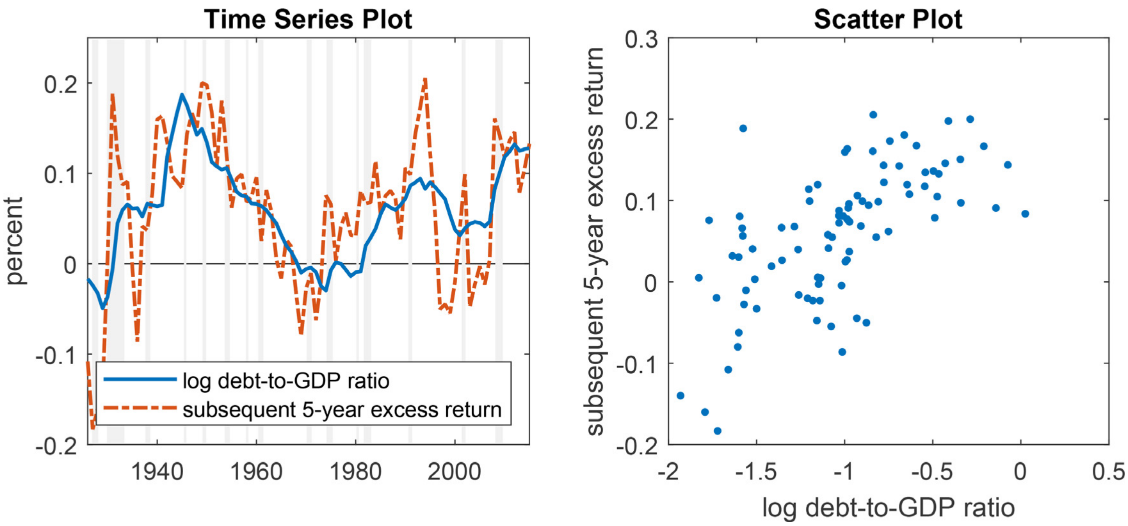

Fig. 1. Debt-to-GDP ratio and subsequent returns. *Notes:* The left figure shows 5-year subsequent stock market excess returns and the projection of returns on the log debt-to-GDP ratios. The right figure is a scatter plot of the log debt-to-GDP ratios and the returns.

risk. During periods of high debt, larger risk premia imply that fiscal policy is more uncertain, becomes counterproductive, and can lead to debt crises. Therefore, a high debt level makes fiscal policy riskier and less desirable.

In the data, debt-to-GDP ratios robustly predict excess returns on stocks at horizons from one quarter to five years. The predictability evidence is statistically and economically significant; the implied equity premium is 2.3% in periods of low debt and reaches 13.3% in periods of high debt. Debt-to-GDP ratios produce predictive regression R^2 of 11% at an annual horizon and 40% at a five-year horizon. The strong predictive power barely decreases in out-of-sample tests. Government debt contains valuable information beyond the existing macro-financial factors that reflect the business cycle, macro-financial risk, and risk aversion. Fig. 1 shows that higher debt-to-GDP ratios imply higher subsequent stock returns. This relationship is observed in a century of U.S. data and 50 years of data for 20 advanced economies.

I show a similar pattern in which debt-to-GDP ratios positively predict excess returns on government bonds and corporate bonds. Furthermore, debt-to-GDP ratios are negatively associated with 3-month real risk-free rates. This finding is consistent with the risk premia result, as risk-free rates decrease with risk through precautionary saving.

Why does government debt have such significant effects on risk premia? In the neoclassical framework, Ricardian Equivalence states that government debt has no effect on the economy (Barro, 1974). Major existing theories of government debt, such as liquidity, safety, and crowding out, currently do not address or are inconsistent with these facts. New evidence in this paper suggests that the increased risk premia provide compensation for higher fiscal risk. Because fiscal policy is influential both on the economy and the capital markets and yet unpredictable, it becomes a source of concern for investors. There are several potential mechanisms for how fiscal risk could depend on the debt level and propagate through the real economy, government sector, and capital markets.

First, fiscal uncertainty, a measure of how precisely agents can predict future fiscal policy, captures the quantity of fiscal risk. Fiscal uncertainty and the debt-to-GDP ratio have a positive correlation of 0.5. The fiscal channel is novel and distinct from general macro uncertainty or other non-fiscal policy uncertainty, which are barely correlated with the debt ratio. Therefore, government debt levels encode the quantity of risk in fiscal policy that drives the variation in fiscal risk premia. The compensation for fiscal risk increases in times of heightened uncertainty. I present direct evidence that fiscal uncertainty measures are positively associated with equity premia as the debt-to-GDP ratio.

Second, the effect of government spending, often referred to as the fiscal multiplier, depends on indebtedness. The GDP multipliers and consumption multipliers are positive in low-debt periods and negative in high-debt periods. Government spending turns from growth-enhancing to growth-impeding with the rise of the debt level, which contributes to the increased risk premia.

Third, the forgotten history of government defaults implies a nonzero probability of debt crises even among the most advanced economies, including the United States. A debt crisis may not necessarily manifest as government bond defaults. Other forms of fiscal stress, such as debt restructuring, inflation, sudden spending cuts, and tax hikes, can still damage the economy and the capital markets.

The debt-dependent fiscal mechanisms all have empirical support and theoretically generate larger risk premia in high-debt times. To assess their quantitative importance, I introduce rich and realistic fiscal policy into a standard equilibrium asset pricing model. In addition to the non-policy risk, the equity premium stems from government spending shocks and debt crises. These components of the equity premium are dependent on the debt level and can explain the high risk premia in the high-debt state. Calibrated to the data, the model quantitatively matches key macroeconomic dynamics and asset prices. Based on the model, I quantify the contribution of each mechanism. All three mechanisms have sizable quantitative effects on the risk premium differential. The model also demonstrates the interactive effect of volatile and ineffective policy, which further increases the risk premium.

This paper contributes to the study of fiscal policy in asset markets. Risk of fiscal policy is shown as an important determinant of stock returns (Belo and Yu, 2013; Croce et al., 2012a; 2012b; Sialm, 2009), the term structure (Bretscher et al., 2020), and currency returns (Jiang, 2022). There is also evidence that fiscal risk is priced in the cross-section of stocks (Belo et al., 2013; Da et al., 2018). The literature focuses on the fiscal policy implications for the level of risk premia and establishes policy risk as a priced factor. Building on this insight, I investigate how state-dependent policy drives time-varying risk premia. The mechanisms follow the work that risk premia are driven by time-varying volatility (Bansal and Yaron, 2004; Dou, 2017; Segal et al., 2015, among others) and rare events (Barro, 2006; Chernov et al., 2020). More broadly, the current paper is related to the literature on economic policy uncertainty (Baker et al., 2016; Fernández-Villaverde et al., 2015; Pastor and Veronesi, 2013).

To the best of my knowledge, this paper is the first to document the relationship between government debt and risk premia. There is a long-enduring debate on the effects of government debt on interest rates empirically (Engen and Hubbard, 2005). I provide a new perspective by distinguishing between real risk-free rates and risk premia. Croce et al. (2019b) document that government debt increases the expected returns of innovative firms. They study the cross-section of stock returns in the U.S., while I focus on the time series of risk premia across asset classes and countries.[1] Croce et al. (2021) find that the sluggish debt policy worsens the consumption risk. Krishnamurthy and Vissing-Jorgensen (2012) show a convenience yield effect; i.e., high government debt implies lower spreads between assets with different liquidity and safety attributes. Through this channel, government debt is related to currency excess returns (Valchev, 2020). Jiang et al. (2019) point out a debt valuation puzzle and emphasize the convenience yield channel. The debt level and maturity also have rich implications for the term structure (Corhay et al., 2018; Greenwood and Vayanos, 2014; Nguyen, 2021).

Theoretically, government debt has no effect on the economy in a frictionless neoclassical model (Barro, 1974). In the presence of liquidity and safety needs, government debt plays a special role and has significant effects on macroeconomic quantities and asset prices (Bansal and Coleman, 1996; Krishnamurthy and Vissing-Jorgensen, 2012). Government debt has crowding-out effects in heterogeneous agent incomplete market models (Gomes and Michaelides, 2008; Gomes, Michaelides and Polkovnichenko, 2013). These theories are either silent in regard to the new empirical findings or have counterfactual implications. Instead, I propose mechanisms focusing on fiscal policy to understand the new facts.

I contribute to the voluminous literature on stock return predictability by proposing the debt-to-GDP ratio as a return predictor. Welch and Goyal (2008) list many well-known predictors and criticize the out-of-sample performance. The debt-to-GDP ratio has compelling out-of-sample predictive power and outperforms classic predictors such as valuation ratios and the short rate (Ang and Bekaert, 2007). Economically, the debt-to-GDP ratio contains additional information beyond related macro-based predictors such as the investment rate (Cochrane, 1991; Li et al., 2021), the consumption-wealth ratio (Lettau and Ludvigson, 2001), and the government investment rate (Belo and Yu, 2013).

The remainder of the paper is organized as follows. Section 2 documents the empirical findings on government debt and asset prices. Section 3 discusses the fiscal risk mechanisms and evidence. Section 4 quantifies the mechanisms in an equilibrium model. Section 5 concludes the paper.

