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

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Abstract

We investigate whether profits can drive inflation through the interplay of income distribution and aggregate demand—our definition of "greed"—within the New Keynesian framework. We derive an analytical condition for profits to be demand-procyclical and inflationary. When distributional mechanisms are essential, a conundrum emerges: procyclical profits accruing to low-MPC asset-holders imply aggregate dampening and deflation—the opposite of greedflation. Adding capital investment delivers aggregate-demand amplification even under procyclical profits, but the latter are still deflationary. Countercyclical income risk can amplify inflation; yet since this operates through precautionary savings, not profits, it is still inconsistent with the direct "greed" narrative.

JEL Codes: D11, E32, E52, E62.

Keywords: Aggregate demand, inflation, profits, income distribution, inequality

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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 directly and indirectly, as it inherently erodes their wages. 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 recently 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).

However, getting direct empirical evidence on corporate greed as a driver of inflation is challenging. We therefore use economic theory to organize our thinking around these issues. As shown in Figure 1, the recent greedflation episode was characterized by elevated inflation, rising profits and sustained demand. Can our workhorse monetary models generate these co-movements? Throughout the paper, we focus our analysis on demand shocks. This is because, as we show in the data, only demand shocks generate the desired comovement between profits, inflation and output. Indeed, there was no recession in the recent inflationary episode—estimates suggest that output was even

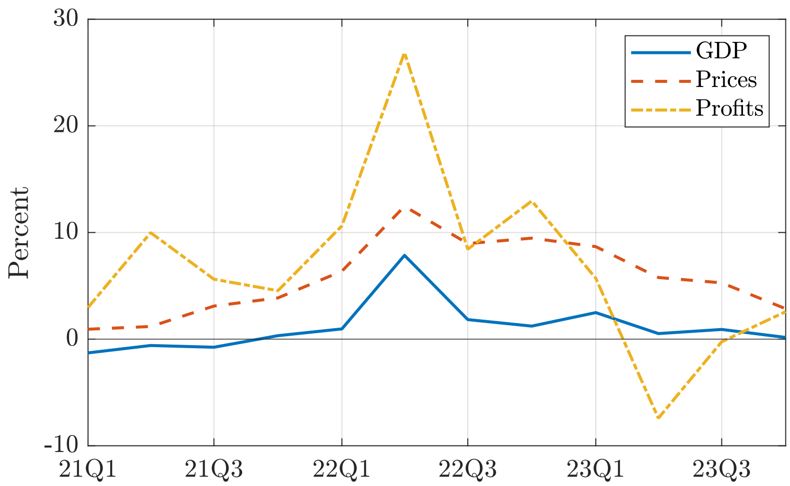

Figure 1: The greedflation episode

Notes: The figure shows the cyclical component of real GDP, the consumer price index and total corporate profits after tax with inventory valuation and capital consumption adjustment, measured with the Hamilton (2018) filter (with $h = 8$ and $p = 4$), over the recent inflationary episode from 2021 to 2023.

above trend. Given these co-movements, under which conditions and to what extent can the unequal distribution of profits amplify the response of inflation, as suggested by the "greedflation" narrative? In a nutshell, our narrow definition of the "greed narrative" is made of two pillars: (i) the positive comovement of *all* of: inflation, profits, aggregate demand, as a minimal condition; and (ii) *unusually* elevated inflation through aggregate-demand effects of profits and their unequal *distribution* in the population.

As an organizing framework for understanding our paper's contribution, it is useful to consider the following way of rewriting the price Phillips curve inherent in any sticky-price new Keynesian model, where for simplicity and without loss of generality we use the static version without expected inflation previously used and microfounded in Bilbiie (2018, 2019):

$$\pi_t = \psi_p mc_t = \psi_p \frac{\alpha + \mathcal{M} - 1}{1 - \alpha} c_t - \psi_p \frac{\mathcal{M}}{1 - \alpha} d_t. \tag{1}$$

In this equation, derived in detail in Section 3, combining the pricing equation and the production function, π denotes the inflation rate and mc real marginal cost, which we then replace by using the definition of profits d (expressed as deviations in shares of steady-state GDP). c stands for consumption and also (in the version without investment) total sales. As to parameters, ψ_p indexes price stickiness (higher values stand for more flexible prices), α is the degree of returns to scale in labor (0 yields constant returns) and $\mathcal{M}$ the post-subsidy markup (equal to 1 under an optimal subsidy).

Our starting point is the well-known but often overlooked observation that, in fact, in the workhorse, representative-agent New Keynesian (NK) model with sticky prices *only*, profits are *negatively* related to inflation—an extreme illustration of which can be immediately seen by inspecting equation (1) under constant returns $\alpha = 0$ and optimal subsidy $\mathcal{M} = 1$, whereby the Phillips curve becomes $\pi_t = -\psi_p \frac{1}{1-\alpha} d_t$. This illustrates the standard core NK intuition that an increase in demand shifts labor demand and increases wages and marginal cost—thus depressing profits while at the same time triggering inflation. As we show using high-frequency identification techniques, this is at odds with the data—where profits co-move strongly positively with output and inflation conditional on demand shocks. This problem of the NK model has been known for decades (Christiano et al., 1997), and so have its fixes, notably wage stickiness (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.

As an aside, it is important to note that 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. Markup shocks, on the other hand, generate inflation and an increase in profits.

Importantly, however, they uniformly imply a recession, and are therefore strictly speaking inconsistent with the "greed" narrative, a main pillar of which is that firms exploit precisely the elevated demand to extract higher profits, charging prices above and beyond what is justified by the cost increase. Empirically, we document that both TFP and oil price shocks transmit like supply shocks, leading to a fall in output and profits and a rise in inflation. This 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]

Our key equation (1) points to a tension that is inherent in NK models, which we label the deflationary *direct* effect of profits through sticky prices. Even when profits are procyclical to demand shocks, they constitute a dampening force on inflation: insofar as prices are to some extent sticky, there is always a negative source of partial comovement between inflation and profits in response to demand shocks (as an expansion in demand increases real marginal costs). Now, the quantitative NK literature (Christiano et al., 2005; Justiniano et al., 2010; Smets and Wouters, 2003) already studied under what parameter configurations a richer version of this model can fit standard business cycles. It is a separate question, however, how to explain an *elevated* inflationary episode of the type experienced in 2021-2023, and whether this can be done through "greed" understood as distributional considerations related to profits.

The idea we explore, through the lens of equation (1), is to rely on *indirect* effects via the general-equilibrium aggregate-demand reaction (c), and study under what conditions these can dominate the deflationary direct effects of procyclical profits, to the point of delivering a magnified general-equilibrium response of inflation.[2]

We study household heterogeneity as a natural and relevant source of such general-

[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).

[2] Evidently, such amplified inflation with high demand c_t does occur if profits are countercyclical, but that is inconsistent with the evidence.

equilibrium amplification through distributional effects linked to profits. Importantly, this allows us to capture distributional mechanisms as a relevant plank of the "greed" narrative, i.e. in addition to the three-fold comovement between profits, inflation, and aggregate demand. We show that this points to a conundrum for the "greed mechanism" that is inherent in this class of models: the very 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.[3] In other words, this is not only inconsistent with but in fact the opposite of "greed": to get even higher inflation, one would need to *mitigate* the increase in profits.

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 hand-to-mouth agents with a high marginal propensity to consume (MPC). 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, and thus contradicts the greed narrative that associates such increases in profits in aggregate-demand expansions with higher-than-usual inflation. Quantitatively, we show that these contradicting forces are balanced in such a way that the heterogeneous-agent (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 final contribution is to point out a way out of this conundrum, made of two components. The first is to introduce capital investment and consider accounting profits as the relevant profit measure. This makes profits more procyclical and delivers demand amplification through an investment channel. However, explaining an irregular inflation

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

upsurge is still quantitatively challenging because of the inherent deflationary force of procyclical profits. The second component is therefore to turn on an amplification channel that is orthogonal to profits and their impact on the income distribution: countercyclical income risk.

More specifically, the natural extension to a model with investment in physical capital overturns our theoretical "conundrum" 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 this is that in a model with capital the correct notion of profits—and the data counterpart, as has been known since Christiano et al. (1997)—includes 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 "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 still encapsulated in a version of our core equation (1): 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.

Therefore, we study a separate amplification channel emphasized by a large part of the

HANK literature: countercyclical income *risk*. This channel can yield enough aggregate-demand amplification even under procyclical profits to compensate the deflationary effect of the latter and magnify the equilibrium inflation response. Importantly, however, this amplification occurs through self-insurance, precautionary-saving motives—agents increase their demand because they liquidate their savings in response to a fall in income risk in expansions—and again not through or because of profits. 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 monetary models. Accommodating it requires other, substantial departures from the baseline framework that we hint to in the concluding section.

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. There is strong 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.[4]

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 two-agent New Keynesian (TANK)

[4]We discuss below how this is related to and different from an earlier analytical contribution by Cantore et al. (2020), which focused on the cyclicality of real wages and the labor share.

model in Bilbiie (2008).[5] 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., 2022b). 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; our contribution is complementary to Melcangi and Sterk (2024), who emphasize the interaction of investment with stock market participation. Finally, HANK models emphasizing the role of countercyclical income risk in amplifying aggregate demand include Ravn and Sterk (2017, 2020), McKay and Reis (2016), Challe et al. (2017), Werning (2015), Acharya and Dogra (2020), Debortoli and Galí (2023), and Bilbiie (2018) for analytical models, and Auclert et al. (2020), Bayer et al. (2019), Gornemann et al. (2016), Den Haan et al. (2017), and Alves et al. (2019) for quantitative models; but none of these contributions discussed the amplification of the *inflation* response, and especially in relationship to the cyclicality of profits.

[5] More recently, Bilbiie (2020, 2018); Debortoli and Galí (2024); 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).

2 Profits, Inflation and the Cycle in the Data

How do profits and inflation co-move with the cycle? To shed light on this question, we estimate the response of output, inflation and profits to different shocks driving the business cycle. Our main focus is on monetary policy shocks, which we use as a stand-in for demand shocks. However, we also consider TFP and oil shocks to study the potential role of supply shocks.

To identify monetary policy shocks, we follow a burgeoning literature exploiting high-frequency asset price movements around monetary policy announcements (Kuttner, 2001; Gürkaynak et al., 2004; Nakamura and Steinsson, 2018, among many others). Specifically, we use high-frequency changes in interest rate futures around FOMC announcements as an instrument in a monetary VAR to identify a structural monetary policy shock. Following Bauer and Swanson (2023), we purge the monetary surprises from relevant macroeconomic and financial data predating the announcement. For the VAR specification, we closely follow Gertler and Karadi (2015). In a next step, we augment the model by one variable at a time to map out the responses of the variables of interest. For more details, see Appendix A.

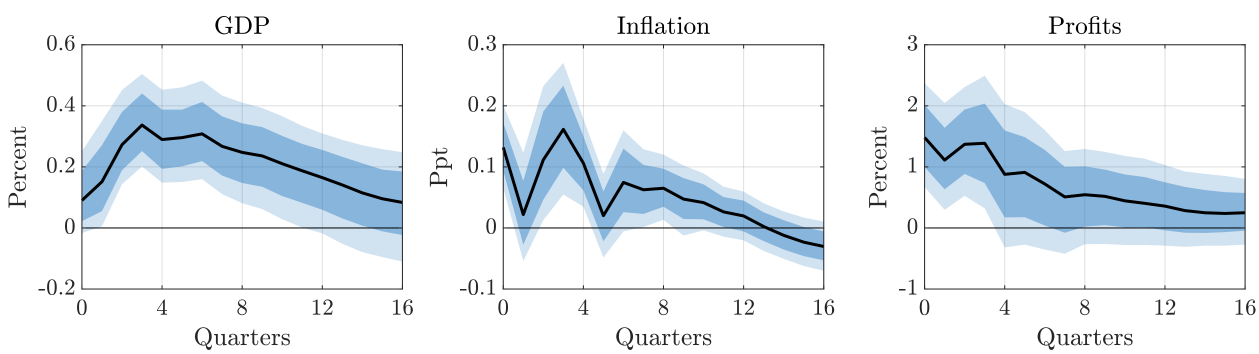

Figure 2: Impulse responses to a monetary policy shock in the data

Notes: The figure shows the impulse responses to a 25 basis points expansionary monetary policy shock. The responses are estimated from a quarterly monetary VAR augmented by the respective variable, using high-frequency identified monetary policy shocks as an instrument. The solid line is the point estimate and the dark and light shaded areas are 68 and 90 percent confidence bands, respectively, computed using a moving-block bootstrap. Inflation is expressed in annualized terms.

