Comment on "Monetary Policy, Bond Returns and Debt Dynamics" by Antje Berndt and Sevin Yeltekin

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Berndt and Yeltekin's study "Monetary Policy, Bond Returns and Debt Dynamics" is motivated by concerns that high levels of government debt may raise the risk of inflation. They seek to address a pertinent question, developing a forecasting model for U.S. government debt relative to GDP during periods of conventional and unconventional monetary policy.

This comment investigates further the relation between debt-to-GDP ratios, inflation, and inflation risk, which helps motivate Berndt and Yeltekin's study. I present a highly stylized two-period model with exogenous debt levels clarifying under which conditions we may expect a relation between government debt and inflation. In a model, where the government trades off distortions from taxes and inflation, high government debt can raise expected inflation, inflation uncertainty, and the risk of stagflationary recessions.

In contrast to basic intuition, I find that U.S. data from 1970 to 2012 does not display a strong relation between government debt-to-GDP ratios and proxies for inflation, inflation uncertainty, and inflation risk. Survey inflation expectations even appear negatively correlated with debt-to-GDP ratios. While debt-to-GDP was exceptionally high at the end of 2012, survey inflation expectations were low.

One possibility is that we simply do not have enough data to evaluate the co-movement between highly persistent inflation expectations and debt-to-GDP ratios and the correlations may be spurious. While it would be of great interest to policy makers and academics to forecast not only debt-to-GDP ratios but also the resulting risk of high inflation, I conclude that such an analysis may face important data limitations. In the presence of such data limitations, Berndt and Yeltekin provide an important first step by forecasting government debt-to-GDP ratios.

1 Government Debt and Inflation Risk

In order to understand the relevance of Berndt and Yeltekin's results, one needs to take a stance on why government indebtedness matters for the economy. At one extreme, Ricardian equivalence implies that the government's choice to finance expenditures with taxes or bonds has no implications for welfare. On the other hand, Berndt and Yeltekin argue that government debt relative to GDP may be especially concerning if it leads to increased inflation.[1] If inflation enters into consumer welfare, this may generate a channel for government debt to matter.

This section provides a brief model to show under which conditions we obtain a relation between government debt and inflation. Next, I provide empirical evidence from U.S. inflation, inflation uncertainty, and the level of government debt.

1.1 Two-Period Model of Government Debt, Inflation, and Inflation Risk

To fix ideas, I present an extremely simplified two-period model. The model uses the smallest number of assumptions needed to generate predictions about the level of government debt, expected inflation, inflation volatility and inflation-output covariances.

The model has two periods. In period 0, the economy has output $Y_0 = 1$. The face value of outstanding nominal government debt is given exogenously by D_0 and the price level is exogenously set to one. It is important that government debt is nominal, since with real debt the government does not face a trade-off between inflation and taxes to repay debt.

In period 1, the government must repay the debt. The government's only decision is to choose a combination of taxes and inflation. New debt issuance at time 1 is not permitted. In order to get any interesting interaction between government debt and inflation, I assume that fiscal policy and inflation are controlled by the same government decision maker. Aggregate pre-distortion output in period 1 is Y_1, tax revenue is τ_1, and inflation is π_1. Ignoring growth for simplicity, I assume that output in period 1 is equal

[1] See Cochrane (2011) for a recent survey of the literature of the fiscal theory of the price level, which emphasizes the relation between government debt and inflation.

output in period 0 times a multiplicative mean-zero shock u_1

$$Y_1 = (1 + u_1), \quad (1)$$

$$u_1 \sim N(0, \sigma_u^2). \quad (2)$$

I assume that σ_u is small, so the second moments of period 1 realized output and inflation can be computed using the delta method.

Let P_1 denote the price level at time 1. I use π_1 to denote the decline in the real value of one unit of currency from period 0 to period 1:

$$\pi_1 = 1 - \frac{1}{P_1}. \quad (3)$$

When P_1 is close to 1, $\pi_1 \approx P_1 - 1$. For a low inflation environment, such as the U.S. 1970-2012, π_1 is therefore approximately equal to the increase in the price level.