2. Government debt and asset prices

In this section, I document several new facts relating government debt to asset prices. First, debt-to-GDP ratios positively predict equity risk premia both in sample and out of sample. This result is robust to a broad set of controls, different definitions of government debt, international data, and persistent predictor issues. Second, I show the connection between government debt and bond risk premia. Third, I document that high government debt is associated with low risk-free rates. The data sources are detailed in the appendix.

2.1. Government debt

Government debt is measured as the market value of the U.S. federal government debt held by the public. Market value is constructed by summing the value of all the credit market instruments across maturities (Treasury bonds, Treasury notes, Treasury bills, TIPS, etc.). This measure excludes holdings in government accounts and the Federal Reserve and corresponds to theoretical depictions (Hall and Sargent, 2011). Historical data are from Hall and Sargent (2011), and recent data are updated monthly by the Federal Reserve Bank of Dallas. Figure 1 demonstrates the time series plot of the log debt-to-GDP ratio. The debt-to-GDP ratio rises from the 1930s to the 1950s, declines steadily after WWII, increases from the 1970s to the 1990s, decreases in the late 1990s, and surges again during and after the Great Recession. A large part of the variation in this ratio is driven mainly by military spending (WWII, the Cold War) and fiscal policy reforms (entitlement programs, tax cuts). The ratio rises rapidly during the Great Depression and the Great Recession, as low GDP and countercyclical deficits increase the ratio in economic downturns. However, business cycles only account for a small proportion of its variation.

[1] After the circulation of this paper, Croce et al. (2019b) also investigate the debt-risk-premia relation in their endogenous growth model.

Table 1
Government debt and equity premium.

	1Y			3Y			5Y		
by	0.14	0.15	0.17	0.40	0.42	0.44	0.59	0.61	0.61
	(0.05)	(0.05)	(0.05)	(0.10)	(0.13)	(0.14)	(0.12)	(0.14)	(0.14)
pd		−0.07	−0.07		−0.20	−0.20		−0.31	−0.31
		(0.04)	(0.04)		(0.04)	(0.04)		(0.06)	(0.05)
rf			0.18			0.23			0.17
			(0.66)			(1.10)			(0.95)
Δy			0.17			−0.32			−0.98
			(0.59)			(0.95)			(0.91)
vol			−0.30			−0.89			2.73
			(2.17)			(3.56)			(4.55)
R^2	0.11	0.14	0.16	0.28	0.37	0.38	0.40	0.52	0.55
out-of-sample									
R^2_{os}	0.10	0.12	0.06	0.32	0.01	−0.25	0.36	0.00	−0.20
p-val	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: The table reports estimates from OLS regressions of future excess stock returns on the log debt-to-GDP ratio (by) and other control variables. The regressors are as follows: log price-dividend ratio (pd); risk-free rate (rf); annual GDP growth (Δy); log stock volatility (vol). Newey-West standard errors with optimal lag selection are in the parentheses. The last two columns report the out-of-sample R^2. The out-of-sample test is recursive, starting in 20 periods from the beginning of the sample. The column "p-val" shows the p-values of testing the null hypothesis that the mean square error of a model nested with by is larger than that of a model without by. The sample period is from 1926 to 2020.

The debt-to-GDP ratio is acyclical and averages 42% in normal times and 37% in recessions. In the recent example, the ratio continued to rise rapidly after the end of the Great Recession. Furthermore, the debt-to-GDP ratio has a mild correlation of 0.15 with the price-dividend ratio. Therefore, linking the debt-to-GDP ratio to asset prices sheds new light on risk premia from the government debt cycle instead of the widely studied business cycle.

2.2. Equity premia

After studying the time-series properties of the debt-to-GDP ratio, I assess its relation to variations in expected returns on stocks. Table 1 reports the results for 1929–2020 from regressions of future excess stock returns on the log debt-to-GDP ratios. Higher debt-to-GDP ratios forecast higher stock returns. The coefficients are statistically significant at 99% across one-year, three-year, and five-year horizons. The Newey-West HAC standard errors are computed using the Bartlett kernel with parametric optimal lag selection. This model predicts 11% of the return variation in the next year. The forecasting power increases with the horizon, as the R^2 rises to 40% at the five-year horizon. Fig. 1 shows that the subsequent returns comove closely with debt-to-GDP ratios. The scatter plot demonstrates the large explanatory power.

Beyond statistical significance, the economic impact of the debt-to-GDP ratio on the expected excess return is substantial. A one-percentage-point increase in the debt-to-GDP ratio indicates a 34 basis-point increase in expected excess return per annum.[2] Taking the Great Recession as an example, we observe a rapid increase in the debt-to-GDP ratio from 30% to 60%. This swing implies that the expected return is 10% higher than that at the precrisis level. If we split the sample by the debt ratio, the equity premium is 2.3% in low-debt times and 13.3% in high-debt times. In standard rational pricing models, excess return predictability is equivalent to the time-varying equity premium. Thus, a high debt level indicates that investors require a high premium to compensate for equity risk. The classic equity premium puzzle emphasizes the difficulty of rationalizing the 6% average equity premium, given the low risk in the consumption profile. It is now more puzzling that the equity premium varies over time from 2% to 13% with the government debt.

The forecasting power of the debt-to-GDP ratio is not subsumed by other documented return predictors. The price-dividend ratio is arguably the most popular predictor that is both theoretically grounded and empirically successful. Controlling for the price-dividend ratio, both the coefficients and significance of the debt-to-GDP ratio are unchanged. I include the real risk-free rate, the GDP growth rate, and the stock volatility as the additional predictors. These predictors span information about the business cycle, time-varying risk aversion, and financial market risk. Conditioning on a large information set, the debt-to-GDP ratio still contributes to the prediction model at a 99% significance level. The other predictors do not mitigate the explanatory power of the debt ratio, which suggests that the debt ratio contains unique information. The marginal improvement in R^2 of adding by to the regressions with pd or the four predictors is 12%. The equity premium increases by 7.0% with 1 s.d. increase in by and decreases by 3.3% with 1 s.d. increase in pd. Therefore, the sensitivity to debt is relatively strong. Furthermore, there is an evident link between debt, political parties, and wars. Stock returns are higher under Democratic presidents (Pastor and Veronesi, 2020). As reported in the appendix, the predictability is unchanged when controlling for dummies on political parties and wars.

[2] The debt-to-GDP ratio enters the regressions in log units. Given that debt-to-GDP ratio has a mean of 0.41, a 1% increase is equivalent to a 0.41 percentage point increase in the debt-to-GDP ratio.

2.2.1. Out-of-sample test

The literature has documented considerable in-sample predictability, but the out-of-sample performance is usually dissatisfactory (Welch and Goyal, 2008). Notably, the debt-to-GDP ratio has strong out-of-sample predictive power. I use out-of-sample $R^2_{os} = 1 - MSE_1/MSE_0$ to evaluate predictive accuracy. The benchmark model assumes a constant expected return estimated from the historical data. MSE_0 and MSE_1 are the mean square errors obtained using the historical mean and the predictive model, respectively. A positive R^2_{os} suggests that the predictive model generates a smaller mean square error and thus is superior to the benchmark.

The last two lines in Table 1 present the results. The R^2_{os} of the univariate regression using the debt-to-GDP ratio is 0.10 at the annual horizon and 0.36 at the five-year horizon. The R^2_{os} are similar to the in-sample R^2. The p-values of the tests for equal predictive accuracy (Clark and West, 2007) show that the debt-to-GDP ratio delivers smaller errors than the historical mean. This superior out-of-sample performance implies that the predictive relationship is stable and robust over time. In multivariate models, the R^2_{os} declines from the R^2 by a large margin because of the poor performance from other predictors. We test equal predictability of models with and without the debt ratio. For example, at the annual horizon, the R^2_{os} for *pd* is -0.01 while the bivariate R^2_{os} is 0.12. The p-values mean that the debt-to-GDP ratio significantly improves the performance of alternative forecasting variables. In the appendix, I compare the debt-to-GDP ratio with a battery of predictors in the literature and find that it performs among the best.[3]

2.2.2. Quarterly sample

I further extend the analysis to the U.S. postwar quarterly data. Table 2 summarizes the results for 1947Q1-2020Q4. The predictive power is present even at the quarterly frequency.[4] The regression coefficients are highly significant and close to the coefficients in the long sample, and the R^2 remains similar. The multivariate regressions include the consumption-wealth ratio "cay" (Lettau and Ludvigson, 2001) and the expected GDP growth from the Survey of Professional Forecasters (Campbell and Diebold, 2009) in addition. The evidence suggests that the debt-to-GDP ratio provides information about future returns that is not captured by these predictors.

2.2.3. Par value, Federal Reserve, and foreign holdings

In the benchmark, government debt is defined as the market value of net debt held by the public. This measure is the most natural and is tightly linked to the theoretical concept (Hall and Sargent, 2011). I examine other definitions of debt. First, the par value of debt excludes the potential contaminating force from the time-varying market price of debt. Second, the benchmark measure does not include the debt held by the Federal Reserve, which has expanded to 22 percent of GDP in 2020 after the quantitative easing. Thus, I consider the sum of public and the Fed holdings. Third, the foreign holdings have sharply increased in the last two decades (Favilukis et al., 2014) and accounted for 41% of the public holdings in 2020. Table 2 Panel B shows the results for the various measures of debt. Par value and the Fed holdings make little difference. The magnitude is slightly weakened after the exclusion of the foreign holdings.