Figure 2 shows the responses of real GDP, inflation, as measured by the annualized percentage change in the GDP deflator, and profits, measured as total profits after taxes with inventory valuation and capital consumption adjustment. As we can see, an expansionary monetary policy shock leads to a significant increase in GDP and a rise in inflation. The output response is hump-shaped and features a considerable degree of persistence. The response of inflation is more short-lived. Of key interest is the response of profits, which is positive and persistent. The procyclicality of profits is a very robust result, in particular with respect to using different instruments for the monetary policy shock, the specification of the VAR, and the exact measurement of profits (see Appendix A). Overall, our findings update previous evidence in Christiano et al. (1997, 2005) and provide a stylized fact for any monetary model to match.

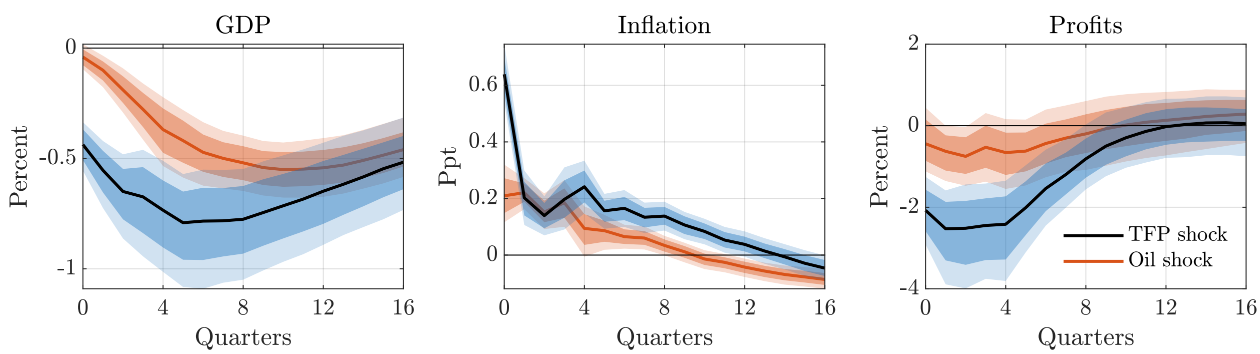

Figure 3: Impulse responses to supply shocks in the data

Notes: The figure shows the impulse responses to supply shocks. The responses to a negative TFP news shock, identified using the Kurmann and Sims (2021) approach, are depicted in blue. The responses to a contractionary oil supply news shock from Känzig (2021) are depicted in red. The solid lines are the point estimates and the dark and light shaded areas are 68 and 90 percent confidence bands, respectively, computed using a moving-block bootstrap. Inflation is expressed in annualized terms.

How do things look with supply shocks? We consider two of the most salient examples of supply shocks: technology shocks and oil supply shocks. For the technology shock, we use the TFP news shocks, identified using the approach in Kurmann and Sims (2021). For the oil supply shock, we employ the approach from Känzig (2021). For more details, see Appendix A.5. The results are shown in Figure 3. We can see that both shocks transmit to the economy as supply shocks: they lead to a significant contraction in output, a rise in inflation and a fall in profits. Thus, they cannot account for the threefold co-movement of output, inflation and profits that we observed during the recent inflationary episode. This suggests that demand shocks were a dominant driver behind this episode and motivates our focus on such shocks.

3 Profit Cyclicality and Inflation in the Simple New Keynesian Model

Our starting point is the plain-vanilla New Keynesian model with rigidities in prices and wages—essentially a stripped-down version of Schmitt-Grohé and Uribe (2005), and a variant of the textbook model in Galí (2015). We sketch the model here in log-linear form and relegate the full description to Appendix B.[6] Labor supply decisions are delegated to a labor union that faces wage-setting frictions. The optimal wage markup is

$$\mu_t^w = \sigma^{-1} c_t + \varphi n_t - w_t. \tag{2}$$

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

$$c_t = E_t c_{t+1} - \sigma(r_t^n - E_t \pi_{t+1}). \tag{3}$$

The production technology features decreasing returns-to-scale in labor

$$y_t = c_t = (1-\alpha) n_t, \tag{4}$$

[6] All variables are expressed in log-deviations from steady state, except profits d_t, which are 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.

where we have already imposed goods market clearing. Marginal costs and profits are, respectively

$$mc_t = -\mu_t = w_t + \frac{\alpha}{1-\alpha} c_t \tag{5}$$

$$d_t = y_t - \frac{1-\alpha}{\mathcal{M}} (w_t + n_t) = \left(1 - \frac{1}{\mathcal{M}}\right) c_t - \frac{1-\alpha}{\mathcal{M}} w_t, \tag{6}$$

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

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., 2022b):

$$\pi_t = \psi_p mc_t = \psi_p \left(w_t + \frac{\alpha}{1-\alpha} c_t\right) \tag{7}$$

$$\pi_t^w = w_t - w_{t-1} + \pi_t = \psi_w \left(\sigma^{-1} c_t + \varphi n_t - w_t\right). \tag{8}$$

All our results generalize easily to the more standard forward-looking Phillips curves we use in Sections 4 and 5.1.

The core rewritten Phillips curve (1) discussed in the Introduction follows directly by using the profits equation (6) to replace the real wage w_t in the Phillips curve (7), thus obtaining inflation as a function of aggregate demand c_t and profits d_t.

The cyclicality of profits. Combining the above equations, we derive the following expression for profits:

$$d_t = \frac{\mathcal{M} - 1 + \Omega}{\mathcal{M}} c_t - \frac{1-\alpha}{\mathcal{M}} \Theta w_{t-1}, \tag{9}$$

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

$$\Omega \equiv \left[\psi_p \alpha - \psi_w \left(\sigma^{-1}(1-\alpha) + \varphi\right)\right] \Theta, \tag{10}$$

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 these 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 $r_t \equiv r_t^n - E_t \pi_{t+1,}$ which by the Euler equation (3) 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:*

$$\frac{\psi_w \left[(1-\alpha)\sigma^{-1} + \varphi\right] - \alpha \psi_p}{1 + \psi_p + \psi_w} < \mathcal{M} - 1. \tag{11}$$

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, consider two polar cases. First, take the plain-vanilla, most basic 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

$$\frac{\partial d_t}{\partial c_t} = 1 - \frac{1 + \varphi + (1-\alpha)\sigma^{-1}}{\mathcal{M}}. \tag{12}$$

We 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 under an optimal subsidy offsetting steady-state markups, $\mathcal{M} \to 1$, profits are *always* countercyclical in this sticky-price-only model.

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

$$\frac{\partial d_t}{\partial c_t} = 1 - \frac{1-\alpha}{\mathcal{M}}, \tag{13}$$

and we can see that profits 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 ($\psi_w, \psi_p \to \infty$), 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; 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 closest antecedent to our analytical condition for procyclical profits in Proposition 1 is a condition derived by Cantore et al. (2020) in a closely-related NK model—but focusing on the responses of real wages and the labor share, and in particular emphasizing that the latter is always procyclical in this model. This is true in our model too, where it can be easily shown that the cyclicality of the labor share ($w_t + n_t - y_t$) is given by $(\alpha - \Omega) / (1 - \alpha)$; since $\Omega < \alpha$ is a restriction, this response is always procyclical. Our focus instead is complementary, on the procyclicality of profits $\Omega > 1 - \mathcal{M}$—yet it still holds true that while profits can be procyclical they can never be so enough to make the markup procyclical and the labor share countercyclical (which is what Cantore et al., 2020, pointed out).

The cyclicality properties of profits are illustrated in Figure 4, 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, $\alpha = 0.33$, $\mathcal{M} = 1.3$ (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.

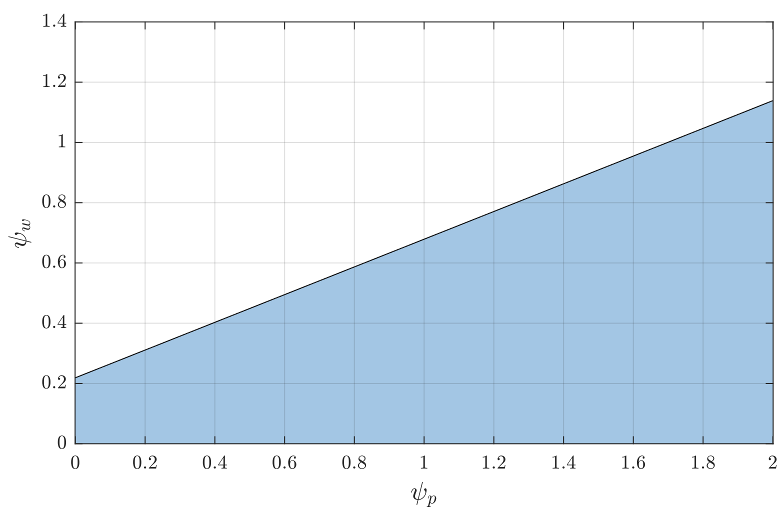

Figure 4: Cyclicality of profits as a function of price and wage stickiness

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 ($\alpha = 0.33$, $\mathcal{M} = 1.3$, $\sigma = 1$ and $\varphi = 1$).

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. Assume without loss of generality that an optimal subsidy is in place such that $\mathcal{M} = 1$ and (9) becomes

$$d_t = \Omega c_t + \Theta d_{t-1}. \tag{14}$$

We use this to rewrite the Phillips curve (1) as

$$\begin{aligned} \pi_t &= \psi_p \frac{\alpha}{1-\alpha} c_t - \psi_p \frac{1}{1-\alpha} d_t \qquad (15) \\ &= \Theta \pi_{t-1} + \frac{\psi_p}{1-\alpha}(\alpha - \Omega) c_t - \alpha \frac{\psi_p}{1-\alpha} \Theta c_{t-1}, \qquad (16) \end{aligned}$$

where $\Omega \in [0, \alpha]$. This makes transparent, first, that the endogenous-persistence parameter 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. This brings us closer to our key question: "how to get (i) comovement between inflation, profits and aggregate demand and then (ii) an amplification of the inflation response through redistribution". Having dealt with part (i), we thus turn to part (ii) of that question: the determination of aggregate demand, which is the only potential source of endogenous, *indirect* inflationary pressures in this class of models when profits are procyclical and thus deflationary through direct effects.

4 Profits, Inequality, and Aggregate Demand: A Conundrum

In this section, we study the potential for delivering aggregate-demand amplification and thus general-equilibrium amplification of inflation too in an economy with heterogeneous agents; we focus on the role of the distribution of profits in engineering an elevated-inflation episode through such demand effects. To keep the analysis tractable, we consider a model with two agents.

Setup. We assume that a share of households $\lambda \in (0,1)$ are hand-to-mouth H, and $1-\lambda$ are savers S (Bilbiie, 2008); all households work for a union that faces wage-setting frictions (Ascari et al., 2017).[7] 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 $\eta < 1$, profits are skewed to the savers who own and price the firm shares.

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

$$c_t^H = (1-\alpha)\left(w_t + n_t\right) + \eta d_t. \tag{17}$$

Savers choose their consumption intertemporally based on their Euler equation

$$c_t^S = E_t c_{t+1}^S - \sigma\left(r_t^n - E_t \pi_{t+1}\right). \tag{18}$$

Finally, aggregate consumption is

$$c_t = \lambda c_t^H + (1-\lambda) c_t^S, \tag{19}$$

where we imposed that consumption across households is equalized in steady state.[8] We close the model by fixing the real rate $r_t \equiv r_t^n - E_t \pi_{t+1}$.

[7]In a setting with heterogeneous agents, this implies that labor earnings are equalized across households. In Appendix C, we relax this assumption and consider a framework with heterogeneity in labor earnings.
[8]This can be implemented by a fixed steady-state subsidy.

