A Note on Unconventional Monetary Policy in HANK[*]

Greg Kaplan   Benjamin Moll   Giovanni L. Violante

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Abstract

This note contains supplementary material to Kaplan, Moll, and Violante (2016). In the first part, we analyze the effectiveness of forward guidance in HANK. We show that, in contrast to representative-agent economies, the announcement of a future interest rate cut in our baseline economy has a smaller impact on current consumption than an equal-size contemporaneous cut. We explain the role of hand-to-mouth households and fiscal policy in accounting for this finding. In the second part, we study the transmission of a conventional monetary policy shock in an economy where household liquidity is provided by the private sector rather than by the government. Like in our baseline economy, it is also true that indirect general equilibrium effects dominate the direct intertemporal substitution channel for stimulating consumption: lowering the nominal interest rate reduces the cost of funds for firms and induces an investment boom that, in turn, triggers a rise in aggregate labor demand.

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1 Introduction

This note contains results from additional experiments run in the Heterogeneous-Agent New Keynesian (HANK) framework developed in Kaplan, Moll and Violante (2016) (KMV hereafter).

Section 2 is an analysis of forward guidance in HANK. When the monetary authority is constrained in its ability to lower nominal rates, forward guidance, i.e. the public announcement of the monetary authority's intention to implement a certain path of future rates, may be a tempting alternative policy tool.

As highlighted by Carlstrom, Fuerst and Paustian (2012) and Del Negro, Giannoni and Patterson (2015), this strategy holds great promise when viewed through the lens of Representative-Agent New Keynesian (RANK) models: a commitment to lower interest rates far in the future is at least as effective as conventional monetary policy at increasing aggregate consumption in the short run. In RANK, when interest rates are expected to fall in the future, output is expected to rise. The forward-looking unconstrained representative agent anticipates this increase in income and immediately starts spending more in order to smooth consumption. This leads to an increase in aggregate demand which raises current household labor income up, generating (possibly substantial) further increases in consumption.

We begin by revisiting, and confirming, this result in a simple version of the RANK model that yields closed-form solutions for the effectiveness of forward guidance. We then show that introducing hand-to-mouth households into this economy does not diminish the power of forward guidance, but only alters the decomposition of its effects in favor of indirect general equilibrium effects, vis-a-vis direct intertemporal substitution effects. As long as a positive fraction of households are not constrained *and* these are the agents that are largely responsible for the initial impulse to aggregate demand, forward guidance is as effective as conventional monetary policy.

Recent research by McKay, Nakamura and Steinsson (2015) and Werning (2015) examines to what extent this finding carries over to economies with incomplete markets where, because of idiosyncratic uncertainty, households have a precautionary saving motive. In partial equilibrium, this precautionary motive leads households to choose a more conservative consumption response to future cuts in the interest rate. Werning (2015) provides a useful benchmark in which nevertheless the overall effectiveness of forward guidance is unaffected relative to a representative agent economy, because the lareger indirect general equilibrium

effects exactly offset the smaller partial equilibrium response. In contrast, McKay, Nakamura and Steinsson (2015) consider an alternative incomplete-market economy in which forward guidance is less effective than conventional monetary policy.

Here, we follow the lead of these two papers and examine the quantitative effects of forward guidance in our HANK framework. Our main conclusion is that forward guidance is generally *less* effective in HANK than is conventional monetary policy at boosting aggregate consumption in the short run. The crucial distinction between RANK and HANK is the identity of the households who are responsible for the initial impulse from a conventional monetary shock into aggregate demand. In our baseline HANK economy, in which lump-sum transfers adjust to balance the intertemporal government budget constraint, it is predominantly hand-to-mouth households who are the principal source of this initial impulse, because of their high marginal propensities to consume out of the rise in government transfers. In contrast, unconstrained households do not contribute much to the initial impulse to aggregate demand because income effects and portfolio reallocation effects largely offset the standard intertemporal substitution channel. But when the interest rate cut is far in the future, so is the ensuing fiscal adjustment, and hence the initial impulse is lacking. Thus the current impact of forward guidance is much diminished.

Section 3 develops an alternative version of the model in KMV. One of the conclusions of KMV is that the fiscal policy response to the monetary policy shock matters for the overall effectiveness of monetary policy and for the decomposition of the transmission mechanism of the monetary shock into direct/indirect effects. Here, we develop a model without government debt to abstract from the fiscal-monetary policy interaction - in this economy the private sector, rather than the government, supplies liquid assets to the household sector.