2.2.4. Private credit

A growing body of literature shows that one important driver of expected returns is private credit growth, especially the balance sheet of the financial intermediaries (Baron and Xiong, 2017). Government debt and risk premia may be connected through the important role of Treasuries in intermediary financial conditions and balance sheet constraints. I include two measures of private credit: the annual asset growth of commercial banks (Baron and Muir, 2021) and the log change of the broker-dealer leverage (Haddad and Muir, 2021). As presented in Table 2 Panel C, the public debt effect is robust to the controls, suggesting that the risks of public debt are distinct from those of private debt.

2.2.5. Safe asset

Government debt plays a special role in liquidity and safety provision (Bansal and Coleman, 1996; Krishnamurthy and Vissing-Jorgensen, 2012). As a major form of safe asset, government debt supply lubricates the economy and lowers the liquidity premium and thus the expected excess return on equity.[5] I show that the effect of government debt is not concealed by measures of liquidity premium: the spread between Moody's Aaa bond and the 10-year Treasury yield (Krishnamurthy and Vissing-Jorgensen, 2012) and the spread between 3-month bankers' acceptance/general collateral repo rate and the Treasury rate (Nagel, 2016). Therefore, the debt-dependent equity premium cannot be explained only by the safe asset channel. Liu et al. (2020) evaluate the dual role of government debt on safety provision and fiscal risk in a general equilibrium model.

[3] The predictors include the price-dividend ratio, the risk-free rate, the GDP growth, stock volatility, dividend yield, the price-earnings ratio, the dividend-earnings ratio, the book-to-market ratio, net equity expansions, Treasury bill rate, long-term bond yield, long-term bond return, term spread, default yield spread, inflation, the investment-capital ratio, the consumption-wealth ratio "cay" (Lettau and Ludvigson, 2001), the GDP growth forecast (Campbell and Diebold, 2009), the labor income share (Santos and Veronesi, 2005), the aggregate expected investment growth (Li et al., 2021), and the government investment rate (Belo and Yu, 2013).

[4] The predictability results also hold at the one-month horizon.

[5] Bansal and Coleman (1996) and Krishnamurthy and Vissing-Jorgensen (2012) argue that part of the equity premium is liquidity premium. This liquidity premium channel can partially solve the equity premium puzzle.

Table 2
Government debt and equity premium: Extensions.

	1Q			1Y			3Y		
A. Post-war quarterly sample									
by	0.04	0.05	0.06	0.13	0.17	0.17	0.37	0.46	0.45
	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.04)	(0.06)	(0.06)	(0.07)
pd		−0.04	−0.04		−0.14	−0.14		−0.34	−0.35
		(0.01)	(0.01)		(0.04)	(0.05)		(0.05)	(0.06)
cay		0.20	0.23		1.01	1.26		1.86	2.68
		(0.25)	(0.27)		(0.68)	(0.82)		(1.33)	(1.75)
rf			0.13			−0.01			−1.36
			(0.34)			(0.84)			(1.32)
Δy			−0.33			−1.21			−0.87
			(0.22)			(0.55)			(0.64)
$E(\Delta y)$			0.58			0.26			0.47
			(0.35)			(1.43)			(1.83)
vol			1.04			1.19			2.05
			(0.71)			(1.09)			(2.68)
R^2	0.04	0.07	0.09	0.11	0.22	0.26	0.32	0.53	0.56
	1Y			**3Y**			**5Y**		
B. Debt measures									
par value	0.15			0.42			0.62		
	(0.05)			(0.10)			(0.12)		
net + Fed		0.15			0.42			0.61	
		(0.06)			(0.10)			(0.11)	
domestic			0.13			0.34			0.48
			(0.05)			(0.10)			(0.11)
R^2	0.11	0.11	0.10	0.29	0.29	0.24	0.41	0.40	0.32
C. Private credit									
by	0.15	0.13	0.13	0.39	0.33	0.27	0.58	0.50	0.40
	(0.05)	(0.05)	(0.06)	(0.11)	(0.08)	(0.08)	(0.12)	(0.14)	(0.16)
Δ*bank asset*	0.11		0.01	−0.81		−0.97	−1.31		−1.45
	(0.37)		(0.54)	(0.49)		(1.04)	(0.61)		(1.21)
Δ*BD lev*		−0.02	−0.02		−0.04	−0.04		−0.18	−0.17
		(0.20)	(0.20)		(0.18)	(0.18)		(0.26)	(0.25)
R^2	0.11	0.11	0.11	0.30	0.24	0.25	0.44	0.31	0.33
D. Safe asset									
by	0.15	0.15	0.15	0.39	0.45	0.44	0.60	0.69	0.70
	(0.05)	(0.07)	(0.06)	(0.10)	(0.12)	(0.12)	(0.12)	(0.13)	(0.13)
Aaa/Treasury	1.12		1.07	−4.31		−4.65	4.01		3.50
	(4.40)		(4.50)	(6.77)		(6.99)	(8.74)		(9.12)
Repo/Treasury		1.01	0.97		7.26	7.39		14.84	14.77
		(4.05)	(4.07)		(5.52)	(5.51)		(5.61)	(5.72)
R^2	0.11	0.11	0.11	0.29	0.30	0.30	0.40	0.44	0.44

Notes: The table reports estimates from OLS regressions of future excess stock returns on the log debt-to-GDP ratio (*by*) and other control variables. The regressors are as follows: log price-dividend ratio (*pd*); consumption-wealth ratio (*cay*); risk-free rate (*rf*); annual GDP growth (Δy); GDP growth expectation ($E(\Delta y)$); log stock volatility (*vol*); commercial bank asset growth (Δ*bank asset*); log change of broker-dealer leverage (Δ*BD lev*); AAA-Treasury spread (*Aaa/Treasury*); Repo-Treasury spread (*Repo/Treasury*). In the alternative debt-to-GDP ratio measures, debt is the par value (*par value*), or the sum held by the public and the Fed (*net + Fed*) or by domestic investors (*domestic*). Newey-West standard errors with optimal lag selection are in the parentheses. The sample period is from 1947Q1 to 2020 Q4 in Panel A and from 1926 to 2020 in Panel B, C, and D.

2.2.6. Persistent regressors and overlapping observations

The debt-to-GDP ratio is slow-moving with an autocorrelation of 0.96. In theory, the debt-to-GDP ratio should be stationary. Otherwise, it would implausibly diverge to infinity with probability one. Empirically, the high persistence of the predictor leads to potential invalidity of the inference in small, overlapping samples (Campbell and Yogo, 2006; Stambaugh, 1999).

The out-of-sample tests alleviate these concerns to some extent. To further mitigate them, I first investigate the predictability by taking differences in the debt-to-GDP ratio.[6] In regressions with the change in debt ratio and the lag debt ratio, both variables significantly contribute to the positive predictive power.

Second, I evaluate the evidence by a more restricted VAR specification (Hodrick, 1992). The VAR(1) model contains the debt-to-GDP ratio and the excess return. There are no overlapping observations in the specification. I use Bayesian inference, which is not subject to small sample bias and nonstandard asymptotic distribution, as advocated by Stambaugh (1999). The

[6] In theory, the level of debt is the state variable, just as the price-dividend ratio is used for prediction instead of its difference. Given a high debt level, fast growth of debt may contain some additional information.

Table 3
International evidence.

Country	1Y			3Y			5Y		
	by	(s.e.)	R^2	*by*	(s.e.)	R^2	*by*	(s.e.)	R^2
Panel	0.09	(0.03)	0.06	0.21	(0.07)	0.11	0.27	(0.11)	0.15
Australia	0.01	(0.08)	0.18	−0.01	(0.17)	0.23	0.11	(0.19)	0.29
Austria	0.07	(0.06)	0.03	0.20	(0.12)	0.07	0.34	(0.18)	0.17
Belgium	0.19	(0.07)	0.09	0.46	(0.12)	0.21	0.54	(0.14)	0.23
Canada	0.20	(0.12)	0.07	0.38	(0.20)	0.09	0.55	(0.24)	0.13
Denmark	0.14	(0.06)	0.10	0.21	(0.11)	0.09	0.07	(0.15)	0.08
Finland	0.39	(0.10)	0.17	0.77	(0.34)	0.17	0.65	(0.29)	0.10
France	0.07	(0.06)	0.04	0.19	(0.11)	0.11	0.23	(0.14)	0.16
Germany	0.08	(0.06)	0.03	0.20	(0.08)	0.06	0.25	(0.12)	0.11
Ireland	0.29	(0.16)	0.22	0.79	(0.29)	0.43	1.06	(0.27)	0.56
Italy	0.07	(0.10)	0.03	0.19	(0.25)	0.02	0.31	(0.41)	0.04
Japan	−0.01	(0.05)	0.11	0.05	(0.07)	0.23	0.10	(0.10)	0.39
Netherlands	0.38	(0.16)	0.18	0.72	(0.29)	0.27	0.84	(0.34)	0.38
New Zealand	0.05	(0.12)	0.05	0.06	(0.16)	0.01	0.08	(0.15)	0.03
Norway	0.12	(0.17)	0.10	0.23	(0.27)	0.16	0.09	(0.32)	0.12
Portugal	−0.13	(0.17)	0.03	−0.24	(0.29)	0.06	−0.95	(0.50)	0.18
Spain	0.09	(0.05)	0.09	0.33	(0.12)	0.32	0.51	(0.13)	0.47
Sweden	0.52	(0.09)	0.32	0.86	(0.20)	0.33	0.68	(0.23)	0.22
Switzerland	0.22	(0.20)	0.04	0.24	(0.21)	0.03	0.00	(0.28)	0.04
UK	−0.02	(0.06)	0.16	−0.13	(0.21)	0.29	-0.16	(0.22)	0.46