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

$$\gamma_t^C \equiv c_t^S - c_t^H.^{9} \tag{20}$$

Using this and the aggregate consumption definition (19), we express the savers' consumption as a function of aggregate consumption and consumption inequality:

$$c_t^S = c_t + \lambda \gamma_t^C. \tag{21}$$

Replacing in the savers' Euler equation (18), the aggregate(*d*) Euler equation reads

$$c_t = E_t c_{t+1} - \lambda \left(\gamma_t^C - E_t \gamma_{t+1}^C \right) - \sigma r_t. \tag{22}$$

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

$$\gamma_t^C = \frac{1-\eta}{1-\lambda} d_t \tag{23}$$

$$\Rightarrow c_t = E_t c_{t+1} - \lambda \frac{1-\eta}{1-\lambda} \left(d_t - E_t d_{t+1} \right) - \sigma r_t. \tag{24}$$

Solving this forward, we obtain

$$c_t = \frac{1-\lambda}{1-\lambda\left[1-(1-\eta)\Omega\right]} \sigma E_t \sum_{j=0}^{\infty} \left(-r_{t+j} \right) - \frac{\lambda(1-\eta)}{1-\lambda\left[1-(1-\eta)\Omega\right]} \Theta d_{t-1}. \tag{25}$$

This equation illustrates that the interaction of profits' distribution η and cyclicality Ω,

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

which is in turn driven by the relative price and wage stickiness, is key for the model's 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, 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 insofar as delivering a "greed" narrative is concerned: 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 makes the boom smaller and mitigates 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; therefore, distributional considerations lead to *lower-than-usual* inflation in times of high and procyclical profits, which is literally the opposite of the "greed" view.

When we relax the assumption of no labor earnings heterogeneity, it is possible to obtain amplification even under procyclical profits and concentrated stockholding, see Proposition 4 in Appendix C. However, as Bilbiie et al. (2022a) show empirically, the cyclicality of heterogeneity in *post-tax* labor earnings (the relevant object for consumption) is not that stark; thus, this channel is likely not that important and the conundrum remains, in a quantitative sense. A more realistic way to circumvent the conundrum consists of adding countercyclical income risk, which can amplify aggregate demand despite procyclical profits enough to also yield an inflation amplification; we outline this extension in Section 5.2.

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:

$$c_t = E_t c_{t+1} + \frac{\lambda}{1-\lambda}(1-\eta)(1-\alpha)\left(E_t \pi_{t+1} - E_t \pi_{t+1}^w\right) - \sigma r_t. \tag{26}$$

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., 2022b; 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 and have a unit MPC out of it (are hand-to-mouth).

Quantitative (ir)relevance. We study a simple quantitative example. Here, we close the model by a simple Taylor rule $r_t^n = \phi\pi_t + \varepsilon_t$. We set the share of hand-to-mouth to $\lambda = 0.27$, which is in the range estimated by Kaplan et al. (2014), $\psi_w = 0.025$ and $\psi_p = 0.1$, which lie in the ballpark of empirical estimates (see e.g. Christiano et al., 2005; Hazell et al., 2022; Gagliardone et al., 2023), 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 25 basis points (in annualized terms) are shown in Figure 5.

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: 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, profit redistribution (summarized by whether η is smaller or larger than 1) plays an implausibly large role for the amplification properties of the model.

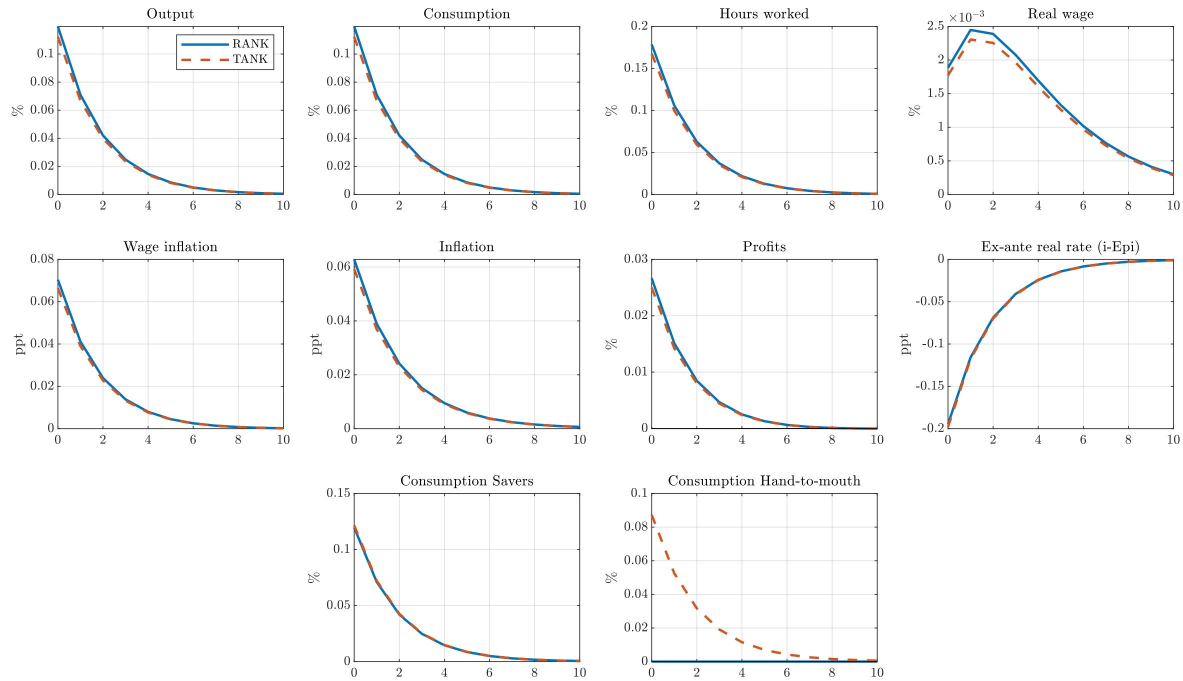

Figure 5: Impulse responses to a monetary policy shock in simple NK model

Notes: Impulse responses to a 25 basis points 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.

Isomorphism between sticky prices and wages? In the representative-agent world and under constant-returns-to-scale $\alpha = 0$, there is an isomorphism between wage and price stickiness (see Bilbiie and Trabandt, 2023): the two extreme cases of sticky-price with flexible-wage, and flexible-price with sticky-wage yield isomorphic, observationally equivalent aggregate-supply sides. The Phillips curves are equivalent, and amount to a reinterpretation of the stickiness parameters, which further implies that in the representative agent case the whole equilibrium is identical (the aggregate-demand side Euler equation is the same in both cases). Obviously, this isomorphism breaks down in a heterogeneous-agent setting such as ours, as the demand side can potentially be radically different, depending on the relative stickiness in wages versus prices.

5 A Way Out: Inflationary Profits through Demand and Distributions

Is there a way to get amplification under empirically realistic assumptions with regards to the cyclicality and distribution of profits? In this section, we explore extensions of the basic model incorporating two key channels of the HANK literature that can in principle yield amplification of aggregate demand through distributional mechanisms, and thus compensate for the ceteris paribus deflationary direct effect of profits inherent in any sticky-price model.

5.1 Profits as an Investment Payoff

We start by considering a more realistic framework that features capital investment as an additional amplification channel and revisit the relationship between profits and income distribution in shaping inflation and aggregate demand.

Model. The model here extends the economy from Section 4 with capital investment. We discuss here the parts of the model, in loglinear form, that change relative to the economy without capital and describe the full model in the appendix.[10] The production technology is now

$$y_t = \alpha k_t + (1-\alpha) n_t \tag{27}$$

and the respective labor and capital demand equations are

$$w_t = mc + y_t - n_t \tag{28}$$

$$r_t^K = mc + y_t - k_t. \tag{29}$$

Capital markets are segmented: only the savers can hold and invest in physical capital.

[10] This model follows closely our earlier work (Bilbiie et al., 2022b) and can be regarded as a variant of the TANK model with capital by Galí et al. (2007). It captures mechanism that are also at work (among others) in richer models of heterogeneity with investment such as Alves et al. (2019); Auclert et al. (2020); Melcangi and Sterk (2024).

Savers' behavior is described by the same Euler equation for bonds as before (18) and by the capital Euler equation:

$$q_t = \beta E_t q_{t+1} + \left[1 - \beta(1-\delta)\right] E_t r_{t+1}^K - \sigma^{-1}(E_t c_{t+1}^S - c_t^S), \tag{30}$$

where q_t is Tobin's marginal q:

$$\omega q_t = i_t - k_t. \tag{31}$$

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

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 loglinearized individual budget constraints are

$$\frac{C}{Y} C_t^H = (1-\alpha)(w_t + n_t) + \eta d_t^A \tag{32}$$

$$\frac{C}{Y} c_t^S + \frac{1}{1-\lambda}\frac{I}{Y} i_t = (1-\alpha)(w_t + n_t) + \alpha \frac{1}{1-\lambda}\left(r_t^K + k_t\right) + \frac{1-\eta\lambda}{1-\lambda} d_t^A, \tag{33}$$

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

Consumption amplification via investment. Taking the difference, we obtain directly consumption inequality 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 (22) 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 $\omega = 10$ and depreciation $\delta = .025$ are displayed in Figure 6.

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

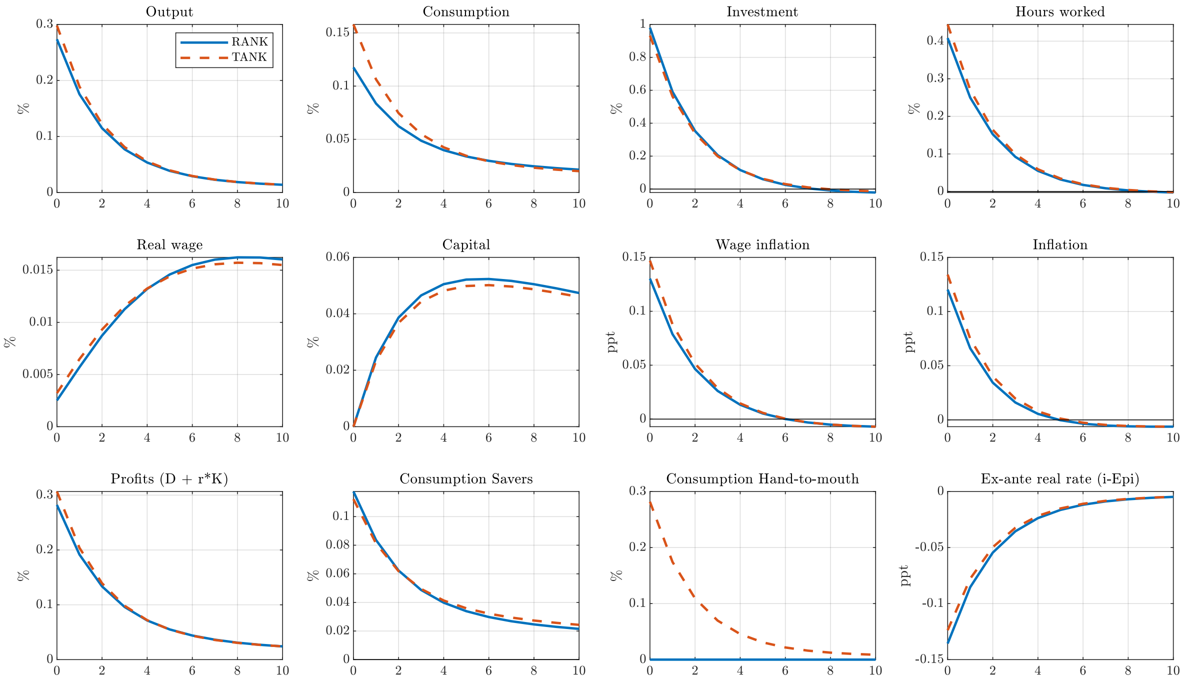

Figure 6: Impulse responses to a monetary policy shock in NK model with capital

Notes: Impulse responses to a 25 basis points 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.

understood as this three-folded comovement. To understand why, it is useful to revisit the Phillips curve representation (15): even if the response of consumption is amplified, as it is here, procyclical profits create 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.[11]

It *is* possible to get inflation amplification through such general-equilibrium, aggregate-demand effects without capital, but not with procyclical profits. This is be-

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

cause 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 (15)—but for the model with capital. Merely rewriting the expression for real marginal cost using the firms' optimality conditions, production function, and profits definition, we obtain:

$$\pi_t = \psi_p \frac{\alpha}{1-\alpha} y_t - \psi_p \frac{\alpha}{1-\alpha} d_t^A. \tag{34}$$

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

5.2 Cyclical Income Risk

Thus, we turn to a separate amplification channel that is independent of profits: cyclical income risk and its impact on precautionary saving. If income risk is countercyclical, this can amplify fluctuations, e.g. if in an aggregate recession risk goes up and cannot be insured, agents increase their demand for precautionary saving which, insofar as output is demand-determined as prices are sticky, further reduces aggregate demand.[12]

We show that incorporating this well-understood channel can also provide a means to also amplify the inflation response to demand shocks, through the amplification of aggregate demand and while profits are still procyclical, thus bringing the model closer to replicating the "greed narrative". To study the role of this channel, we adopt an analytical formalization that captures the cyclicality of risk together with but distinct from the inequality channel emphasized above, based on Bilbiie (2018)—but related to the other analytical contributions referred to in the literature review. We refer the interested reader to that paper for details and only outline here the key equation that changes relative to our baseline model.

