Price level determination in general equilibrium

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1 Introduction

The current situation

- In what have been conventional macroeconomic models there are two policy "anchors".
- Most widely understood: Monetary policy has to control the level of some nominal variable: E.g. the money stock, inflation, the price level itself.
- The other is that fiscal policy has to refrain from interference with this "nominal anchoring" by itself in effect targeting a *real* value for interest-bearing nominal public debt — a real-valued "fiscal anchor".

What has changed

- Ordinarily, there is a tight link between reserve deposits at the Federal Reserve and monetary aggregates, because banks strive to keep reserves down to the minimal required level.
- This is not true now. Reserves are many times the required level. The "money multiplier" no longer works, so the quantity of reserves is not a nominal anchor in the usual sense.
- Drastic innovations in fiscal policy are being undertaken whose future consequences could follow a variety of trajectories. So the "real anchor" is in question.
- The line between fiscal and monetary policy has become quite unclear.

2 The Fed balance sheet

An eerie new landscape

- Size of the balance sheet. US has doubled. UK has doubled. Sweden has tripled.
- Assets no longer mainly Treasuries.
- Large "special" Treasury deposit.
- Swaps with foreign central banks.
- "Excess" reserves now far bigger than required reserves.
- Deposits bear interest, at rates for now above Treasuries.

How did we get here?

- To stabilize markets, the Fed acquired non-Treasury assets.
- It could to some extent do so without expanding its balance sheet, by selling Treasuries in corresponding amounts.
- But it began to run out of Treasuries to sell: Two ways to get around this.
  - The special Treasury deposit. Provided T-bills, with a corresponding deposit liability to the Treasury.
  - Interest on reserves. Allowed raising funds directly from deposit inflows to the Fed.

Alternatives

- The special treasury deposits and the abililty to pay interest on deposits can both serve the same purpose.
- While interest rates are positive and there is no interest on reserves, expansion of the Fed balance sheet results in approximately proportionate expansion of the money stock and commercial bank balance sheets (the money multiplier).

- The special Treasury deposit in principle allows trading of Treasury debt for private assets without expanding bank reserves.
- Interest-bearing deposits at the Fed do not (yet) count against the Federal debt ceiling.
- If substantial interest is paid on reserves, they could constitute a major leak in the US system for legislative control of debt creation.
- Or, they are not backed by the "full faith and credit" of the US government — which has implications for inflation control.

3 Implications for monetary policy instruments and their effects

Why interest on reserves?

- Traditional argument: paying no interest and requiring reserves is a tax on banking and presumably therefore distorting.
- Interest at close to market rates can achieve the effect of the "Friedman rule" (satiating the public in money balances) without requiring deflation — at least if we ignore currency. (Now 1/3, instead of over half, of Fed liabilities.)
- In the current circumstances, the main appeal may be that raising the rate on reserves can create a strong contractionary effect without requiring sale of (illiquid) assets.

The money multiplier, the Fed Funds rate

- "High powered money" no longer has high power, if interest on reserves is at or above the rate on T-bills and the perceived return on private sector loans.
- The Fed still sets a Fed Funds target, but there is little trading now on this market and the actual rate remains below the announced target and below the rate paid on deposits.
- In effect, the policy rate is now the rate on deposits, and commercial banks are not using the Fed Funds market.

4 Implications for "central bank independence"

Fiscal dimensions of monetary policy

- Changing the interest rate changes the "interest expense" item in the government budget.
- Central bank operations generate fluctuating levels of net earnings (seigniorage), most of which are turned over to the Treasury as revenue.
- A central bank balance sheet may sometimes go into the red. The Treasury may then recapitalize it by creating, and giving to the central bank, new government debt.

The old working definition of Fed independence

- Balance sheet risk was negligible, as assets were interest earning, dollar-denominated, US debt and liabilities were also dollar-denominated government paper.
- Seignorage was therefore always positive, though varying.
- Interest rates were low and debt not very high, so the interest expense item in the budget was modest. (Though it rose to 20% of the budget for a few years in the early 80's in the US.)
- Independence meant that the legislature and the Treasury did not complain (much) about seignorage fluctuations or about the effects of interest rate changes on the Treasury's interest expense.

Balance sheet risk

- The Fed has tried to minimize the risk it is taking on. The TARP legislation was intended to provide a mechanism for taking on risk that would free the Fed from doing much of that.
- Nonetheless it has taken on risk, most notably in its recent issuance of guarantees in the CitiBank rescue and in the "Maiden Lane LLC" invention that supported Bear Stearns, but also in some of the other new types of assets it is acquiring.

- With interest being paid on reserves, the flow of seignorage will be smaller, and could become negative.

Why does the Fed's current net worth matter?

- Fed can always "print money" to pay its bills.
- There is no possibility of a run on the Fed, since its liabilities make no conversion promise.
- A commitment to a path for inflation or the price level makes the balance sheet matter.
- Without Treasury backing, the Fed must rely on seigniorage to raise revenues, and that can conflict with inflation-control goals.

5 The fiscal anchor

The Fiscal Theory of the Price Level

- This is not really a new theory — its basic insight is that of Neil Wallace's "Modigliani-Miller theorem for open market operations", in the *AER* in 1981.
- It may help to think of it as just "general equilibrium without leaving out the government budget constraint."
- If what we usually think of monetary policy instruments are to provide a nominal anchor, they can do so only if they are systematically "backed up" by fiscal policy adjustments.
- In particular, when monetary policy raises interest rates on government debt, fiscal policy must reliably respond with increased taxes or reduced expenditure to provide resources to cover the increased interest expense.
- If it does not do so, then monetary policy alone cannot control inflation. The "nominal anchor" role shifts over to fiscal policy, which controls inflation by controlling the total volume of nominal government liabilities.

The basic idea

- The price level is the rate at which *all* mature paper liabilities of the government trade for goods.
- Nominal debt issue promises only a stream of returns in the form of government-issued paper.
- Its real value is determined by the future primary surpluses, plus seigniorage, that generate real payments to the debt holders.
- This is the same algebra that determines the price of a firm's equity.
- Neither private equity nor public nominal debt promises any specific real return. Their value depends on expectations of what real resources and commitments back them up.