Notes: The table reports estimates from OLS regressions of future excess stock returns on the log debt-to-GDP ratio (*by*) and the price-dividend ratio. Newey-West standard errors with optimal lag selection are in the parentheses. The "Panel" row shows the estimates from a balanced panel of 15 countries (except for Finland, Ireland, New Zealand, and Portugal). The standard errors are clustered by time and country. The sample period is from 1970 to 2018.

posterior means of the predictive coefficients are close to the OLS estimates, and the 99% Bayesian credible sets are all positive.

Third, I use the efficient test proposed by Campbell and Yogo (2006) that corrects the endogeneity bias and provides an accurate approximation to the finite-sample distribution of test statistics under flexible degrees of persistence. The test confirms the significant predictability after accounting for the persistence of the predictor. The detailed results are reported in the appendix.

2.2.7. International evidence

I assess the empirical pattern between debt and risk premia in other advanced economies. The sample consists of 19 major industrialized countries from 1970 to 2018. I use the debt-to-GDP ratio of each country to predict the excess return on the country's MSCI Index over the 3-month Treasury bill rate, controlling for the price-dividend ratio in each country. Table 3 presents the results. Consistent with the U.S. evidence, debt-to-GDP ratios positively predict stock returns. In a balanced panel regression, the point estimate is 0.09 at a one-year horizon and 0.27 at a five-year horizon, comparable to the U.S. estimates. The double-clustered t-stats indicate that the results are statistically significant across predictive horizons. In country-level regressions, the point estimates are positive in 17 out of 19 countries and significant in 10 countries at the five-year horizon.

In principle, the country-level estimates have more noise because of country heterogeneity in data measurement and debt management. Each country's measurement can differ in several dimensions: external debt, government holding, local debt, and market value. There are multiple approaches to government debt management, including fiscal consolidation, default, inflation, financial repression, and currency depreciation. While fiscal consolidation is the major practice in the U.S., there could be sizable default, inflation, and exchange rate risk in other countries. Despite the challenges in the multicountry study, the estimates point to a consistent picture.

In conclusion, both a century of U.S. experience and 50 years of international evidence show that risk premia increase with government debt.

2.3. Bond premia

Risk premia are manifested in different asset classes. This section assesses how government debt is associated with risk premia in the bond markets.

To this end, I decompose the stock excess return into two components: the stock return in excess of the bond return and the long-term government bond return in excess of the risk-free rate. The second term reflects the bond risk premium or term premium. Table 4 Panels A and B present the results of predictive regressions of the two excess returns on the debt-to-GDP ratios. The debt-to-GDP ratios positively predict both bond excess returns and stock returns in excess of bonds. The coefficients of bond excess returns are approximately one fifth of the stock coefficients in Table 1, with the remaining four fifths stemming from the stock returns in excess of bonds. A one-percentage-point increase in the debt-to-GDP ratio is

Table 4
Government debt and risk premium: Stock, bond, and risk-free rate.

	1Y			3Y			5Y		
A. stock return – bond return									
by	0.119	0.131	0.134	0.349	0.374	0.369	0.552	0.576	0.516
	(0.050)	(0.054)	(0.052)	(0.111)	(0.128)	(0.137)	(0.145)	(0.154)	(0.155)
pd		−0.096	−0.098		−0.255	−0.271		−0.398	−0.426
		(0.048)	(0.047)		(0.050)	(0.048)		(0.064)	(0.049)
rf			−0.044			−0.238			−1.085
			(0.634)			(1.142)			(1.281)
Δy			0.000			−0.466			−1.454
			(0.507)			(0.858)			(0.877)
vol			−2.034			−7.652			−7.777
			(2.350)			(3.774)			(4.683)
R^2	0.06	0.11	0.12	0.21	0.33	0.38	0.32	0.50	0.54
B. bond return – risk-free rate									
by	0.026	0.023	0.035	0.050	0.045	0.075	0.039	0.033	0.091
	(0.019)	(0.015)	(0.017)	(0.047)	(0.040)	(0.036)	(0.082)	(0.071)	(0.061)
pd		0.024	0.030		0.051	0.070		0.092	0.113
		(0.016)	(0.015)		(0.038)	(0.027)		(0.067)	(0.042)
rf			0.229			0.469			1.253
			(0.201)			(0.390)			(0.610)
Δy			0.166			0.144			0.471
			(0.123)			(0.227)			(0.310)
vol			1.738			6.767			10.504
			(0.799)			(1.419)			(2.164)
R^2	0.02	0.03	0.07	0.03	0.06	0.25	0.01	0.06	0.31
C. risk-free rate									
by	−0.020	−0.020	−0.021	−0.078	−0.078	−0.082	−0.092	−0.093	−0.097
	(0.011)	(0.011)	(0.011)	(0.044)	(0.045)	(0.049)	(0.052)	(0.055)	(0.061)
r_f	0.509	0.510	0.490	0.762	0.756	0.651	1.412	1.402	1.176
	(0.106)	(0.113)	(0.093)	(0.379)	(0.386)	(0.429)	(0.431)	(0.438)	(0.462)
pd		−0.001	−0.002		0.006	0.001		0.010	0.002
		(0.007)	(0.007)		(0.023)	(0.018)		(0.049)	(0.032)
Δy			−0.048			−0.256			−0.524
			(0.081)			(0.242)			(0.425)
vol			−0.325			−1.784			−4.657
			(0.339)			(1.085)			(1.707)
R^2	0.44	0.44	0.44	0.35	0.35	0.38	0.36	0.36	0.45

Notes: The table reports estimates from OLS regressions of future returns on the log debt-to-GDP ratio (*by*) and other control variables. The returns are the stock returns in excess of bond, the bond excess returns, and the risk-free rates. The regressors are as follows: log price-dividend ratio (*pd*); risk-free rate (*rf*); annual GDP growth (Δy); log stock volatility (*vol*). Newey-West standard errors with optimal lag selection are in the parentheses. The sample period is from 1926 to 2020.

associated with a 6 basis-point increase in bond excess return. The point estimates of bond premium are all positive and are significant in the multivariate model.[7] The marginal improvement in one-year R^2 of adding *by* is 3%.

I assess the relative predictive power for equity and bond premia. As the average bond premium is approximately 30% of the equity premium, the variability and the sensitivity to debt are expectedly smaller. The bond predictability in terms of the point estimate, univariate R^2, and marginal improvement in multivariate R^2 are 18%, 16%, and 25% of those of stock predictability, respectively. Therefore, adjusting for the difference in the equity and bond premium level and volatility, the evidence shows relatively weak government bond predictability. It is likely that government debt affects stocks mainly through the fiscal risk mechanism, while bonds are affected by other mechanisms, such as inflation risk, bond market clienteles, and the safe asset channel discussed in Section 2.2.5. Inflation and monetary policy are crucial determinants of bond premia (Campbell et al., 2020). Nguyen (2021) show strong positively contemporaneous correlations between debt and bond yields that are rationalized by a model featuring inflation risk. Greenwood and Vayanos (2014) show similar positive debt-yield correlations and further find that maturity-weighted debt ratios improve the bond return predictability of the standard debt-to-GDP ratios, consistent with a clientele effect.

Corporate bonds are another important asset class that reflects the risk premium for firms. The debt-to-GDP ratio positively predicts excess returns on corporate bonds. At a one-year horizon, the predictive coefficient is 0.05, approximately one third of the stock coefficient. Details are reported in the appendix. Taken together, the stock and credit results suggest that high debt levels imply high costs of capital for firms. Liu et al. (2020) provide a detailed empirical and theoretical analysis of the government debt effect on credit risk.

[7] The results are robust to adding other predictors such as term premium and inflation.

2.4. Real risk-free rate

The effect of government debt on real interest rates is a long-standing empirical question with little consensus in the literature (Engen and Hubbard, 2005). In contrast to previous studies of long-term real rates, I focus on short-term real risk-free rates, measured as the nominal risk-free rate minus the inflation expectation. I use the four-quarter moving average of past inflation to measure inflation expectations. The regression controls for the lag risk-free rate and forecasts its change. Panel C of Table 4 shows that debt-to-GDP ratios negatively predict future risk-free rate changes.[8] A one-percent increase in the debt-to-GDP ratio is associated with a 5-bp decrease in the 3-month real risk-free rate.[9] The result is concentrated at the one-year horizon and weakens at longer horizons.

