The Grumpy Economist

John Cochrane's blog

Saturday, July 20, 2019

New Papers

I've been remiss about blogging lately while I finished two new papers, "The Fiscal Roots of Inflation," and "The Value of Government Debt." I'm posting here for those who might be interested, and I appreciate comments.

Both papers apply asset pricing variance decompositions to questions of government finance and inflation. The inflation paper is part of the long-running fiscal theory of the price level project. (Note: this post uses MathJax which may not show properly on all devices.)

I start by deriving an analogue to the Campbell-Shiller linearization of the return identity:

$$\beta v_{t+1} = v_t + r^n_{t+1} - \pi_{t+1} - g_{t+1} - s_{t+1}.$$

The log debt to GDP ratio at the end of period $t+1$, v_{t+1}, is equal to its value at the end of period t, v_t, increased by the log nominal return on the portfolio of government bonds r^n_{t+1} less inflation π_{t+1}, less log GDP growth g_{t+1}, and less the primary surplus s_{t+1}. The "surplus" in this linearization is the surplus to GDP ratio, divided by the steady state debt to GDP ratio. It's not a log, so it can be negative. $\beta = e^{-(r-g)}$ is a discount rate corresponding to the steady state real rate r less GDP growth rate g.

Iterating forward, the present value identity is

$$v_t = \sum_{j=1}^{\infty} \beta^{j-1}\left[s_{t+j} - \left(r^n_{t+j} - \pi_{t+j} + g_{t+j}\right)\right].$$

I simplify by using $\beta = 1$ as the point of linearization. 1 vs. 0.99 doesn't make any significant difference for empirical purposes.

Now apply standard asset pricing ideas. To focus on inflation, in "Fiscal Roots" I take the time $t+1$ innovation of the present value identity, $\Delta E_{t+1} \equiv E_{t+1} - E_t$. Rearranging, we have the unexpected inflation identity,

$$\Delta E_{t+1}\pi_{t+1} - \Delta E_{t+1}\left(r^n_{t+1} - g_{t+1}\right)$$
$$= -\sum_{j=0}^{\infty} \Delta E_{t+1} s_{t+1+j} + \sum_{j=1}^{\infty} \Delta E_{t+1}\left(r^n_{t+1+j} - \pi_{t+1+j} - g_{t+1+j}\right).$$

A decline in the present value of surpluses, coming either from a change in expected surpluses or a rise in their discount rates, must result in a lower real value of the debt. This reduction can come about by unexpected inflation, or by a decline in nominal long-term bond prices. The value of debt drops out, which is handy and simplifies matters.

I run a VAR and calculate the terms on the right, which are simply sums of impulse-response functions. If you follow asset pricing, you will not be surprised at the first main result: Discount rates matter a lot. Changes in the present value of surpluses are driven in large part by changes in the discount rate rather than by changes in expected surpluses.

I do this as part of a program to apply fiscal theory ideas to data. It's always been a challenge to link inflation to movements in surpluses. It turns out we can do so -- *future surpluses* do matter in this decomposition. But discount rates matter too, and empirical work both pro and con fiscal theory has largely ignored those.

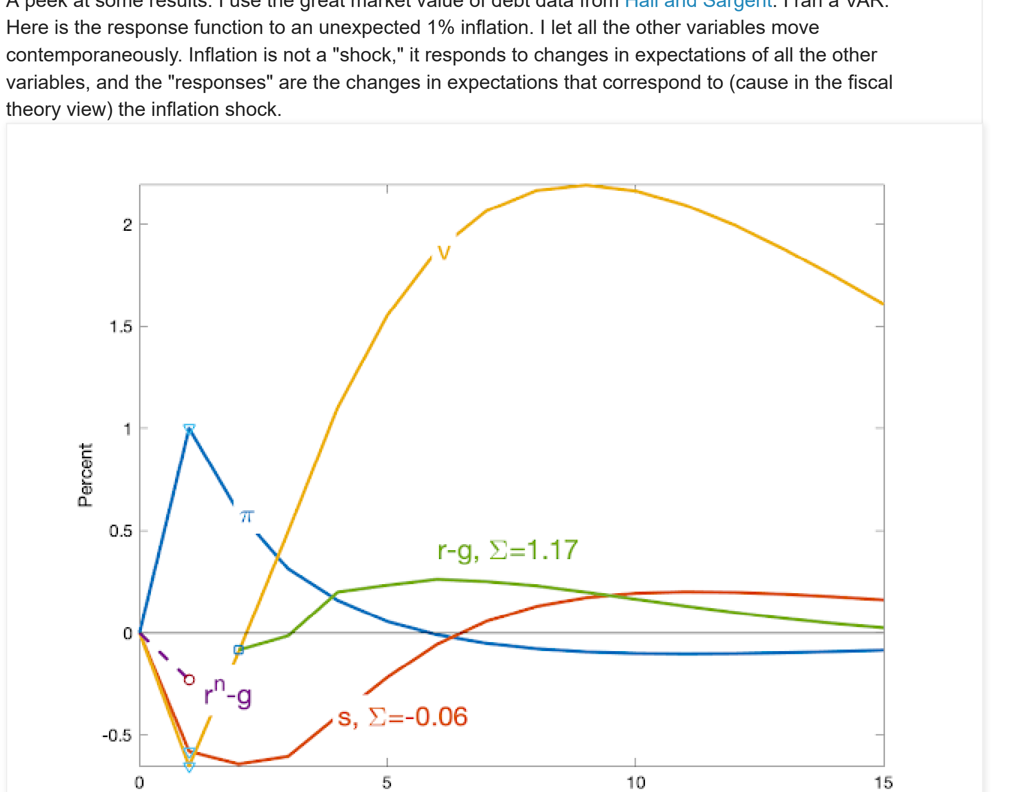
(Nothing in this empirical work needs fiscal theory however. These are identities that hold in every model in which the government faces a budget constraint. You can read them as measures of just how "passive" fiscal policy is achieved, which is important to closing out conventional models. Footnotes about lump-sum taxes are nice, but we don't have any. That discount rates move to make the present value identity hold is news there too.)

