Fiscal Multipliers: A Heterogenous-Agent Perspective

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April 6, 2020

Abstract

We show that, in a straightforward extension of a representative-agent New Keynesian model to a simple, but plausibly calibrated, heterogeneous-agent model, fiscal multipliers shrink significantly: they are smaller when goods prices are sticky than when they are flexible. The key insight is that in the representative-agent model, large multipliers rely on (i) profits falling after a fiscal stimulus and (ii) the representative worker working harder as a result of the implied negative income effect. This channel is muted entirely in our heterogeneous-agent model, which is a plausible model precisely in that workers do not own stocks. With a realistic degree of wage stickiness, on the other hand, the New Keynesian transmission mechanism does not rely on the countercyclical response of profits and looks the same in the representative- and heterogeneous-agent models.

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*We thank Valerie Ramey for the key impetus to this paper.
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1 Introduction

This paper can be viewed as a brief, but we believe important, followup on our earlier paper (Broer et al., 2020). There, we argued that sizable effects of monetary policy on the real economy in the textbook, three-equation New Keynesian (NK) model rely on an implausible transmission mechanism. In this paper we argue a closely related point for the effects of fiscal policy. Fiscal multipliers, in particular, can be large in the NK setting but, we argue here, only because of the same implausible transmission mechanism. We also argue that the standard NK model with wage rigidity offers a plausible transmission mechanism for fiscal shocks and is also able to generate large fiscal multipliers.

Our argument builds on relaxing the standard assumption of a representative agent: we consider a very simple, but yet quantitatively relevant, case of a heterogeneous-agent (HA)NK model. Such models are currently built and analyzed by many researchers, not only because their basic assumptions are much more in line with microeconomic studies of household behavior but also because they can deliver more powerful propagation mechanisms in response to macroeconomic shocks.\footnote{For a survey of this literature, see Kaplan and Violante (2018). McKay and Reis (2015), Bhandari et al. (2017) and Hagedorn et al. (2019) all study various aspects of fiscal stabilization policy using HANK models.} Our HANK model allows us to relax a key feature of the RANK model: that workers not only receive labor income but also firms’ dividends. Our key intuitive insight is then that, in the RANK model without wage rigidity, the representative worker adjusts their labor supply due to strong income effects caused by the profits they receive from firms. In particular, in response to a fiscal stimulus, output rises but profits fall, and it is the fall in dividends that make workers work harder, so that output rises more. This mechanism is implausible not only because profits are procyclical in the data but also because workers barely hold stock in the data. As any reasonably calibrated HANK model would respect this fact—and our simple HANK model makes this point by assuming workers own no stock at all—we conclude that such models cannot offer large fiscal multipliers. In the model with wage rigidities, in contrast, profits go up after the stimulus and workers supply labor off their labor supply curve. For the HANK literature, going forward, we thus argue that including wage rigidities is key for assessing...
the desirability of using fiscal policy as a stabilization tool.\footnote{A related point is made in Auclert and Rognlie (2017). An earlier literature has suggested that NK models with preferences of the Greenwood et al. (1988) type, for which there are no income effects on labor supply, have several desirable properties compared to standard preferences. The analysis in Auclert and Rognlie (2017) shows that NK models with such preferences predict absurdly large fiscal multipliers, suggesting that a rigid-wage setting is a more viable alternative than Greenwood et al. (1988) preferences for NK models.}

Fiscal multipliers have been argued to be particularly potent in situations where the monetary authority is up against a zero lower bound (ZLB) on the nominal interest rate. In our concluding section we discuss the ZLB constraint and argue that it is actually not critical from the perspective of the simple models we consider here. The RANK model’s high multipliers in such situations only materialize due to the implausible transmission mechanism, and the sticky-wage fiscal multiplier, whether in a RANK or HANK model, is close to one and largely unaffected by the presence of the ZLB.

2 The two models and an experiment

The goal here is to compare the responses to fiscal shocks across two models: the standard RANK model and our simple HANK model. We describe the two models in turn. We focus on models without physical capital—the “textbook” representative-agent New Keynesian (RANK) model—and without government bonds.