If taxes, inflation, or both are distortionary, government debt may present the government with a trade-off between minimizing tax distortions and inflation fluctuations. While surprise inflation allows the government to reduce the real value of outstanding debt and hence taxes, inflation may lead to costly resource misallocations when there are nominal rigidities. There is a long and rich literature characterizing jointly optimal monetary and fiscal policies (Lucas and Stokey, 1983; Sims, 2001; Ayiagari et al., 2002; Siu, 2004; Schmitt-Grohé and Uribe, 2004, 2007).

In the spirit of Barro (1979), I assume that the government faces quadratic distortions from raising taxes. For symmetry and in the tradition of optimal monetary policy (Clarida et al., 1999), I also assume a quadratic cost to inflation. Let a_τ and a_π be constants. Formally, the government minimizes a cost function that depends on the level of taxes relative to GDP and inflation:

$$C = a_\tau \left(\frac{\tau_1}{Y_1} \right)^2 + a_\pi \pi_1^2. \quad (4)$$

Assuming that the government never chooses outright default, it minimizes the cost function subject to the constraint:

$$\tau_1 \quad = \quad D_0(1 - \pi_1). \tag{5}$$

The model generates the following four predictions:[2]

Prediction 1: Expected period 1 inflation increases in D_0.

Prediction 2: The covariance between inflation and output is negative.

Prediction 3: The relation between inflation volatility and the face value of government debt D_0 is hump-shaped. Inflation volatility increases in D_0 if and only if $D_0 < \sqrt{\frac{a_\pi}{a_\tau}}$.

Prediction 4: The relation between the inflation-output covariance and the face value of government debt D_0 is U-shaped. The covariance between inflation and output decreases in D_0 if and only if $D_0 < \sqrt{\frac{a_\pi}{a_\tau}}$.

Prediction 1 confirms Berndt and Yeltekin's intuition that a higher level of debt-to-GDP increases the government's incentive to inflate away the debt. Intuitively, taxes depend much more strongly on inflation when the face value of debt is high.

Predictions 2 through 4 extend and sharpen Berndt and Yeltekin's predictions regarding the relation of debt-to-GDP ratios and inflation risk. In this simple model, higher debt-to-GDP not only raises expected inflation, it also raises the probability of unexpectedly high inflation during recessions.[3]

[2] For proofs, see the supplementary materials available online.

[3] This holds at least in the preferred case with $D_0 < \sqrt{\frac{a_\pi}{a_\tau}}$, corresponding to a low inflation economy, where the government repays at least 50% of the face value of debt with taxes rather than inflation. While D_0 represents face value debt-to-GDP ratios, analogous predictions hold for market debt-to-GDP ratios in the preferred case.

1.2 Empirical Relation between Debt, Inflation, and Inflation Risk

This section provides empirical evidence regarding the model predictions from Section 1.1. All empirical analyses use U.S. data from 1970.Q3 to 2012.Q4. I use Berndt and Yeltekin's measure of market debt-to-GDP, which is available 1960.Q1-2012.Q4. I measure inflation expectations and inflation uncertainty using 1-year GDP price index inflation forecasts from the Survey of Professional Forecasters. Finally, I consider the beta of 10-year nominal bond returns with respect to stock returns as a proxy for perceived inflation counter-cyclicality.[4]

If real rates are relatively stable over time, nominal bond returns are inversely related to inflation expectations. A positive bond beta therefore suggests that on average investors tend to revise their inflation expectations upwards when there is bad news about the aggregate stock market. A high nominal bond beta should therefore indicate higher perceived risk of stagflations. (Viceira, 2012; Campbell et al., 2013).