Specifically, agents transition stochastically between the two states H and S according to Markov chains, with conditional transition probabilities $1 - s$ (from S to H) and $1 - h$ (from H to S), respectively. The unconditional probabilities of the Markov chain are the respective shares in the stationary distribution, where $\lambda = (1 - s) / (2 - s - h)$. In state H, agents are liquidity constrained, so they hold no asset and have no Euler equation—they are, as above, hand-to-mouth. When in state S, agents can hold a liquid asset (bond) in order to self-insure against the risk of transitioning to state H; while they price this bond and a well-defined demand for it exists, we assume that it is in zero supply (so this is a "zero-liquidity" economy). The only new equation relative to the benchmark model is the Euler equation for holding this liquid bond, which we assume holds with equality:

$$U'\left(C_t^S\right) = \beta E_t \left\{ \frac{1 + i_t}{1 + \pi_{t+1}} \left[sU'\left(C_{t+1}^S\right) + (1 - s)\, U'\left(C_{t+1}^H\right) \right] \right\}$$

[12] This mechanism is at the core of several contributions reviewed in the introduction. See Debortoli and Galí (2023) for a counterpoint to this view, showing that aggregate amplification does not occur if cyclical idiosyncratic risk is concentrated among low-consumption individuals.

To capture a *cyclical risk* component that is distinct from *cyclical inequality* and further differentiate from the cited papers, we assume that the probability of becoming constrained depends on *current* aggregate demand $1 - s(Y_t)$.[13] If the first derivative of $1 - s(.)$ is negative $-s'(Y_t) < 0$, the probability is lower in expansions; insofar as being constrained leads on average to lower income, this makes income risk *countercyclical*. Risk is instead *procyclical* when $-s'(Y_t) > 0$.

Loglinearizing the self-insurance Euler equation around a steady state with consumption inequality, denoted by $\Gamma^C = C^S/C^H \geq 1$ yields

$$c_t^S = -\sigma(i_t - E_t\pi_{t+1}) + \frac{s}{s + (1-s)\Gamma^{\frac{1}{\sigma}}} E_t c_{t+1}^S + \frac{(1-s)\Gamma^{\frac{1}{\sigma}}}{s + (1-s)\Gamma^{\frac{1}{\sigma}}} E_t c_{t+1}^H + \frac{s'(Y)Y}{1 - s(Y)} \frac{\sigma(1-s)\left(\Gamma^{\frac{1}{\sigma}} - 1\right)}{s + (1-s)\Gamma^{\frac{1}{\sigma}}} c_t.$$

Using the same notation $c_t^S = c_t + \lambda\gamma_t^C$ and $c_t^H = c_t - (1-\lambda)\gamma_t^C$, we obtain an aggregate Euler equation

$$\begin{aligned} c_t = {} & E_t c_{t+1} - \sigma(i_t - E_t\pi_{t+1}) - \lambda\left(\gamma_t^C - E_t\gamma_{t+1}^C\right) \\ & - \frac{(1-s)\left(\Gamma^C\right)^{\frac{1}{\sigma}}}{s + (1-s)\left(\Gamma^C\right)^{\frac{1}{\sigma}}} E_t\gamma_{t+1}^C + \frac{s'(Y)Y\left(\left(\Gamma^C\right)^{\frac{1}{\sigma}} - 1\right)\sigma}{s + (1-s)\left(\Gamma^C\right)^{\frac{1}{\sigma}}} c_t \end{aligned} \tag{35}$$

that echoes the one in Bilbiie (2018) and captures two separate self-insurance, precautionary-saving channels from the literature. First, if expected income inequality is countercyclical and there is a risk of transitioning to the "constrained" state, this yields an additional source of amplification as agents self-insure more in an expected aggregate recession, anticipating that their income in the constrained state will fall disproportion-

[13] In Ravn and Sterk (2020) or Challe et al. (2017), this happens in equilibrium through search and matching leading to endogenous unemployment risk. To capture purely idiosyncratic variation, λ is invariant.

ately, and thus amplifying the aggregate recession itself. Similarly, if risk is countercyclical through the probability $s'(Y_t) > 0$ and there is a risk of a de facto consumption drop when transitioning to the H state $\left(\Gamma^C\right)^{\frac{1}{\sigma}} > 1$, agents increase their saving in a downturn which further amplifies the recession.

The latter channel is unrelated to inequality and to profits, and can thus lead to aggregate-demand amplification regardless of the cyclicality of profits and inequality. Therefore, it can also lead to an amplified response of inflation even under procyclical profits. However, just as for the model with investment in physical capital, this inflation amplification works not *through* profits but through the orthogonal, precautionary-saving channel described above. In other words, inflation amplification occurs not because of but *despite* procyclical profits, which still tend to dampen the inflation response—which can be understood intuitively by inspecting again the Phillips curve representation linking inflation, demand, and profits (15).

A quantitative version of the model illustrates that this channel can nevertheless yield significant amplification of the inflation response, concomitantly with procyclical profits in a demand expansion. We embed the above channel in the model with physical capital (a similar conclusion applies to the model without capital, too). We parameterize both the level of risk and its cyclicality in line with the evidence of Bilbiie et al. (2022a), who argue that this channel accounts for most of the significant amplification through heterogeneity of business cycles in US data. The values we use are $s = 0.987$ and $s'(Y) = .16$ (the latter is dictated by constraints imposed by determinacy requirements under our Taylor rule). As the figure illustrates, the model comprising this channel yields significant amplification of the inflation response—through the response of aggregate demand—while also preserving the procyclicality of profits. This is the closest that our model gets to reproducing the "greed narrative", even though the force that dampens the inflation response when profits are procyclical is still there, the AD amplification (occurring through an orthogonal, cyclical-risk channel) is enough to overcome it.[14]

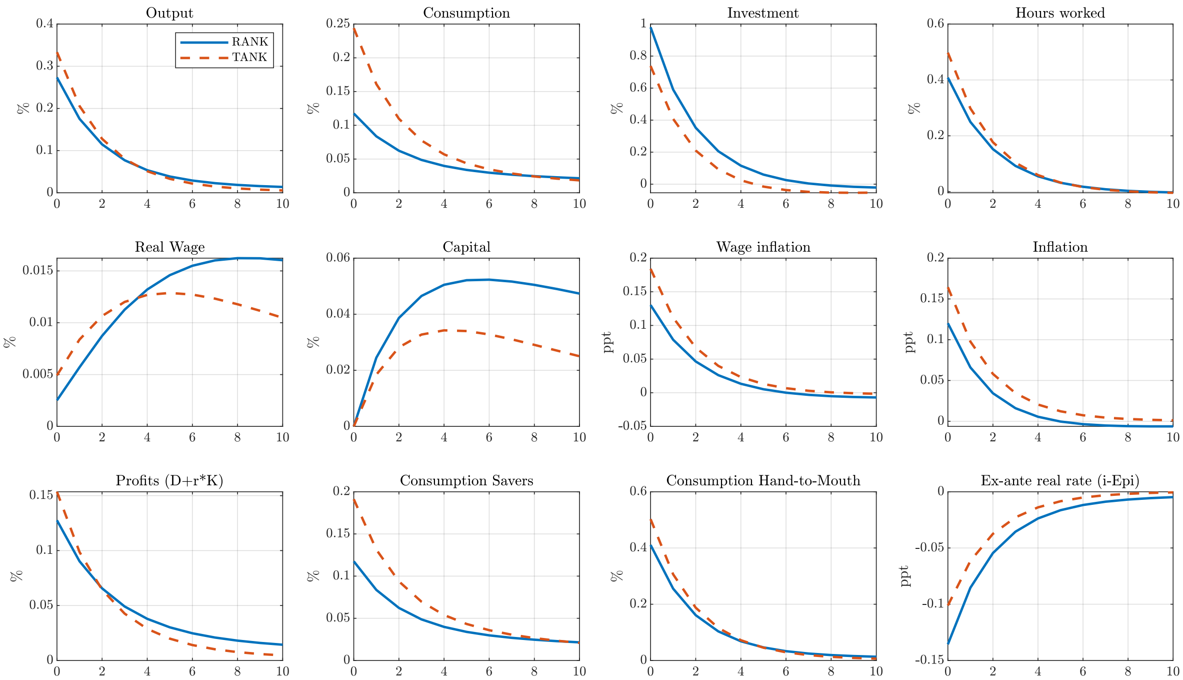

Figure 7: Impulse responses to monetary policy shock under countercyclical income risk

Notes: Impulse responses to a 25 basis points monetary policy shock in the representative-agent (blue solid line) and two-agent NK model (red dashed line) with capital and countercyclical risk.

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

[14]A distinct way to obtain inflationary supply (TFP) shocks relies on countercyclical income risk, as discovered by Ravn and Sterk (2020); if risk falls enough with a TFP expansion, this reduces precautionary saving and triggers a demand expansion which can lead to inflation—and higher profits. Notice, however, that this pertains to *favorable* TFP shocks—the opposite of the kind of supply shocks widely regarded as a potential source of part of the recent surge in inflation.

complying with Lucas' litmus test.[15]

6 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 and through *distributional* effects, an aggregate demand expansion?

We show, analytically and by quantitative simulations, that such a three-fold comovement is surprisingly difficult to come by in this class of models. The core reason, captured in our simple key Phillips-curve equation (1), is that when profits are procyclical they constitute a dampening force on inflation: insofar as prices are to some extent sticky, there is always a *direct-effect* negative source of partial comovement between inflation and profits in response to demand shocks. One way to obtain a magnified response of inflation is then to obtain, through *indirect* effects, a magnified response of aggregate demand of a degree high enough to counteract the dampening effect of procyclical profits. We study household heterogeneity as a natural and relevant source of such indirect-effect driven amplification.

We identify a conundrum for the "greed hypothesis" in models with heterogeneous households: the very same parameter condition that generates procyclical profits also implies that heterogeneity leads to dampening, not amplification of aggregate demand fluctuations and inflation—as long as profit income is skewed towards low-MPC asset holders. In other words, in the empirically plausible case where profits are countercyclical and predominantly accrue to wealthier, low-MPC households, inflation turns out to be less cyclical compared to a model where profits are uniformly distributed across society.

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

This is literally the opposite of the "greed" view, insofar as explaining higher-than-usual inflation would in fact require a *fall* in profits.

To compensate for the ceteris paribus deflationary effect of profits, we consider two alternative amplification channels. The first is by introducing capital investment and 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, generally 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. A similar amplification occurs when income risk and precautionary saving are countercyclical. However, in both cases 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. Should corporate greed emerge as a salient driver of inflation in the data, perhaps based on micro data on firms' marginal costs and prices, this would call for alternative monetary theories that can generate the desired co-movements and amplification properties consistent with the "greed hypothesis". A natural avenue in this vein would be to follow microfounded theories of pricing and markups taking into account consumers' dislike prices that are perceived as "too high" (cf. Shiller, 1997), which firms in turn take into account in their pricing decision: see Eyster et al. (2021) for such a recent microfounded model in the Rotemberg (2005, 2011) "customer anger" tradition. Merging such frameworks with heterogeneous-agent models in which profits have both distributional and aggregate consequences seems like a fruitful extension that we leave for future research.