Conventional wisdom suggests that real interest rates increase with government debt. This relation seems to be at odds with the recent experience in advanced economies. One argument is that governments time the market and issue more debt in low-interest-rate environments. Motivated by the risk premium evidence presented above, I suggest a new risk interpretation that the increased risk in high-debt periods reduces the risk-free rate through precautionary saving.[10]

3. Fiscal risk mechanisms

Why does government debt have such significant effects on asset prices? The first mechanism that comes to mind is the response of fiscal surplus in various forms: spending cuts, tax hikes, welfare reforms, etc (D'Erasmo et al., 2016). These fiscal policy tools have well-established effects on the level of the economy, but the influence on the risk in the economy is not obvious and is usually small in equilibrium models. In this section, I inspect fiscal policy mechanisms that potentially have significant effects on economic risk. Because fiscal policy is influential on the economy and the capital markets and yet unpredictable, it becomes a source of risk for investors. Fiscal risk depends on the debt level and manifests itself in three ways: fiscal uncertainty, fiscal multiplier, and debt crises.

3.1. Fiscal uncertainty

A key determinant of risk premia is the quantity of risk. Fiscal policy uncertainty may change over the debt cycle and contribute to high risk premia during high-debt periods. Evidence suggests that government debt and fiscal uncertainty positively comove with each other. Fiscal uncertainty drives asset prices in the same direction as the debt-to-GDP ratio.

3.1.1. Fiscal uncertainty measures

Fiscal policy uncertainty measures how precisely agents can predict future fiscal policy (Fernández-Villaverde et al., 2015). In many periods throughout history, there was little consensus about future policy. Policymakers in Congress and the White House debated issues such as military expenditures, tax reforms, entitlements, debt limits, and consolidations. In other periods, fiscal policy was relatively stable, and households and firms reacted accordingly with more certainty and confidence.

It is ideal to have empirical measures of fiscal uncertainty to examine its effects. The first measure is the Economic Policy Uncertainty Index (EPU) in Baker et al. (2016). These indices are based on newspaper coverage of policy-related economic uncertainty. The indices start from 1985 and span 11 specific policies such as monetary policy, fiscal policy, and trade policy.

To complement the recent news-based measure, I propose a measure of fiscal uncertainty in a data-rich environment that spans the postwar sample. This method follows Jurado et al. (2015) who measure macroeconomic and financial uncertainty. I take an a priori data-driven approach to include 37 fiscal policy variables from the national accounts. They follow a dynamic factor model that features stochastic volatility in common and idiosyncratic shocks. Fiscal uncertainty is defined as the first principal component of the conditional forecast error volatility of these fiscal variables. The appendix describes the data and the econometric model in detail. This seemingly complicated approach has two important advantages. First, big data span an extensive information set that helps to identify policy shocks from expected policy changes to estimate the shock volatility more precisely. Second, different types of fiscal policy are determined jointly. The common component of broad-based fiscal policy uncertainty averages out the noise in each policy instrument.

3.1.2. Fiscal uncertainty and government debt

Government debt can increase fiscal uncertainty because of fiscal consolidation. In general, the primary balance positively responds to government debt to guarantee debt sustainability (D'Erasmo et al., 2016). Serving a large amount of debt requires large interest expenditures. As spending needs and tax bases are stochastic, the spending and tax rates need to adjust more responsively to aggregate shocks to guarantee the funds to pay the debt. The increased sensitivity to shocks increases the uncertainty (Croce et al., 2019b). In the extreme case of no debt, the fiscal policy does not have to respond to macro conditions to serve the debt.

[8] In a univariate regression with *by*, the R^2 is 0.23 at an annual horizon. The marginal improvement in R^2 of adding *by* to the regressions with the four predictors is 5%.

[9] Related to this result, Nagel (2016) finds a negative correlation between debt-to-GDP ratios and nominal short rates.

[10] Laarits (2020) shows the importance of the precautionary saving mechanism on stocks and bonds.

Table 5
Government debt and fiscal uncertainty.

A. Debt and fiscal uncertainty								
Broad-Based	corr		EPU	corr		EPU	corr	
Fiscal Uncertainty 1Y	0.28	(0.16)	Fiscal Policy	0.36	(0.17)	Economic Policy	0.26	(0.16)
Fiscal Uncertainty 3Y	0.49	(0.14)	Taxes	0.33	(0.17)	Monetary policy	−0.18	(0.13)
Fiscal Uncertainty 5Y	0.54	(0.14)	Gov. spending	0.37	(0.16)	National security	−0.14	(0.13)
Macro Uncertainty 1Y	0.06	(0.20)	Health care	0.58	(0.15)	Regulation	0.51	(0.13)
Macro Uncertainty 3Y	0.06	(0.20)	Entitlement	0.45	(0.18)	Financial Regulation	0.27	(0.18)
Macro Uncertainty 5Y	0.06	(0.17)	Sovereign debt	0.36	(0.15)	Trade policy	−0.01	(0.24)

B. Fiscal uncertainty and risk premium	1Y		3Y		5Y	
Broad-based	0.02		0.07		0.17	
	(0.02)		(0.04)		(0.06)	
EPU		0.05		0.15		0.19
		(0.02)		(0.05)		(0.04)
R^2	0.02	0.08	0.07	0.25	0.21	0.24

Notes: Panel A shows the correlation between log debt-to-GDP ratios and measures of uncertainty. Standard errors are in the parentheses are computed from GMM. Panel B reports estimates from OLS regressions of future excess stock returns on fiscal uncertainty. Newey-West standard errors with optimal lag selection are in the parentheses. The sample period is from 1947Q1 to 2014Q4 (broad-based) and from 1985Q1 to 2014Q4 (EPU).

Furthermore, there is uncertainty over the composition and timing of fiscal consolidation. Bi, Leeper and Leith (2013) study historical episodes of fiscal consolidation and show that (i) consolidation can be driven by spending or transfer cuts or tax increases and that (ii) consolidation occurs at both high and low debt levels. This uncertainty emerges from the policymaking process. Depending on the political stance, the government faces tradeoffs between spending cuts and tax increases and between early and late consolidations. For example, the U.S. government once favored fiscal austerity (i.e., 1990s); however, it has been biased toward greater deficits recently (i.e., 2010s). Essentially, the uncertainty of fiscal consolidation increases with the level of debt. With little debt, there is no uncertainty or need for consolidation. These channels can be amplified in learning models (Pastor and Veronesi, 2013).

Fiscal policy is a factor of economic growth and affects the stochastic discount factor. An increase in fiscal volatility potentially changes the discount rate. As debt is the discounted future surplus, it is related to fiscal volatility through the discount rate channel.

Motivated by these channels, I empirically study how fiscal uncertainty measures are related to the debt-to-GDP ratio. In Table 5, the debt-to-GDP ratio has a correlation of 0.49 with 3-year fiscal uncertainty and a correlation of 0.36 with EPU measures. This positive relationship is observed in a variety of fiscal-related policies, such as taxes, government spending, health care, and entitlement. In contrast, the debt-to-GDP ratio is mildly related to non-fiscal policies, such as monetary, national security, and trade policies. Therefore, the results robustly show that the debt-to-GDP ratio captures fiscal uncertainty.

Fiscal uncertainty may be reflected in other maco-financial risk factors. The correlation between the broad-based uncertainty and pd is -0.08, and the correlation with cay is 0.04. For the news-based measure, the correlation with pd and cay is -0.39 and -0.11, respectively. The results suggest that debt-to-GDP ratios encode fiscal uncertainty to a larger extent than other factors that are potentially driven by non-fiscal risk, risk appetite, and cash flow news.

If this risk channel exists, fiscal uncertainty should have direct effects on risk premia. Table 5 shows that fiscal uncertainty positively predicts stock excess returns. The amount of predictability is large and holds in both the broad-based measure and the news-based measure.

3.2. Fiscal multiplier

The fiscal multiplier, commonly defined as the impact of government expenditure on output, is a gauge of the effectiveness of fiscal policy. A low or negative multiplier suggests that government spending fails to stimulate the economy. The size of the fiscal multiplier can vary over time and depend on economic conditions. I show that the multiplier is much smaller and often turns negative when the debt level is high.