Our main conclusion is that, even in this economy, the direct intertemporal substitution channel is very small and almost all of the response of consumption is due to general equilibrium indirect effects. Here the source of the direct impulse to aggregate demand is obviously not an increase in net fiscal transfers or in government expenditure, but is rather through investment. Cutting the nominal interest rate reduces the cost of funds for firms and induces an investment boom. This investment boom is sufficient to trigger the larger indirect effects from increased labor income, which contribute to the majority of aggregate consumption growth.

2 Forward Guidance

We begin by studying forward guidance in a simple version of RANK, as in Section 2 of KMV. We then move to the analysis in HANK.

2.1 Forward Guidance in Benchmark New-Keynesian Models

We now generalize the analysis of a conventional monetary policy shock that we conducted in Section 2 of KMV to forward guidance. Within that same RANK model analyzed in section 2.1 of KMV, we now assume that the monetary authority commits to the following path of real rates:

$$
r_t = \begin{cases} \rho, & t < \tau \\ \rho + e^{-\eta(t-\tau)}(r_\tau - \rho), & t \geq \tau \end{cases} \tag{1}
$$

where $r_\tau \neq \rho$ and where $\tau \geq 0$. To analyze the effects of forward guidance about future interest rates we set $\tau > 0$.

As in Section 2.1 one can calculate the overall effect of monetary policy from the Euler equation only: $C_t = \bar{C} \exp\left(-\frac{1}{\gamma}\int_t^\infty (r_s - \rho)ds\right)$. It is straightforward to show that the elasticity of current aggregate consumption to the forward guidance announcement in (1) is given by:

$$
\frac{d\log C_0}{dr_\tau} = -\frac{1}{\gamma\eta}. \tag{2}
$$

The overall effect on initial consumption is therefore unchanged, independently of the date at which the shock occurs. In other words, forward guidance and conventional monetary policy are equally effective. When the assumption of perfect price rigidity is relaxed, forward guidance turns out to be even more powerful than conventional monetary policy.[1] This somewhat counterintuitive result has to do with the relative importance of direct and indirect effects which we turn to next.

To decompose the overall consumption response into direct and indirect effects, we make use of the fact that KMV's Proposition 1 applies for arbitrary interest rate time paths $\{r_t\}_{t\geq 0}$. We can therefore simply feed in the interest rate path under forward guidance (1). While forward guidance does not change the overall responsiveness of consumption to an interest

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[1]This is because forward guidance triggers a larger rise in inflation that feeds back into even lower real rates. See e.g. Del Negro, Giannoni and Patterson (2015).
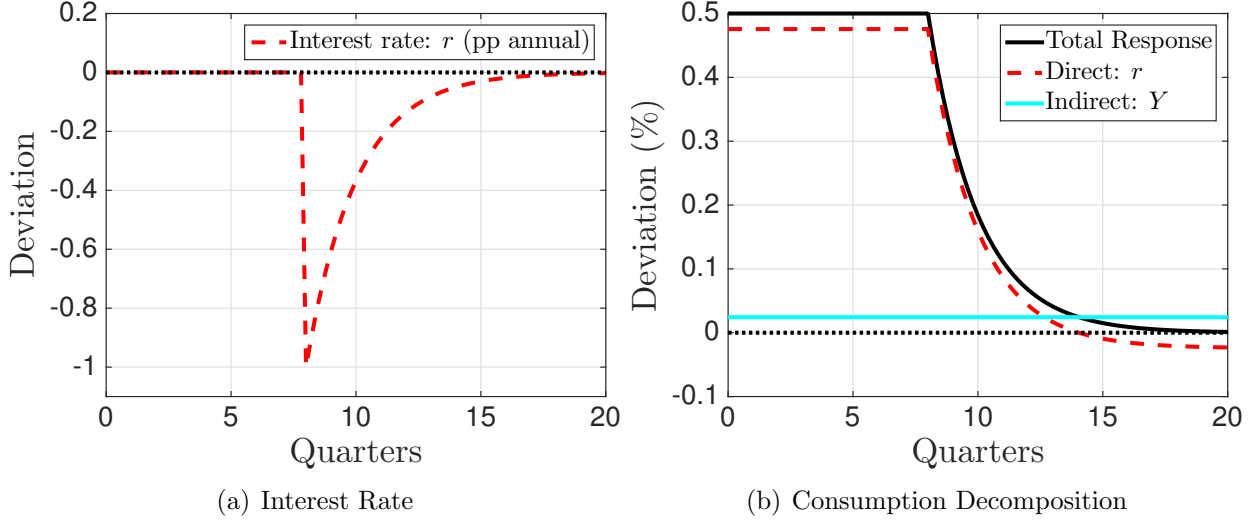
(a) Interest Rate   (b) Consumption Decomposition