Gaps in existing policy models

- Existing policy models in central banks have nonexistent, thin (e.g. with no distinction between long and short term debt), or internally contradictory treatments of intertemporal aspects of fiscal policy.
- My view is that this is their most important shortcoming as frameworks for thinking about the current crisis — even more important than their lack of explicit treatment of credit risk in the private sector.

The fiscal multiplier

- A formula for FTPL price level determination

$$\frac{B_t}{P_t} = E_t \sum_{s=1}^{\infty} \Phi_s \tau_{t+s} \, .$$

- A deficit backed by expected future increases in primary surpluses has no impact on prices.
- A deficit unbacked by any expected future increases in primary surpluses has an impact on prices — until prices increase, it makes individuals' wealth, and hence their desired spending, rise.

- This is the right way to think of Keynesian multipliers (if we introduce sticky prices).
- They can be very large or non existent, depending on how deficits affect expectations of future fiscal policy.

Unhealthy demand for government debt from a drop in expected real growth

Representative agents solve

$$\max_{C,B,K} E\left[\sum_{t=0}^{\infty} \beta^t \log C_t\right] \qquad \text{subject to}$$
$$C_t + \frac{B_t}{P_t} + K_t = AK_{t-1} + \frac{R_{t-1}B_{t-1}}{P_t} - \tau_t$$

Suppose government fixes $\tau_t = \bar{\tau}$, and, from an equilibrium with a given A in place forever and expected to persist forever, we shift to a new equilibrium with lower A, and hence lower equilibirum growth rate $A\beta$.

Result of the growth rate shift

- In this model consumption grows by the factor A each period, so the lower value of A lowers the real rate of time discount.
- This raises the real value of the debt with a given stream of future primary surpluses.
$$\frac{B_t}{P_t} = \frac{\bar{\tau}}{A-1}\,.$$
- If nominal deficits are held constant so B does not increase, P_t must drop to achieve portfolio equilibrium.
- If sudden deflation has bad consequences because of incompletely contingent nominal contracts or price and wage viscosity, the policy options are to run current deficits and/or to reduce expected future primary surpluses.

Qualifications about this model

- It's obviously over simple.
- Its conclusions would hold up or strengthen with diminishing returns technology, or introduction of labor.
- They could come out quite differently if real growth has systematic impacts on expected future primary surpluses.
- The recent crisis at least in part probably involves increased demand for liquidity services of government debt, rather than simply reduced expectations of real growth.

Why "expand" FTPL?

- The existing formal FTPL models mostly assume all government liabilities to be domestic-currency denominated. (One or two also introduce "dollar" denominated debt to discuss developing countries.)
- We are now considering a unified government balance sheet that includes substantial holdings of assets that are not risk free.
- The asset returns may not rise in proportion to a rise in the interest rate on government liabilities — indeed may well move in the opposite direction.
- With interest paid on reserves, the central bank has to set (at least) two interest rates — that on reserve deposits, and that on government debt held for its yield alone.

Some fallacies

- The Fed needs to be allowed to issue debt on its own account
- The Fed could have trouble "unwinding" its balance sheet as fast as necessary to control inflation
- The vast expansion of reserves in itself poses an inflationary threat

- Fiscal stimulus can get us out of recession; then a resolute Fed can prevent inflationary consequences
- The administration should be setting targets now for when it will have the budget back in primary surplus

6 History and data

History

- Some historical time series plots: They suggest that the assumption that there is a stable, fiscal rule that makes primary surpluses increase with the size of the debt is implausible in the US during 1970-2000.
- This implies that the convention that omits fiscal policy and the government budget constraint from macro models, under the assumption that monetary policy alone determines the price level, is untenable.

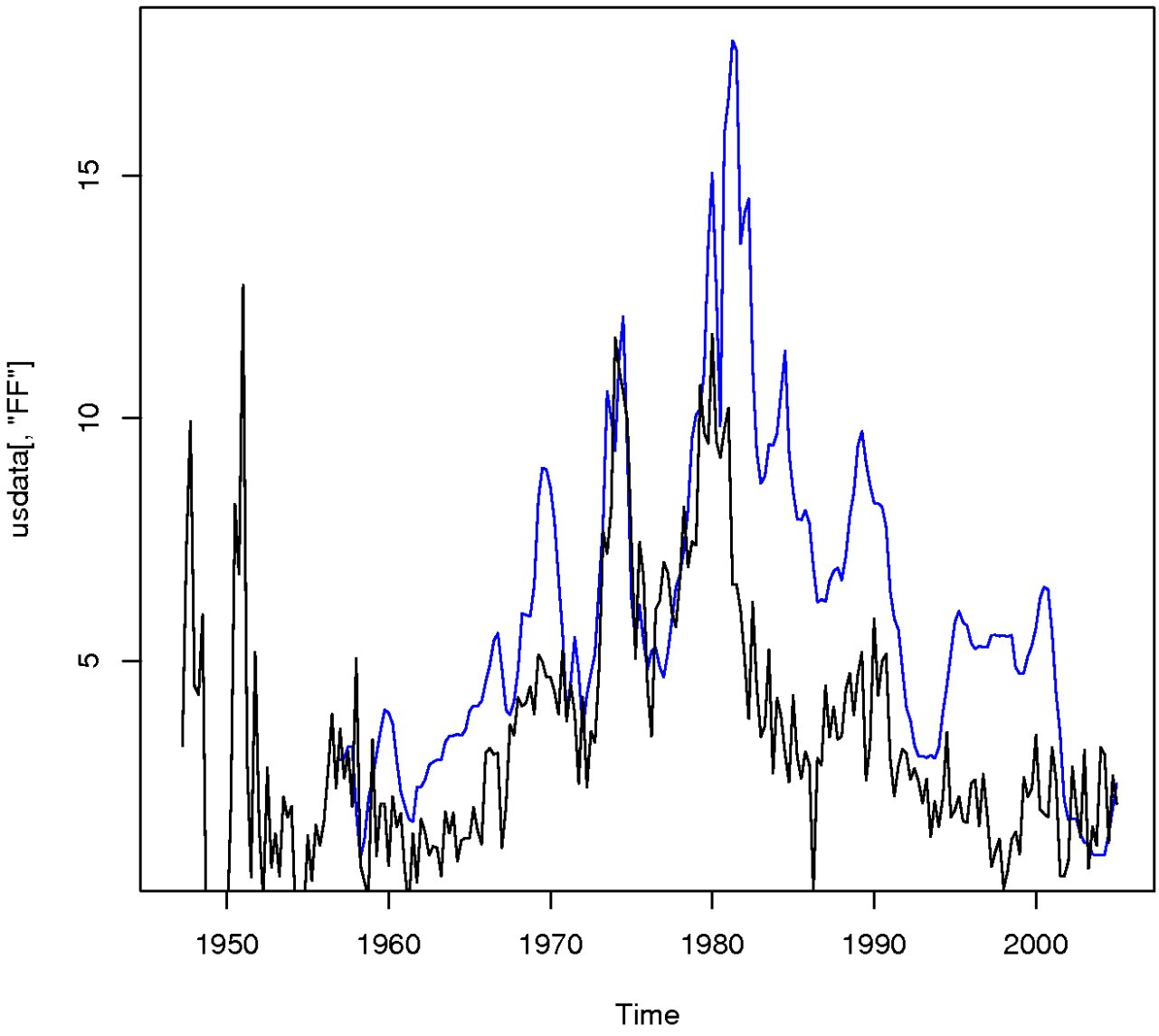
A model (from "Stepping on a Rake...")

