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Greed? Profits, Inflation, and Aggregate Demand[I]

PRELIMINARY AND INCOMPLETE. COMMENTS WELCOME.

Florin O. Bilbiie[II] Diego R. Känzig[III]

August 2023

Abstract

Amidst the recent resurgence of inflation, this paper investigates the interplay of corporate profits and income distribution in shaping inflation and aggregate demand within the New Keynesian framework. We derive a novel analytical condition for profits to be procyclical and inflationary. Furthermore, we show that the cyclicality of profits is a key determinant of the propagation properties of these models under household heterogeneity, but there is a catch: for aggregate-demand fluctuations and inflation to be amplified by heterogeneity, profits have to be *countercyclical*—an implication that is at odds with the data. Adding physical capital investment to the model can resolve this conundrum, generating aggregate-demand amplification even under procyclical profits. However, the amplification works through an investment channel and not through profits, inconsistent with the narrative attributing elevated inflation to corporate greed.

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1 Introduction

The return of inflation has brought two interrelated old issues to the forefront: ”corporate greed”, the profit motive of corporations and their search for higher margins, on the one hand; and the ensuing distributional implications, as the distribution of income between capitalists and workers changes, on the other. A prevalent narrative is that inflation is associated with, or even caused by, higher profit margins. This situation, in turn, disproportionately impacts the poor in two ways: it inherently erodes their wages and can potentially intensify any recession associated with inflation. A common theme is that the current inflationary episode is sustained by corporations making higher profits above and beyond what would be justified by the mere increase in costs, thus exploiting the elevated—perhaps through distributional mechanisms—aggregate demand.

These concerns have been front and center in the policy debate, as testified by the focus of speeches of central bank leaders (Lagarde, 2023; Schnabel, 2023) and numerous articles in the press. On the first anniversary of the Inflation Reduction Act, President Biden just stated (Biden, 2023): “one reason we've seen inflation fall by two thirds without losing jobs is corporate profits are coming back down to earth. The excesses are being eliminated by the corporations.” On the academic side, this spurred renewed interest in the related notion of “sellers' inflation” and price controls as a way to cure it (see e.g. Weber and Wasner, 2023).

We use economic theory to organize our thinking around these issues. We start from the well-known but often overlooked observation that, in fact, in the workhorse New Keynesian (NK) model with sticky prices only, profits are *negatively* related to inflation. This is of course true in response to demand shocks, because an increase in demand shifts labor demand and increases wages and marginal cost—thus depressing profits while at the same time triggering inflation. This problem of the NK model has been known for decades (Christiano et al., 1997), and so have its fixes, notably wage stickiness that contains the wage increase (Christiano et al., 2005).

Our first Proposition provides a novel analytical condition under which profits are procyclical and inflationary in response to demand shocks: intuitively, this requires wages to be relatively stickier than prices. The condition makes explicit how the threshold depends on the deep model parameters: labor elasticity and income effect, elasticity of intertemporal substitution, long-run monopoly rents and the degree of returns to scale in production.

Matters are different with supply shocks, which generate procyclical profits even under sticky prices only. Thus, there is no puzzle in that respect: a bad TFP shock triggers an increase in marginal cost, a fall in profits, and a fall in output. However, this is still puzzling for the comovement with *inflation*: inflation goes up, so there is again negative comovement with profits: the opposite of a "greed" view. This is a relatively uncontroversial feature, and reinforces the view that the positive correlation between profits and inflation needs to be driven by something else—thus our focus on demand shocks and their amplification.[1]

The role of the cyclicality of profits in the NK model, while something of a side show for the literature for decades, received renewed attention with the outset of heterogeneous-agent (HA) models, used to speak to the distributional considerations hinted to above (see e.g. Violante, 2021, for a survey). Indeed, the distribution of profits is a key determinant of the propagation properties of those models, as discussed explicitly in their earliest incarnations (Bilbiie, 2008) and up to the more recent literature. Specifically, if profits are countercyclical and accrue to the asset owners, an aggregate demand expansion leaves a larger fraction of output as income in the hands of workers. Provided that workers have a higher marginal propensity to consume (MPC), this can substantially amplify the effects of demand shocks by setting off a Keynesian-cross multiplier.

Our second contribution is to identify a conundrum for HANK models: the very

[1] A separate debate is that supply shocks in fact do *not* generate a recession defined as a negative output *gap*: output under sticky prices goes down in response to a negative TFP shock by less than under flexible prices, so the output gap stays positive. To fix this and have a negative output gap, the model needs endogenous entry-exit, see Bilbiie and Melitz (2020).

same parameter condition that generates procyclical profits also implies that heterogeneity leads to *dampening*, not amplification of demand shocks—as long as profit income is skewed towards low-MPC asset holders.[2] We illustrate this analytically in a tractable two-agent economy with both sticky prices and wages: aggregate-demand amplification through heterogeneity requires either countercyclical profits that are skewed towards the rich or procyclical profits that are skewed towards high-MPC, hand-to-mouth agents. In the empirically realistic case where profits are procyclical and mostly go to low-MPC asset holders, the effects of demand shocks and monetary policy are *mitigated* by heterogeneity. Consequently, such an economy will in fact have *lower inflation* than a representative-agent (RA) economy in response to demand shocks. Quantitatively, we show that these contradicting forces are balanced in such a way that the HA economy is very close to the RA economy. The reason is that wage stickiness leads to a high degree of correlation between the income processes of the two agents.

Our third contribution is to show that the natural extension to a model with investment in physical capital cures these issues: it overturns our theoretical "dilemma" proposition and instigates a significant quantitative departure from the aforementioned "almost-irrelevance"—with investment in physical capital, there is now amplification by heterogeneity when profits are procyclical and go to asset-holders. Most importantly perhaps, disciplining the model by the cyclicality of profits makes the redistribution of profits essentially irrelevant, while it is often the key determinant of the economy's dynamic properties in many HA studies, including some of our own past work. We view this as a desirable property.

Key to the above is that in a model with capital the right notion of profits—and the data counterpart, as has been known since Christiano et al. (1997)—include payments on physical capital. We provide an analytical condition for a model with investment to deliver aggregate-demand amplification: it amounts to investment being procyclical

[2]When we refer to *amplification*, we always think of the responses relative to the representative-agent benchmark.

"enough", i.e. its cyclicality has to be larger than a threshold that is comfortably satisfied in the data. We then show quantitatively that there can be substantial aggregate-demand amplification even with procyclical profits.

However, the substantial aggregate-demand amplification occurring in this model does not trigger a similar inflationary spiral. The reason is that amplification occurs not through but *despite* procyclical profits, which still tend to dampen the inflation response; as in the most basic NK model, demand-generated increases in profits are associated with falling marginal costs and thus deflationary forces. As a consequence, the amplification of the inflation rate turns out to be more muted. In other words, an elevated demand-driven inflationary episode necessarily requires relatively stickier prices than wages. This in turn generates *countercyclical* profits, setting off indirect general-equilibrium amplifying effects that dominate the direct (partial-equilibrium) dampening effect on inflation of stickier prices. Overall, the "greed narrative"—whereby higher inflation is associated with or even caused by a higher demand expansion *and* higher profits—seems incompatible with workhorse macroeconomic theories.

Related literature. Time-varying markups are a crucial feature of New Keynesian models. Yet, the textbook model with sticky prices has the counterfactual implication that profits are countercyclical to demand shocks. In fact, there is growing empirical evidence that markups are procyclical, conditional on demand shocks (see e.g. Nekarda and Ramey, 2020; Burstein et al., 2020). As Christiano et al. (1997) pointed out, the main shortcoming of this model is that there are no frictions on the labor market that may dampen the marginal cost of production after demand shocks. Christiano et al. (2005) and Galí (2011) showed that wage stickiness is key for the model to match crucial features of the data, including the cyclicality of profits. Erceg et al. (2000) and Schmitt-Grohé and Uribe (2005) study optimal monetary policy under the assumption of sticky wages. We contribute to this literature by providing a new analytical condition for procyclical profits that crucially depends on the rigidity in wages relative to prices.