[FIGURE 1 ABOUT HERE]

Figure 1 Panel A shows market debt-to-GDP ratios jointly with inflation expectations. While inflation expectations trended down over the past few decades, market debt-to-GDP ratios showed a secular increase, resulting in a univariate correlation of -64%. The recently very high debt-to-GDP ratio is accompanied by very low inflation expectations. When I consider three-year changes instead of levels, the correlation decreases in magnitude but

[4] Ang et al. (2007) argue that surveys provide reliable inflation forecasts. I measure inflation uncertainty using responses from the Survey of Professional Forecasters as in Kang and Pflueger (2015). The Survey of Professional Forecasters asks respondents to assign probabilities to various GDP price index inflation rates over the next years. For instance, respondents might be asked to assign a probability to the event that inflation over the next year will be between 1% and 3%. I measure inflation uncertainty with the difference between the 90th and 10th percentiles of the implied inflation distribution, smoothed over the past eight quarters. Inflation uncertainty is available starting 1970.Q3 and determines the start date of my analysis. Nominal bond betas are computed using daily returns over the past three months. I smooth quarterly bond betas over the past eight quarters. Face debt-to-GDP ratios are available from the St. Louis Federal Reserve Fred Data base (GFDEGDQ) at http://research.stlouisfed.org/fred2/series/GFDEGDQ188S.

remains negative at -36%. The correlations in levels and in changes are similarly negative when I consider face debt-to-GDP ratios.

Figure 1 Panel B plots debt-to-GDP ratios against inflation uncertainty. While inflation uncertainty and debt-to-GDP ratios are negatively correlated in levels, this correlation shrinks to near zero when considering three-year changes. The correlations again look similar for face debt-to-GDP ratios.

Figure 1 Panel C shows nominal bond betas jointly with debt-to-GDP ratios. Overall, I do not find a strong relation in the data. While nominal bond betas are slightly negatively correlated with debt-to-GDP ratios in levels, the correlation becomes slightly positive in three-year changes. During the most recent period of extremely high debt-to-GDP levels, nominal bond betas were negative. On the other hand, high debt-to-GDP ratios in the early 1990s were accompanied by positive bond betas. Campbell et al. (2014) analyze changes in the bond-stock comovement in a New-Keynesian asset pricing model and argue that the recently negative bond-stock comovement is related to gradualism and strong persistence in the monetary policy rule.

The empirical evidence presented in Figure 1 appears puzzling when viewed through lens of the simple model. However, I want to be careful not to over-interpret the results. Persistent series, such as those in Figure 1, are necessarily dominated by a small number of long-lasting episodes, limiting the number of effective observations. In addition, Figure 1 does not control for any potential omitted factors that might drive both inflation and government indebtedness.

While Figure 1 finds no strong relation between government indebtedness, inflation expectations and inflation risk in the U.S., these results may very well be specific to the post-war U.S. experience. For instance, Reinhardt and Rogoff (2009) argue in the context of international data that "default through inflation is an important component of the domestic default calculus" (Chapter 8).

2 Conclusion

This discussion supplements Berndt and Yeltekin's analysis, seeking to clarify why policy makers, investors and academics might have a strong interest in debt-to-GDP ratios. Berndt and Yeltekin provide new forecasts of debt-to-GDP ratios, taking into account unconventional monetary policy.

While policy makers should have great interest in forecasting debt-to-GDP ratios, it would be even more interesting and relevant to accompany these forecasts with an assessment of the related macroeconomic and inflation risks. I find that debt-to-GDP ratios appear negatively correlated with inflation expectations and uncorrelated with inflation uncertainty and nominal bond betas in U.S. data 1970-2012. While potentially highly relevant, it appears that an empirical analysis of debt-to-GDP ratios and associated macroeconomic risks would need to address serious data limitations.