2.1 RANK

The representative household has “KPR preferences” over consumption and leisure as in King et al. (1988)), to be consistent with balanced growth; for convenience, we use the additively separable version from MaCurdy (1981), where $\varphi$ regulates the (constant) Frisch elasticity of labor supply. Each of a continuum of the household’s members provides a differentiated labor service in a monopsonistic fashion and pays a Rotemberg (1982)-type adjustment cost when changing the wage.\footnote{An isomorphic model would also be obtained if assuming a Calvo-type friction in the wage setting problem, as in Erceg et al. (2000). We opt for the Rotemberg adjustment cost as it is easier to solve when we move to our heterogeneous-agent version of the NK model, given that the equilibrium wage} There is a continuum of monopolistically competitive firms operating a production function that is
linear in the Dixit-Stiglitz composite of the differentiated labor inputs. Firms set their output prices subject to the Calvo (1983) friction.

The monetary authority sets interest rates according to a Taylor rule that only reacts to inflation and the fiscal authority taxes the household lump-sum to fully finance its spending.\footnote{In other words, we abstract from the distortionary effects of taxes and government debt.}

The log-linear approximation of the equilibrium around a zero-inflation steady state is described by the following equations.\footnote{The derivation of our results here are standard; for details, see Broer et al. (2020).}

\begin{align}
\text{IS} & \quad : \quad \hat{c}_t = E_t \hat{c}_{t+1} - (\hat{c}_t - E_t \hat{\pi}_p) \\
\text{Price Phillips} & \quad : \quad \hat{\pi}_t = \beta E_t \hat{\pi}_t + \lambda_p \hat{\omega}_t \\
\text{Wage Phillips} & \quad : \quad \hat{\pi}_w = \beta E_t \hat{\pi}_w - \lambda_w (\hat{\omega}_t - (\hat{c}_t + \varphi \hat{n}_t)) \\
\text{Wage accounting} & \quad : \quad \hat{\omega}_t = \hat{\omega}_{t-1} + \pi_w - \pi_p \\
\text{Resources} & \quad : \quad (1 - \bar{\tau}) \hat{c}_t + \bar{\tau} \hat{\tau}_t = \hat{n}_t \\
\text{Taylor rule} & \quad : \quad \hat{\tau}_t = \phi \pi_t \\
\text{Tax policy} & \quad : \quad \hat{\tau}_t = \rho \hat{\tau}_{t-1} + \nu_t.
\end{align}

Here, \( \hat{x}_t \) denotes the log-deviation of \( x \) at \( t \) from its steady state value. Let us now briefly describe the equations one by one.

Equation (1) in the New Keynesian IS curve, an Euler condition that links current consumption \( \hat{c} \) to expected future consumption and the expected real interest rate. Equation (2) is the New Keynesian Phillips curve, relating current price inflation \( \hat{\pi}_t \) to expected inflation and the current real marginal cost; the latter, with linear production, equals the real wage \( \hat{\omega} \). \( \lambda_p \) is a combination of structural preference parameters and the price-resetting probability, which together govern the price response to changes in marginal costs.\footnote{Specifically, \( \lambda_p = \frac{(1-\theta_p)(1-\theta_p)}{\theta_p} \), where \( \beta \) is the discount factor and \( \theta_p \) the per-period Calvo probability that a firm cannot reset its price.} Equation (3) is the Phillips curve for wages implied by the household’s wage-setting problem. It describes how nominal wage inflation \( \hat{\pi}_w \) responds to changes in the difference between the real wage and the marginal rate of substitution between consumption and hours, where \( \lambda_w \) is another combination of structural distribution becomes degenerate.
parameters, including the adjustment-cost parameter for wages.\textsuperscript{7} Equation (4) is an accounting identity, describing the evolution of the real wage in terms of wage and price inflation. Equation (5) is the economy’s resource constraint, with \( \bar{\tau} = g \) representing the share of government expenditures, \( g \), in output, \( c + g \). It thus sets the share-weighted average of consumption and taxes equal to output, which absent productivity shocks and under linear production equals hours worked \( \hat{n} \).

Notice that we do not use a variable for the “output gap” in our equation system; it is implicit, and we use consumption instead as this is the natural counterpart to the variables in focus in the HANK model below. For given expectations, the system (1)–(5) determines the five unknown endogenous variables—\( \hat{c}, \pi^p, \pi^w, \hat{\omega}, \) and \( \hat{n} \)—uniquely as a function of the policy variables \( \hat{i} \) and \( \hat{\tau} \). Equations (6) and (7) then provide the policy rules (a Taylor rule and an AR(1) for the fiscal shock) and for our calibrated model the implied full dynamic system has a unique stable solution around its zero-inflation steady state, which is also uniquely determined.