We also relate to a growing literature that emphasizes the role of sticky wages in heterogeneous-agent NK models. Early incarnations include Colciago (2011) and Furlanetto (2011), which extended the benchmark analytical TANK model in Bilbiie (2008).[3] Ascari et al. (2017) and Diz et al. (2023) study similar analytical NK frameworks with two agents and sticky wages, focusing on monetary policy, including an analysis of determinacy and optimal policy. More recently, Auclert et al. (2023) and Broer et al. (2023) analyze the role of wage stickiness for the determination of fiscal multipliers with heterogeneity. However, to the best of our knowledge, none of these contributions address the conundrum that we identify, i.e. the tension between profits' procyclicality and aggregate-demand amplification. Furthermore, these studies generally abstract from investment in physical capital. A more recent literature studies the role of heterogeneity for the propagation of macroeconomic fluctuations in more quantitative frameworks, often under the assumption of rigid wages (Broer et al., 2020; Hagedorn et al., 2019a; Auclert et al., 2020; Alves et al., 2019; Bilbiie et al., 2022). We highlight the role of capital investment and profits in the sense of accounting profits to remedy the tension between aggregate-demand amplification and the cyclicality of profits in heterogeneous-agent NK models.

2 Profits, Inflation and the Cycle in the New Keynesian Model

Model. Our starting point is the plain-vanilla New Keynesian model with rigidities in prices and wages. This is essentially a stripped-down version of the model in Schmitt-Grohé and Uribe (2005), and a variant of the textbook model in Galí (2015). We sketch the model here in log-linear form. A full description of the model can be found in Appendix

[3] More recently, Bilbiie (2020, 2018); Debortoli and Galí (2018); Cantore and Freund (2021) study TANK models in their relationship with rich-heterogeneity HANK models such as e.g. Auclert (2019); Bayer et al. (2019); Den Haan et al. (2017); Gornemann et al. (2016); Hagedorn et al. (2019b); Kaplan et al. (2018); Luetticke (2021); McKay et al. (2016); McKay and Reis (2016).

A.[4] Labor supply decisions are relegated to a labor union that faces wage-setting frictions. The optimal wage markup is given by

$$\mu_t^w = \sigma^{-1} c_t + \varphi n_t - w_t. \tag{1}$$

Households choose their consumption intertemporally according to the standard Euler equation, where r_t^n is the nominal interest rate set by the central bank

$$c_t = E_t c_{t+1} - \sigma(r_t^n - E_t \pi_{t+1}). \tag{2}$$

We assume a production technology that has decreasing returns-to-scale in labor

$$y_t = c_t = (1-\alpha) n_t, \tag{3}$$

where we have already imposed goods market clearing. Marginal costs and profits are given by

$$mc_t = -\mu_t = w_t + \frac{\alpha}{1-\alpha} c_t \tag{4}$$
$$d_t = y_t - \frac{1-\alpha}{\mathcal{M}} (w_t + n_t) = \left(1 - \frac{1}{\mathcal{M}}\right) c_t - \frac{1-\alpha}{\mathcal{M}} w_t, \tag{5}$$

where μ_t is a time-varying markup and $\mathcal{M}$ is the gross post-subsidy markup in steady state.

In order to obtain closed-form analytical results and without loss of generality, we assume static price and wage Phillips curves (see also Bilbiie, 2018, 2019; Bilbiie et al.,

[4] All variables are expressed in log-deviations from steady state, except profits d_t, which are expressed as absolute deviations from steady state relative to steady-state output $d_t = \frac{D_t - D}{Y}$, as they can take zero value in steady state.

2022):

$$\pi_t = \psi_p mc_t = \psi_p \left(w_t + \frac{\alpha}{1-\alpha} c_t \right) \tag{6}$$

$$\pi_t^w = w_t - w_{t-1} + \pi_t = \psi_w \left(\sigma^{-1} c_t + \varphi n_t - w_t \right). \tag{7}$$

All our results generalize easily to the more standard forward-looking Phillips curves we use in Sections 3 and 4.

The cyclicality of profits. By combining the above equations, we can derive the following expression for profits:

$$d_t = \frac{\mathcal{M} - 1 + \Omega}{\mathcal{M}} c_t - \frac{1-\alpha}{\mathcal{M}} \Theta w_{t-1}, \tag{8}$$

where $\Theta \equiv \frac{1}{1+\psi_p+\psi_w} \in [0,1]$.

The model generates endogenous persistence in real variables if both prices and wages are sticky—and this will translate into endogenous inflation persistence. The stickier are prices and wages (the flatter the Phillips curves, i.e. the lower ψ_p and ψ_w), the more persistence there is.

The key determinant of the *cyclicality* of profits is

$$\Omega \equiv \left[\psi_p \alpha - \psi_w \left(\sigma^{-1}(1-\alpha) + \varphi \right) \right] \Theta, \tag{9}$$

a composite parameter that depends on the relative stickiness of wages and prices. As we shall show, this parameter plays a key role in the propagation of shocks in this class of models. This is emphasized in the following Proposition, where we assume without loss of generality that aggregate demand is given, e.g. by assuming that the central bank controls the real rate real rate $r_t \equiv r_t^n - E_t \pi_{t+1,}$ which by the Euler equation (2) fully determines aggregate demand.

Proposition 1 (Profits' cyclicality) *Profits are procyclical with respect to an aggregate demand expansion, i.e.* $\frac{\partial d_t}{\partial c_t} > 0$*, iff* $\mathcal{M} - 1 + \Omega > 0$*, implying:*

$$\frac{\psi_w\left[(1-\alpha)\sigma^{-1}+\varphi\right]-\alpha\psi_p}{1+\psi_p+\psi_w} < \mathcal{M}-1. \tag{10}$$

Note that positive steady-state profits $D > 0$*, which implies* $\alpha > 0$ *or* $\mathcal{M} > 1$*, is necessary but not sufficient for this condition to hold.*

To illustrate Proposition 1, let us consider two polar cases. First, take the plain-vanilla, most basic textbook NK model with sticky prices *only*: i.e., assume that wages are completely flexible $\psi_w \to \infty$ but prices are sticky. In this case, we have that

$$\frac{\partial d_t}{\partial c_t} = 1 - \frac{1+\varphi+(1-\alpha)\sigma^{-1}}{\mathcal{M}}. \tag{11}$$

We can immediately see that profits are generically countercyclical—that is, unless labor supply is close to infinitely elastic and the income effect on hours worked σ^{-1} very low, $\varphi + (1-\alpha)\sigma^{-1} < \mathcal{M} - 1$. Note that if we assume an optimal subsidy that offsets steady-state markups, $\mathcal{M} \to 1$, profits are *always* countercyclical in this sticky-price-only model.

Second, let us assume the opposite extreme: that prices are perfectly flexible $\psi_p \to \infty$ while wages are sticky. In this case, we have

$$\frac{\partial d_t}{\partial c_t} = 1 - \frac{1-\alpha}{\mathcal{M}}. \tag{12}$$

We can see that profits in this case are always *procyclical*.

These two polar cases sharply illustrate two contradicting forces that are at work in the fully general case with arbitrary stickiness. Under flexible prices and wages ($\psi_w, \psi_p \to$

∞), aggregate-demand shocks are neutral as prices and wages increase proportionally and thus real wages and profits remain unchanged. If prices are sticky but wages remain flexible, an increase in aggregate demand leads to an increase in wages as labor demand goes up. But firms cannot completely pass-through the increase in labor costs because prices are sticky, which leads to an increase in real marginal costs. This in turn generally induces a fall in markups and profits, unless labor is very elastic and income effects are very low such that the marginal cost curve is so flat that sales relatively adjust more.