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Appendix

A VAR Approach and Additional Empirical Results

A.1 High-frequency identification of monetary policy shocks

This appendix provides additional information for the empirical Section 2 on the cyclicality of profits and inflation. We start by discussing our empirical approach. Starting point is a reduced-form VAR model

$$Y_t = b + B_1 Y_{t-1} + \cdots + B_p Y_{t-p} + u_t,$$

where p is the lag order, Y_t is a $n \times 1$ vector of endogenous variables, u_t is a $n \times 1$ vector of reduced-form innovations with covariance matrix $Var(u_t) = \Sigma$, b is a $n \times d$ vector of deterministic variables, and $B_1, \ldots, B_p$ are $n \times n$ coefficient matrices. For the specification of the VAR model, we follow closely Gertler and Karadi (2015): Y_t contains the one-year rate, industrial production, the CPI, and the excess bond premium. We also include a commodity price index, which has been shown to include relevant information for monetary policy (Sims, 1992). All variables enter in log-levels, except the one-year rate and the excess bond premium, which are included in levels. All variables are sourced from FRED except the excess bond premium which is available through the Federal Reserve Board website (for more details, see Appendix A.2). The data frequency is monthly and the sample spans the period from 1976 to 2019. As is customary with monthly data we use 12 lags, and in terms of deterministics, we include a constant term and a linear trend.

Under the assumption that the VAR is invertible, we can write the innovations u_t as linear combinations of the structural shocks ε_t, i.e. primitive driving forces of the economy:

$$u_t = S\varepsilon_t \tag{A1}$$

By definition, the structural shocks are mutually uncorrelated and without loss of generality we normalize the variance to unity, i.e. $Var(\varepsilon_t) = I$. From the invertibility assumption (A1), we get the standard covariance restrictions $\Sigma = SS'$.

We are interested in characterizing the causal impact of a single shock: the monetary policy shock. Without loss of generality, let us denote the monetary policy shock as the first shock in the VAR, $\varepsilon_{1,t}$. Our aim is to identify the structural impact vector s_1, which corresponds to the first column of S.

Provided that there is an external instrument available, z_t, we can identify the structural impact vector as follows. For z_t to be a valid instrument, we need

$$E[z_t \varepsilon_{1,t}] = \alpha \neq 0 \tag{A2}$$
$$E[z_t \varepsilon_{-1,t}] = 0, \tag{A3}$$

where $\varepsilon_{1,t}$ is the monetary policy shock and $\varepsilon_{-1,t}$ is a $(n-1) \times 1$ vector consisting of the other structural shocks. Assumption (A2) is the relevance requirement and assumption (A3) is the exogeneity condition. These assumptions, in combination with the invertibility requirement (A1), identify s_1 up to sign and scale:

$$s_1 \propto \frac{E[z_t u_t]}{E[z_t u_{1,t}]},$$

provided that $E[z_t u_{1,t}] \neq 0$.[16]

The key challenge is then to find an instrument that credibly satisfies (A2)-(A3). High-frequency surprises are strong candidates in this respect, as it is unlikely that any other structural shocks move financial markets significantly in the narrow window around monetary announcements. As the baseline, we use the purified monetary policy surprises from Bauer and Swanson (2023). Their measure is constructed in two steps: First, they measure how interest rates futures change in a 30 minutes window around FOMC announcements. Because the literature found substantial predictability of high-frequency monetary surprises with macroeconomic or financial market information predating the FOMC announcements, they orthogonalize these monetary surprises in a second step, regressing them on key macroeconomic and financial news to remove the component of the monetary policy surprises that is predictable. Using such orthogonalized monetary policy surprises should help to eliminate any attenuation bias or "price puzzle" types of effects, providing better estimates of monetary policy's true effects.

As a robustness check, we also use two alternative instruments to identify monetary policy shocks. Miranda-Agrippino and Ricco (2021) provide an alternative approach to purge monetary policy surprises from potential information or Fed responds to news effects. In particular, they remove the component in the monetary surprises that can be explained by revisions in the Fed's Greenbook forecasts. As a final check, we also use the original monetary policy surprises from Gertler and Karadi (2015) that do not account for

[16] To be more precise, the VAR does not have to be fully invertible for identification with external instruments. As Miranda-Agrippino and Ricco (2023) show, it suffices if the shock of interest is invertible in combination with a limited lead-lag exogeneity condition.

potential predictability in the surprises.

We implement the approach with a 2SLS procedure and estimate the coefficients above by regressing $\hat{u}_t$ on $\hat{u}_{1,t}$ using z_t as the instrument. To conduct inference, we employ a residual-based moving block bootstrap, as proposed by Jentsch and Lunsford (2019). To facilitate interpretation, we scale the structural impact vector such that it decreases interest rates by 25 basis points.

A.2 Data sources

As discussed above, our baseline model includes six variables: the one-year rate, industrial production, the CPI, a commodity price index, and the excess bond premium. All variables and its sources are overviewed in Table A.2.

Table A.1: Data Description, Sources, and Coverage

Variable	Description	Source
Baseline VAR		
MPS_ORTH	Purified high-frequency monetary surprises from Bauer and Swanson (2023)	Michael Bauer's website
MPS	Updated high-frequency monetary surprises from Gertler and Karadi (2015)	Michael Bauer's website
MM_IV1	Purified high-frequency monetary surprises from Miranda-Agrippino and Ricco (2021)	Silvia Miranda-Agrippino's website
GS1	Market yield on U.S. Treasury securities at 1-year constant maturity	FRED
INDPRO	Industrial production: Total index	FRED
CPIAUCSL	Consumer price index for all urban consumers: All items in U.S. city average	FRED
PPIACO	Producer price index by commodity: All commodities	FRED
EBP	Excess bond premium	FRB website
Quarterly variables		FRED
GDPC1	Real gross domestic product	FRED
GDPDEF	Gross domestic product: Implicit price deflator	FRED
PCECC96	Real personal consumption expenditures	FRED
GPDIC1	Real gross private domestic investment	FRED
CPATAX	Corporate profits after tax with inventory valuation adjustment (IVA) and capital consumption adjustment (CCAdj)	FRED
CPROFIT	Corporate profits before tax with IVA and CCAdj	FRED
W273RC1Q027SBEA	Domestic corporate profits after tax with IVA and CCAdj	FRED
W328RC1Q027SBEA	Domestic corporate profits after tax with IVA and CCAdj: Non-financial industries	FRED
Other shocks		
OILSUPPLY	Oil supply news shock, identified using high-frequency approach from Känzig (2021)	Diego Känzig's website
TFPNEWS	TFP news shock, identified using Kurmann and Sims (2021) approach (on updated sample)	Own calculations

A.3 Baseline VAR results

In the following, we present the results from the monthly baseline VAR model. In the left panel of Figure A.1, we depict the high-frequency monetary surprises from Bauer and Swanson (2023) that we use as an external instrument in the baseline VAR model.

Figure A.2 shows the estimated impulse responses to a monetary policy shock, nor-

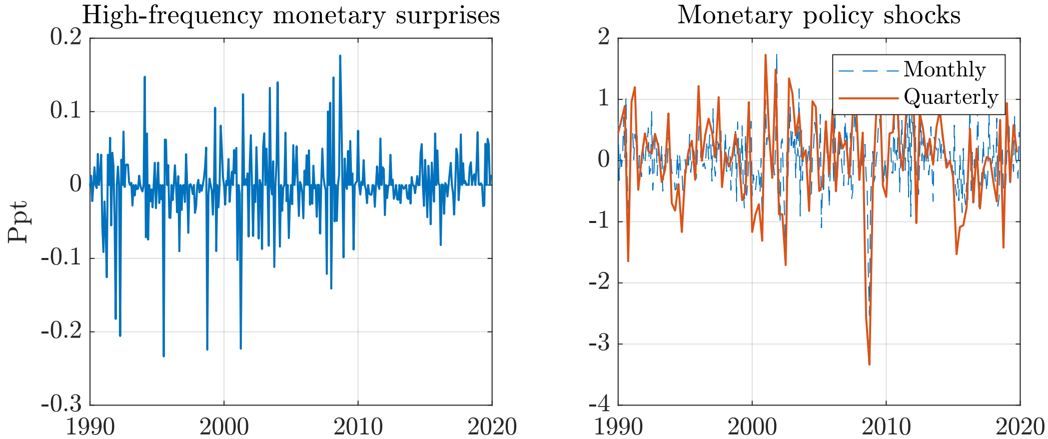


Figure A.1: High-frequency monetary surprises and identified monetary shocks

Notes: The figure shows the purified high-frequency monetary surprises from Bauer and Swanson (2023), together with the identified monetary policy shock – at the monthly frequency as well as aggregated to the quarterly frequency by summing over the respective months.

malized to decrease the one-year rate by 25 basis points.[17] We can see that the shock leads to a significant increase in industrial production that reaches its peak after roughly a year. Consumer prices increase significantly and the response displays a considerable degree of inertia. Commodity prices respond more quickly and increase significantly as well. The excess bond premium falls on impact, reflecting an improvement of credit conditions. Overall, these results are consistent with conventional theory, and confirm previous findings by Gertler and Karadi (2015) and Bauer and Swanson (2023).

To better understand the transmission mechanism of monetary policy and in particular the role of profits, it is instructive to look at the responses of a wider set of economic variables. A challenge here is that many of the variables of interest, and in particular profits, are only available at the quarterly frequency. Therefore, we aggregate all the variables in the monthly baseline VAR to the quarterly frequency and estimate a quarterly VAR. Using the high-frequency monetary surprises as an instrument at the quarterly frequency poses some difficulties though, as the monetary surprises are typically small and may also offset each other over the course of a quarter – rendering the signal-to-noise ratio too low to draw credible inference. To overcome this, we extract an estimate of the monetary shock from the monthly VAR as $\hat{\varepsilon}_{mp,t} = s_1' \Sigma^{-1} u_t$, aggregate it to a quarterly shock measure by summing over the respective months and use this shock estimate as an instrument for the monetary shock. The advantage of using the VAR monetary shocks as an instrument is that they are monthly shocks that are consistently observed, which alleviates the power problem discussed above. The right panel of Figure A.1 shows the estimated monthly

[17] This magnitude is close to a one-standard deviation monetary policy shock.