- A model to illustrate the point that in an equilibrium where monetary policy cannot control the price level, the response of the economy to a monetary tightening could be qualitatively very similar to that in an economy where it does control the price level.
- Monetary contraction produces recession and a *temporary* decline in inflation, followed by a higher level of inflation — as seemed to happen after monetary contractions in the 70's.
- Thus there is no simple way, from looking at monetary policy alone, to be sure that fiscal policy is not impacting inflation: Despite fiscal dominance, interest rate policy may be capable of producing recessions; reaction functions that satisfy the Taylor Principle do not preclude fiscal dominance.

Possible conclusion

- Unstable fiscal policy may have played a role in the difficulty of controlling inflation with monetary policy in the 70's.
- Looking forward, it may once again be important to stabilize expectations about future fiscal policy.

6.1 The 70's: A Monetary Story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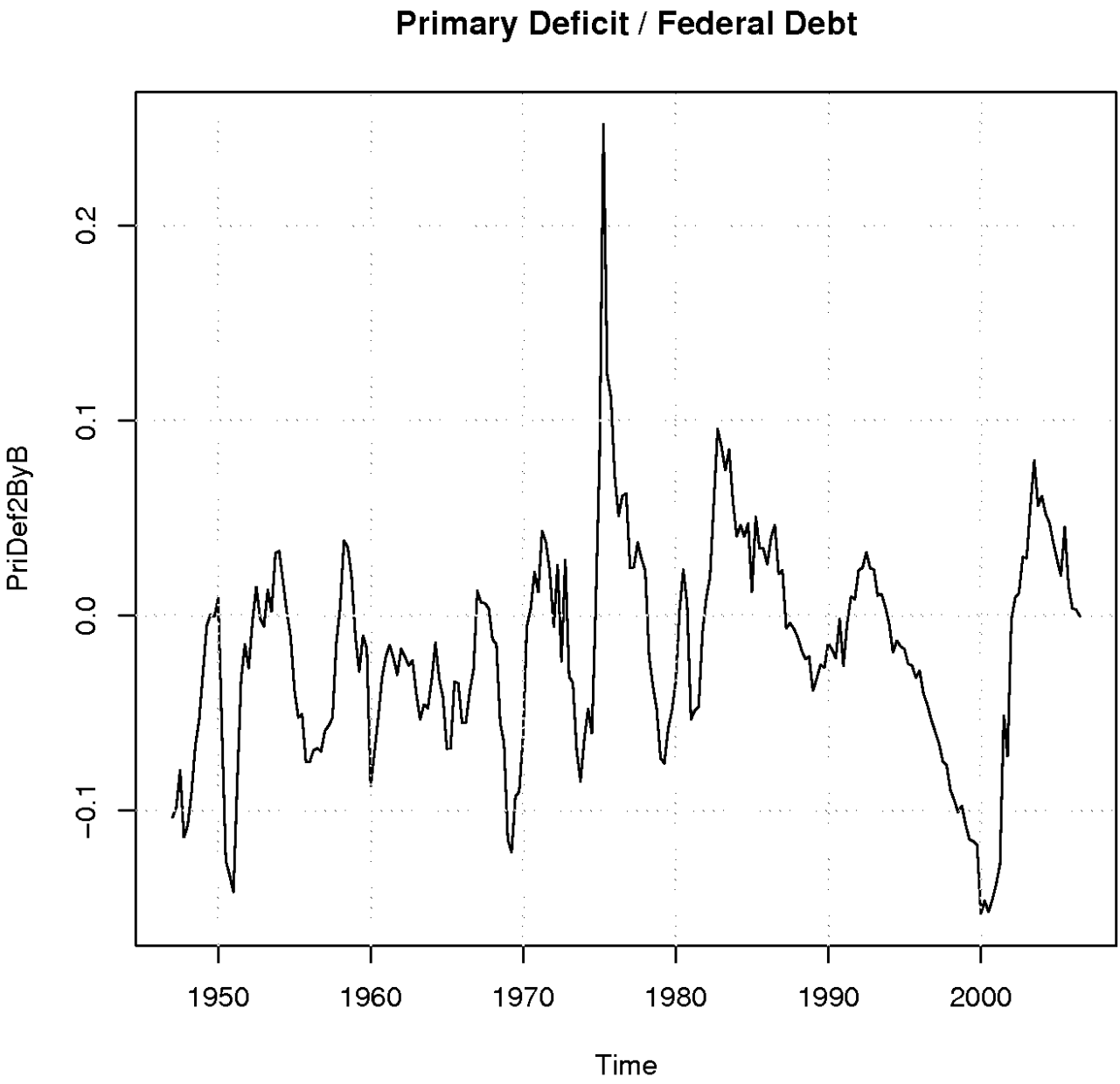
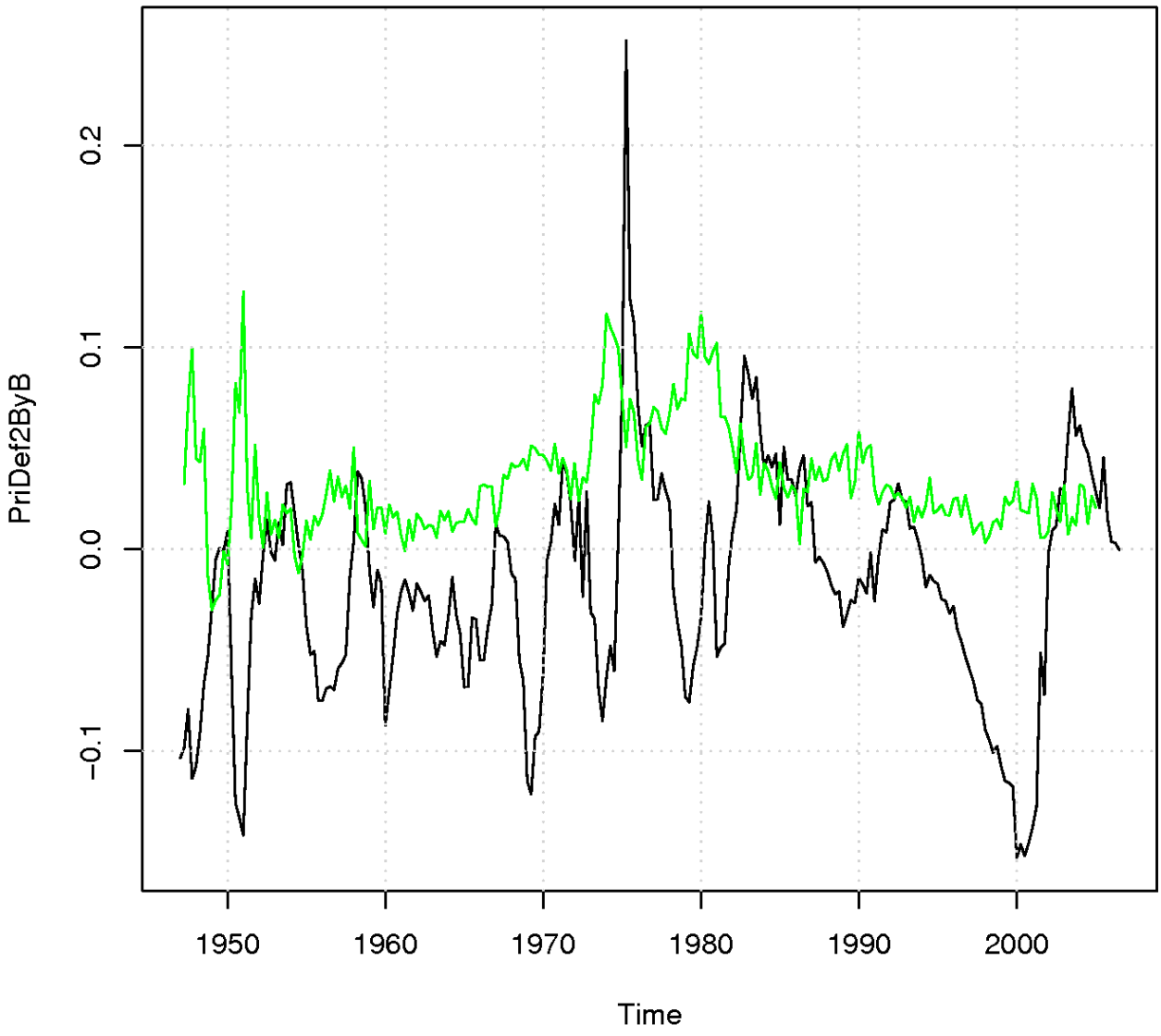
6.2 The 70′s: A Fiscal Story