Figure 1: Forward guidance in RANK

rate cut, the decomposition changes and becomes:

$$-\frac{d\log C_0}{dr_\tau} = -\frac{d\log C_0}{dr_0} = \frac{1}{\gamma\eta}\Big[\underbrace{e^{-\rho\tau}\frac{\eta}{\rho+\eta}}_{\text{direct response to } r} + \underbrace{1-e^{-\rho\tau}\frac{\eta}{\rho+\eta}}_{\text{indirect effects due to } Y}\Big].$$

Importantly, the direct effect is decreasing in the horizon of forward guidance τ. However, the indirect effects are increasing in the horizon of forward guidance and this exactly offsets the declining direct effect. Intuitively, the forward-looking unconstrained representative agent anticipates this increase in income and starts spending more immediately to smooth consumption. In turn, this rise in aggregate demand pushes current income up, and so on. This being said, for forward guidance about interest rates in the not-too-distant future, the direct effect still account for most of the overall effect. For instance with quarterly values of $\rho = 0.5\%$ and $\eta = 0.5$ as in KMV and an interest rate cut in $\tau = 8$ quarters, the direct effect accounts for $e^{-\rho\tau}\frac{\eta}{\rho+\eta} \approx 95\%$ of the overall effect.

Figure 1 illustrates forward guidance in this simple RANK model. Panel (a) plots the time path for the interest rate (1) with $\tau = 8$ and $r_\tau - \rho = -1\%$ annually. Panel (b) plots the overall consumption response and decomposes it into direct and indirect effects. As expected, the direct effect accounts for most of the overall consumption response.[2]

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[2]The reader may wonder why size of the indirect effect does not depend on calendar time t. This follows immediately from the fact that the representative household is Ricardian and therefore her consumption depends only on her permanent income which is the same for all time t.

Finally, we analyze forward guidance in the Two-Agent New Keynesian (TANK) model with debt studied in section 2.2 of KMV in which a fraction Λ of households are Non-Ricardian "spenders." First consider the case without government debt $B_0 = 0$. One can then show that, even though introducing hand-to-mouth households into this economy, alters the decomposition in favor of indirect effects it does not change the overall effect of forward guidance which is still given by (2). The reason is that in both economies, the households who are responsible for the direct effects are forward-looking and can borrow at the risk-free rate. These households (the "savers") understand that consumption, and hence income, will increase at the time of the actual interest rate change. Seeking to smooth consumption in response to this perceived increase in future income, they increase current consumption, which in general equilibrium leads to an increase in current income. That forward guidance may be effective even if direct effects are small is essentially the point made by Werning (2015), who emphasizes the importance of such general equilibrium effects.

Next, consider forward guidance in the TANK model with government debt, $B_0 > 0$. In this model, it can be shown that for small deviations of r_τ from its steady state value ρ, we have:

$$\frac{d \log C_0}{d r_\tau} = -(1 - \Lambda)^{-1} \Lambda^T \frac{B_0}{\bar{Y}} \mathbf{1}_{\{\tau=0\}} + \frac{1}{\gamma \eta}. \tag{3}$$

Here Λ is the fraction of Non-Ricardian "spenders" in the economy, Λ^T is the fraction of government transfers they receive, B_0 is the level of government debt and $\mathbf{1}_{\{\cdot\}}$ is the indicator function. Equation (3) shows that in this economy the consumption response to a reduction in interest rates at $\tau > 0$ is weaker than a reduction at time $\tau = 0$, as long as there is positive government debt in steady state ($B_0 > 0$) *and* a positive fraction of Non-Ricardian households who receive transfers ($\Lambda^T > 0$) when the government budget constraint adjusts. The reason is that, under forward guidance, the reduction in interest payments on government debt (and therefore any transfers to Non-Ricardian households) occurs in the future, that is the first term in the right-hand side of (3) vanishes. This logic, as we will see, extends to HANK.

2.2 Forward Guidance in HANK

Forward guidance is effective at increasing consumption at short horizons as long as the households who account for the *impulse* to aggregate demand, following a conventional monetary policy shock, increase their consumption in response to future increases in income. This is the case for RANK and for TANK models without government debt (as explained

in Section 2), as well as for heterogeneous-agent models that fall into the 'as if' category defined by Werning (2015).