Income in this economy is the sum of labor earnings, \( \hat{\omega} + \hat{n} \) and dividends from the monopolistic firms, \( d \); time-\( t \) dividends can therefore be solved residually from

\[
\text{Household income : } \hat{n}_t = \bar{S}(\hat{\omega}_t + \hat{n}_t) + (1 - \bar{S})\hat{d}_t.
\]

Here, the weights \( \bar{S} \) and \( 1 - \bar{S} \) are the steady-state shares in output of earnings and dividends, respectively. The role of dividends is key for the intuitive comparison to the HANK model.

In the flexible limit of wage setting, \( \lambda_w \to \infty \) in the wage Phillips curve (3), implying that the real wage equals the marginal rate of substitution:

\[
\hat{\omega}_t = \hat{c}_t + \varphi \hat{n}_t.
\]

In this case, the model equations can be collapsed into the familiar 3-equation representation, augmented with the tax policy equation.

\textbf{2.2 HANK}

The HANK model is the natural extension of the RANK model to the kind of incomplete-markets model studied in Huggett (1993): households can only imperfectly insure

\textsuperscript{7}Specifically, \( \lambda_w = -\frac{\omega^{-1}}{\chi} \) where \( \epsilon_w \) is the elasticity of substitution between labor inputs and \( \chi \) is the Rotemberg adjustment-cost parameter.
themselves against idiosyncratic labor productivity shocks by trading a risk-free bond subject to a borrowing constraint. We consider a particularly simple HANK model here. In particular, the household sector consists of workers and a (small) mass of capitalists. These are ex-ante identical in all aspects (including their tax share of income) except that the capitalists own the firms and derive income from firm dividends, whereas workers only receive wage income. This assumption captures the fact that equity ownership is extremely concentrated (see, e.g., Kuhn and Rios-Rull (2016)). As we shall see, the fact that workers do not receive dividends makes a crucial difference for the workings of the model. We also follow Krusell et al. (2011), Werning (2015), McKay and Reis (2017), and Ravn and Sterk (2018) and assume a zero borrowing constraint such that households cannot borrow at all, and have no saving in equilibrium. This assumption allows closed-form expressions for our key aggregates but is not essential for the key insights. We moreover posit that aggregate shocks are small relative to idiosyncratic shocks to worker productivity (and thus income), together with a small fixed cost of employment, implying that the agent with the highest propensity to save is always a worker in this economy and that capitalists do not work. For details, see Broer et al. (2020).

In terms of the implied equations, the HANK model is different to the RANK model in two ways. One is that consumption, $\hat{c}$, now refers to worker (and not aggregate) consumption. The second, and implied, difference is that the resource constraint (5) is now replaced by the worker’s budget constraint, evaluated at equilibrium (where bond holdings are zero):

$$\text{Worker income} : \quad (1 - \bar{\tau})\hat{c}_t + \bar{\tau}\hat{\tau}_t = \hat{\omega}_t + \hat{n}_t. \quad (10)$$

The key here is that income, on the right-hand side, is not aggregate income $\hat{n}$ (which, expressed in terms of factor payments as in (8), would include dividends) but rather worker earnings: $\hat{\omega} + \hat{n}$.

Before moving on to the analysis of fiscal multipliers let us quickly note that our HANK model, which is really like a two-agent model with workers and capitalists, is different than the increasingly popular so-called TANK models (see, e.g., Galí et al. (2004) and Bilbiie (2008)), where the typical assumption is that a fraction of the consumers is hand-to-mouth, with the remainder being standard permanent-income consumers. The difference—that our workers do not receive dividend income whereas the
hand-to-mouth consumers do—is crucial, and in all essential respects that we discuss below, the typical TANK model really functions like the RANK model.\textsuperscript{8}

### 2.3 Calibration and a fiscal shock

We now consider the implications of an innovation in government spending in the RANK and HANK models. We look at three different cases: no rigidities, price rigidities, and wage rigidities.\textsuperscript{9} For the tax policy, we assume that the innovations have standard deviation $\sigma_\nu = 0.01$ and we assume that their auto-correlation is $\rho = 0.5$. We assume a tax/output share of 30 percent and take the other standard parameter values from Galí (2008), Ch. 3 and 6: for a quarterly model the discount factor equals 0.99, the Frisch elasticity $1/\varphi$ is set at 1, the elasticity of substitution between goods as well as that between labor inputs equals 6, the price reset probability is $1/3$, the Rotemberg adjustment cost for wage setting is set so as to replicate a corresponding Calvo wage reset probability of $1/4$, and the Taylor coefficient on inflation is 1.5.