The situation is very different if prices are flexible and wages are sticky. In this case, wages are no longer demand-determined. Thus, after an increase in aggregate demand wages fall, as we move along the downward sloping labor demand equation $w_t = -\alpha n_t = -\frac{\alpha}{1-\alpha} c_t$. Thus, inflation and profits always go up—and the elasticity is given by the profit share $1 - \frac{1-\alpha}{\mathcal{M}}$. Finally, if both prices and wages are sticky, the latter channel dominates if wages are relatively more rigid than prices.

The cyclicality properties of profits are illustrated in Figure 1, which plots in the shaded area the combination of wage (on the vertical) and price (on the horizontal axis) stickiness such that profits are procyclical; the other parameters are standard, $\alpha = .33$, $\mathcal{M} = 1.3$ (no sales subsidy), $\sigma = 1$ and $\varphi = 1$. This formalizes analytically the quantitative insights from Christiano et al. (2005); indeed, most estimates of the two Phillips curve slopes from the empirical literature lie in the area close to the origin.

Inflation dynamics and persistence. To shed light on the drivers of inflation dynamics, it is useful to derive a modified Phillips curve in our model. Let us assume without loss of generality that an optimal subsidy is in place such that $\mathcal{M} = 1$. Thus we have

$$d_t = \Omega c_t + \Theta d_{t-1}. \tag{13}$$

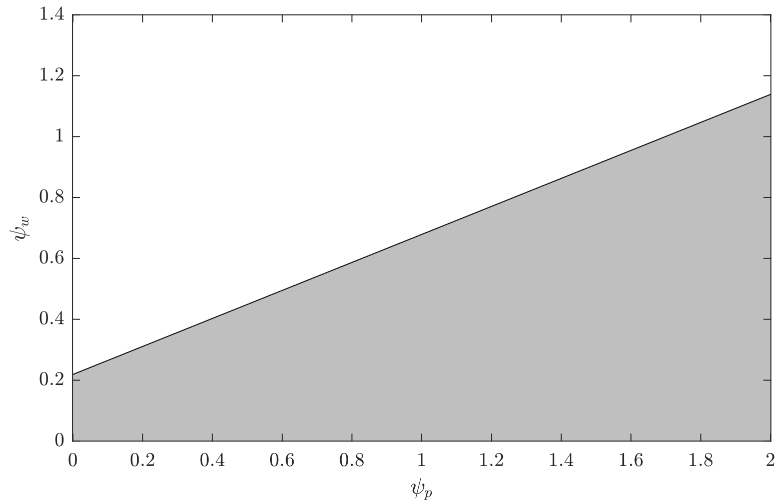

Figure 1: Cyclicality of profits as a function of price and wage stickiness

Notes: The gray area shows the region in the ψ_p and ψ_w space for which profits are procyclical, holding all other parameters constant ($\alpha = .33$, $\mathcal{M} = 1.3$, $\sigma = 1$ and $\varphi = 1$).

We can use this to rewrite the Phillips curve as

$$\pi_t = \psi_p \frac{\alpha}{1-\alpha} c_t - \psi_p \frac{1}{1-\alpha} d_t \tag{14}$$

$$= \Theta \pi_{t-1} + \frac{\psi_p}{1-\alpha}(\alpha - \Omega) c_t - \alpha \frac{\psi_p}{1-\alpha} \Theta c_{t-1}, \tag{15}$$

where $\Omega \in [0, \alpha]$. This makes transparent, first, that the endogenous-persistence parameter derived above, Θ, is a key determinant of inflation persistence too—despite the absence of indexation or rule-of-thumb firms, often considered as sources of endogenous inflation persistence in sticky-price-only models (see Woodford, 2003; Galí, 2015). Second, and most importantly, this illustrates how the general-equilibrium determination of aggregate demand and profits shapes inflation dynamics and how different models of aggregate demand (c_t) will imply different inflation dynamics. We thus turn to the determination of aggregate demand.

3 Profits, Inequality, and Aggregate Demand: A Conundrum

In this section, we study an economy with heterogeneous agents and the role of the distribution of profits therein. To keep the analysis tractable, we focus on a model with two agents.

Setup. We assume that a share of households $\lambda \in (0,1)$ are hand-to-mouth H, and a share of $1-\lambda$ are savers S (Bilbiie, 2008). As before, all households work for a union that faces wage-setting frictions (Ascari et al., 2017). The hand-to-mouth may get some profits per capita $\eta \in \left[0, \frac{1}{\lambda}\right]$, for instance because profits are taxed and redistributed at rate τ such that $\eta = \frac{\tau}{\lambda}$. In the empirically plausible case of $\eta < 1$, profits are skewed to the savers who own and price the shares of the firms.

The hand-to-mouth consume their labor income plus any transfers they may receive from the government. In log-linear form, their consumption is characterized by

$$c_t^H = (1-\alpha)\left(w_t + n_t\right) + \eta d_t. \tag{16}$$

Savers choose their consumption intertemporally based on their Euler equation

$$c_t^S = E_t c_{t+1}^S - \sigma\left(r_t^n - E_t \pi_{t+1}\right). \tag{17}$$

Finally, aggregate consumption is given by

$$c_t = \lambda c_t^H + (1-\lambda) c_t^S, \tag{18}$$

where we have imposed that consumption across households is equalized in steady state.[5] We close the model by fixing the real rate $r_t \equiv r_t^n - E_t \pi_{t+1}$.

[5]This can be implemented by a fixed steady-state subsidy.

Consumption inequality as a sufficient statistic. We can define consumption inequality as:

$$\gamma_t^C \equiv c_t^S - c_t^H.^{6} \tag{19}$$

Using this and the definition of aggregate consumption (18), we can express the savers' consumption as a function of aggregate consumption and consumption inequality:

$$c_t^S = c_t + \lambda \gamma_t^C. \tag{20}$$

Replacing in the savers' Euler equation (17), the aggregate(*d*) Euler equation reads

$$c_t = E_t c_{t+1} - \lambda \left(\gamma_t^C - E_t \gamma_{t+1}^C \right) - \sigma r_t. \tag{21}$$

From this we can see directly that aggregate-demand fluctuations are *amplified* relative to a representative-agent economy $\lambda = 0$ iff consumption inequality is *countercyclical* $\frac{\partial \gamma_t^C}{\partial c_t} < 0$.

We can also express consumption inequality as a function of profits

$$\gamma_t^C = \frac{1-\eta}{1-\lambda} d_t \tag{22}$$

$$\Rightarrow c_t = E_t c_{t+1} - \lambda \frac{1-\eta}{1-\lambda} \left(d_t - E_t d_{t+1} \right) - \sigma r_t. \tag{23}$$

Solving this forward, we obtain

$$c_t = \frac{1-\lambda}{1-\lambda \left[1 - (1-\eta)\Omega \right]} \sigma E_t \sum_{j=0}^{\infty} \left(-r_{t+j} \right) - \frac{\lambda(1-\eta)}{1-\lambda \left[1 - (1-\eta)\Omega \right]} \Theta d_{t-1}. \tag{24}$$

This equation illustrates that the interaction of profits' distribution η and cyclicality Ω, which is in turn driven by the relative price and wage stickiness, is key for the model's

[6] With two agents, this definition is proportional to the Gini coefficient or measures of entropy (see Bilbiie, 2018).

amplification properties.

Proposition 2 (Aggregate-demand Conundrum) *There is aggregate-demand amplification—the effect of an interest rate increase is larger than its representative-agent economy counterpart σ—iff:*

$$(1-\eta)\Omega < 0.$$

That is, there is aggregate-demand amplification if either (i) profits are countercyclical and go to the savers ($\eta < 1$) or (ii) profits are procyclical but go to the hand-to-mouth. Importantly, with procyclical profits $\Omega > 0$ skewed towards asset holders $\eta < 1$ there is always dampening.

The model's amplification properties as outlined in Proposition 2 are summarized in Table 1.