However, as explained in KMV, in HANK its often non-Ricardian hand-to-mouth households that account for the bulk of the initial impulse of monetary policy into aggregate demand. When this is the case, we should expect the power of forward guidance relative to that of conventional monetary policy to be greatly weakened. Even though these households understand that their consumption, and hence income, will increase at the future date of the actual rate cut, they are unable or unwilling to borrow against that future increase in income, and so current consumption is unaffected. Because current consumption is not affected, there is no impulse to spark the (potentially substantial) general equilibrium amplification.

To quantify the effects of forward guidance in HANK, we conduct the following experiment in the baseline model of KMV where transfers absorb the adjustment in the government budget constraint. At $t = 0$ the monetary authority announces that there will be an innovation $\epsilon < 0$ to the Taylor rule at $t = 8$ quarters, which will then decay at a rate of 0.5 as in the experiments in KMV. The resulting equilibrium time path for the real liquid rate is shown in Figure 2(a) (dash blue line). The real rate increases only slightly on impact as the Taylor rule endogenously responds to the small rise in inflation that arises from the modest boom occurring at impact. At the time of the cut, the real rate falls by a similar amount as it does under conventional monetary policy on impact.

In response to forward guidance, at $t = 0$ consumption increases by less than one fifth of the response to an actual cut in rates at $t = 0$ (Figure 2(b)). Following the announcement, consumption continues to increase and peaks around the time of the rate cut. The reason for the smaller initial response is that the interest payments on government debt do not fall until the actual policy change. With our baseline assumption about fiscal policy, this means that transfers also do not rise until that time, as evident from Figure 2(c).[3] As explained in KMV, absent this initial impulse coming from the hand-to-mouth households, monetary policy is very weak because in HANK, the direct intertemporal substitution channel is negligible.[4]

Forward guidance is equally ineffective under alternative assumptions about fiscal policy. When government expenditures adjust (Figure 3), the results are even more more stark. For the reasons described in KMV, the effects of an immediate reduction in rates are larger

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[3]The small rise before $t = 8$ is due to the small boom and the ensuing equilibrium expansion of the tax base and of tax revenues.

[4]Clearly, if the government responded to forward guidance by increasing transfers at $t = 0$, this policy response would have an immediate impact on consumption. In this case, forward guidance is merely a signal from the central bank to the government, and fiscal policy is doing the work.

when G adjusts. However, the consumption response to forward guidance is essentially zero, since in this scenario, virtually all of the impulse of monetary policy comes from higher government expenditures, which do not occur until the government budget constraint is affected. A significant macroeconomic response on impact is not only lacking for aggregate consumption, but also for government expenditures and output.

When government debt adjusts (Figure 4), the economy responds very weakly to both conventional monetary policy and forward guidance. The reason that the two forms of monetary policy are approximately equally (in)effective is that virtually the entire initial impulse is driven by unconstrained households. But the impulse from intertemporal substitution is small due to offsetting income and portfolio reallocation effects, and therefore so is the economy's response to both conventional monetary policy and forward guidance.

3 Financial Leverage and Return Linkages

The results in KMV may leave some readers with the impression that a fiscal response is necessary for monetary policy to have any real effects in the HANK model. This is not true. In this section we describe a modification to the model in which fiscal adjustment plays essentially no role –yet all of the key conclusions of KMV remain.

To do this we assume that the government does not issue any debt, $B_t^g = 0$. Instead we allow the financial sector, as represented by the representative investment fund, to issue liquid liabilities to the household sector, B_t^f. We assume that the investment fund has access to a liquidity transformation technology, which enables it to reinvest these funds as illiquid assets. Since this effectively allows the investment fund to earn a positive return $r_t^a - r_t^b$ on each unit of these liabilities, we limit the quantity that it can issue to be less than an exogenous fraction ζ of its assets K_t.