In Figure 1, we display the responses to a 1-percent increase in government spending. The blue solid lines are the responses of the RANK model and the red dashed lines are the responses of the HANK model. All responses are expressed in terms of percent (or percentage-point) deviations from steady state.

Under flexible prices (left column), the RANK and simple HANK models produce identical responses. The fiscal stimulus makes workers work harder due to an income shortfall and hence raises output, but it does so less than one-for-one. Current consumption thus decreases, and the real interest rate increases. Real wages are constant, given constant TFP and no stickiness. Because this model has constant markups and production is linear in labor, profits thus respond 1-to-1 with output. The real-interest increase implies a rise in inflation; the Taylor rule embodies a stronger than one-for-one increase in the nominal rate to inflation.

Under sticky prices (middle column), the real wage rises: the fully flexible wages respond more strongly than do prices, which are to some extent fixed. The rise in real wages, in turn, implies a fall in profits. What happens to output? In the RANK model,

\textsuperscript{8}See Galí and Debortoli (2017) for a discussion of the implications of different profit-distribution schemes in a TANK model.

\textsuperscript{9}In the case of wage rigidities, we assume no price rigidities; the behavior of this version of the model does not depend on whether or not there are price rigidities.
Figure 1: Responses to 1 percent rise in government spending

the fall in profits induces workers to work even harder than under flexible prices, due to an additional income effect: the fiscal multiplier rises. Thus, the high multiplier in the RANK model relies critically on (i) profits falling in response to fiscal stimulation of output and (ii) workers experiencing a reduction in their income due to the fall in dividends.

In the simple HANK model, in contrast, the fall in profits induces no extra income
effect, because workers do not own firms. The wage rise, instead, actually makes workers work somewhat less than under flexible prices, because the income effect of a wage rise exceeds substitution effect in the presence of taxes in steady state.\textsuperscript{10} In sum, the fiscal multiplier is actually somewhat smaller in the HANK model than in the model with fully flexible prices.

To examine the comparison between the RANK and HANK models formally, combine the optimality condition for labor supply (9) with the worker’s equilibrium budget—(5) and (8) for the RANK model and (10) for the HANK model—to obtain the following conditions for the determination of hours worked:

\begin{align}
\text{RANK:} & \quad [\varphi(1 - \bar{\tau}) + \bar{S}] \hat{n}_t = (1 - \bar{S})\hat{d}_t + \bar{\tau}\hat{r}_t + (1 - \bar{S} - \bar{\tau})\hat{\omega}_t \\
\text{HANK:} & \quad [\varphi(1 - \bar{\tau}) + 1] \hat{n}_t = \bar{\tau}(\hat{r}_t - \hat{\omega}_t)
\end{align}

These equations allow us to gain insights into the hours determination conditional on knowing how dividends and real wages react to a positive fiscal shock; we take as given that real wages rise and that dividends fall. Beginning with the HANK model, then, we see clearly that the direct positive effect of the rise in taxes on labor supply is counteracted by a procyclical response of wages. We also see that both these effects are smaller, the smaller is the share of taxes in income. As for the RANK model, the terms in the HANK model are present as well but there are two new terms. First, there is the dividend channel that we emphasize: it makes hours rise more, given that \( \hat{d}_t < 0 \). Second, whether or not the income or the substitution effect of a real wage change dominates depends on whether the total post-tax income is larger or smaller than earnings. If the two are equal, due to KPR preferences the two effects cancel. If, in contrast, the steady-state size of dividends exceeds the tax burden \( 1 - \bar{S} > \bar{\tau} \), the substitution effect dominates, providing an additional boost to hours. In our calibration, the price elasticity is \( \epsilon = 6 \), which implies \( 1 - \bar{S} = \frac{1}{6} \), which is lower than our \( \bar{\tau} = 0.3 \), so the net effect of the real wage increase on hours is actually negative.