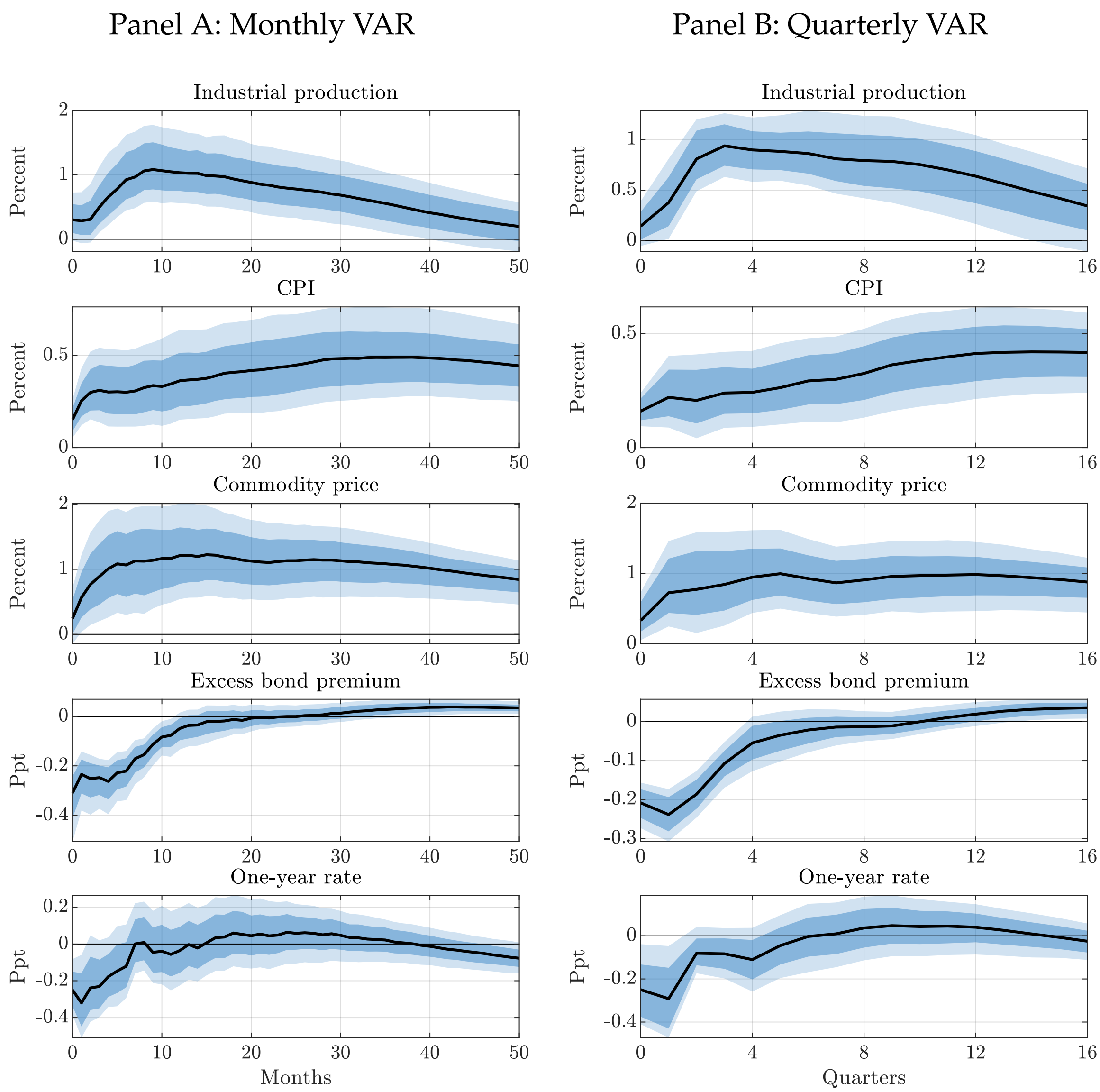


Figure A.2: Impulse responses to monetary policy shock

Notes: The figure shows the impulse responses to a 25 basis points expansionary monetary policy shock. The left panel shows the baseline responses from a monetary VAR using the purified high-frequency monetary surprises as an instrument. The right panel shows the responses from a quarterly VAR, using the aggregated monthly monetary policy shock as an instrument. The solid line is the point estimate and the dark and light shaded areas are 68 and 90 percent confidence bands, respectively.

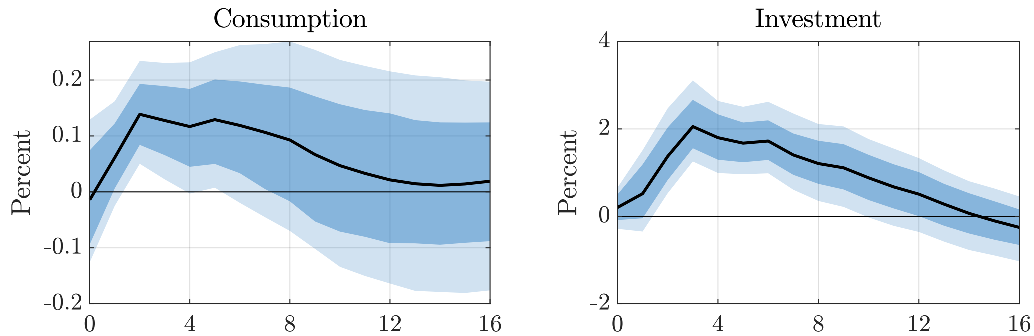


Figure A.3: Consumption and investment responses to monetary shock

Notes: The figure shows the impulse responses of consumption and investment to a 25 basis points expansionary monetary policy shock, estimated by augmenting the quarterly VAR by one variable at a time. The solid line is the point estimate and the dark and light shaded areas are 68 and 90 percent confidence bands, respectively.

and aggregated quarterly monetary shocks that we use as an instrument in the quarterly VAR.

In this quarterly model, we use 4 lags and in terms of deterministics, we use again a constant and a linear trend. The corresponding impulse responses are shown in the right panel of Figure A.2. We can see the impulse responses to a monetary shock based on the quarterly VAR are highly consistent with the monthly evidence. This is reassuring that the quarterly VAR is well suited to map out the impulse responses to a wider set of variables. To be able to do so, we follow Gertler and Karadi (2015) and augment the quarterly VAR by one variable at the time.

In the main text, we show the responses of GDP, inflation and profits. In Figure A.3 we report in addition the responses of consumption and investment. We can see that both consumption and investment increase significantly in response to an expansionary monetary policy shocks, in line with the findings in Christiano et al. (2005).

A.4 Robustness

In this appendix, we perform a series of sensitivity checks. First, we show that the procyclicality of profits is robust to the measure of profits used. In particular, we use total profits before taxes, domestic profits after taxes and domestic profits after taxes in the non-financial sector. All profit measures include an inventory valuation and capital consumption adjustment.

Figure A.4 shows the impulse responses of the different profit measures to a monetary policy shock. We can see that the procyclicality of profits is robust to the exact measure of profits used.

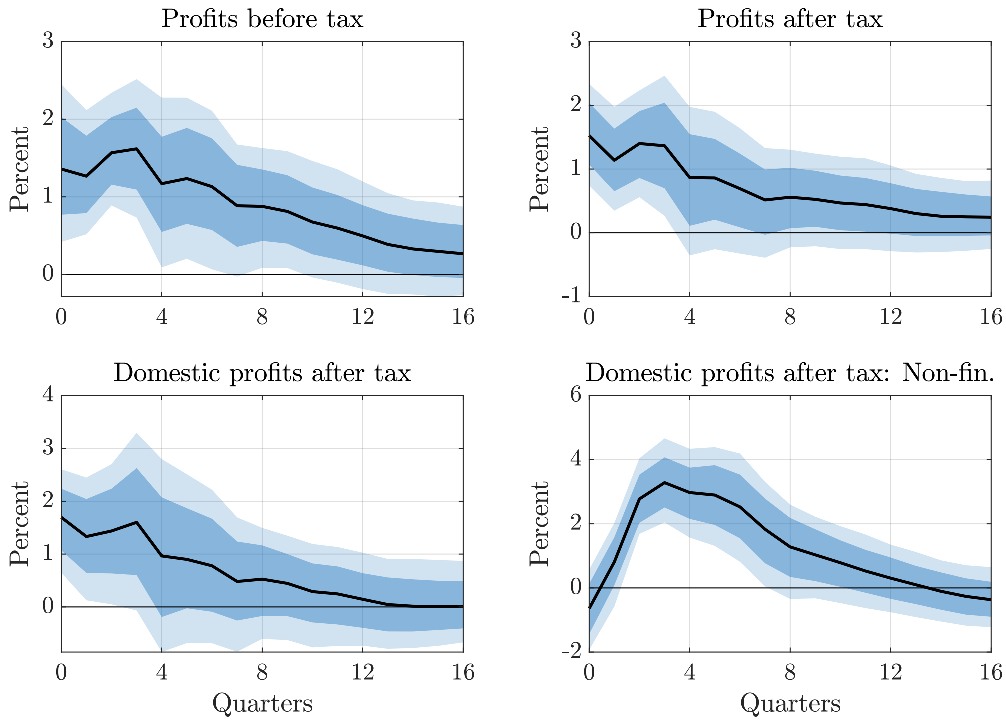


Figure A.4: Impulse responses of different profit measures

Notes: The figure shows the impulse responses of different profit measures to a 25 basis points expansionary monetary policy shock. The solid line is the point estimate and the dark and light shaded areas are 68 and 90 percent confidence bands, respectively.

Second, we show that the results are robust to using different high-frequency monetary surprise measures as an external instrument. From Figure A.5, we can see that using the purified monetary surprises from Miranda-Agrippino and Ricco (2021) or the original surprises from Gertler and Karadi (2015) produces consistent results. This is not only true for the responses of the variables in the baseline model but also for the profit responses, as shown in Figure A.6.

Finally, we find that the results are robust along a number of other dimensions including the model specification (lag order as well as the deterministics included), as well as the variables included in the VAR. These results are available from the authors on request.

Panel A: Using Miranda-Agrippino and Ricco (2021) monetary surprises

Panel B: Using Gertler and Karadi (2015) monetary surprises

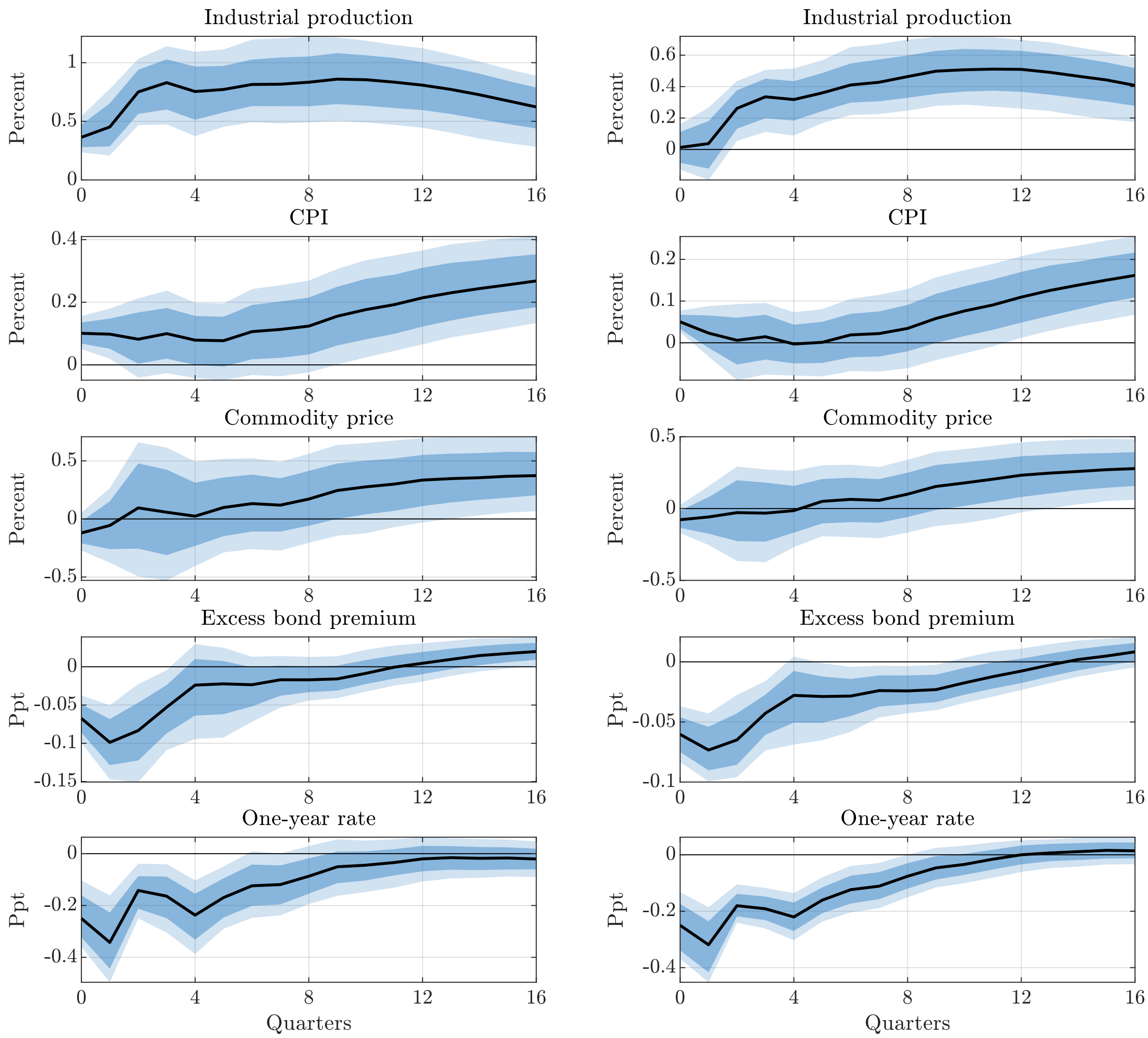
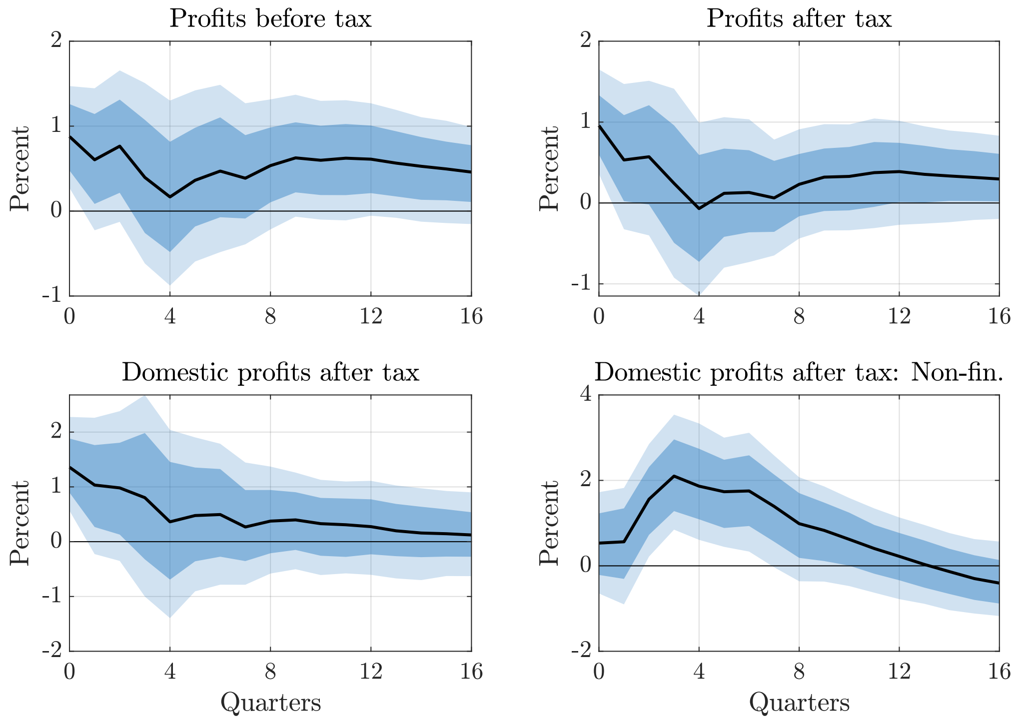


