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Household Heterogeneity, Nonseparable Preferences, and the Taylor Principle*

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Abstract

We consider a two-agent New Keynesian model with savers and hand-to-mouth households with quasi-separable utility functions as introduced by Bilbiie (2020a). This framework allows for separate parameterization of consumption-hours complementarity and income effects on labor supply. We examine how variations in the size of income effects, the degree of non-separability between consumption and hours worked, and the share of hand-to-mouth households impact aggregate dynamics and determinacy properties of interest rate rules. Complementarity between consumption and hours worked and small income effects can reverse the Taylor principle and result in expansionary monetary contractions.

Keywords: Heterogeneity; Monetary policy; Nonseparable preferences; Real indeterminacy; Taylor principle; TANK.

JEL classifications: E32; E52; E58; E44; E24

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1 Introduction

We examine the role of nonseparable preferences over consumption and labor hours in designing simple interest rate rules within a New Keynesian model featuring household heterogeneity. Specifically, we incorporate a quasi-separable utility function, as proposed by Bilbiie (2020a), into a standard two-agent New Keynesian (TANK) model comprising savers (or Ricardian households) and hand-to-mouth households, who lack access to financial markets. This utility function allows for the separate parameterization of the wealth effect on labor supply and the degree of Edgeworth complementarity (or Edgeworth substitutability) between consumption and hours worked in household preferences. Using this framework, we examine how the size of the wealth effect, the degree of non-separability between consumption and labor hours, and the share of hand-to-mouth households influence the impact of real interest rate changes on aggregate demand and the determinacy properties of interest rate rules.

In an influential article, Bilbiie (2008) showed that in a TANK model with separable preferences over consumption and hours worked, and where the wealth effect on labor supply is set to unity, the IS curve can exhibit a positive slope if the population share of hand-to-mouth households is sufficiently large. This leads to what he terms Inverted Aggregate Demand Logic (IADL), where an increase in the real interest rate boosts aggregate demand. In the IADL region, the well-known Taylor principle is reversed: the monetary authority should lower the real interest rate in response to inflation to ensure the local uniqueness of the rational expectations equilibrium.

The underlying mechanism of this phenomenon is that cyclical changes in income distribution can significantly influence standard economic outcomes when heterogeneous agents are present. Consider, for instance, a monetary contraction in a TANK model.

When the real interest rate increases, saver households cut back on consumption, which decreases aggregate demand and shifts labor demand leftward due to sticky prices. As a result, both employment and real wages decline. Lower labor income then causes a further drop in aggregate demand as hand-to-mouth households reduce their consumption.

However, the decline in marginal costs (real wages) boosts profits and, therefore, the dividend income of non-constrained savers. This additional income for savers can offset the initial reduction in their consumption caused by the higher real interest rate, potentially rendering the IS curve positively sloped. In such a scenario, the only equilibrium involves expansionary monetary contractions and a reversed Taylor principle.

In this paper, we demonstrate that non-separability in preferences and variations in the wealth effect (also referred to as income effect) on labor supply significantly alter the parameter space within which the economy operates under inverted aggregate demand logic. Specifically, we show that when consumption and hours worked are Edgeworth complements and the income effect on labor supply is small, the parameter space where IADL holds expands considerably. Conversely, when consumption and labor hours are Edgeworth substitutes and the income effect is pronounced, the parameter space where IADL is valid contracts significantly.

The reasoning behind this result is as follows. Consumption-hours complementarity amplify changes in employment, output, real wages, and profits in response to variations in economic activity, for a given wealth effect on labor supply. This amplification fosters the reversal of the IS curve's slope. Conversely, consumption-hours substitutability dampens variations in employment, output, real wages, and profits, preventing the reversal of the IS curve's slope and restoring the standard Taylor principle as a guideline for monetary policy. Notably, the impact of varying the wealth effect on labor supply on model dynamics depend on the whether consumption and labor hours are Edgeworth complements or Edgeworth substitutes. If consumption and hours worked are complements, reducing the wealth effect amplifies economic fluctuations, making a reversal of the slope of the IS curve more likely. By contrast, when consumption and hours worked are substitutes, a smaller wealth effect dampens the changes in employment, output, real wages, and profits in response to variations in economic conditions which makes it less likely that the IS curve becomes positively sloped.

