Data Appendix to 'A Frictionless View of U.S. Inflation'

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1 Introduction

This document describes the U.S. government debt data used in "A Frictionless View of U.S. Inflation". The data is available at my website, http://www-gsb.uchicago.edu/fac/john.cochrane/

2 Sources

The CRSP bond files (mbx.dat) give the identity, price, total quantity and quantity held by the public of every marketable security of the U.S. government. The CRSP data are hand-collected by CRSP from the *Quarterly Treasury Bulletin* and the *Monthly Statement of the Public Debt.* Currently, this data is reported in Table PD0-1 of the *Treasury Bulletin,* now available at http://ww.fms.treas.gov. The quantity outstanding data contain errors, some of which I was able to clean by a series of filters. For example, if debt outstanding takes on the same value for many months in a row, jumps (often to zero) and then jumps back, I smooth over the jump.

It is important for our purposes to count only the amount of debt held by the public. A large and increasing amount of debt is held by the Federal Reserve, the Social Security Trust Fund, Federal retirement funds and other agencies. In December 1996, for example, of $5,317 billion total face value, only $3,032 billion was in private hands. Alas, the Treasury and hence CRSP only break quantity outstanding into publicly held vs. total for bonds and notes, i.e. debt with initial maturity of two years or greater. I obtained the time series of privately held bills directly from the Treasury department. Where necessary I assigned the same fraction of each bill to private vs. total. Hall and Sargent[1] impute the number of privately held bills by subtracting the privately held bonds and notes from the total privately held debt with maturity less than a year reported in table OFS-1. The two approaches correlate well.

3 Annual identities

For each December 31, I collected the publicly held quantities of each bond. We want to produce annual data on value, return and surplus that satisfy accounting identities, given a once per year slice of debt data. The central difficulty is that a discrete-time model specifies that prices are constant within a "period," and this is a poor approximation for a year. Therefore, it makes sense to think of the model period as much shorter than a year, and to develop relations for infrequently measured data.

[1] Hall, George J. and Thomas J. Sargent, 1997, "Accounting for the Government's Cost of Funds" *Federal Reserve Bank of Chicago Economic Perspectives* 21, 18-28.1997)

Denote by $x_{t,k}$ the value of variable x on year t day k. Let there be K "days" in a year. Denote by V the nominal value of the debt, and denote bonds by maturity date j, so that $B_{t,k}(j)$ is the amount of debt outstanding in year t day k that will mature at time j and $Q_{t,k}(j)$ is their price. Then,

$$V_{t,k} \equiv \sum_j Q_{t,k}(j) B_{t,k}(j)$$

Denote real debt $v_{t,k} = V_{t,k}/p_{t,k}$. Start by defining the annual value series as value at the end of the year (December 31),

$$v_t^a \equiv v_{t,K}$$

Our task is then to define the annual surplus s_t^a, and return r_{t+1}^a from the high-frequency counterparts in the right way, so that identity

$$v_{t+1}^a = v_t^a r_{t+1}^a - s_{t+1}^a \tag{1}$$

hold in the annual data. Iterating the standard identity (**??**) expressed at a daily frequency

$$v_{t,k} = r_{t,k}^b (v_{t,k-1} - s_{t,k-1})$$

we obtain

$$v_{t-1}^a = v_{t-1,K} = \sum_{k=1}^{K} \left(\prod_{l=1}^{k-1} \frac{1}{r_{t,l}^b} \right) s_{t,k-1} + \left(\prod_{l=1}^{K} \frac{1}{r_{t,l}^b} \right) v_t^a$$

Thus, if we define the annual return as the cumulated daily return,

$$r_{t+1}^a = \prod_{l=1}^{K} r_{t,l}^b. \tag{2}$$

and if we define the annual surplus s_t^a as the daily surplus brought to the end of the year at the average government bond return,

$$s_t^a \equiv r_t^a \sum_{k=1}^{K} \left(\prod_{l=1}^{k-1} \frac{1}{r_{t,l}^b} \right) s_{t,k}. \tag{3}$$

we obtain (1). The analogous nominal definitions work the same way.

4 Annual data

With the above identities in mind, I produced the following annual data series. These series are available on my website.

1) Total value of the debt

Since we have the price and quantity of each bond, I multiply price times quantity to determine the market value V_t^a of the government debt at each December 31. I use the actual prices, not a fitted zero-coupon yield curve, so the market value time series is exact. I divide by the December CPI to obtain the real value of the debt v_t^a.

2) Zero-coupon face values

I added up the coupons due in each year and the principal of maturing bonds to produce the maturity distribution of zero-coupon equivalents. $B_t^a(t+j)$ is the debt outstanding on December 31 year t, coming due in year $t+j$. Below, I include the monetary base and savings bonds as zero-maturity debt. I aggregate all debt into one-year maturity classes. Money base is zero maturity debt, debt with maturity between 1 day and a year is one-year debt, etc.

3) Return and surplus

We want return and surplus measures that respect identity (1). Alas, neither the annual bond return (2) nor the annual surplus (3) can be exactly deduced from end-of-year data alone. In computing the return, the portfolio weights may change during the year. In computing the surplus, it obviously matters whether a payment is made early or late in the year.

There are two approaches: 1) Try to estimate the surplus s_t^a by tracking the net revenue from bond purchases and sales at each date, brought forward to the end of the year. Then impute the rate of return on government bonds using (1). 2) Try to estimate the rate of return on the government bond portfolio, then impute the surplus using (1). I follow the second approach, because it turns out to be more accurate. The maturity weights α do not vary that much. The surplus-first approach gives similar numbers for the surplus, but can imply annual returns on government bonds that lie outside the minimal and maximal returns on zero-coupon bonds.

To estimate the overall rate of return on the government bond portfolio I weight annual returns on zero-coupon bonds by the share of each maturity in the total value of the debt at the beginning of the year. Again, defining prices $Q_t^a(t+j)$ and quantities $B_t^a(t+j)$ as their December 31 values, and denoting by $R_{t+1}^j$the zero coupon return for maturity j, I estimate

$$R_{t+1}^a = \sum_{j=0}^{30} R_{t+1}^j \times \frac{Q_t^a(t+j)B_t^a(t+j)}{\sum_{k=0}^{30} Q_t^a(t+k)B_t^a(t+k)}$$

The ambiguity here is whether one should use beginning or end of year weights, but since weights change little from year to year, this is a small source of error. For 1-5 year maturities, I use the returns in the Fama-Bliss (1987) dataset maintained by CRSP. I assume the yield curve is flat above 5 years. For 0-1 year maturity debt, I use the compounded three-month Treasury bill return. I add the monetary base separately, with a zero interest rate. The real return is of course the nominal return deflated by the December 31/December 31 price levels.

With the real return in hand, I compute the real surplus for year t from the accounting identity (1), i.e.

$$s_{t+1}^a = v_t^a r_{t+1}^a - v_{t+1}^a.$$

For comparison, I also estimate the annual surplus as the negative of revenue from debt transactions,

$$p_t s_t^a \equiv -\sum_{k=1}^{K} \left(\prod_{l=k+1}^{K} R_{t,l}^b \right) \sum_j Q_{t,k}(j) \left[B_{t,k}(j) - B_{t,k-1}(j) \right].$$

For bonds that exist this and last year, I add the change in the quantity outstanding times this December 31 price. I then subtract coupon payments, the face value of bonds that matured during the year, and add the value (price $\times$quantity) of all new bonds. I bring intra-year cash flows forward to the end of the year at the one-year bill rate. Then, I use identity (1) to impute bond returns.