As the paper progressed, I came to appreciate the second term more and more. A low long-term bond return mechanically means higher expected nominal returns, which we can break to expected inflation and real returns. With a geometric maturity structure, in which the face value of maturity j debt declines at rate ω^j, we can write another identity

$$\Delta E_{t+1} r^n_{t+1} = -\sum_{j=1}^{\infty} \omega^j \Delta E_{t+1}\left[\left(r^n_{t+1+j} - \pi_{t+1+j}\right) + \pi_{t+1+j}\right].$$

It turns out that expected inflation dominates. So, a fiscal shock (lower surpluses, higher discount rates) can be met by a rise in expected inflation, which devalues long term bonds, rather than just by a sudden price level jump which devalues short term bonds. This allows us to think about the fiscal underpinnings of episodes of steady inflation, like the 1970s. This mechanism also dominates as the time intervals shrinks. In one version of a continuous time model there are no price level jumps, all debt is long term debt, and all devaluation comes from expected inflation. This also allows us to have a model in which the central bank is still vital for understanding inflation dynamics. In typical active-fiscal. models the central bank, by setting interest rates, can set the path of expected inflation, but not unexpected inflation. Now, setting the path of expected inflation has a big impact on unexpected inflation. The Fed chooses whether to smooth inflation over time or suffer a quick bout of unexpected inflation.

A peek at some results: I use the great market value of debt data from Hall and Sargent. I ran a VAR. Here is the response function to an unexpected 1% inflation. I let all the other variables move contemporaneously. Inflation is not a "shock," it responds to changes in expectations of all the other variables, and the "responses" are the changes in expectations that correspond to (cause in the fiscal theory view) the inflation shock.