Figure A.5: Impulse responses based on different high-frequency instruments

Notes: The figure shows the impulse responses to a 25 basis points expansionary monetary policy shock. The left panel shows the responses based on the purified monetary surprises from Miranda-Agrippino and Ricco (2021), the right panel shows the responses based on the updated, original monetary surprises from Gertler and Karadi (2015). The solid line is the point estimate and the dark and light shaded areas are 68 and 90 percent confidence bands, respectively.

Panel A: Using Miranda-Agrippino and Ricco (2021) monetary surprises



Panel B: Using Gertler and Karadi (2015) monetary surprises

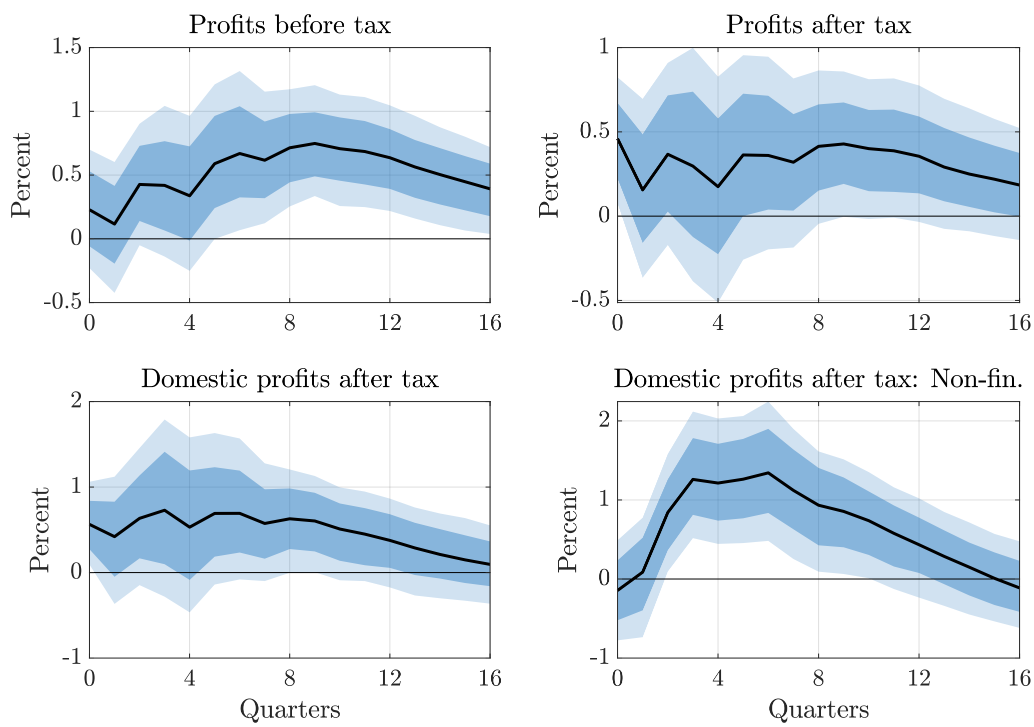


Figure A.6: Profit responses based on different high-frequency instruments

Notes: The figure shows the impulse responses of different profit measures to a 25 basis points expansionary monetary policy shock using different high-frequency instruments. The solid line is the point estimate and the dark and light shaded areas are 68 and 90 percent confidence bands, respectively.

A.5 Supply shocks

Can supply shocks generate the comovement between output, profits and inflation as observed during the recent greedflation episode? To investigate this, we look at the empirical responses to two salient types of supply shocks: technology and oil shocks. To this end, we use credibly identified shock measures from the literature and use them as external instruments in our quarterly VAR model. For the technology shock, we use the TFP news shocks as identified by Kurmann and Sims (2021). We estimate their 4 variable VAR in utility-adjusted TFP, consumption, hours and inflation, based on an updated sample going through 2019, and recover an estimate of the TFP news shock. In a next step, we use the estimated TFP news shock as an external instrument in our quarterly VAR.[18]

For the oil shock, we rely on the high-frequency identification approach from Känzig (2021). Following our strategy in the case of high-frequency monetary policy shocks, we first run a monthly VAR where we instrument the commodity price innovation with the high-frequency oil supply surprises around OPEC announcements. In a next step, we extract a monthly series of oil supply news shocks, aggregate the shock to the quarterly frequency, and use it as an instrument in our quarterly VAR.

The results are shown in Figure A.7. We can see that both shocks are associated with a fall in activity and a rise in prices, as can seen from the industrial production and the CPI and commodity price responses. These results confirm our findings from the main text. Overall, the two shocks have comparable effects on the economy. Interestingly, however, the monetary response turns out to be different. While monetary policy seems to accommodate negative TFP shocks, it turns out that the central bank seems to lean against oil shocks.

As before, to map out the responses to a wider set of quarterly variables, such as GDP or profits, we use these quarterly models as a marginal VAR that we augment by one variable at a time.

[18]Note that because all the VAR innovations are linear combinations of all the structural shocks, we can asymptotically instrument any of the innovations. However, in small samples, it makes sense to instrument the variable that is most closely associated with the shock. We instrument the CPI innovation, but results from instrumenting other innovations are comparable.

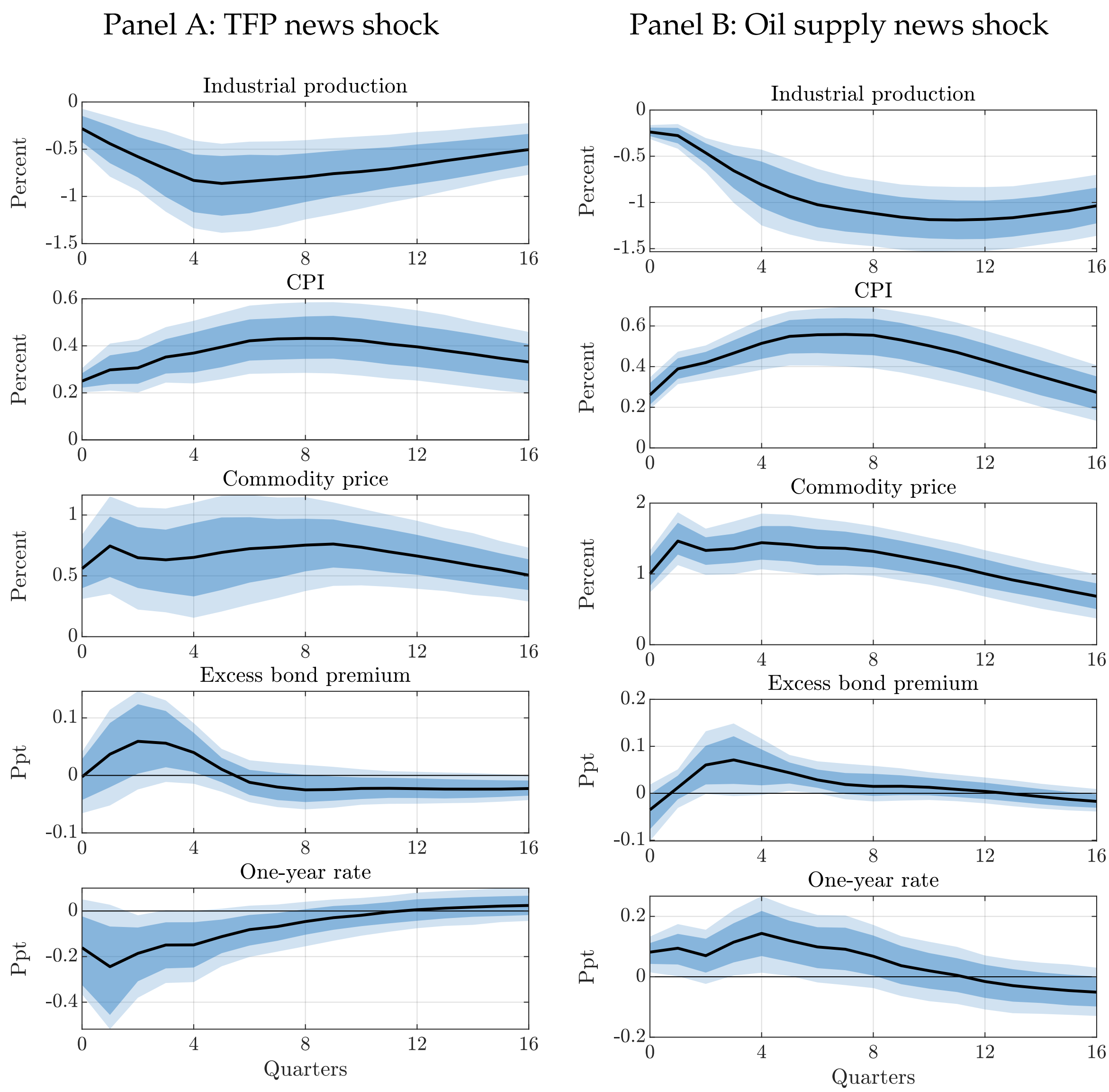


Figure A.7: Impulse responses to supply shocks

Notes: The figure shows the impulse responses of the economy to technology and oil shocks. The left panel shows the responses to a negative TFP news shock. The shock is identified using the TFP news shock series from Kurmann and Sims (2021) as an instrument and the identified shock is normalized to increase consumer prices by 0.25 percent on impact. The right panel shows the responses to a contractionary oil supply news shock, identified using the aggregated monthly oil supply news shock from Känzig (2021) as an instrument. The shock is normalized to increase commodity prices by 1 percent on impact. The solid line is the point estimate and the dark and light shaded areas are 68 and 90 percent confidence bands, respectively.