Ramey and Zubairy (2018) discuss the pitfalls of computing multipliers and propose an advantageous method. Following their specification, I use a state-dependent instrumental variable method to estimate the multipliers. For each horizon h, I estimate the following model:

$$\sum_{j=0}^{h-1} y_{t+j} = I_{t-1}\left[\alpha_H + m_{H,h}\sum_{j=0}^{h-1} g_{t+j} + \psi_{H,y}(L)y_t + \psi_{H,g}(L)g_t\right] + (1-I_{t-1})\left[\alpha_L + m_{L,h}\sum_{j=0}^{h-1} g_{t+j} + \psi_{L,y}(L)y_t + \psi_{L,g}(L)g_t\right] + \varepsilon_{t:t+h-1}, \quad (1)$$

Table 6
Fiscal multiplier and government debt.

h	Linear	s.e.	Low debt	s.e.	High debt	s.e.	p-value
GDP							
2 years	0.27	(0.21)	1.03	(0.34)	0.17	(0.27)	0.05
4 years	0.25	(0.24)	1.18	(0.30)	−0.16	(0.28)	0.00
8 years	0.20	(0.42)	1.47	(0.21)	−0.73	(0.38)	0.00
Consumption							
2 years	−0.25	(0.13)	0.22	(0.21)	−0.42	(0.11)	0.01
4 years	−0.37	(0.19)	0.42	(0.20)	−0.69	(0.12)	0.00
8 years	−0.62	(0.37)	0.73	(0.19)	−1.29	(0.17)	0.00

Notes: The table reports estimates of the fiscal multiplier as in Eq. 1. Column "h" shows the horizons. Column "Linear" shows the multipliers in a model without state dependence. Column "Low debt" and "High debt" show the multipliers in the two states. Standard errors are in parentheses. p-values are from tests of equal multipliers across states. The sample period is from 1947Q1 to 2019Q4.

where y and g are the real GDP and government expenditures, respectively, divided by the trend GDP. $\psi(L)$ is the lag operator with four lags. I_t is a dummy variable that equals one if the debt level is above the historical mean. The coefficients can differ in different states of the economy. $m_{H,h}$ and $m_{L,h}$ are the multipliers in the high-debt and low-debt states for horizon h. The magnitude measures the ratio of a dollar change in GDP to a dollar increase in government spending. As $\sum_{j=0}^{h-1} g_{t+j}$ is endogenous, I use g_t as an instrument. The identification assumption is that discretionary government spending is implemented in response to GDP with a one-quarter lag. Table 6 shows the estimates of fiscal multipliers in the high-debt and low-debt states and in a linear model without state dependence. The multiplier is approximately 0.3 in the linear model. During low-debt periods, the multiplier is larger than 1 and increases with the horizon. Thus, government expenditures have a positive and persistent impact. However, during high-debt periods, the multiplier is small and negative for longer horizons. The p-value indicates a significant difference between the multipliers in the two states.

The evidence shows that fiscal stimulus may do more harm than good in highly indebted situations, suggesting that indebtedness should affect the fiscal transmission mechanism. When the government has a large amount of debt to pay off, the current expansionary policy is likely to be followed by contractionary adjustments such as distortionary tax hikes and spending reversals in the near future. In worse cases, debt build-ups may cause fiscal stress, debt restructuring, or inflation pressure. Expecting the undoing of the current policy path, the private sector reduces private demand, which leads to an ineffective stimulus. Consistent with our results, Ilzetzki et al. (2013) show that fiscal multipliers are significantly smaller and negative in highly indebted countries in a panel of 44 countries.

I further estimate the consumption multiplier, defined as the consumption response to government spending. I replace GDP with consumption as y in Eq. (1). Table 6 shows that consumption decreases with government spending, known as the consumption crowding-out effect. This finding is consistent with positive GDP multipliers because government spending itself contributes to GDP. Similar to the debt dependence in GDP multipliers, consumption increases in the low-debt state but decreases in the high-debt state by a much larger magnitude. The response of consumption is useful for asset pricing analysis. When the debt level is high, fiscal shocks increase the marginal utility of representative agents and decrease the stock price, amounting to a positive risk premium. During low-debt periods, both the price of risk and risk exposure change signs. Although the risk premia of fiscal spending are positive in both states, the size is larger in the high-debt state. Therefore, this state-dependent fiscal multiplier mechanism contributes to increased risk premia when the country is heavily indebted.

3.3. Debt crisis

The European debt crises remind us of the forgotten history of government defaults in advanced economies. Reinhart and Rogoff (2011) document multiple defaults and restructuring events in the most developed countries, including Germany, Japan, the U.K., and the U.S. Debt crises are turbulent episodes that lead to considerable economic damage. The restructuring often coincides with large spending cuts, tax hikes, and inflation, which can further depress income and future growth prospects. The costs of debt crises are well studied in the sovereign default literature (D'Erasmo et al., 2016). These insights and quantitative findings point to a large default risk premium. Even though credit events rarely occur in advanced economies, investors carefully assess this risk. Consistent with Chernov et al. (2020), the U.S. sovereign credit default swap spread has increased from essentially zero to approximately 40 bps since 2008, indicating a nonnegligible default probability. The same risk should also be manifested in the stock market. Fearing a stock market crash upon default, investors require sizable risk compensation, even if the probability is low.

While the small number of credit events limits our analysis, debt-ceiling crises have occurred repeatedly in U.S. history. After 1939, Congress used an aggregate debt limit to restrict federal borrowing. The debt limit increases are usually automatic, but a few exceptions have led to debt-ceiling crises. If Congress is reluctant to increase the limit, the government and Congress must negotiate reforms on balanced-budget amendments to avoid the cost of a government shutdown. The first debt-ceiling crisis occurred in 1953. The request of the Eisenhower administration to increase the limit was initially declined. After three temporary increases in 1954, 1955, and 1956, the limit reverted to its 1953 level. Another famous case was the government shutdown in 1995–1996. Recently, we have witnessed multiple fiscal cliffs, debt-ceiling crises, and government shutdowns from 2011 to 2018. In every crisis, the negotiations have led to large fiscal risk and adverse consequences. Each of these crises took place when the government was highly indebted.

Overall, a high debt level can lead to fiscal stress, debt crises, and even government defaults. The increased probability of these disruptive events is priced in the asset markets and increases the risk premia.

4. Quantifying the mechanisms

In this section, I propose a general equilibrium model to investigate the link between government debt and risk premia. Motivated by the evidence on debt-dependent fiscal risk, I introduce rich and realistic policy in a standard long-run risk model (Bansal and Yaron, 2004). Since the main contribution of the paper is the empirical finding, I keep the model in a relatively simple endowment economy framework to illustrate the channels transparently based on the closed-form solution. The model rationalizes the new facts and quantifies different fiscal policy mechanisms.

4.1. Preferences

The economy is populated by representative agents with Epstein and Zin (1989) recursive preferences. For these preferences, the log stochastic discount factor is

$$m_{t+1} = \theta \log \delta - \frac{\theta}{\psi} \Delta c_{t+1} + (\theta - 1) r_{c,t+1}, \tag{2}$$

where δ is the time discount factor; γ is the relative risk aversion; ψ is the intertemporal elasticity of substitution; $\theta = (1-\gamma)/(1-/\psi)$. $r_{c,t+1}$ is the log return on the consumption claim.

4.2. Cash flow dynamics and the fiscal policy

The consumption growth has the dynamics

$$\Delta c_{t+1} = \mu + x_t + \sigma \eta_{c,t+1} + \xi(S_t) J_{t+1}, \tag{3}$$

$$x_{t+1} = \rho x_t + \varphi_x \sigma \eta_{x,t+1} + \varphi_g(S_t) \sigma_g(S_t) \eta_{g,t+1} + \varphi_J \xi(S_t) J_{t+1}, \tag{4}$$

where x_t is the expected growth. The consumption growth shock $\eta_{c,t+1}$, the expected growth shock $\eta_{x,t+1}$, and the government expenditure shock $\eta_{g,t+1}$ all follow standard normal distributions and are independent. I model debt crises as a jump component $\xi(S_t)J_{t+1}$ with $\xi(S_t)$ being 1 with probability $p_J(S_t)$ and $J_{t+1} \sim N(\mu_J, \mu_J^2/4)$ being the jump size. The parameters φ_x, $\varphi_g(S_t)$, and φ_J capture the loadings of expected growth on the shocks.

The government-expenditure-to-GDP ratio g_t and the debt-to-GDP ratio by_t follow

$$g_{t+1} = \mu_g(1-\rho_g) + \rho_g g_t + \sigma_g(S_t) \eta_{g,t+1}, \tag{5}$$

$$by_{t+1} = \mu_b(S_t)(1-\rho_b) + \rho_b by_t + \sigma_b \eta_{b,t+1}, \tag{6}$$

where $\eta_{b,t+1}$ is the shock to the debt ratio.

Following Song (2017), I use regime switching to model the time-varying policy. $S_t \in \{L, H\}$ is a discrete state variable that follows a Markov chain with a transition matrix

$$\Pi = \begin{bmatrix} p_L & 1-p_L \\ 1-p_H & p_H \end{bmatrix}. \tag{7}$$

State L is the low-debt state and state H is the high-debt state: $\mu_b(L) < \mu_b(H)$. Given the previous discussion on fiscal mechanisms, I let some model parameters evolve according to the two-state Markov chain. First, the volatility of the government spending shock is larger in the high-debt state: $\sigma_g(L) < \sigma_g(H)$. Second, the effect of fiscal policy is positive in the low-debt state ($\varphi_g(L) > 0$) and negative in the high-debt state ($\varphi_g(H) < 0$). Third, the probability of fiscal crises is nonzero only in the high-debt state: $p_J(L) = 0$, $p_J(H) > 0$. To focus on the new fiscal mechanisms, I choose the simplest structure and allow a minimum number of parameters to vary across states.