There are three key differences from the baseline model. First, the liquid asset market clearing condition becomes

$$B_t^h + B_t^f = 0. \tag{4}$$

Second, the capital market clearing condition becomes

$$K_t = (1 - \omega) A_t - B_t^f, \tag{5}$$

and, since it is optimal for the investment fund to issue liquid liabilities to the full extent

allowed, in equilibrium $B_t^f = -\zeta K_t$. Hence the equilibrium capital stock is

$$K_t = \frac{(1 - \omega)A_t}{1 - \zeta}. \tag{6}$$

Third, the equilibrium return on illiquid assets becomes

$$r_t^a = \frac{1}{1 - \zeta} \left(\max_u \{r_t^k u - \delta(u)\} + q_t - \zeta r_t^b \right). \tag{7}$$

where u denotes capacity utilization, as in KMV. The return on illiquid assets reflects the fact that in this economy illiquid assets are effectively a leveraged claim on capital. When $\zeta = 0$ the return collapses to the return in the baseline model. When $\zeta > 0$, the return on illiquid assets r^a is increasing in the amount of allowed leverage.

Introducing financial leverage creates an additional channel through which monetary policy can effect the economy. A fall in r_t^b effectively lowers the cost of funds for the financial sector. This force puts upward pressure on r_t^a: the investment fund levers up more cheaply and hence generates larger profits for its investors —those households who hold illiquid assets.[5] From households' perspective this manifests as an increase in the spread between r_t^a and r_t^b, which induces them to shift resources towards illiquid assets and thus increases the supply of capital. Relative to the baseline economy without leverage, it is this additional investment that occurrs in equilibrium that represent the main impulse from monetary policy onto aggregate demand.[6]

We calibrate the leverage parameter $\zeta = 9.5\%$ so that in steady-state, the quantity of liquid assets issued by the fund B_t^f are the same as the liquid assets held by the household sector in the baseline economy. In order to keep the steady-state illiquid return the same as in the baseline economy we increase the depreciation rate on capital from 10% to 8.5% per annum. The resulting steady state economy is essentially identical to the baseline economy.

Figure 5 shows the impulse response for non-durable consumption in response to a monetary shock in the baseline economy and the economy with financial leverage. With financial leverage the total elasticity to the initial drop in r^b is 2.6 (in absolute value) as opposed to 2.1 in the baseline economy of KMV. Almost the entire response of consumption is due

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[5]Note though that r_t^a may still fall in equilibrium depending on the size of the monetary shock and the fall in the rental rate r_t^k.

[6]Intuitively, in the baseline economy when r_t^b falls, the reduced interest payments on liabilities to the household sector are redistributed to households via government transfers. In this economy, when r_t^b falls the reduced interest payments on liabilities to the household sector are returned to households via an increase in the illiquid asset return.

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to the indirect effects. In this economy the source of the impulse into aggregate demand is investment. Investment increases more than in the baseline economy because when liquid rates fall, investing in illiquid assets becomes more attractive since leverage is cheaper. This investment boom is sufficient to trigger the larger indirect effects from increased labor income, which contribute to the bulk of the growth in aggregate consumption. As in the baseline model, the indirect general equilibrium effects account for almost all of the overall effect, and the direct intertemporal substitution channel is tiny.

Finally, one can show that in this economy, the aggregate consumption response to a monetary policy shock depends on the degree of leverage ζ. When leverage is greater, the response of investment is stronger and, as a result, consumption grows more. Therefore, the model suggests that the effectiveness of monetary policy may heavily depend on all those institutional and economic features that determine the aggregate degree of financial leverage of the economy.