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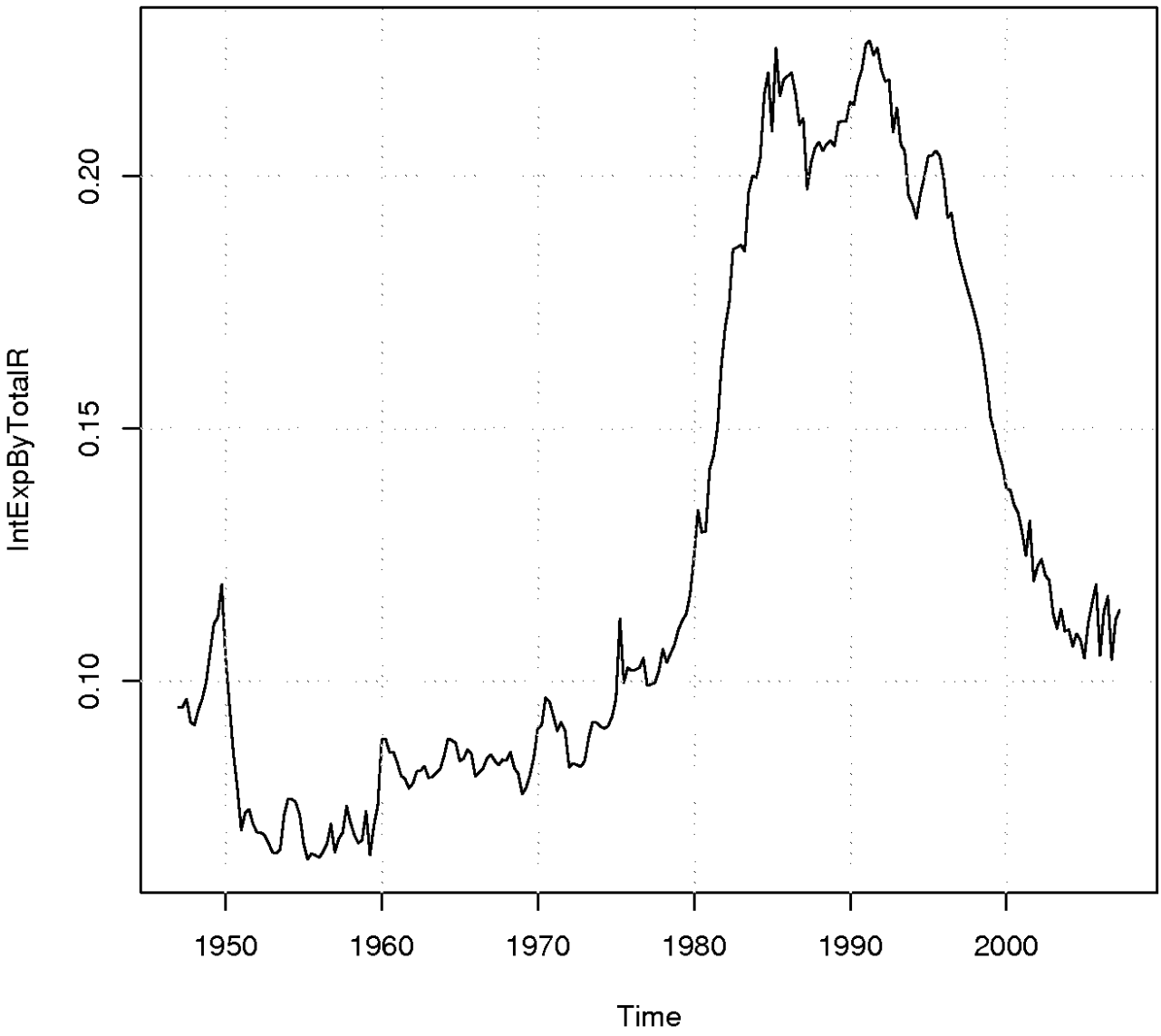
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7 FTPL sticky-price models