Table 1: The role of profits for aggregate-demand amplification

Profits	*Distribution (skewed towards)*	
Cyclicality	Asset holders $\eta < 1$	Hand-to-mouth $\eta > 1$
Procyclical $\Omega > 0$	dampen	amplify
Counter-cycl. $\Omega < 0$	amplify	dampen

This constitutes a conundrum for heterogeneous-agent models: the exact same condition that delivers procyclical profits implies aggregate-demand dampening by heterogeneity, not amplification. The reason is that procyclical profits redistribute income to low-MPC savers in a boom, which in turn makes the boom smaller and ameliorates inflationary pressures. We refer to this as a conundrum because in this class of models it is therefore impossible to have simultaneously *all* of procyclical profits, concentrated stockholding (profits go to low-MPC asset holders) and amplification through heterogeneity.

As an aside, we can also express the consumption function in terms of relative inflation

$d_t - d_{t-1} = (1-\alpha)\left(\pi_t - \pi_t^w\right)$. The function then reads:

$$c_t = E_t c_{t+1} + \frac{\lambda}{1-\lambda}(1-\eta)(1-\alpha)\left(E_t \pi_{t+1} - E_t \pi_{t+1}^w\right) - \sigma r_t. \tag{25}$$

This makes transparent that there is aggregate-demand amplification (when $\eta < 1$) if expected price inflation is larger than expected wage inflation.

Reconciling previous findings. The foregoing analytical results allow us to understand several results form the recent literature on household heterogeneity with sticky wages. Adding sticky wages to sticky prices dampens the amplifying forces through heterogeneity. The intuition is that sticky wages contain the wage increase which makes profits less countercyclical which in turn, to the extent that profits accrue to the savers, dampens the aggregate-demand effects (Ascari et al., 2017; Bilbiie et al., 2022; Diz et al., 2023).

In the case with flexible prices but fixed wages we have $\Omega = \alpha > 0$, which also implies dampening (in the benchmark with $\eta < 1$). This is akin to the case in Auclert et al. (2018, 2020) who assume constant returns to scale ($\alpha = 0$), thus yielding proportional incomes. Finally, in the framework by Broer et al. (2020), there is aggregate-demand amplification under sticky wages, but this is because it implicitly features a version of, in our taxonomy, $\eta > 1$: workers are in fact the marginal saver and price assets through their Euler equation, while capitalists receive profit income are hand-to-mouth.

Quantitative (ir)relevance. We study a simple quantitative example. Here we close the model by assuming a simple Taylor rule $r_t^n = \phi \pi_t + \varepsilon_t$. Further, we set the share of hand-to-mouth to $\lambda = 0.27$, which is in the range estimated by Kaplan et al. (2014), $\psi_w = 0.05$ and $\psi_p = 0.25$, which lie in the ballpark of empirical estimates (see e.g. Christiano et al., 2005), and $\mathcal{M}$ =1.3. Furthermore, we assume that the intertemporal elasticity of substitution σ and the labor supply elasticity φ are 1 and the Taylor rule coefficient on inflation is 1.5. The impulse response functions to a monetary policy shock of 100 basis point (in annualized terms) are shown in Figure 2.

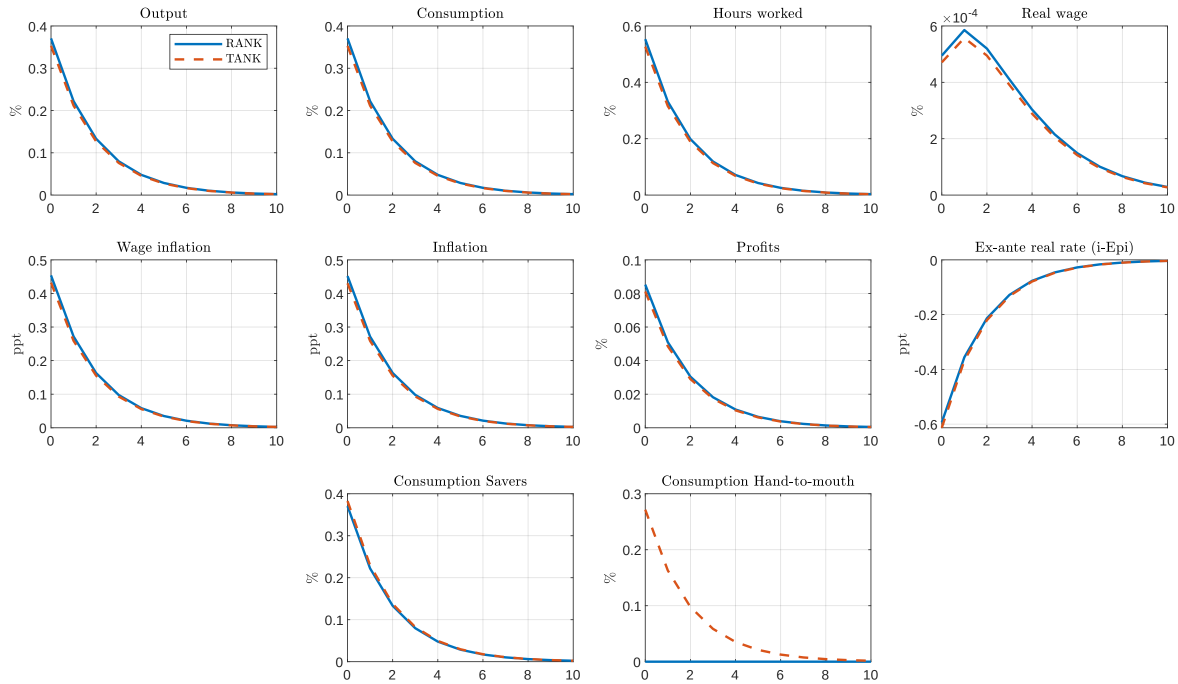

Figure 2: Impulse responses to a monetary policy shock

Notes: Impulse responses to a 100bp monetary policy shock in the standard representative-agent (blue solid line) and two-agent NK model (red dashed line) without capital. The inflation rates and real ex-ante interest rate are expressed in annualized terms.

We can see that in the economy with heterogeneous agents, the consumption response is dampened relative to the representative agent case. However, heterogeneity is almost neutral as the responses are very close to each other. This is because procyclical profits make the income processes of hand-to-mouth and savers very highly correlated: the elasticity of H's consumption to aggregate consumption is $[1-(1-\eta)\Omega] = 0.819$, which yields equilibrium dampening by a factor of 0.937.

One success of the model is that it is able to generate inflationary demand shocks with procyclical profits. However, it is a rather crude model of profits, as they have no other role than the income transfer. Furthermore, as we have seen, the role of profit redistribution (summarized by whether η is smaller or larger than 1) plays an implausibly large role for the amplification properties of the model.

Isomorphism between sticky prices and wages?[7] In the representative-agent world and under constant-returns-to-scale, there is in fact an isomorphism between wage and price stickiness (see Galí, 2015). Namely, imposing constant returns ($\alpha = 0$), we have that under flexible prices

$$mc_t = w_t = 0 \rightarrow \pi_t^w = \pi_t = \psi_w \left[\sigma^{-1} + \varphi\right] c_t. \tag{26}$$

Flexible wages on the other hand imply

$$\pi_t = \psi_p mc_t = \psi_p \left[\sigma^{-1} + \varphi\right] c_t. \tag{27}$$

Thus, the two extreme cases (sticky-price, flexible-wage, and vice versa) yield isomorphic, observationally equivalent aggregate-supply sides: the Phillips curves are equivalent, and amount to a reinterpretation of the stickiness parameters. This further implies that in the representative agent case the whole equilibrium is identical, as the aggregate-demand side (Euler equation) is the same in both cases.

Obviously, this isomorphism breaks down in a heterogeneous-agent setting, as the demand side can potentially be radically different, depending on the relative stickiness in wages versus prices.

4 A Way Out: Profits as an Investment Payoff

Is there a way to get amplification under empirically realistic assumptions with regards to the cyclicality and distribution of profits? In this section, we introduce a more realistic framework that features capital investment and revisit the relationship between profits and income distribution in shaping inflation and aggregate demand.