B Model Derivations

This appendix provides the derivations for the models introduced in Sections 3–5.1. 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.

B.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 earnings 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 earnings between households. The common labor earnings is given by $W_t N_t^d = \int_0^1 W_t(i) N_t(i) di = N_t^d \int_0^1 W_t(i) \left(\frac{W_t(i)}{W_t}\right)^{-\epsilon_w} di$. In Appendix C, we alternatively consider a variant of the model with heterogeneity in labor earnings.

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.[19] 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:

$$\begin{aligned} \pi_t^w &= \beta E_t \pi_{t+1}^w + \psi_w \mu_t^w \\ \mu_t^w &= \sigma^{-1} c_t + \varphi n_t - w_t \\ \pi_t^w &= w_t - w_{t-1} + \pi_t, \end{aligned} \tag{A4}$$

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

[19]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.

B.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:

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

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:

$$Y_t = C_t + I_t.$$

B.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 $MC/P = \mathcal{M}^{-1}$.[20]

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

[20] 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:

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

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 $D/Y = 1 - \mathcal{M}^{-1}$.[21] 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.

B.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-

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

linearize the gross rates, which will be approximately equal to the net rates. The two 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 B.1 summarizes the log-linear equilibrium conditions.

Table B.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 B.2.

Table B.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	$r_t^n = \phi_\pi \pi_t + \epsilon_t$

C Amplification Through Earnings Heterogeneity

An alternative way of breaking the conundrum from Section 4 is to assume that earnings for the hand-to-mouth agents are more cyclical than for asset holders. In the data, there is ample heterogeneity in the cyclicality of labor earnings, see e.g. Heathcote et al. (2010, 2020) or Guvenen et al. (2014) in the context of the literature on countercyclical income risk. Patterson (2023) provides evidence that the cyclicality of earnings is positively correlated with MPCs; Cantore et al. (2023) find a similar result conditional on monetary policy shocks. Bilbiie et al. (2022a) shed light on this channel based on an estimated heterogeneous-agent DSGE model. In their framework, the bottom of the distribution is more elastic as they are unskilled and more easily substitutable with capital than skilled workers, as in Krusell et al. (2000).

To formalize this in the simplest setup, we assume that profit income goes to S agents only, so if profits are procyclical this gives dampening in the standard model. We have the same model of profits as before, with cyclicality $\partial d / \partial c = \Omega$, and aggregation of factor incomes (with optimal subsidy)

$$y_t = (1-\alpha)(w_t + n_t) + d_t.$$

The only difference now is that agents have different *earnings*; we still normalize steady-state values, but consider that they have different elasticities/cyclicalities. We assume a reduced-form version of Bilbiie et al. (2022a), where the bottom of the distribution is more elastic. Specifically, we denote by θ the reduced-form elasticity of H earnings to aggregate earnings:[22]

$$c_t^H = \theta (1-\alpha)(w_t + n_t).$$

Then we have for S

$$c_t^S = \frac{1-\lambda\theta}{1-\lambda}(1-\alpha)(w_t + n_t) + \frac{1}{1-\lambda} d_t.$$

Thus, consumption inequality (still the sufficient statistic for amplification) is:

$$\gamma_t^C = \frac{1-\theta}{1-\lambda}(1-\alpha)(w_t + n_t) + \frac{1}{1-\lambda} d_t.$$

And the countercyclicality condition, using the aggregation of factor incomes, is emphasized in the following Proposition.

Proposition 4 (Amplification through earnings heterogeneity) *In the model with segmented capital markets, aggregate-demand fluctuations are amplified if earnings of hand-to-mouth are procyclical enough*

$$\frac{\partial \gamma_t^C}{\partial c_t} < 0 \Leftrightarrow (1-\theta)\frac{\partial (1-\alpha)(w_t + n_t)}{\partial c_t} + \frac{\partial d_t}{\partial c_t} < 0,$$

implying

$$\theta > \frac{1}{1-\Omega}.$$

Intuitively, the cyclicality of earnings of H needs to be high enough to compensate for the procyclicality of profits going to low-MPC agents. The more procyclical are profits, the higher the threshold. Note: this is bounded since $\Omega < \alpha$. So if $\theta > (1-\alpha)^{-1}$ there is always amplification (even though the profit cyclicality is likely different with a microfounded model of θ).

The aggregate Euler equation becomes

$$c_t = E_t c_{t+1} - \sigma \frac{1-\lambda}{1-\lambda\theta(1-\Omega)} r_t,$$

illustrating that amplification occurs when $\theta(1-\Omega) > 1$. Finally, for inflation dynamics

[22] A related simplifying assumption is used by Pfauti and Seyrich (2022), where the union has an allocation rule for hours worked that has different elasticities for each type's hours to the aggregate; the reduced-form equilibrium implications are very similar if we adopt their assumption.

we still have (15) so the response of inflation is

$$\begin{aligned}
\frac{\partial \pi_t}{\partial\left(-r_t\right)} &= \psi_p \frac{\alpha}{1-\alpha} \frac{\partial c_t}{\partial\left(-r_t\right)} - \psi_p \frac{\Omega}{1-\alpha} \frac{\partial c_t}{\partial\left(-r_t\right)} \\
&= \psi_p \frac{\alpha-\Omega}{1-\alpha} \frac{\partial c_t}{\partial\left(-r_t\right)} = \psi_p \frac{\alpha-\Omega}{1-\alpha} \sigma \frac{1-\lambda}{1-\lambda\theta\left(1-\Omega\right)}.
\end{aligned}$$

Therefore, we can obtain an amplified response of inflation at a given profits' cyclicality by demand amplification if θ is large enough. However, as Bilbiie et al. (2022a) show, while the cyclicality of pre-tax labor earnings differs vastly across households, post-tax, there is actually much less heterogeneity. Consequently, we would not expect θ to be substantially larger than 1. Thus, while theoretically, there may be inflation amplification through the earnings heterogeneity channel, quantitatively, it is likely not that important and the conundrum remains. We illustrate this in our quantitative model from Section 5.1 in the paper. Here, we set $\theta = 1.25$. As we can see from Figure C.1, there is only little amplification through earnings heterogeneity and the impulse responses look fairly similar to the baseline case with $\theta = 1$.

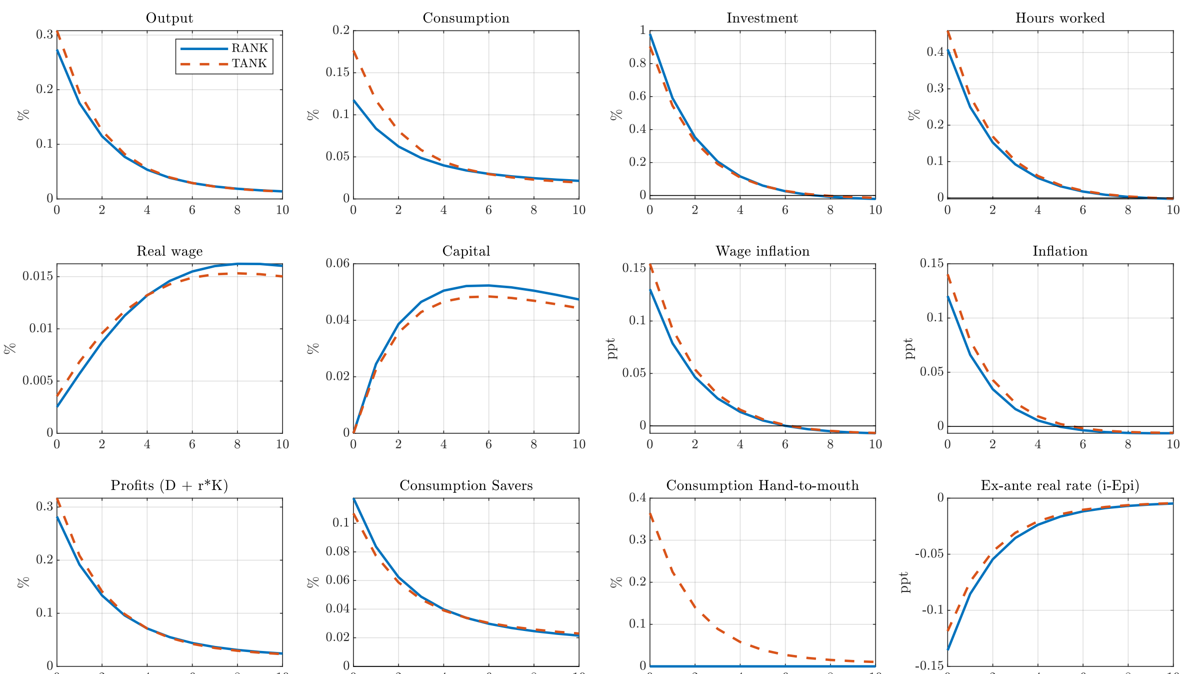


Figure C.1: Impulse responses to a monetary policy shock under earnings heterogeneity

Notes: Impulse responses to a 25 basis points monetary policy shock in the representative-agent (blue solid line) and two-agent NK model (red dashed line) with capital and earnings heterogeneity. The inflation rates and real ex-ante interest rate are expressed in annualized terms.

D Additional Figures

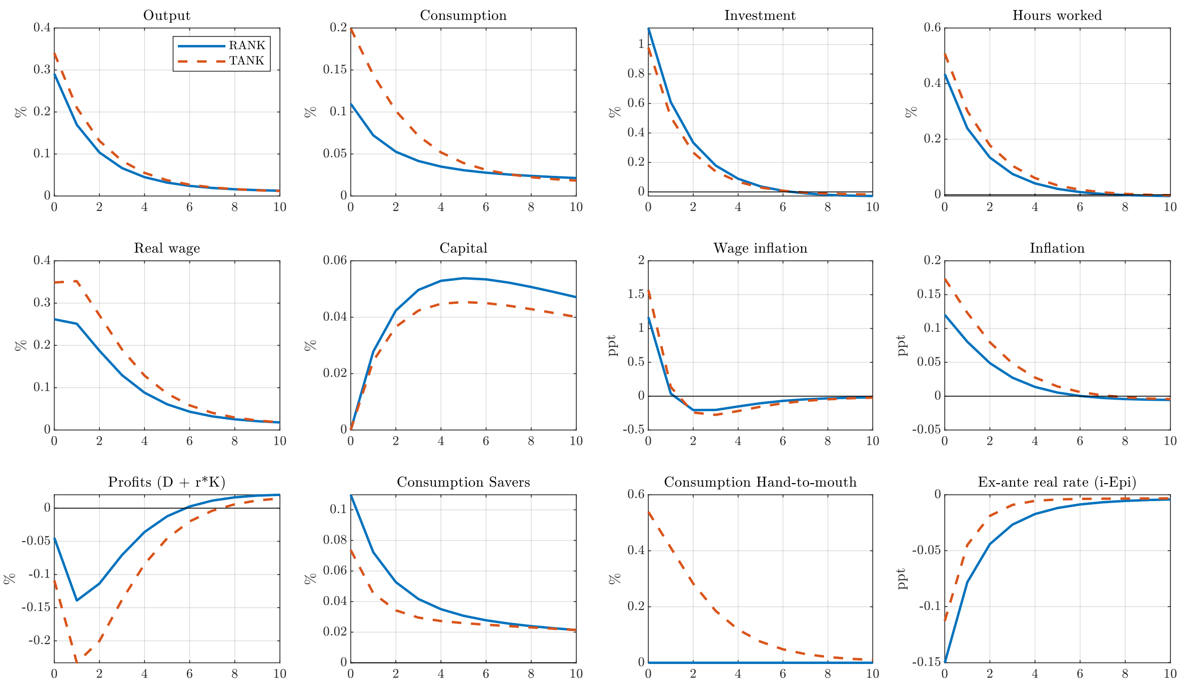


Figure D.1: Impulse responses to monetary policy shock under stickier prices than wages

Notes: Impulse responses to a 25 basis points 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 ($\psi_p = 0.025$ and $\psi_w = 1$). The inflation rates and real ex-ante interest rate are expressed in annualized terms.