Bare-bones flex-price FTPL

$$
\begin{aligned}
M \text{ policy}: &\quad \dot{r} = -\gamma(r-\rho) + \theta\dot{p} + \varepsilon_m \\
\text{Fisher}^\star: &\quad r = \rho + \dot{p} \\
\text{Govt. Budg. Cnstr.}: &\quad \dot{b} = -b\dot{p} + rb - \tau \\
\text{Fiscal policy}: &\quad \dot{\tau} = \varepsilon_\tau\,.
\end{aligned}
$$

Implications of the bare-bones model

- If monetary policy pegs the interest rate, a surprise, permanent increase in the interest rate *increases* inflation, and has no other effect.
- A surprise, permanent increase in the primary surplus produces a downward, discontinuous jump in the price level, and no other effect.
- These properties make the model look unrealistic to monetary policy-makers.
- However, one guesses that with sticky prices, the model might not be so unrealistic. This was probably first investigated by Eduardo Loyo in his PhD thesis.

Extending the model

- We'd like to add sticky prices, so that real activity is affected by nominal adjustments.
- To avoid forcing big, discontinuous price jumps, we'd like to have long government debt. This allows the value of outstanding debt to adjust in response to discontinuous changes in the long interest rate, which are more plausible than discontinuous changes in the price level.
- To get a continuous, instead of jump, response of output to shocks, we introduce habit in consumption via a quadratic penalty on $\dot{c}^2$.

Stepping-on-a-rake model

$$
\begin{aligned}
M \text{ policy}: &\quad \dot{r} = -\gamma(r - \bar{\rho}) + \theta\dot{p} + \phi\dot{c} + \varepsilon_m \\
\text{Fisher}^\star: &\quad r = \rho + \dot{p} \\
\text{IS}^\star: &\quad \rho = -\frac{\dot{\lambda}}{\lambda} + \bar{\rho} + \varepsilon_r \\
\text{Govt. Budg. Cnstr.}: &\quad \dot{b} = -b\dot{p} - b\frac{\dot{a}}{a} + ab - \bar{\tau} - \tau \\
\text{term struct.}^\star: &\quad r = a - \dot{a}/a \\
\text{Phillips curve}^\star: &\quad \ddot{p} = \beta\dot{p} - \delta c - \varepsilon_{pc} \\
\text{Fiscal policy}: &\quad \dot{\tau} = \omega\dot{c} + \varepsilon_\tau \\
\text{habit}^\star: &\quad \lambda = e^{-\sigma c} + \psi(\ddot{c} - \dot{c}^2)e^{-c}
\end{aligned}
$$