Having concluded that the RANK model with sticky prices exhibits larger fiscal multipliers compared to its flexible-price counterpart due to an implausible transmission mechanism, let us now briefly look at the case of sticky wages, where we find (i) that the transmission mechanism is plausible and (ii) that fiscal multipliers are large(r).\textsuperscript{10}This effect is due to taxes being lump-sum.
In the sticky-wage model, there is no substantive difference between the fiscal multipliers in the RANK and HANK models. When firms have linear production and the demand structure is such that they set a constant markup, then in the absence of a nominal wage change, since the marginal cost of production will consequently not change, firms do not raise prices. Hence, given strong wage stickiness, inflation will be (close to) zero. Hence, there is no central-bank reaction in monetary policy and the real interest rate will not change. Consumption is unaffected and output simply rises by the size of $g$: there is (virtually) no crowding out and the multiplier is one (which is large in this context). Profits do go up, since sales rise and costs do not. This does not, however, induce a change in labor supply in the RANK model since labor supply is not responding to incentives—due to the nature of the wage contracts. Workers in the RANK and HANK models thus supply hours mechanically and all macroeconomic aggregates behave the same way.\footnote{We have derived these results assuming that prices can be set flexibly. If they are sticky too, nothing changes since the unrestricted response is not to change prices.}

We conclude by tabulating the aggregate effect of government spending on output in terms of “cumulative multiplier” in Table 1. The cumulative multiplier is the ratio of the integral of the output response to the integral of the tax/spending response, normalized by the steady state tax share of output.

<table>
<thead>
<tr>
<th>No rigidity</th>
<th>Price rigidity</th>
<th>Wage rigidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>RANK</td>
<td>HANK</td>
</tr>
<tr>
<td>Benchmark</td>
<td>0.59</td>
<td>0.59</td>
</tr>
</tbody>
</table>

Table 1: Cumulative Fiscal Multipliers

The ranking is as discussed, with the wage-rigidity model producing multipliers of almost 1.

3 Concluding remarks

For robustness, we also examined models with significantly less wage rigidity (letting the reset probability go from 1/4 to 1/2) and found very small differences between the HANK and RANK models and only marginally lower multipliers. We also found that
the assumption of linear production is not material for our results: with a labor input elasticity of output equal to 0.7, the responses in the sticky-wage versions of the RANK and HANK models are still close to identical; with sticky prices, the difference between RANK and HANK increases, since profits respond even more countercyclically in this case.

A more interesting other case is that when the monetary authority is constrained by a zero lower bound (ZLB) on the interest rate. In particular, representative-agent models with nominal rigidities have been found to predict multipliers that can be significantly larger that one in those circumstances, providing a rationale for using discretionary fiscal policy as a stabilization tool (see, e.g, Woodford (2011), Christiano et al. (2011), and Eggertsson (2011)). The intuitive reason for their prediction is simple. With active monetary policy, real interest rates rise in response to higher inflation and partly crowd out the positive effect of a fiscal shock on output. When monetary policy is constrained and nominal interest rates unaffected by shocks, in contrast, the rise in inflation in response to a fiscal stimulus implies a fall in real interest rates, thus further stimulating consumption and increasing both the output response and the multiplier. What can we learn about this mechanism from our analysis? First, under sticky prices, the insight that countercyclical profits are a necessary condition for amplification does not depend on the state of monetary policy, but follows directly from the household’s labor supply decision together with the market clearing condition. Thus, the amplification of the multiplier is only consistent with the representative agent’s optimal choice of labor supply because profits respond countercyclically. That is, for multipliers to be larger in the ZLB case, it must be that profits respond more strongly (negatively) to the fiscal stimulus. I.e., to the extent one agrees with our term “implausible” to describe the sticky-price model’s amplification mechanism, this mechanism becomes even more implausible in the case of the ZLB. How does the behavior of the rigid-wage model change when monetary policy is constrained? Virtually not at all: the multiplier remains one. As is clear from the impulse responses with rigid wages in Figure 1, there is virtually no response of inflation and the interest rate to the fiscal shock and, hence, the lower bound on the nominal interest rate has virtually no effect. More broadly, the rigid-wage setting dampens the fluctuations in marginal costs, and therefore restrains
the amplification of the multiplier at the zero lower bound.\footnote{The ZLB can play a role in a HANK setting with sticky prices and sticky wages. However, for modest departures from the benchmark here, including to a case where the production has some curvature, we found that the ZLB plays a very limited role.}

The main take-away from our present note is not a critique of the three-equation representative-agent New Keynesian model. We do think that the representative-agent focus of this model is problematic and that the supply side is inadequate, but this model has been very important in providing a clear mechanism for the dynamics of demand (through its dynamic IS equation and monetary policy). Instead, the main goal here is to provide some guidance in the construction of quantitative HANK models. In particular, models where nominal wages are not flexible need to be considered. We also think that there is a need to develop such models—in particular their foundations—further; they have received much less attention than models with price rigidities. Such work is at least on our own agenda.

References