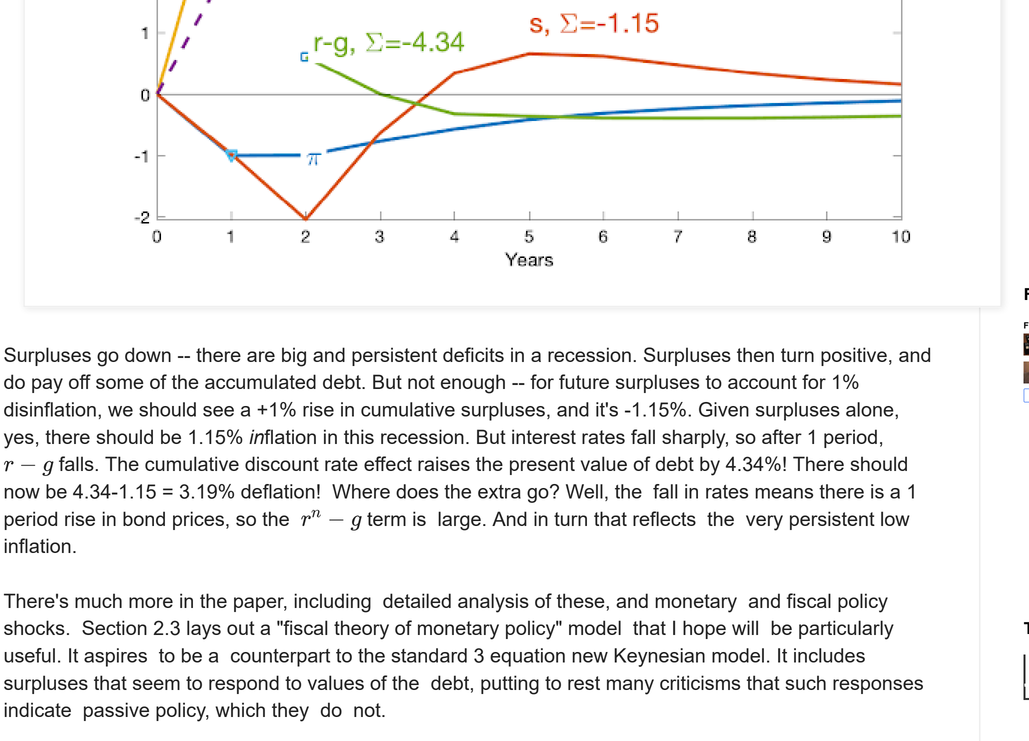


Response to 1% unexpected inflation

In terms of the inflation decomposition, the 1% unexpected inflation does correspond to deficits. But those deficits turn around to eventual surpluses, and the sum of all surpluses is essentially zero. "r-g" is the total discount rate term, nominal return, less inflation, less growth. The cumulative discount rate term is 1.17 -- accounting for all the inflation and more. In sum, then, the 1% inflation shock corresponds to a 1.17% rise in discount rate, a 0.06% decline in surpluses. That's too much decline in present value of the debt, so we see a 0.23% decline in current bond value, the $r^n - g$ response in the graph and the first term of the decomposition. That turns out largely to come from expected inflation. The rise in expected inflation -- the slow AR(1) response in the graph causes expected future interest rates to rise, and thus pushes down the bond price immediately.

One more. These inflation shocks are, on average, stagflationary. They come with a decline in GDP, which you can see in the above graph by the decline in surplus, which is pro cyclical. The average Phillips Curve is upward sloping, more inflation with more unemployment, in the postwar period. I wanted to understand a recession-related disinflation like 2008. Every time I give a fiscal theory seminar, the question comes up: What about 2008? The economy tanks, inflation goes way down, but there are huge deficits. Shouldn't that mean more inflation, not less? Well, not necessarily. Inflation responds to the present value of all future surpluses. It's unlikely there was good surplus news in 2008, but interest rates declined sharply. So the present value of surpluses could rise, causing disinflation, even if surpluses themselves do not.

Is that true? To find out, I defined a "recession shock" as a 1% decline in inflation accompanied by a 1% decline in GDP. Here are the responses:



Surpluses go down -- there are big and persistent deficits in a recession. Surpluses then turn positive, and do pay off some of the accumulated debt. But not enough -- for future surpluses to account for 1% disinflation, we should see a +1% rise in cumulative surpluses, and it's -1.15%. Given surpluses alone, yes, there should be 1.15% *in*flation in this recession. But interest rates fall sharply, so after 1 period, $r-g$ falls. The cumulative discount rate effect raises the present value of debt by 4.34%! There should now be 4.34-1.15 = 3.19% deflation! Where does the extra go? Well, the fall in rates means there is a 1 period rise in bond prices, so the $r^n - g$ term is large. And in turn that reflects the very persistent low inflation.

There's much more in the paper, including detailed analysis of these, and monetary and fiscal policy shocks. Section 2.3 lays out a "fiscal theory of monetary policy" model that I hope will be particularly useful. It aspires to be a counterpart to the standard 3 equation new Keynesian model. It includes surpluses that seem to respond to values of the debt, putting to rest many criticisms that such responses indicate passive policy, which they do not.

"Value of debt" I applies the standard price-dividend ratio volatility decompositions. (If you're not familiar with those, "Discount Rates" has a summary.) Multiply by $v_t - E(v_t)$ and take expectations, giving

$$var\left(v_t\right) = \sum_{j=1}^{\infty} cov(v_t, s_{t+j}) - \sum_{j=1}^{\infty} cov\left[v_t, \left(r^n_{t+j} - \pi_{t+j} - g_{t+j}\right)\right].$$

Dividing by $var\left(v_t\right)$, we can express the result as fractions of variance of the debt to GDP ratio due to each component. I estimate them via a VAR. Discount rates matter here too.

Posted by John H. Cochrane at 9:55 AM

Labels: Academic Articles, Economists, Inflation, Monetary Policy

11 comments:

LAL July 20, 2019 at 2:10 PM

What are real nominal returns?

Reply

Replies

John H. Cochrane July 22, 2019 at 1:18 PM

A typo. Thanks.

Reply

LAL July 20, 2019 at 6:44 PM

“Has the US has entered a long-lasting period with growth less than the average return on government bonds, r < g, so that the debt-to-GDP ratio will decline even with zero primary surpluses?” You mean growth greater than i think?

Reply

Replies

John H. Cochrane July 22, 2019 at 1:21 PM

Typo. Thanks much.