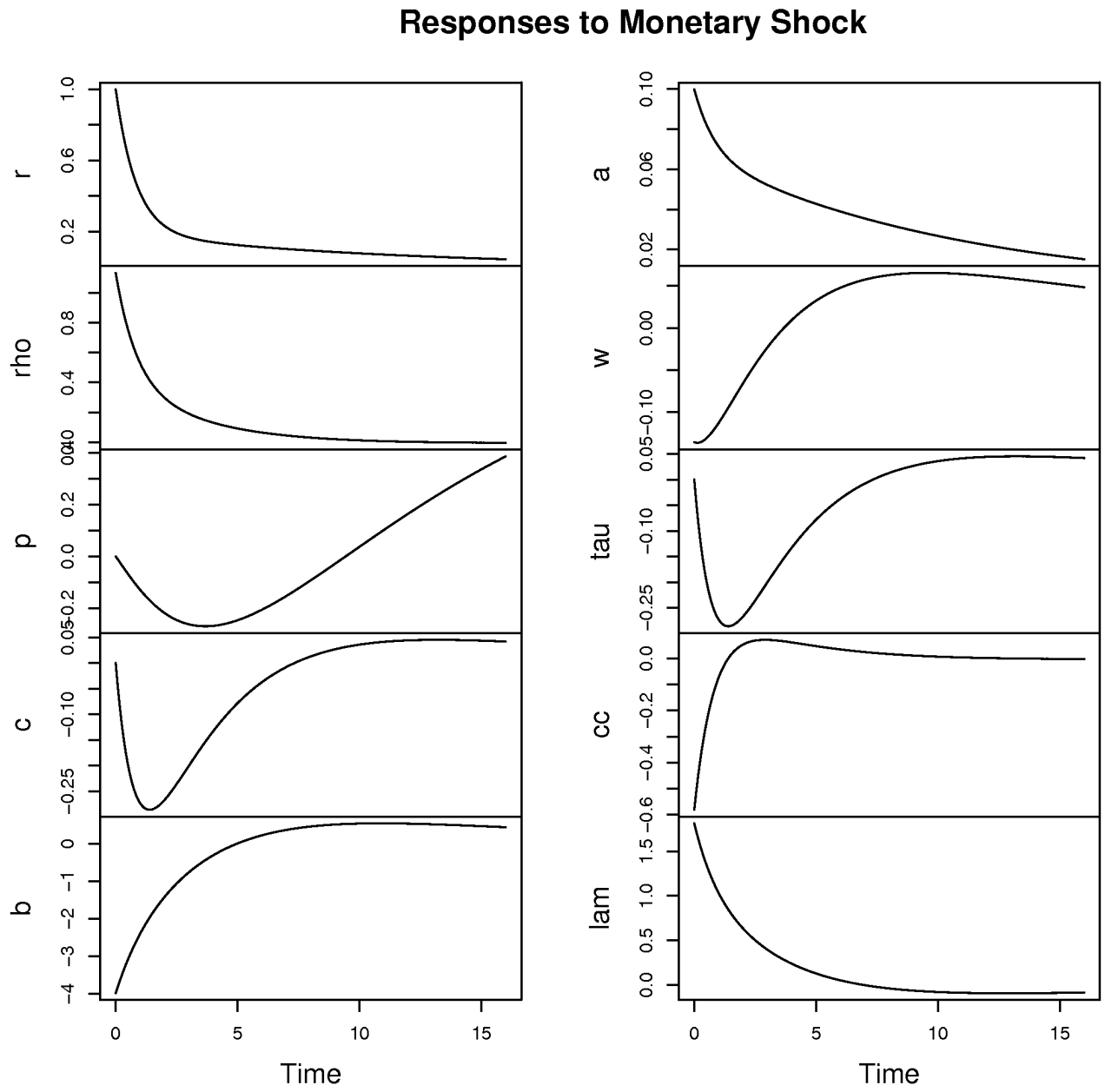
$\star$: forward-looking equation; a: consol rate; b: $B/(aP)$; P: the price level; B: the number of outstanding consols; λ: Lagrange multiplier on the consumer's budget constraint

Parameter values for impulse responses:

γ	θ	ϕ	σ	$\bar{\rho}$	$\bar{\tau}$	β	δ
0.20	0.208	0.10	2.00	0.05	0.10	0.50	1.00

Insights from a reduced form VAR

- This is a model fit to quarterly data from 1957-2005 on the primary deficit divided by market value of marketable Treasury debt, the consumption price deflator, real GDP, the federal funds rate, and the 10 year Treasury rate.
- Observe that there is one shock, the consumption deflator innovation (after contemporaneous correlation with the primary deficit variable is removed), that is the most important source of long run variation in both the primary deficit divided by gdp, and the price level.
- Long run effects are sometimes poorly estimated. But these are statistically fairly firm.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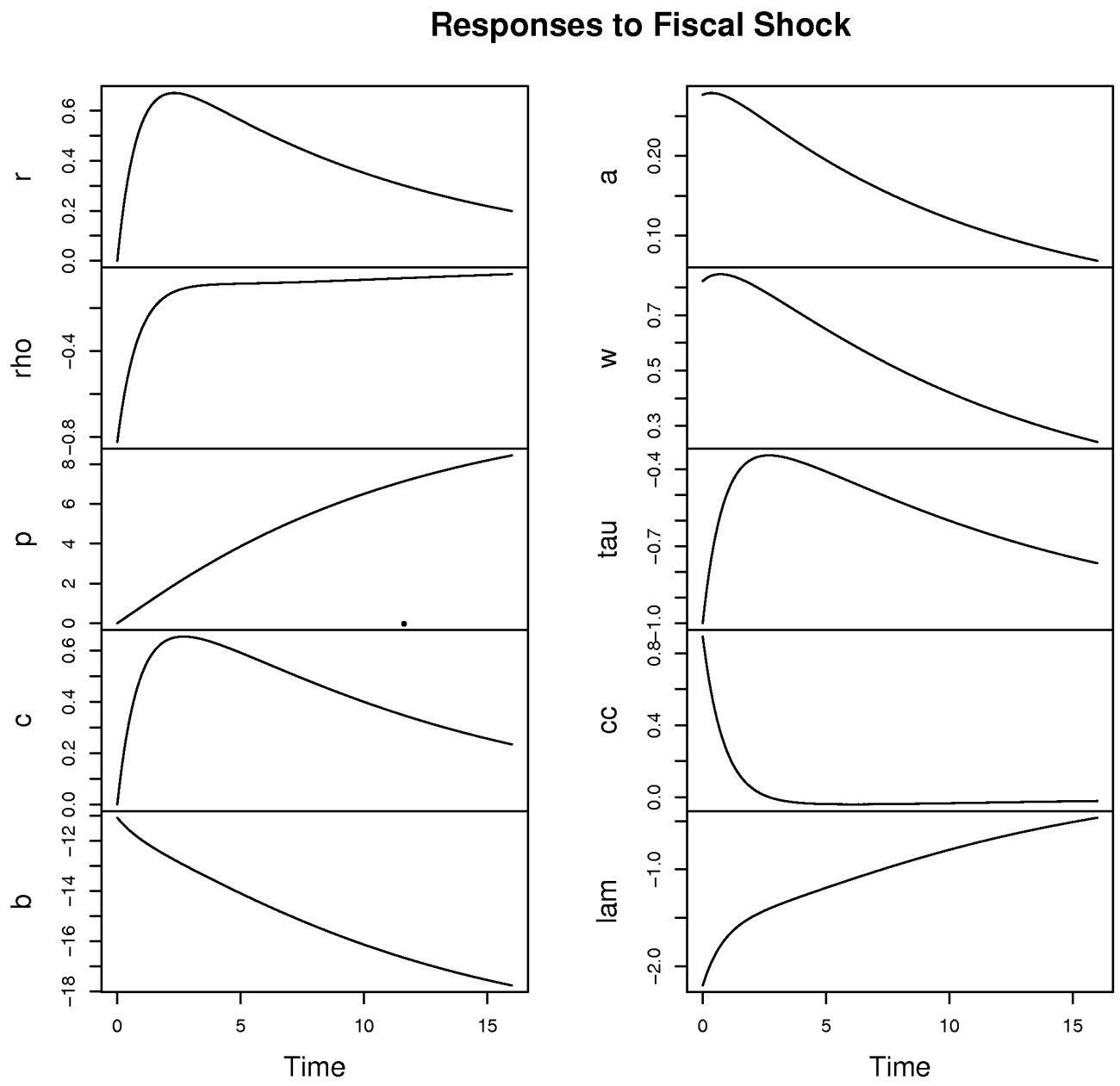
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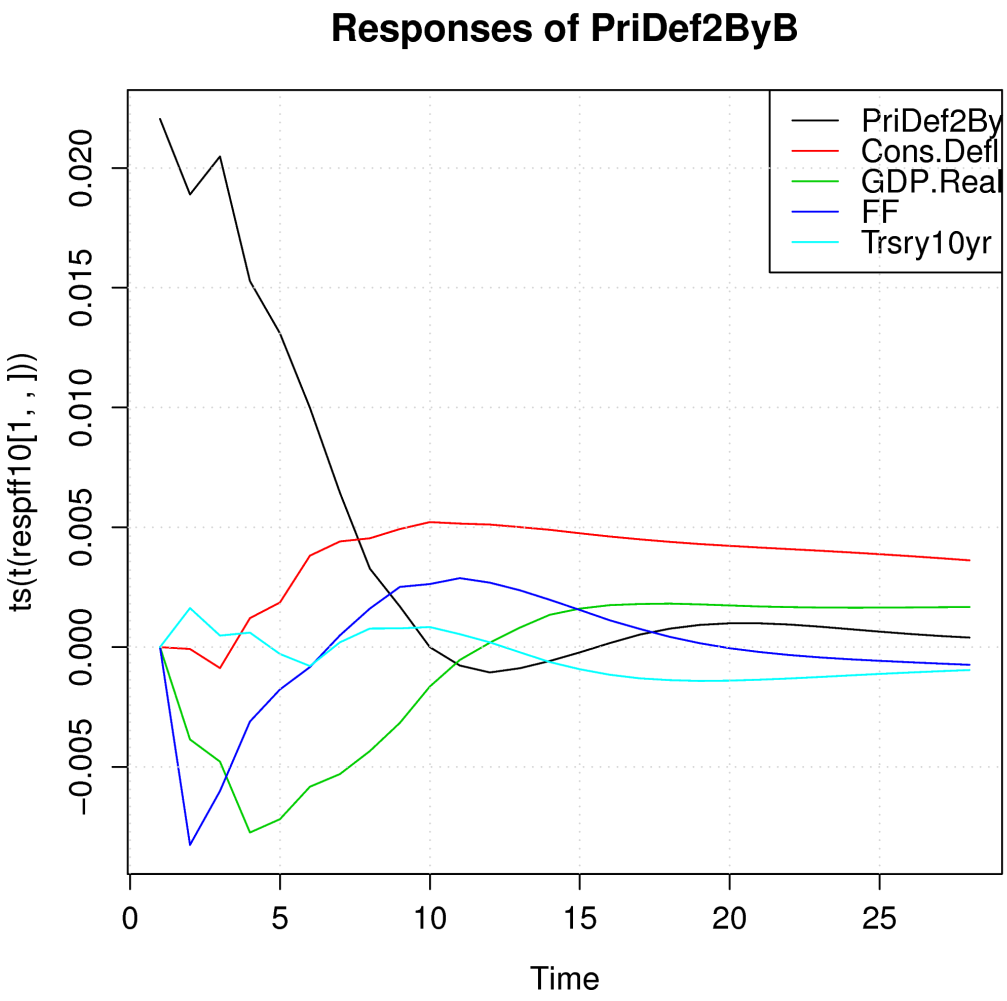
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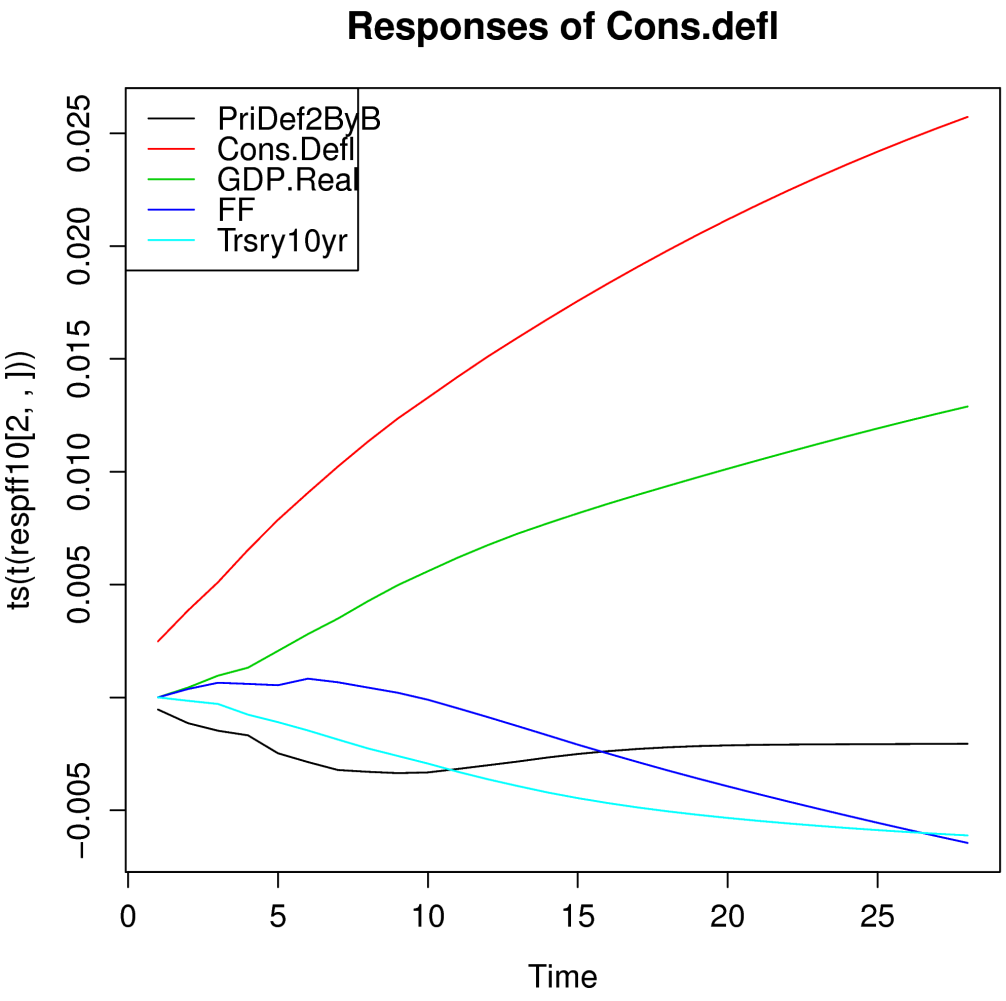
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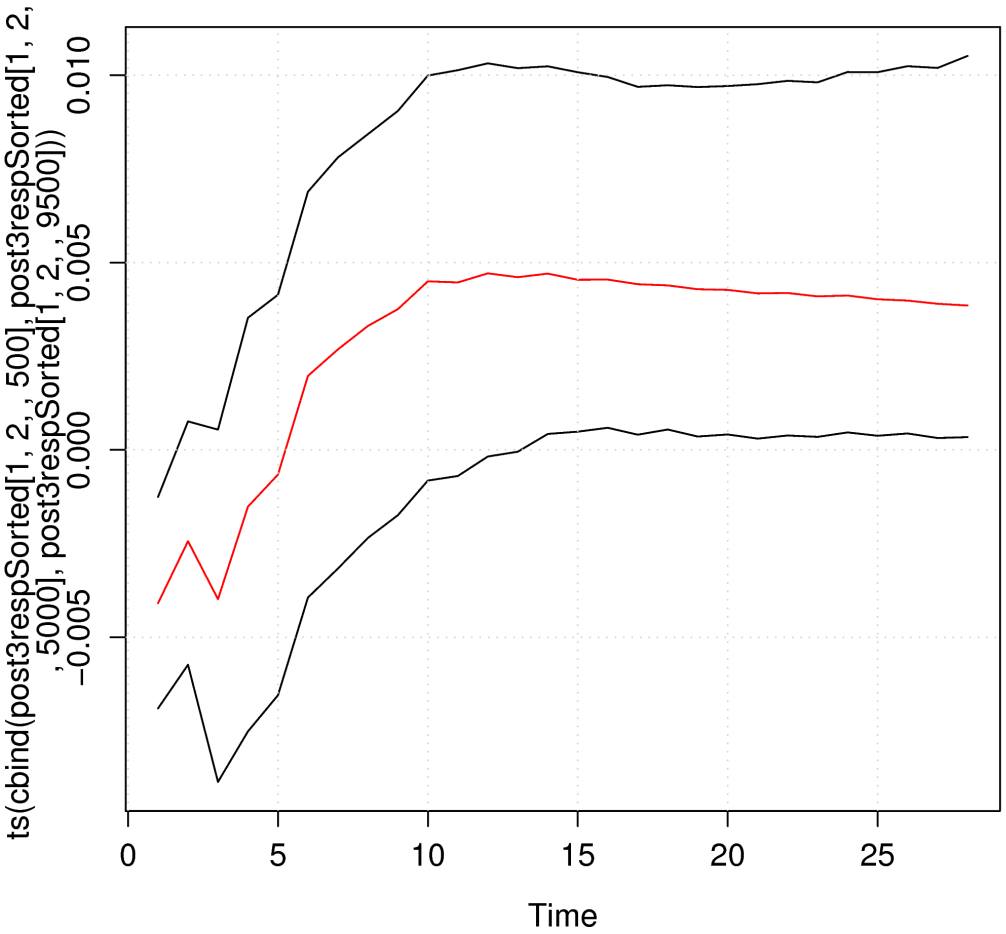
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Fiscal/monetary interaction, policy models, and the current crisis