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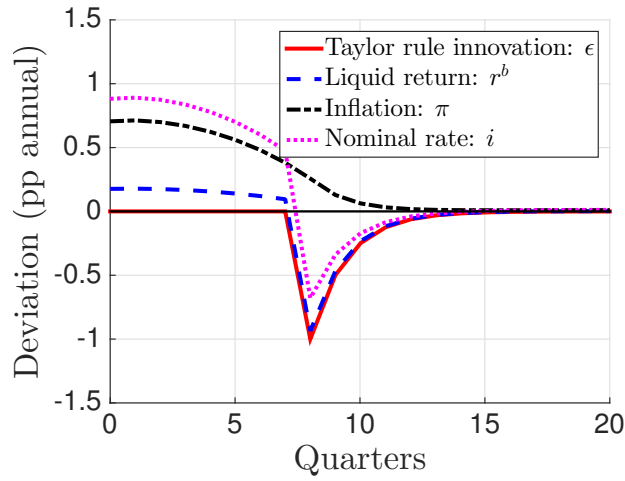
(a) MP Shock, Interest Rate, Inflation
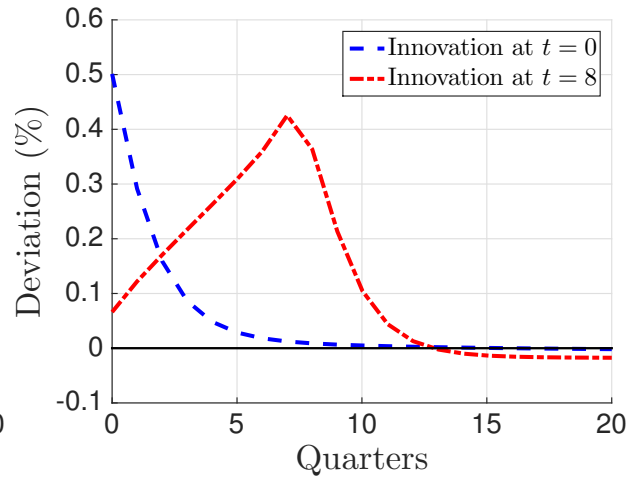
(b) Nondurable consumption
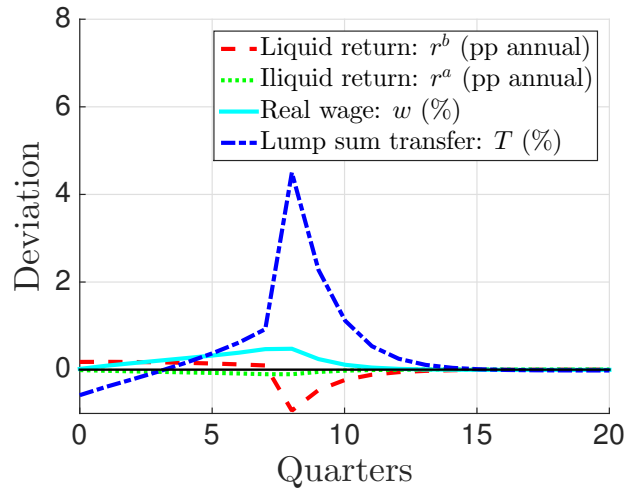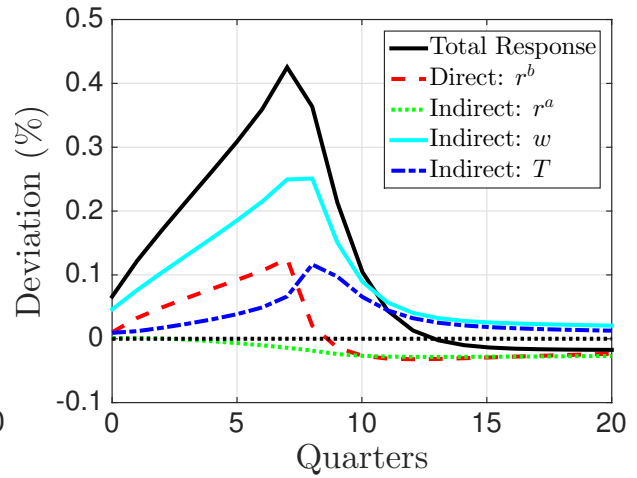
(c) Prices

(d) Consumption Decomposition

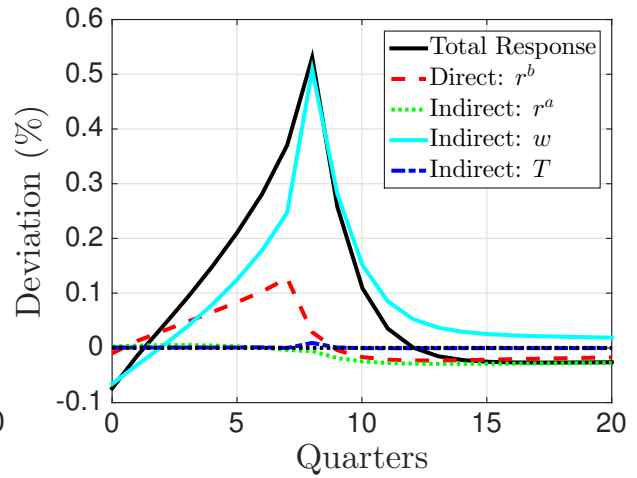Figure 2: Forward guidance: transfers adjusting
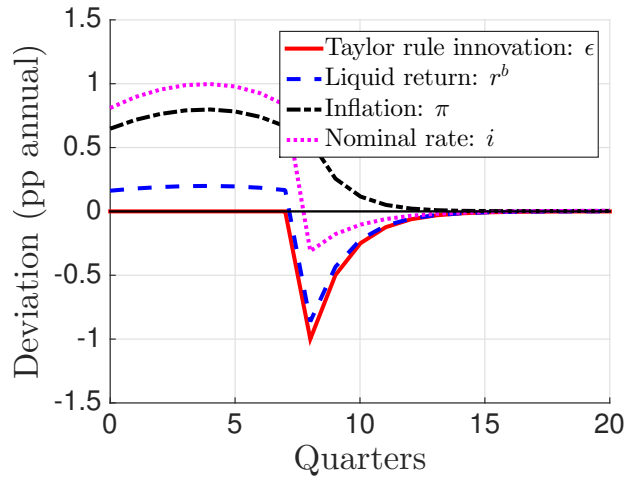
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(a) MP Shock, Interest Rate, Inflation