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Supplementary Materials [Not For Publication]

Writing $b = \frac{a_\tau}{a_\pi}$, the inflation solution can be written as

$$\pi_1 \quad = \quad 1 - 1/\left(\frac{bD_0^2}{(1+u_1)^2} + 1\right). \tag{6}$$

The first derivative of inflation with respect to the output shock is given by

$$\frac{d\pi_1}{du} \quad = \quad \frac{-2D_0^2 b}{(1+u_1)^3} \frac{1}{\left(\frac{bD_0^2}{(1+u_1)^2} + 1\right)^2} < 0. \tag{7}$$

The cross-partial with respect to the output shock and the level of debt is given by

$$\frac{d^2\pi_1}{dD_0 du} \quad = \quad \frac{-4D_0 b(1+u_1)((1+u_1)^2 - D_0^2 b)}{((1+u_1)^2 + D_0^2 b)^3}. \tag{8}$$

Now, at $u_1 = 0$, the cross partial is given by

$$\left.\frac{d^2\pi_1}{du_1 dD_0}\right|_{u_1=0} \quad = \quad \frac{-4D_0 b(1 - D_0^2 b)}{(1 + D_0^2 b)^3}. \tag{9}$$

Hence

$$\left.\frac{d^2\pi_1}{du_1 dD_0}\right|_{u_1=0} \quad < \quad 0 \text{ if } D_0^2 < \frac{a_\pi}{a_\tau}, \tag{10}$$

$$\left.\frac{d^2\pi_1}{du_1 dD_0}\right|_{u_1=0} \quad > \quad 0 \text{ if } D_0^2 > \frac{a_\pi}{a_\tau}. \tag{11}$$

By the Delta method, we have the following approximate expressions for the variance of inflation and the output-inflation covariance

$$Var(\pi_1) \quad \approx \quad \sigma_u^2 \left(\frac{d\pi_1}{du_1}(0)\right)^2, \tag{12}$$

$$Cov(\pi_1, Y_1) \quad \approx \quad \sigma_u^2 \frac{d\pi_1}{du_1}(0). \tag{13}$$

Predictions 3 and 4 then follow from $\frac{dCov(\pi_1)}{dD_0} = \sigma_u^2 \left. \frac{d^2\pi_1}{du_1 dD_0}\right|_{u_1=0}$ and $\frac{dVar(\pi_1)}{dD_0} = 2\sigma_u^2 \frac{d\pi_1}{du_1}(0) \left. \frac{d^2\pi_1}{du_1 dD_0}\right|_{u_1=0}$.

Finally, for every realization of u_1, the derivative of taxes with respect to the face value of debt is

$$\frac{d\tau_1}{dD_0} = \frac{(1+u_1)^2\left((1+u_1)^2 - bD_0^2\right)}{\left(D_0^2 b + (1+u_1)^2\right)^2} \tag{14}$$

$$> 0 \text{ iff } D_0^2 < \frac{a_\pi}{a_\tau}. \tag{15}$$

It follows that the slope of the market value of debt with respect to the face value of debt is given by $\frac{dB_0}{dD_0} = E_0\left(\frac{d\tau_1}{dD_0}\right)$. Convergence in distribution does not necessarily imply convergence in expectation. However, it is easy to simulate $\frac{dB_0}{dD_0}$ as a function of bD_0^2 and σ_u. I find that for small σ_u the derivative $\frac{dB_0}{dD_0}$ is greater than zero if and only if $D_0^2 b < 1$ or $D_0 < \sqrt{\frac{a_\pi}{a_\tau}}$.