[7]We thank Mathias Trabandt for suggesting to check this implication.

Model. The model here extends the economy from Section 3 with capital investment. We discuss here the parts of the model, in loglinear form, that change relative to the economy without capital. The full model is described in the appendix.[8] The production technology is now given by

$$y_t = \alpha k_t + (1-\alpha) n_t \tag{28}$$

and the respective labor and capital demand equations are

$$w_t = mc_t + y_t - n_t \tag{29}$$

$$r_t^K = mc_t + y_t - k_t. \tag{30}$$

Capital markets are segmented, only the savers can hold and invest in physical capital. Savers' behavior is described by the same Euler equation for bonds as before (17) and by the capital Euler equation:

$$q_t = \beta E_t q_{t+1} + (1 - \beta(1-\delta)) E_t r_{t+1}^K - \sigma^{-1}(E_t c_{t+1}^S - c_t^S), \tag{31}$$

where q_t is Tobin's marginal q:

$$\omega q_t = i_t - k_t. \tag{32}$$

Capital accumulation is given by $k_{t+1} = (1-\delta)k_t + \delta i_t$.

Consumption inequality is now also a function of portfolio choice, but as we will see it is still a sufficient statistic for Euler equation amplification of aggregate consumption. However, inequality has now a richer set of determinants; the individual budget con-

[8] This model follows closely our earlier work (Bilbiie et al., 2022) and can be regarded as a variant of the TANK model with capital by Galí et al. (2007).

straints in loglinearized form are:

$$\frac{C}{Y}C_t^H = (1-\alpha)(w_t + n_t) + \eta d_t^A \tag{33}$$

$$\frac{C}{Y}c_t^S + \frac{1}{1-\lambda}\frac{I}{Y}i_t = (1-\alpha)(w_t + n_t) + \alpha\frac{1}{1-\lambda}\left(r_t^K + k_t\right) + \frac{1-\eta\lambda}{1-\lambda}d_t^A, \tag{34}$$

where $d_t^A \equiv \alpha^{-1}d_t + \left(r_t^K + k_t\right)$ is a measure of accounting profits, as proposed by Christiano et al. (1997).

Consumption amplification via investment. Taking the difference, we obtain directly consumption inequality $\gamma_t^C \equiv c_t^S - c_t^H$ as:

$$\frac{C}{Y}\gamma_t^C = \frac{1}{1-\lambda}\left((1-\eta)\,\alpha d_t^A - \frac{I}{Y}i_t\right) = \frac{\alpha}{1-\lambda}\left((1-\eta)\,d_t^A - \frac{\delta}{r+\delta}i_t\right).$$

Since the aggregate(d) consumption Euler equation (21) still holds unchanged, the requirement for consumption amplification of demand shocks is still that consumption inequality be countercyclical $\frac{\partial\gamma_t^C}{\partial c_t} < 0$. The ensuing requirement on the relative cyclicality of investment and profits is emphasized in the following proposition.

Proposition 3 (Amplification through investment) *In the model with segmented capital markets, aggregate-demand fluctuations are amplified if investment is procyclical enough*

$$\frac{\partial\gamma_t^C}{\partial c_t} < 0 \Leftrightarrow \frac{\partial i_t}{\partial c_t} > (1-\eta)\left(1+\frac{r}{\delta}\right)\frac{\partial d_t^A}{\partial c_t}.$$

This is generally satisfied even with procyclical profits.

Having an additional amplification channel through investment can solve the conundrum in the heterogeneous-agent economy without capital: there can still be amplification even when profits are procyclical and go to asset owners. The reason is that investment by low-MPC households boosts income of all households, including high-MPC ones. With nominal rigidity, this feeds back into a demand expansion which further expands income, and triggers additional rounds as part of this income is invested and saved by the low-MPC asset holders, and so on and so forth.

Furthermore, the (re)distribution of profits now plays a subordinate, quantitative but not qualitative role: the amplification properties do not *flip sign* depending on who receives the profits, unlike in the economy without capital. When profits are procyclical, their redistribution towards high-MPC households helps the inequality in the Proposition be satisfied; but even when all profits go to the low-MPC ($\eta = 0$), the requirement is likely to be satisfied since investment is typically much more procyclical than profits.

The amplification properties of this economy, parameterized as above and with investment elasticity to q given by $\omega = 10$ and depreciation $\delta = .025$ are displayed in Figure 3.

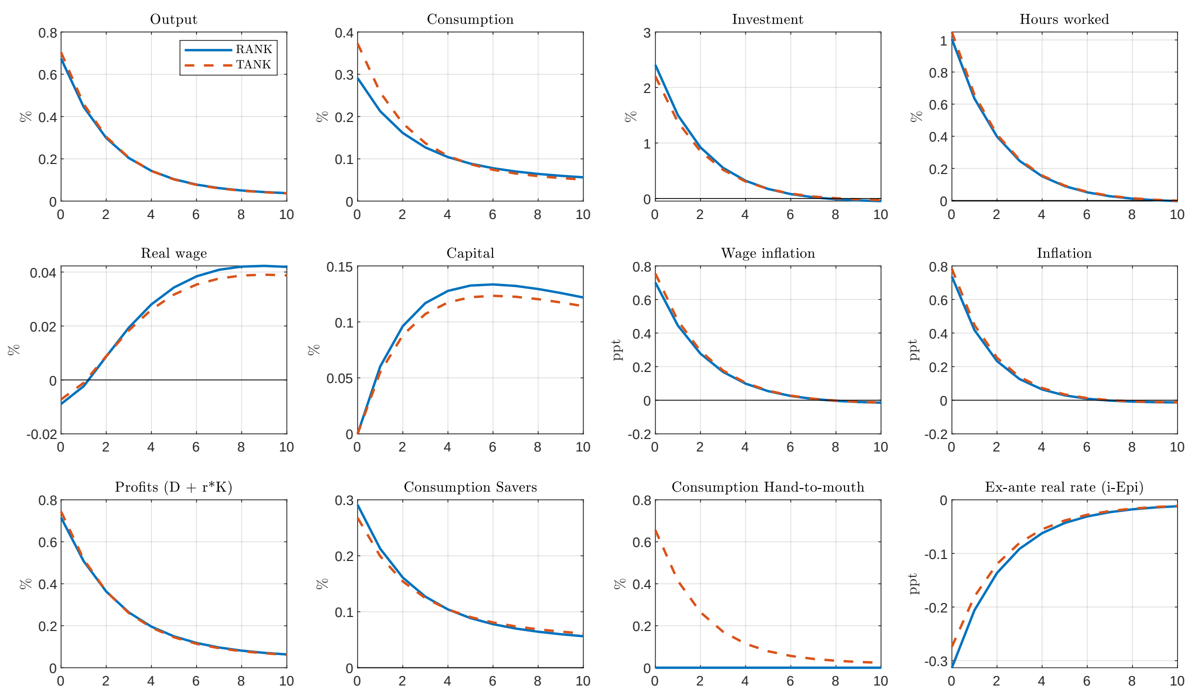

Figure 3: Impulse responses to a monetary policy shock in NK model with capital

Notes: Impulse responses to a 100bp monetary policy shock in the representative-agent (blue solid line) and two-agent NK model (red dashed line) with capital. The inflation rates and real ex-ante interest rate are expressed in annualized terms.

Inflation amplification and "greed". While the investment channel yields aggregate-demand amplification, note that there is still no amplification of inflation through an increase in profits; in other words, there is no support for the "greed" narrative understood as this three-folded comovement. To understand why, it is useful to revisit the Phillips curve representation (14): even if the response of consumption is amplified, as it is here, if profits are procyclical this creates a counteracting, deflationary force—by the intrinsic mechanics emphasized at the outset, stemming from the presence of sticky prices. In other words, price stickiness has both direct and indirect effects on inflation dynamics. Directly, higher price stickiness (lower ψ_p) implies lower inflation movements for any given change in real variables. But indirectly, through general-equilibrium forces, price stickiness implies more inflation insofar as it leads to aggregate-demand amplification and a larger consumption response.[9]

It *is* possible to get inflation amplification through such general-equilibrium, aggregate-demand effects without capital, but not with procyclical profits. This is because with procyclical profits the general equilibrium forces are such that both the equilibrium response of consumption is dampened, *and* profits exert deflationary pressures as explained above. Thus, inflation amplification necessarily requires $\Omega < 0$, i.e. *countercyclical* profits—contradicting one of the three pillars of the "greed" narrative.