(b) Nondurable consumption

(c) Prices

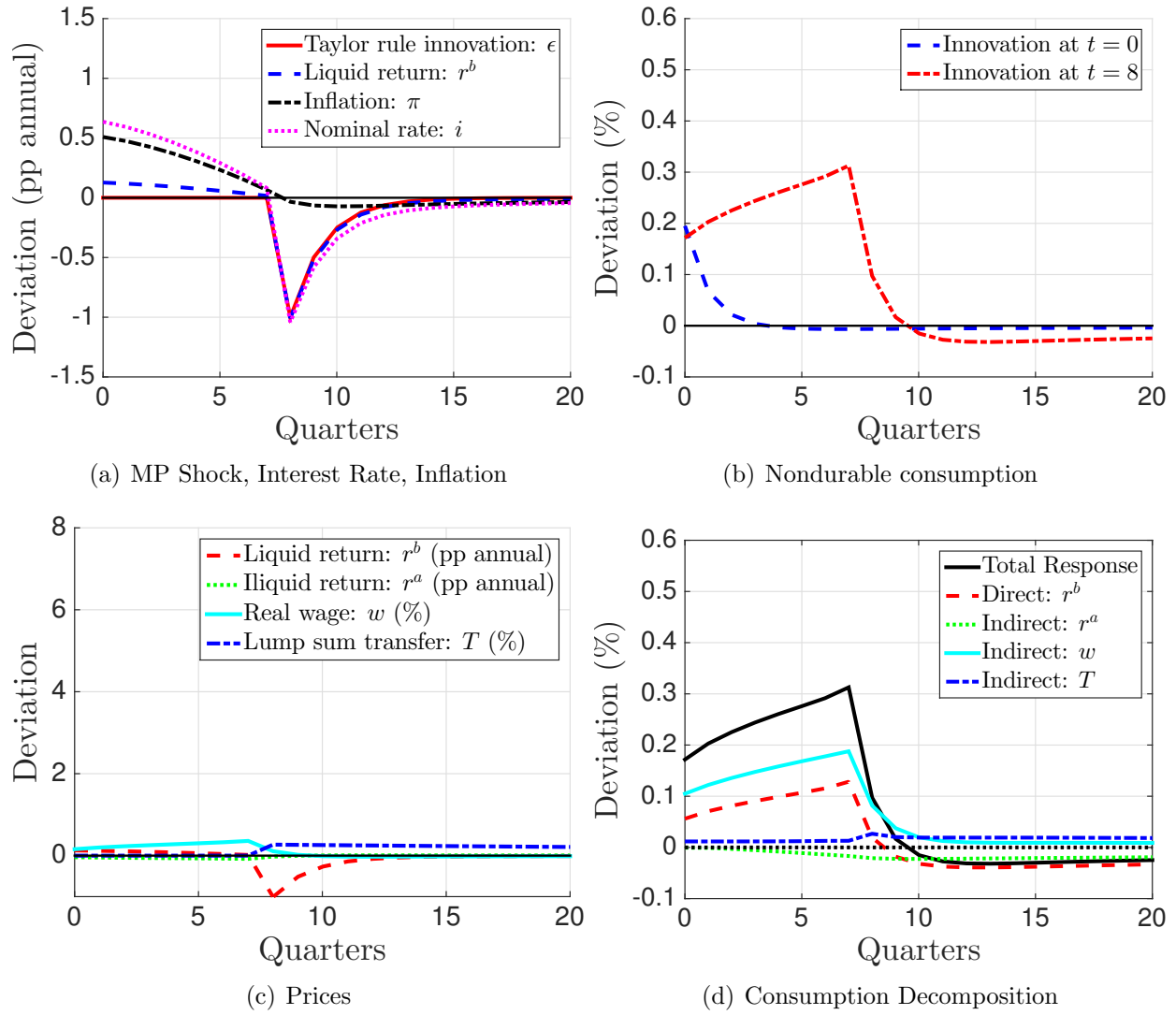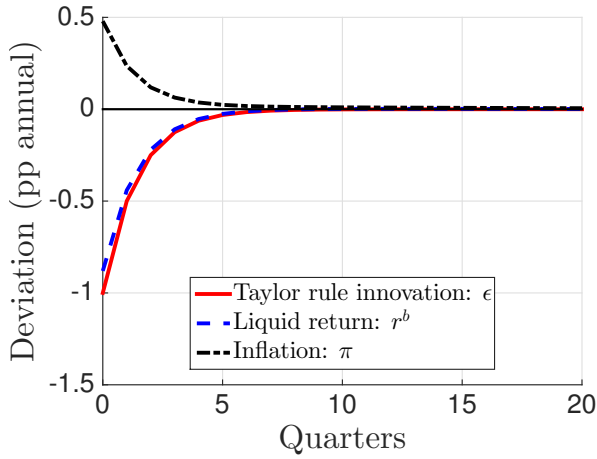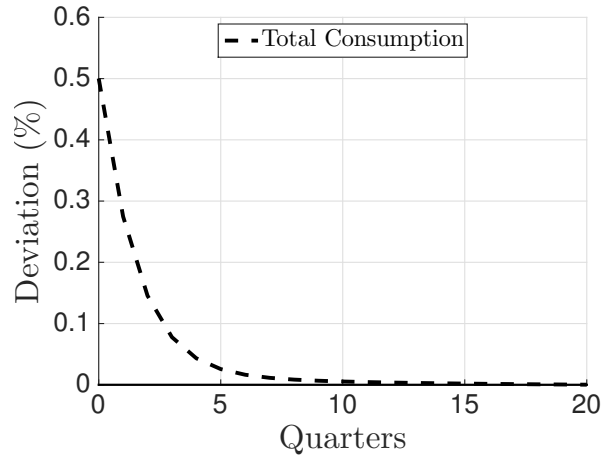(d) Consumption Decomposition