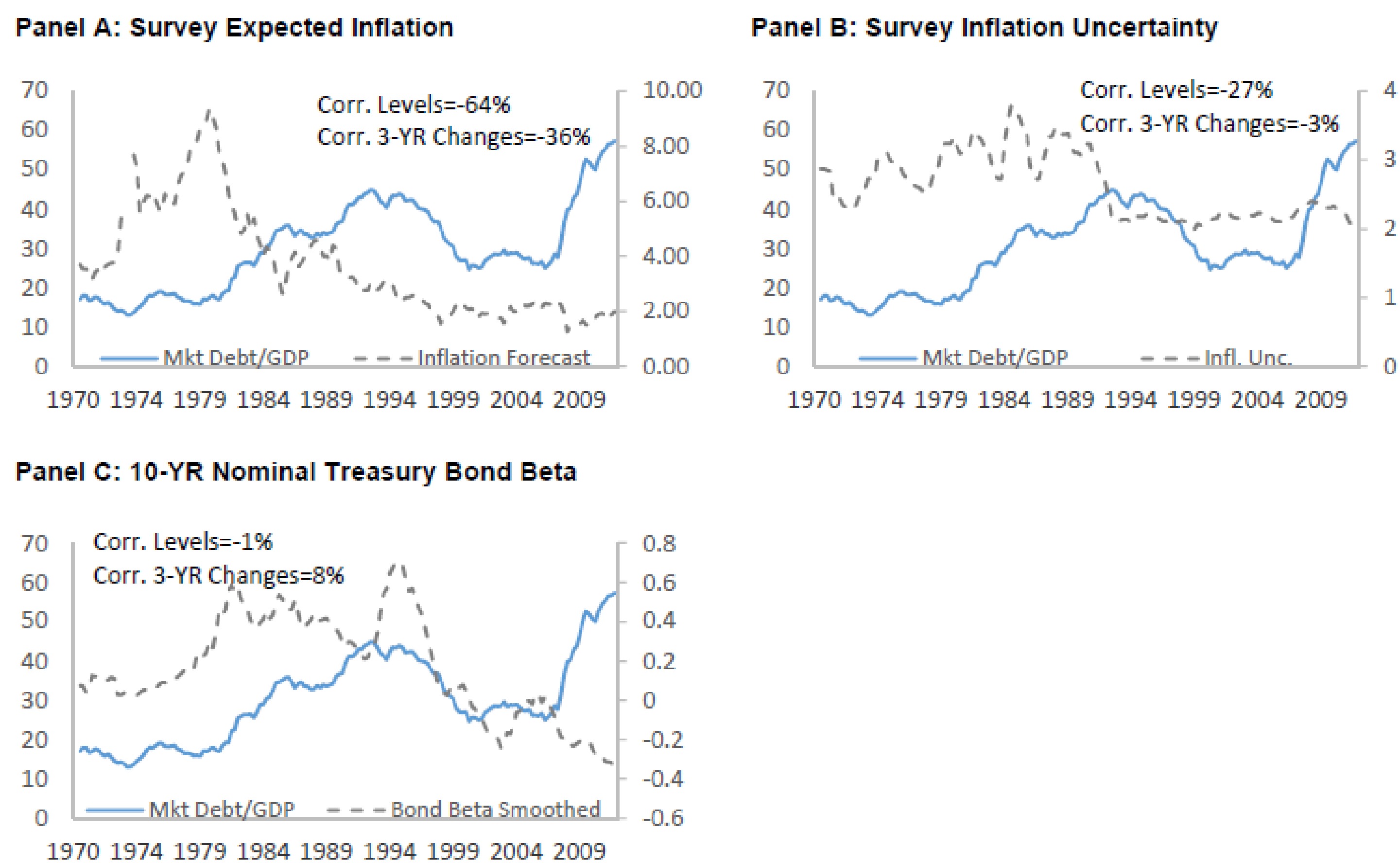

Figure 1: Annualized market debt/GDP from Berndt and Yeltekin (2015) against measures of expected inflation (Panel A), inflation uncertainty (Panel B), and nominal bond risks (Panel C) 1970.Q3-2012.Q4. Expected inflation is measured as the 1-year median forecast for GDP price index inflation from the Survey of Professional Forecasters. The Survey of Professional Forecasters provides forecasters' average survey probabilities that annual-average over annual-average GDP price index inflation will fall into a particular range. We obtain quantiles from this distribution as in Kang and Pflueger (2015). When the lowest inflation range receives a weight of more than 10%, we infer quantiles from a fitted beta distribution following Engelberg, Manski, and Williams (2009). Inflation uncertainty is measured as the difference between the 90th and 10th percentile smoothed over the past eight quarters. Beta of daily 10-year nominal Treasury bond with respect to CRSP value-weighted stock returns over the past three months as in Campbell, Sunderam, and Viceira (2013). The figure shows bond betas smoothed over the past eight quarters.