In the model with capital, it is possible to generate inflation amplification even under procyclical profits. However, this works not through profits but through the investment channel described above. In other words, inflation amplification occurs not because of but *despite* procyclical profits, which still tend to dampen the inflation response. This can be understood intuitively by inspecting the equivalent of the Phillips curve representation linking inflation, demand, and profits (14)—but for the model with capital. Indeed, merely rewriting the expression for real marginal cost using the firms' optimality condi-

[9]See Hagedorn and Mitman (2023) for a different feedback loop between price setting and (nominal) demand stemming from state-dependent pricing.

tions, production function, and profits definition, we obtain:

$$\pi_t = \psi_p \frac{\alpha}{1-\alpha} y_t - \psi_p \frac{\alpha}{1-\alpha} d_t^A. \tag{35}$$

An amplified inflation response can happen despite procyclical profits if the response of total demand (output) is amplified enough, that is if the amplified consumption response dominates both the dampened investment response and the procyclical profits. Overall, because of these contradicting forces, the quantitative amplification of inflation is a fortiori muted.

With *countercyclical* profits, we can get a more substantially amplified inflation response in the model with capital, as we illustrate in Figure B.1 in the appendix. There we assume that prices are stickier than wages, which results in a countercyclical response of profits.

Real wage cyclicality and Lucas' less famous critique. Our final set of remarks concerns what Christiano and Eichenbaum (1992) have referred to as "Lucas' less famous critique". In the class of models studied here, aggregate-demand amplification is necessarily driven by procyclical-enough real wages. However, Lucas (1981, pp. 226) noted four decades ago that "observed real wages are not constant over the cycle, but neither do they exhibit consistent pro- or counter-cyclical tendencies. [...] any attempt to assign systematic real wage movements a central role in an explanation of business cycles is doomed to failure." As our results above make clear, (enough) wage stickiness is a crucial ingredient to ensure aggregate-demand amplification in this class of models while complying with Lucas' litmus test.[10]

[10] See Bilbiie and Straub (2004) for an earlier discussion of "Lucas' less famous critique" in NK models with heterogeneous households.

5 Conclusion

Do modern macroeconomic models with heterogeneous agents and nominal rigidities deliver a mechanism similar to the much-discussed "greed hypothesis", in the current inflation crisis? What does it take, in this class of models, to explain a surge in inflation associated with, or driven by, an increase in corporate profits and, at the same time, an aggregate demand expansion?

We have shown, analytically and by quantitative simulations, that such a three-fold comovement is surprisingly difficult to come by in this class of models. To start with, the staple New Keynesian model with sticky prices *only* contains at its core a negative comovement between inflation and profits in response to demand shocks (and supply shocks do not help—indeed, they generate a rather uncontroversial negative comovement between profits and inflation). This comes from a long-noticed empirical failure of that model, the countercyclicality of profits in response to demand shocks (Christiano et al., 1997); the "cure" to this is also long-known in quantitative DSGE models, that is wage stickiness (Christiano et al., 2005). Our first contribution is to provide an analytical condition for the relative stickiness of wages and prices that ensures that profits are procyclical.

However, we next show that in models with heterogeneous households this generates a conundrum: to have aggregate-demand amplification, or a Keynesian-cross multiplier in that class of models (larger effects of demand shocks through heterogeneity), it is impossible to have procyclical profits as long as profit income is predominantly skewed towards low-MPC "savers", or asset holders. In other words, disciplining the model to generate procyclical profits that are a payoff to assets held by savers a fortiori yields dampening of aggregate demand fluctuations—and of inflation.

We provide a way out of this conundrum, by acknowledging that profits are not just a transfer but also a payoff to investment in a productive asset. We show analytically that cyclical enough investment pursued by asset holders, who then also perceive (procyclical) profits, generically restores aggregate-demand amplification. Even if procyclical profit income goes to the low-MPC, a boom is amplified because their saving contributes to a productive asset, which creates income for everyone, including the high-MPC population—which then increases demand, and (with sticky prices) income, part of which is again saved and invested, and so on. If this channel is strong enough, the inflation response can also be amplified. However, that amplification occurs not through but *despite* procyclical profits, which still tend to dampen the inflation response. Thus, the "greed narrative"—whereby higher inflation is associated with or even caused by a higher demand expansion and higher profits—seems incompatible with workhorse macroeconomic theories.

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Appendix

A Model Derivations

This appendix provides the derivations for the models introduced in Sections 2-4. We first detail the model under flexible wages before discussing the model with both sticky prices and wages. The economy comprises households, firms and a government, consisting of a fiscal and a monetary authority. We discuss each sector in turn.

A.1 Households

There is a unitary mass of households, indexed by j. Households have the same CRRA preferences, $U(C,N) = \frac{C^{1-\sigma^{-1}}}{1-\sigma^{-1}} - a\frac{N^{1+\varphi}}{1+\varphi}$, and discount the future at rate β. Here the parameter σ is the elasticity of intertemporal substitution. As discussed, there are two types of households that differ in their asset holdings: A share $\lambda \in [0,1)$ of households are *hand-to-mouth* H. They hold no assets and thus just consume their labor income and any redistributive transfers they receive from the government. The remaining $1-\lambda$ are *savers* S who hold all assets: stocks and capital, understood as both claims to monopoly profits and claims to physical capital income, as well as nominal bonds. Thus, there is *limited asset market participation*.

Labor union. We assume that the labor market is centralized: labor inputs are pooled and a union sets wages on behalf of both households. In particular, we assume that each household supplies each possible type of labor, as in Schmitt-Grohé and Uribe (2005). Wage-setting decisions are made by labor-type specific unions $i \in [0,1]$. Given the wage $W_t(i)$ fixed by union i, households stand ready to supply as many hours to the labor market i, $N_t(i)$, as demanded by firms

$$N_t(i) = \left(\frac{W_t(i)}{W_t}\right)^{-\epsilon_w} N_t^d,$$

where $\epsilon_w > 1$ is the elasticity of substitution between labor inputs. Here, W_t is an index of the nominal wages prevailing in the economy at time t and N_t^d is the aggregate labor demand.

Households are distributed uniformly across unions and hence aggregate demand for labor type i is spread uniformly across households. It follows that the individual quantity of hours worked, $N_t(j)$, is common across households and we denote it as $N_t = N_t^H =$

N_t^S. This must satisfy the time resource constraint $N_t = \int_0^1 N_t(i)di$. Plugging in for the labor demand from above, we get

$$N_t = N_t^d \int_0^1 \left(\frac{W_t(i)}{W_t} \right)^{-\epsilon_w} di.$$

The labor market structure rules out differences in labor income between households without the need to resort to contingent markets for hours. The common labor income is given by $W_t N_t^d = \int_0^1 W_t(i) N_t(i) di = N_t^d \int_0^1 W_t(i) \left(\frac{W_t(i)}{W_t} \right)^{-\epsilon_w} di$.

Unions set their charged wages $W(i)$ by maximizing a social welfare function, given by the weighted average of hand-to-mouth and savers' utility, with weights that are equal to the shares of the households.[11] The optimal wage setting equation reads

$$\frac{W_t(i)}{P_t} = a N_t^{\varphi} \left(\lambda (C_t^H)^{-\sigma} + (1-\lambda)(C_t^S)^{-\sigma} \right)^{-1},$$

where we have used an optimal subsidy to neutralize the wage markup. Note that because everything on the right-hand-side is independent of i, it follows that all unions charge the same wage $W_t(i) = W_t$. From the definition of aggregate labor supply, we further have $N_t^d = N_t$.