- It is a sad fact that none of the policy models in use at central banks, to my knowledge, have complete and correct treatments of the wealth and valuation effects by which fiscal policy influences spending and inflation.
- As many have argued that the Fed *should* have done in the 30's, today's Fed is making risky interventions that have potential fiscal consequences.
- Several recent papers have developed the point that in a deflationary crisis, successful policy must create expectations of future inflation. This requires articulating and implementing an inflation target or goal, and requires that fiscal policy as well as monetary policy aim toward the target.
- The existing crop of models are of little use as frameworks for analyzing how fiscal policy and expectations of future fiscal policy affect inflation.

Conclusion

- We need more thinking, and more discussion, about how inflation can be controlled in the new policy environment.
- This will require planning for the possibility of substantial fiscal impacts from monetary policy and for the possibility of substantial fiscal pressures on monetary policy.
- Policy makers should be clear and explicit that the central bank cannot control inflation if fiscal policy provides it with no backing.
- Central bankers resist talking openly about these issues for fear of undermining confidence, but this may be short-sighted.

FTPL and game theory I: "policy rules"

- This type of theory — rational expectations competitive general equilibirum — postulates behavioral rules for government and explores the resulting equilibrium, assuming the government will stick to the postulated rule.

- Also interesting are models in which government behavior is modeled at a deeper level, assuming given objective functions and/or policy-making institutions.
- But this is harder, and may end up being more unrealistic. It may be easier to specify how the government behaves than to explain why.

FTPL and game theory II: "off equilbrium path behavior"

- Postulated policy rules may be infeasible in case of some behavior of other agents that is technically feasible, even though not optimal for them on the equilibrium path.
- It is therefore important to consider whether there is a plausible and technically feasible behavior for the government in these circumstances that preserves the incentives for agents to stay on the equilibrium path.
- Specifying a game structure that in this way supports FTPL models is not particularly difficult. In fact it is easier to do so than to do the same for traditional active-money, passive-fiscal rational expectations equilibria.
- These are the conclusions of two papers by Bassetto, though in his papers' conclusions he doesn't emphasize that his results are basically supportive of the FTPL approach.