Reply

Matt Young July 21, 2019 at 10:21 PM

Well explained, I liked that part about this being a series of impulse responses, each one an innovation. The assumption is a closed system, central bank has the monopoly, and complete, agents transact based on an adequately long look ahead. (Measurement error held constant)

That is a leak proof system, variance is conserved and prices neutral. A complete double entry accounting system, and people expect government to tax and sequester when the current budget is blown. People do not expect government to break the 14th where government debt is sacred, instead they expect government to tighten belt and pay debt service.

But we break these assumptions, generally once a generation and the moment is arriving. No one plans on 50 years of a half point deflation.

Reply

James Francis Xavier July 22, 2019 at 9:55 AM

And a tip of the derby to Professor Irwin Corey.

Reply

LAL July 22, 2019 at 6:13 PM

I think the signs on the growth term in each of equation (39)-(44) in the appendix of fiscal roots got switched up?

Reply

Benjamin Cole July 22, 2019 at 6:57 PM

Well, shortly after my college, campus was wired up for electricity, I took a calculus course and I passed with flying colors. But I find myself unable to follow the equations in this post.

I think what John Cochrane is saying is that GDP will exceed interest rates going forward. Or perhaps the market is saying so.

Maybe the u.s. is headed towards Japanification, and we will see Zero interest rates, federal budget deficits and lots of quantitative easing.

I am still puzzled how a central bank acting on behalf of a national government can buy back national debt but without inflationary consequence.

Do national governments have a get-out-of-jail-free card?

If investors are indifferent to holding cash or bonds, then the government can exchange cash for bonds. The investors don't spend the money anyway. They just put it in the banks. And the banks don't lend it out.

Reply

JoeMac July 22, 2019 at 8:08 PM

I was taught that the general level of prices is purely a function of the supply and demand for the monetary base. In the old days, the monetary base was gold, and today its bank reserves + currency. Does that apply in the fiscal theory?

Reply

Old Eagle Eye July 23, 2019 at 1:11 PM

Equation 1 simplifies to $(\beta - 1)v_i = -(\pi_i + s_i)$, where i = time index , i.e., i = 0, 1, 2, …, t -1, t , t + 1, …, ∞ . It is not necessary to make the assumption that parameter β = 1. The operator $\Delta E_i()$ can be applied conveniently to the simplified equation.

A weakness in the argument is found in the definition of variable s_i insofar as the definition of that variable depends on knowing the value of the quotient of steady-state GDP (Y^{ss}) and steady-state Debt (D^{ss}), i.e., Y^{ss}/D^{ss}. Perhaps, if one were to restate it, and define the quotient Y^{ss}/D^{ss} as the "normal" or "target" GDP/Debt ratio instead of the "steady-state" GDP/Debt ratio? Would the relation (1) then become a mean-reverting dynamic equation?

The assumption that the parameter β is invariant through time needs to be tested. This is especially so when the time interval is of long duration (e.g., longer than 1 year, say). Writing $\beta(r,g) = \beta_i = -r_i + g_i$ and $\exp(-r_i+g_i)-1 \approx -r_i+g_i \approx -r^n_i+\pi_i+g_i$, r^n_i=nominal rate of return on the portfolio of government debt issued and outstanding.

Simplified equation (1) is in that case approximated by
$v_i=(\pi_i+ s_i)/(r^n_i-\pi_i-g_i)$.

This can be resolved for π_i, thus, $\pi_i=((r^n_i-g_i)v_i-s_i)/(1+v_i)$. In the current era, $v_i>0$, $-s_i>0$, and $r^n_i-g_i<>0$. Some numbers will have to be inserted to gauge whether the relation yields credible estimates for π_i.

Reply

David Seltzer July 24, 2019 at 12:27 PM

Question. 1% inflation corresponds to deficits. If deficit spending increases over time and is financed with more debt, at what point is debt monetized? Do nominal rates, (real rates + anticipated inflation), ramp up to the point of default?

Reply

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John H. Cochrane

This is a blog of news, views, and commentary, from a humorous free-market point of view. After one too many rants at the dinner table, my kids called me "the grumpy economist," and hence this blog and its title. In real life I'm a Senior Fellow of the Hoover Institution at Stanford. I was formerly a professor at the University of Chicago Booth School of Business. I'm also an adjunct scholar of the Cato Institute. I'm not really grumpy by the way!

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- Inflation (141)
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- Micro vs. macro (35)
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- off-topic (9)
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- Politics and economics (169)
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- Regulation (230)
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- Unemployment (32)
- Videos (10)
- writing (7)

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  - ► May (13)
  - ► April (2)
  - ► March (7)
  - ► January (10)
- ► 2018 (91)
- ► 2017 (112)
- ► 2016 (102)
- ► 2015 (130)
- ► 2014 (131)
- ► 2013 (114)
- ► 2012 (127)
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