Log-linearizing this equation, results in the "labor-supply-like" wage schedule as presented in the main text

$$\varphi n_t = w_t - \sigma^{-1} c_t,$$

where we have invoked our assumption of a symmetric steady state of consumption. In the model with sticky wages, the wage setting problem changes accordingly. We introduce wage rigidities following Colciago (2011), assuming that the labor union faces wage-setting frictions in the sense that the wage can only be re-optimized with a constant probability $1 - \theta_w$. By standard results, wage setting can then be characterized by the following equations in log-linear form:

$$\begin{aligned} \pi_t^w &= \beta E_t \pi_{t+1}^w + \psi_w \mu_t^w \\ \mu_t^w &= \sigma^{-1} c_t + \varphi n_t - w_t \\ \pi_t^w &= w_t - w_{t-1} + \pi_t, \end{aligned} \tag{36}$$

where π_t^w represents nominal wage inflation, μ_t^w is a time-varying wage markup and ψ_w

[11] This welfare function follows from the assumption that each household j supplies each possible type of labor input i and that there are a share of λ hand-to-mouth and a share of $1 - \lambda$ savers.

stands for the slope of the wage Phillips curve.

Hand-to-mouth. The problem of the hand-to-mouth is very simple. As they do not have access to asset markets, they simply consume everything they have. Their consumption is thus determined by their budget constraint:

$$C_t^H = \frac{W_t}{P_t} N_t^H + T_t^H,$$

where W_t is the nominal wage, P_t is the aggregate price level, and T_t^H are transfers from the government.

Savers. Savers hold and price all assets. Their budget constraint reads

$$(1 + r_t^n)^{-1} B_{t+1}^S + P_t C_t^S + P_t \frac{I_t}{1-\lambda} = B_t^S + W_t N_t^S + P_t (1 - \tau^K) R_t^K \frac{K_t}{1-\lambda} + (1 - \tau^D) D_t,$$

where B_t^S are nominal bond holdings, r_t^n is the nominal interest rate, I_t is investment, R_t^K is the gross rental rate of capital and D_t are the firms' profits. τ^D and τ^K are taxes levied by the government on firms profits and capital income, respectively.

The capital accumulation equation is given by

$$K_{t+1} = (1 - \delta) K_t + \Phi \left(\frac{I_t}{K_t} \right) K_t,$$

where δ is the depreciation rate and $\Phi(\cdot)$ are costs to adjusting the capital stock, satisfying the standard assumptions $\Phi' > 0$ and $\Phi'' \leq 0$, with $\Phi'(\delta) = 1$ and $\Phi(\delta) = \delta$.

Maximizing lifetime utility subject to the budget constraint as well as capital accumulation gives the standard consumption and investment Euler equations:

$$\begin{aligned} (C_t^S)^{-\frac{1}{\sigma}} &= \beta E_t \left[\frac{1 + r_t^n}{1 + \pi_{t+1}} (C_{t+1}^S)^{-\frac{1}{\sigma}} \right] \\ Q_t &= \beta E_t \left[\left(\frac{C_{t+1}^S}{C_t^S} \right)^{-\frac{1}{\sigma}} \left((1 - \tau^K) R_{t+1}^K + Q_{t+1} \left(1 - \delta + \Phi_{t+1} - \frac{I_{t+1}}{K_{t+1}} \Phi'_{t+1} \right) \right) \right], \end{aligned}$$

where $Q_t = \left(\Phi' \left(\frac{I_t}{K_t} \right) \right)^{-1}$ is Tobin's marginal Q, and $\pi_t = \log(P_t / P_{t-1})$ is the inflation rate.

A.2 Firms

There is a continuum of monopolistically competitive firms producing differentiated goods $Y_t(j)$ using capital $K_t(j)$ and labor $N_t(j)$ according to a constant-returns production function $Y_t(j) = N_t(j)^{1-\alpha} K_t(j)^{\alpha}$, where α is the capital share. Firms rent labor and capital on competitive factor markets and set prices to maximize profits, subject to consumers' demand. However, firms face price-adjustment frictions, giving rise to a nominal rigidity (which can follow the Calvo or the Rotemberg specification).

Cost minimization delivers the optimal factor demands:

$$\frac{W_t}{P_t} = (1-\alpha)\frac{MC_t}{P_t}\frac{Y_t}{N_t}$$
$$R_t^K = \alpha\frac{MC_t}{P_t}\frac{Y_t}{K_t},$$

which are common across firms in equilibrium. The pricing problem delivers the standard Phillips curve for price inflation $\pi_t = \beta E_t \pi_{t+1} + \psi mc_t$ in log-linear form. The slope ψ is governed by the amount of price stickiness: when $\psi \to 0$, prices are completely fixed, while when $\psi \to \infty$ prices are flexible.

Government. The government implements both monetary and fiscal policy. Monetary policy follows a standard Taylor rule, $r_t^n = \phi_\pi \pi_t + \varepsilon_t$. The fiscal authority redistributes all revenues from capital income and profits taxation, running a balanced budget in every period: $\lambda T_{H,t} = \tau^D D_t + \tau^K R_t^K K_t$.

Market clearing. Finally, the resource constraint of the economy takes into account that part of output is used for investment:

$$Y_t = C_t + I_t.$$

A.3 Steady State

We consider a zero inflation steady state with $\pi = 0$. Steady-state real marginal cost is equal to the inverse of the flexible price markup $MC/P = \mathcal{M}^{-1}$.[12]

In our baseline simulations, we assume a symmetric steady state, i.e. $C^H = C^S = C$. This can be implemented by imposing a fixed steady state transfer from savers to hand-to-mouth. We believe that this is a reasonable benchmark and allows for better comparison

[12] For some of the analytical results, we will assume that there is an optimal subsidy in place to neutralize the steady-state markup such that $\mathcal{M} = 1$.

to the analytical part, where we maintain this assumption throughout. Furthermore, it allows us to maintain the same steady state for both the flexible and sticky wage version of the model as discussed below. Importantly, however, this assumption turns out to be inconsequential for our quantitative results. Setting the steady-state transfer to zero and thus allowing consumptions to differ in steady state produces very similar results.

The steady-state interest rate is then given by the Euler equation for bonds as $r^n = \beta^{-1} - 1$, which is equal to the rate of time preference. The steady-state rental rate of capital can be obtained from the investment Euler equation $R^K = (r^n + \delta)/(1 - \tau^K)$. The capital accumulation equation gives the steady-state investment to capital ratio $I/K = \delta$. From firms' capital demand, we have $K/Y = \alpha(1 - \tau^K)/\left[\mathcal{M}\left(r^n + \delta\right)\right]$. We can also get $K/N = (K/Y)^{\frac{1}{1-\alpha}}$ and $N/Y = (K/Y)^{-\frac{1}{\alpha}}$. From the firms' labor demand, we have $W/P = (1-\alpha)\mathcal{M}^{-1}(Y/N)$. The steady state shares of investment and consumption in total output are hence:

$$
\begin{aligned}
\frac{I}{Y} &= \alpha \frac{\delta(1 - \tau^K)}{r^n + \delta} \\
\frac{C}{Y} &= 1 - \alpha \frac{\delta(1 - \tau^K)}{r^n + \delta}.
\end{aligned}
$$

We can also get the wage and capital income shares as $WN/PY = (1-\alpha)/\mathcal{M}$ and $R^K K/Y = \alpha/\mathcal{M}$. Steady-state profits are given by $D/Y = 1 - \mathcal{M}^{-1}$.[13] The steady-state transfer is thus given by $T^H/Y = (\tau^D/\lambda)(D/Y) + (\tau^K/\lambda)(R^K K/Y)$.