I also simplify some general equilibrium conditions. In this endowment economy setting, I directly model the effect of government spending on consumption without specifying goods market clearing and the GDP dynamics. Moreover, the government budget constraint describes the law of motion of government surplus and debt outstanding. I only specify the expenditure and debt dynamics. Given these policies, the government adjusts the lump-sum tax and transfers to guarantee the holding of the government budget constraint state by state (Fernández-Villaverde et al., 2015).

The dividend growth process follows

$$\Delta d_{t+1} = \mu + \phi x_t + \pi \sigma \eta_{c,t+1} + \pi \xi(S_t) J_{t+1} + \varphi_d \sigma \eta_{d,t+1} \tag{8}$$

where $\eta_{d,t+1} \sim N(0,1)$ is the dividend shock. ϕ and π capture the levered exposure of dividends on aggregate shocks.

Table 7
Calibration.

Preferences	δ	γ	ψ			
	0.9989	10	1.5			
Consumption	μ	ρ	φ_x	σ		
	0.0015	0.978	0.027	0.006		
Fiscal Policy	μ_g	ρ_g	φ_J	μ_J	ρ_b	σ_b
	0.18	0.998	0.15	-0.0288	0.95	0.011
State Dependent	μ_b	σ_g	φ_g	p_J	p_{S_t}	
$S_t = L$	0.88	0.0016	0.05	0	0.995	
$S_t = H$	2.05	0.0046	−0.09	0.00033	0.995	
Dividends	ϕ	π	φ_d			
	3.5	1.5	4			

Note: The table presents the calibration of the model parameters.

4.3. Asset prices

I obtain the approximate analytical solution of the model. Specifically, I conjecture that the log price-to-consumption ratio $z_{c,t}$ depends on the state and the expected growth x_t: $z_{c,t} = A_0(S_t) + A_1(S_t)x_t$. To solve the state-dependent coefficients $A_0(S_t)$ and $A_1(S_t)$, I use the Euler equation for the return on consumption claim. Having the solution of the stochastic discount factor, I can solve for the stock return and the risk-free rate. The appendix provides the model solution in detail.

The innovation to the stochastic factor is

$$m_{t+1} - E_t(m_{t+1}) = -\lambda_c \sigma \eta_{c,t+1} - \lambda_x(S_{t+1}|S_t)\sigma\eta_{x,t+1} - \lambda_g(S_{t+1}|S_t)\sigma_g(S_t)\eta_{g,t+1} - \lambda_J(S_{t+1}|S_t)\xi(S_t)J_{t+1} \tag{9}$$

where the prices of risk λ_c, $\lambda_x(S_{t+1}|S_t)$, $\lambda_g(S_{t+1}|S_t)$, $\lambda_J(S_{t+1}|S_t)$ capture the s.d.f. exposures to the four sources of risk. These exposures depend on the state at time t and $t+1$.

In the solution of the aggregate stock return, β_c, $\beta_x(S_{t+1}|S_t)$, $\beta_g(S_{t+1}|S_t)$, and $\beta_J(S_{t+1}|S_t)$ are the risk exposures of the stock return to the shocks. It is straightforward to show that the equity premium conditioning on state $i \in \{L, H\}$ is

$$\log E_t[R_{d,t+1}] - r_{f,t} = \sum_{j=L,H} \Pi_{ij}\left[\beta_c\lambda_c\sigma^2 + \beta_x(j|i)\lambda_x(j|i)\sigma^2 + \beta_g(j|i)\lambda_g(j|i)\sigma_g^2(i) + B_J(i)\right] \tag{10}$$

$B_J(i)$ depends on the cumulant generating function of the jump term. The risk premium has four components, namely, those stemming from the short-run risk, the long-run risk, the government spending risk, and debt crisis risk. This formula provides some intuition on how risk premia change across states. The model formalizes the discussion of mechanisms in Section 3. First, for fear of the joint decreases in growth prospects and stock prices caused by the spending shock, agents demand an equity premium for the government spending risk. Because of the heightened fiscal uncertainty $\sigma_g(H)$, the spending risk premium is larger in the high-debt state. Furthermore, the state-dependent fiscal multiplier changes the signs of risk exposures. During high-debt periods, negative multipliers suggest that fiscal shocks increase the s.d.f. $(\lambda_g(j|H) < 0)$ and decreases stock prices $(\beta_g(j|H) < 0)$. Both signs are the opposite in the low-debt state. Although risk premia are positive in both states, the size depends on the quantitative effect $\varphi_g(S_t)$ that is larger in the high-debt state. Last, debt crises can only occur in the high-debt state, leading to an elevated jump risk premium. The jump term $B_J(S_t)$ is positive only in the high-debt state. Thus, all three mechanisms contribute to a larger equity premium in the high-debt state. The mechanisms do not function independently. The interactions between mechanisms enhance the positive relationship between debt and risk premia.

In the model, the risk-free rate increases with growth through intertemporal smoothing and decreases with risk through precautionary saving. It is straightforward that the three fiscal mechanisms imply a low risk-free rate in the high-debt state, because the volatility of the s.d.f. increases.

4.4. Calibration

I calibrate the model at the monthly frequency to match the macroeconomic and asset market data. Table 7 summarizes the parameter values. The parameters in the preference and consumption dynamics are in line with the long-run risk literature (Schorfheide et al., 2018). The risk aversion γ is 10, and the intertemporal elasticity of substitution ψ is 1.5. I set the consumption mean and volatility parameters to match the consumption data.

In the data, the economy stays in one state for 15.8 years on average, using the sample mean as the cutoff. This cutoff level is consistent with the US CDS spread, which turned from negligible to sizable after 2008. Using 2008 as the turning point, the debt ratio was around its sample mean of 0.41. This duration implies transition probability p_H and p_L to be 0.995. I choose μ_b, ρ_b, and σ_b to match the conditional mean, standard deviation, and autocorrelation of the debt-to-GDP ratio. In the data, the standard deviation of government spending over GDP is 1.07% in the low-debt state and 3.07% in the high-debt state. Therefore, I choose the fiscal shock volatility σ_g to be 0.0016 and 0.0046. The persistence of the government spending determines ρ_g.

Table 8
Dynamics of growth rates and prices.

	Data	s.e.	Model	5%	95%
A. Standard Moments					
$E[\Delta c]$	1.74	(0.23)	1.81	0.81	2.79
$\sigma(\Delta c)$	2.19	(0.30)	2.41	1.91	3.04
AC1(Δc)	0.47	(0.12)	0.53	0.31	0.70
$E[\Delta d]$	1.86	(1.09)	1.82	−1.71	5.24
$\sigma(\Delta d)$	10.55	(1.57)	9.42	7.66	11.44
AC1(Δd)	0.20	(0.13)	0.47	0.27	0.65
$E[r_d]$	6.83	(1.97)	8.11	4.82	11.52
$\sigma(r_d)$	19.24	(1.61)	19.10	14.79	22.74
$E[r_f]$	0.45	(0.37)	1.53	0.78	2.20
$\sigma(r_f)$	3.61	(0.50)	1.25	0.78	1.73
AC1(r_f)	0.62	(0.08)	0.82	0.70	0.90
$E[BY]$	0.41	(0.02)	0.40	0.26	0.55
$\sigma(BY)$	0.19	(0.02)	0.18	0.12	0.21
AC1(BY)	0.96	(0.01)	0.95	0.90	0.98
B. Debt-dependent Moments					
$E[r_d - r_f \| by < \overline{by}]$	2.28	(2.75)	2.82	−0.70	6.00
$E[r_d - r_f \| by > \overline{by}]$	13.34	(2.10)	11.16	5.77	16.61
$\beta_{r_d - r_f, by}$ 1Y	0.14	(0.05)	0.09	0.03	0.17
R^2	0.11	(0.06)	0.06	0.01	0.15
$\beta_{r_d - r_f, by}$ 3Y	0.40	(0.10)	0.24	0.06	0.44
R^2	0.28	(0.09)	0.15	0.01	0.33
$\beta_{r_d - r_f, by}$ 5Y	0.59	(0.12)	0.34	0.05	0.64
R^2	0.40	(0.10)	0.20	0.01	0.44
$E[r_f \| by < \overline{by}]$	1.41	(0.41)	1.95	1.35	2.47
$E[r_f \| by > \overline{by}]$	−1.21	(0.62)	1.04	0.01	2.08
$\beta_{r_f, by}$	−0.04	(0.02)	−0.01	−0.02	0.00
R^2	0.23	(0.13)	0.15	0.00	0.45

Note: Moments are computed from annual data from 1926 to 2020. Standard errors are in the parentheses. Returns and growth rates are annual percentages. The model is simulated at a monthly frequency for 90 years. The moments are the mean of the finite sample simulation ("Model") and the 5th and 95th percentiles of the Monte-Carlo distribution.

The effect of government expenditures φ_g determines the fiscal multipliers. To match the estimates of the multipliers in Table 6, I set φ_g to be 0.05 in the low-debt state and -0.09 in the high-debt state. As shown in the appendix, the model-implied multipliers and impulse responses are close to the empirical counterpart. After pinning down the contribution of the fiscal shock to growth, I choose the volatility of the growth shock φ_x such that the total amount of expected growth risk is consistent with the literature.[11] As a result, around half of the growth risk is from the fiscal shock.