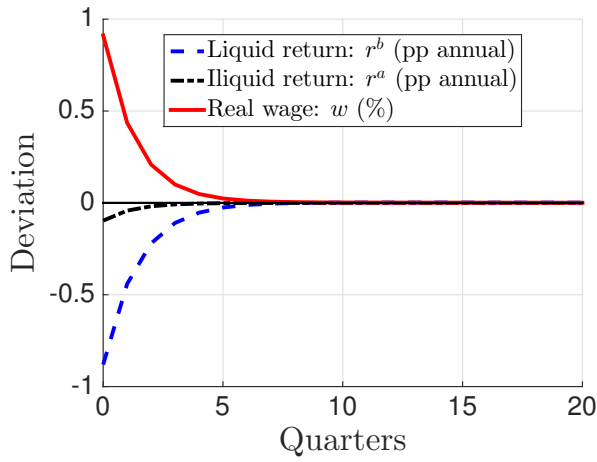Figure 3: Forward guidance: G adjusting

(a) MP Shock, Interest Rate, Inflation

(b) Nondurable consumption

(c) Prices

(d) Consumption Decomposition

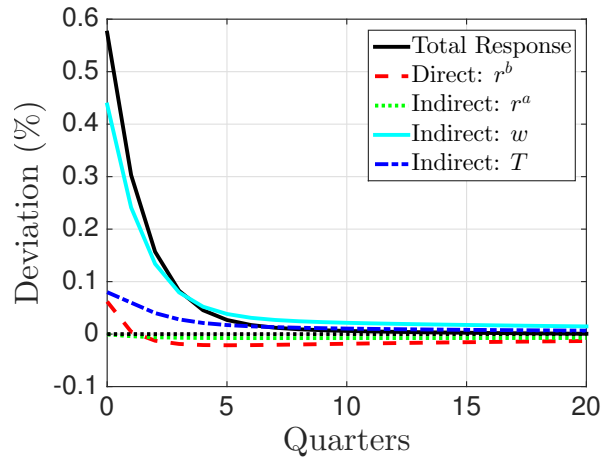Figure 4: Forward guidance: B^g adjusting

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(a) MP Shock, Interest Rate, Inflation

(b) Consumption

(c) Prices

(d) Consumption Decomposition

Figure 5: A Monetary Policy Shock in the Economy with Financial Leverage