Sticky wages. For the sticky wages version of the model, we make a number of additional assumptions to ensure that the two models have the same steady state. In particular, we assume that wage inflation is zero as well, which equalizes the optimal reset wage and the level of real wages in steady state. Furthermore, we assume that there is a subsidy in place that neutralizes the steady-state wage markup. Under our assumption of equal consumptions in steady state, the steady-state real wage is the same as in the flexible wage model.

A.4 Log-linear Model

We consider a log-linear approximation of the THANK model around the deterministic steady state described above. We will express all variables as log deviations from steady state and denote them in lower case format ($x_t = \log(X_t) - \log(X)$). For rates, we log-linearize the gross rates, which will be approximately equal to the net rates. The two

[13] In the model without capital, we have $D/Y = 1 - (1-\alpha)/\mathcal{M}$.

exceptions are transfers and dividends. This is because these variables can take zero value. We thus express these variables as absolute deviations from steady state, relative to steady state output, i.e. $x_t = \frac{X_t - X}{Y}$ for $X = \{D, T^H\}$. Table A.1 summarizes the log-linear equilibrium conditions.

Table A.1: Log-linear equilibrium conditions for the THANK model

No.	Name	Equation
1:	Wage markup	$\mu_t^w = \sigma^{-1} c_t + \varphi n_t - w_t$
2:	Phillips curve wages	$\pi_t^w = \beta E_t \pi_{t+1}^w + \psi_w \mu_t^w$
3:	Wage inflation	$\pi_t^w = w_t - w_{t-1} + \pi_t$
4:	Euler bonds, S	$c_t^S = s E_t c_{t+1}^S + (1-s) E_t c_{t+1}^H - \sigma(r_t^n - E_t \pi_{t+1})$
5:	Euler capital, S	$q_t = \beta E_t q_{t+1} + (1 - \beta(1-\delta)) E_t r_{t+1}^K - \sigma^{-1}(E_t c_{t+1}^S - c_t^S)$
6:	Tobins q, S	$\omega q_t = i_t - k_t$
7:	Capital accumulation	$k_{t+1} = (1-\delta) k_t + \delta i_t$
8:	Budget constraint, H	$\frac{C}{Y} c_t^H = \frac{1-\alpha}{\mathcal{M}}(w_t + n_t) + t_t^H$
9:	Transfer, H	$t_t^H = \frac{\tau^D}{\lambda} d_t + \frac{\tau^K}{\lambda} \frac{\alpha}{\mathcal{M}}(r_t^K + k_t)$
10:	Labor demand	$w_t = mc_t + y_t - n_t$
11:	Capital demand	$r_t^K = mc_t + y_t - k_t$
12:	Phillips curve	$\pi_t = \beta E_t \pi_{t+1} + \psi mc_t$
13:	Production function	$y_t = \alpha k_t + (1-\alpha) n_t$
14:	Profits	$d_t = y_t - \frac{1-\alpha}{\mathcal{M}}(w_t + n_t) - \frac{\alpha}{\mathcal{M}}(r_t^K + k_t)$
15:	Aggregate cons.	$c_t = \lambda c_t^H + (1-\lambda) c_t^S$
16:	Resource constraint	$y_t = \frac{C}{Y} c_t + \frac{I}{Y} i_t$
17:	Taylor rule	$r_t^n = \phi_\pi \pi_t + \epsilon_t$

The model without capital essentially obtains if investment is inelastic to Q (infinite adjustment costs), $\omega = 0$, and if there is no depreciation $\delta = 0$, implying a fixed capital stock. The log-linearized equilibrium conditions in this case are shown in Table A.2.

Table A.2: Log-linear equilibrium conditions for the THANK model without capital

No.	Name	Equation
1:	Wage markup	$\mu_t^w = \sigma^{-1} c_t + \varphi n_t - w_t$
2:	Phillips curve wages	$\pi_t^w = \beta E_t \pi_{t+1}^w + \psi_w \mu_t^w$
3:	Wage inflation	$\pi_t^w = w_t - w_{t-1} + \pi_t$
4:	Euler bonds, S	$c_t^S = s E_t c_{t+1}^S + (1-s) E_t c_{t+1}^H - \sigma(r_t^n - E_t \pi_{t+1})$
5:	Budget constraint, H	$c_t^H = \frac{1-\alpha}{\mathcal{M}}(w_t + n_t) + \ t_t^H$
6:	Transfer, H	$t_t^H = \frac{\tau^D}{\lambda} d_t$
7:	Labor demand	$w_t = mc_t + y_t - n_t$
8:	Phillips curve	$\pi_t = \beta E_t \pi_{t+1} + \psi mc_t$
9:	Production function	$y_t = (1-\alpha) n_t$
10:	Profits	$d_t = y_t - \frac{1-\alpha}{\mathcal{M}}(w_t + n_t)$
11:	Aggregate cons.	$c_t = \lambda c_t^H + (1-\lambda) c_t^S$
12:	Resource constraint	$y_t = c_t$
13:	Taylor rule	$r_t^n = \phi_\pi \pi_t + \epsilon_t$

B Additional Figures

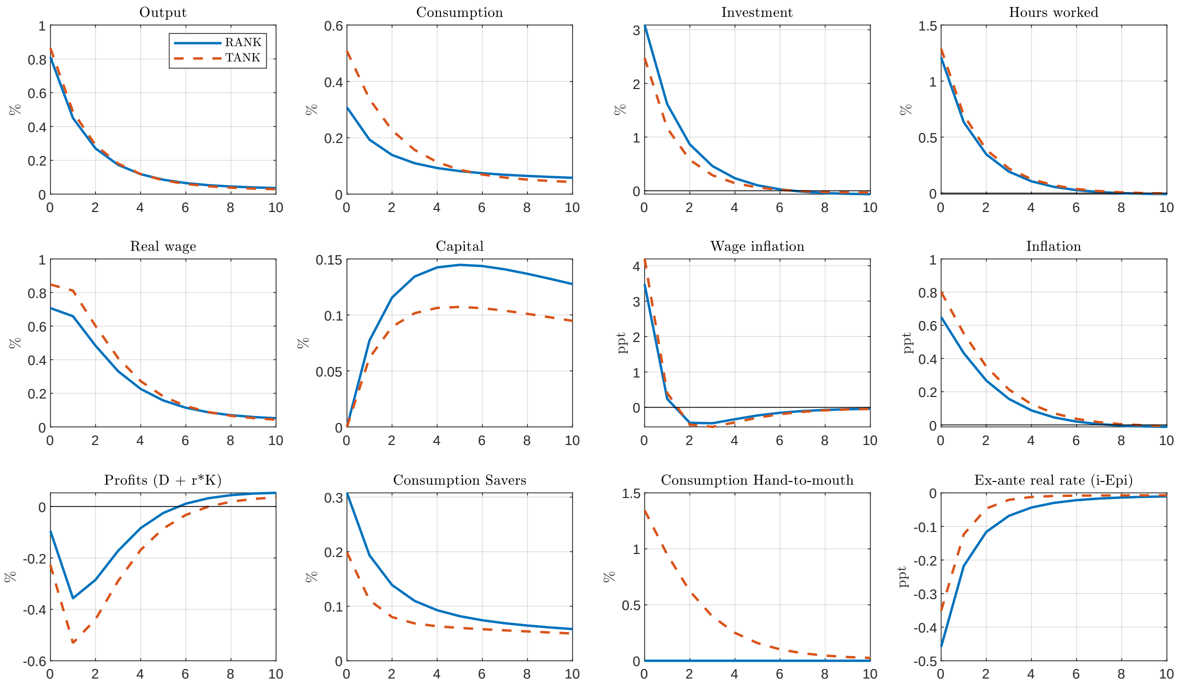

Figure B.1: Impulse responses to monetary policy shock under stickier prices than wages

Notes: Impulse responses to a 100bp monetary policy shock in the representative-agent (blue solid line) and two-agent NK model (red dashed line) with capital. We assume here that prices are stickier than wages (ψ_p = 0.05 and $\psi_w = 1$). The inflation rates and real ex-ante interest rate are expressed in annualized terms.