I set p_J to have no crises in the low-debt state and a 0.4% crisis probability per year in the high-debt state, consistent with the evidence from the U.S. sovereign credit default swap market. During the several historical defaults of advanced economies documented in Reinhart and Rogoff (2011), the per capita output and consumption declined by 26.5% and 24.7%. These defaults in high-income countries coincide with the Great Depression and WWII, and the magnitude may be overstated. During defaults in low-income countries from the 1970s (Asonuma and Trebesch, 2016), I find that the average declines in output and consumption are 7.8% and 8.4% around a five-year window. I use the more conservative estimate to calibrate the size of the crises shocks μ_J and the persistence parameter φ_J. During a debt crisis in the model, the one-year and peak-to-trough consumption drops are 5.3% and 8.4%. The consumption dynamics are illustrated in the appendix. This magnitude is in line with quantitative models with endogenous default and output loss (Mendoza and Yue, 2012). In comparison, the probability and size of the debt crises are much smaller than the more general rare disaster in Barro (2006).

4.5. Quantitative results

Table 8 displays the standard moments of macroeconomic variables and asset prices. The table reports the model-implied moments and the 5th and 95th percentiles of the finite sample Monte-Carlo distribution. The model closely matches the mean, standard deviation, and autocorrelation of consumption and dividend growth rates, the stock market return, and the risk-free rate. The equity premium is similar in the data and in the model, despite the slightly higher model-implied stock return and risk-free rate. The debt-to-GDP ratio has a mean of 0.40, a standard deviation of 0.18, and an autocorrelation of 0.95, all consistent with the data. Generally, the model-implied moments fall well within the 95% confidence intervals in the data.

[11] The volatility of total of fiscal and non-fiscal growth risk $\sqrt{\varphi_x^2\sigma^2 + \varphi_g^2\sigma_g^2}$ is matched to the volatility of expected growth risk of 0.034% in Bansal and Yaron (2004).

Table 9
Risk premium decomposition.

	No Dependence	Uncertainty			Multiplier			Crisis			All		
	Mean	L	H-L	Mean	L	H-L	Mean	L	H-L	Mean	L	H-L	Mean
All	3.51	2.49	2.63	3.81	3.40	2.95	4.87	3.40	2.64	4.73	2.29	10.79	7.69
Short run	0.65	0.65	0.00	0.65	0.65	0.00	0.65	0.65	0.00	0.65	0.65	0.00	0.65
Long run	1.50	1.48	0.00	1.48	1.44	0.00	1.44	1.44	0.00	1.44	1.32	0.00	1.32
Spending	1.37	0.36	2.63	1.67	1.32	2.95	2.79	1.32	0.00	1.32	0.32	8.32	4.48
Crisis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.64	1.32	0.00	2.47	1.23

Note: The table presents the risk premium and its component in the low-debt state ("L"), the difference between the two states, and the unconditional mean. In the column named "No Dependence", the parameter configurations are: $\sigma_g = 0.31$, $\varphi_g = 0.005$, $p_J = 0$. In other panels, parameters of the mechanism(s) follow Table 7.

Table 8 also reports the model implications for debt-dependent moments. In the model, the equity premium is 2.82% in the low-debt state and 11.16% in the high-debt state. The model matches well the sizable difference in equity premium across states, as the debt dynamics feature discrete states. The model reproduces the positive predictive coefficients and the explanatory power in terms of R^2. At the one-year horizon, the model implies a predictive regression coefficient of 0.09 and an R^2 of 0.06. The five-year coefficient and the R^2 are 0.34 and 0.20, respectively. The model undershoots the data and explains half of the magnitude. There can be alternative mechanisms to contribute to a stronger debt-risk-premium relationship. Statistically, the model moments are within the confidence intervals of the data, and the data point estimates are within the model bands. Furthermore, the risk-free rate is lower in the high-debt state. In a regression setting, the debt-to-GDP ratio is negatively correlated with the risk-free rate, as in the data. The model implies a smaller risk-free rate differential, which can be attributed to other channels.[12] Overall, the model and the data are a close match in terms of key consumption, asset price, and debt-dependent moments.

The model sheds light on the quantitative importance of each mechanism. Table 9 presents the risk premium and its components in Eq. 10 under different model specifications. The column named "no dependence" shows a benchmark with no debt-contingent mechanisms. The fiscal policy is homoskedastic ($\sigma_g = 0.31$) and pro-growth ($\varphi_g = 0.005$); there are no debt crises ($p_J = 0$). In this case, the risk premium is 3.51%, with 0.65% from the short-run risk, 1.50% from the long-run risk, and 1.37% from the fiscal spending risk. Because there is no dependence, the risk premia are the same across states. Under the uncertainty mechanism, fiscal spending becomes more volatile and generates a larger risk premium in the high-debt state. In contrast, the spending risk premium diminishes in the low-debt state. Although the average spending premium is similar to the benchmark case, the differential between the two states is 2.63%. Under the multiplier mechanism, fiscal policy weakens growth in the high-debt state. As the growth effect is larger in absolute value, growth is more sensitive to spending, and the spending premium is larger by 2.95%. Under the crisis mechanism, the potential cost of debt crises brings about a premium differential of 2.64%. In the specification with all three mechanisms, the premium differential rises to 10.79%. Unconditionally, fiscal spending risk and debt crisis risk contribute to 4.48% and 1.23% of the equity premium. The uncertainty and multiplier channels reinforce each other and generate a spending premium differential of 8.32% through the interaction. In this case, fiscal policy is more uncertain and less effective in the high-debt state. To summarize, the mechanisms all contribute to a larger risk premium in the high-debt state.

The baseline model assumes no correlation between debt and spending shocks. Intuitively, expansions in government expenditures are financed by debt issuance and can result in a growing debt level. In an extension, the transition probability $p_H(p_L)$ increases (decrease) with g_t such that high spending precipitates a high-debt state. The feedback effect contributes to a stronger predictability and brings the model closer to the data. The five-year predictive coefficient increases to 0.42 from 0.35 in the benchmark case. A sequence of positive spending shocks leads to a high-debt state with high risk and is unlikely to transit back to a low-debt state. This channel amplifies the comovement between debt and risk premium.

The nature of fiscal policy is complex. In studies of fiscal policy, data from asset markets are often ignored. However, forward-looking asset prices provide information about the intertemporal marginal rate of substitution, which is crucial for any intertemporal policy. To explain the risk premium differential, fiscal policy should feature direct debt-dependent risk premium effects. Asset price moments discipline the dynamics and effects of fiscal policy. If I only allow one mechanism in the model to match the risk premium, then the implied fiscal policy is too extreme in comparison with the fiscal data. Therefore, confronting dynamic economic models with new asset pricing facts also sheds light on the assessment of fiscal policy.

5. Conclusion

Risk premia increase with government debt in various asset markets. Debt-to-GDP ratios positively predict excess stock returns. The forecasting power is compelling, and it outperforms many popular predictors. Higher debt is also associated

[12] For example, a high debt level lowers the growth and thus the risk-free rate. Since these growth channels do not affect risk premium in the model, I omit it to sharpen the focus.

with higher bond risk premia, credit risk premia, and lower risk-free rates. The increased risk premium is a new type of cost from government debt that deserves more attention in the debate regarding debt sustainability and consolidation.

I find evidence of debt-dependent fiscal policy that potentially has large risk premia effects. During periods of high government debt, fiscal policy is more uncertain, becomes counterproductive, and can lead to debt crises. Augmented with these fiscal policy features, an equilibrium model can rationalize the large risk premium differential across high-debt and low-debt periods. Through the lens of the model, the risk premium facts help identify and quantify the properties of fiscal policy.

Despite the ever-rising debt relative to GDP, many economists have confidence in the fiscal capacity and see no necessity for consolidation. Blanchard (2019) argues that public debt may have no fiscal cost as the growth rate is higher than the risk-free rate. In his analysis, the cost of debt depends on both the risk-free rate and the risk premium. While most attention is placed on the risk-free rate, the risk premium is no less important. Given a large risk premium, government debt decreases welfare. As risk premia rise with debt, this theory implies a large and increasing welfare cost of government debt.

The benefits of government debt are widely agreed upon. Government debt is crucial to smooth macroeconomic shocks and provides liquidity and safety services in the form of safe assets. A sustainable debt level leaves enough space for necessary fiscal expansion in the future. Debt reduction during normal times is desirable for macroeconomic stability and risk reduction. As John Maynard Keynes said, “The boom, not the slump, is the right time for austerity at the Treasury.”

My analysis focuses on an endowment economy to clarify the mechanisms. These mechanisms can be investigated in a production economy with endogenous government policy decisions. Furthermore, extending this study to monetary-fiscal interaction and inflation, government default, and currency devaluation in a model with large foreign holdings represents important directions for future research. It is valuable to account for more country heterogeneity and extend the study to emerging markets. It is also promising to jointly model the risk and safety channels of government debt. Each of these directions would bring new insights to the understanding of government debt.

Data availability

The authors do not have permission to share data.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jmoneco.2023.01.009.

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