Related literature. Our work relates to two strands of the literature. First, several studies have identified conditions under which the Taylor principle (raising the nominal interest rate more than the rate of inflation) is insufficient to ensure a unique rational expectations equilibrium. These include high levels of public consumption (Natvik, 2009), a positive inflation target (Ascari & Ropele, 2009), a fiscal authority that disregards the state of government debt (Leeper, 1991; Leeper & Leith, 2016), and the presence of financial frictions (Lewis & Roth, 2018). Accounting for household heterogeneity, Galí et al. (2007) show that the existence of hand-to-mouth households may render the standard Taylor principle insufficient for model determinacy. As previously discussed, Bilbiie (2008) demonstrates that the Taylor principle can even invert if there are sufficiently many hand-to-mouth households. Ascari et al. (2017) and Colciago (2011) show that wage stickiness can prevent the reversal of the slope of the IS curve in an otherwise standard TANK model, thereby restoring the standard Taylor principle. Bilbiie (2024) derives a HANK Taylor principle under a parameter restriction that rules out the inversion of the slope of the IS curve: the standard Taylor principle is sufficient for determinacy if income inequality is procyclical. In the case of countercyclical inequality, the central bank must react substantially more than one-for-one to current inflation to ensure determinacy.

Acharya and Dogra (2020) and Ravn and Sterk (2020) show that countercyclical risk may generate indeterminacy even under the Taylor principle. We add consumption-hours complementarity and limited income effects on labor supply to the list of factors under which the Taylor principle may be insufficient to ensure determinacy.

Second, our work also contributes to the literature on the role of non-separable preferences in shaping macroeconomic outcomes. In the New Keynesian framework, it is standard to consider separable preferences over consumption and hours worked (Bilbiie, 2020b; Galí, 2015; Woodford, 2003). Under these preferences, the cross-derivative of hours worked and consumption is zero, and the strength of the income effect on labor supply is constrained by the inverse elasticity of intertemporal substitution in consumption. However, non-separable preferences have been employed to explain various business-cycle phenomena. These include consumption crowding-in following government spending expansions (Auclert et al., 2023; Bilbiie, 2009, 2011), the generation of news-driven business cycles (Beaudry & Portier, 2014; Jaimovich & Rebelo, 2009; Schmitt-Grohé & Uribe, 2012), and the co-movement of consumption and investment after investment-specific technology shocks (Eusepi & Preston, 2015; Furlanetto & Seneca, 2014).

Standard utility specifications that deviate from separable preferences do not allow for separate parameterization of the wealth effect on labor supply and the degree of complementarity (or substitutability) between consumption and labor hours. For instance, the utility function proposed by King et al. (1988) (KPR) incorporates consumption-hours nonseparability but restricts the income effect to unity to maintain consistency with balanced growth. Similarly, Greenwood et al. (1988) (GHH) impose consumption-hours complementarity while assuming a zero wealth effect on labor supply. The framework by Jaimovich and Rebelo (2009) nests KPR and GHH preferences. In contrast, we use the utility function proposed by Bilbiie (2020a), which enables independent variation in the size of the wealth effect on labor supply and the degree of complementarity between consumption and hours worked.

This paper bridges these strands of the literature by investigating the implications of non-separable preferences for the determinacy conditions of a simple interest rate rule in a New Keynesian model with household heterogeneity.

Outline of the rest of the paper. Section 2 introduces the model. In Section 3, we examine how the share of hand-to-mouth households, the magnitude of the wealth effect, and the degree of consumption-hours complementarity influence the slope of the IS curve, thereby determining whether the economy operates under standard aggregate demand logic (SADL) or inverted aggregate demand logic. Additionally, we analyze the model economy's responses to a monetary policy shock within both the SADL and IADL regimes. Section 4 provides concluding remarks.

2 The model

We utilize a two-agent New Keynesian (TANK) model, as outlined by Bilbiie (2008). The model features an economy inhabited by a continuum of households with infinite lifespans, all sharing an identical per-period utility function $U(.)$. The total population of households is normalized to one. Within this population, a fraction λ comprises households that lack access to financial markets and live hand-to-mouth (denoted as H), while the remaining fraction $1-\lambda$ consists of savers (denoted as S), who can smooth their consumption over their lifetime.

2.1 Preferences

The per-period utility function of a representative household of type $* \in \{H, S\}$ takes the quasi-separable form proposed by Bilbiie (2020a):

$$U(C_{*,t}, N_{*,t}) = \frac{1}{1-\frac{\zeta}{1-\gamma}} \left(\frac{C_{*,t}^{1-\gamma}}{1-\gamma} - \omega \frac{N_{*,t}^{1+\varphi}}{1+\varphi} \right)^{1-\frac{\zeta}{1-\gamma}},$$

where $C_{*,t}$ and $N_{*,t}$ denote consumption and hours worked, respectively, of household type $*$. The parameter φ represents the inverse of the constant-consumption labor supply elasticity, while the parameter $\omega > 0$ measures the degree of labor disutility.

The parameter γ reflects the income effect on labor supply, indicating the extent to which the labor supply schedule shifts in response to income changes for a given relative price of consumption and leisure. Note that the utility function is defined for $\gamma \neq 1$; if $\gamma = 1$ the appropriate form is $U(C_{*,t}, N_{*,t}) = \frac{1}{1-\zeta} \left(\log C_{*,t} - \omega \frac{N_{*,t}^{1+\varphi}}{1+\varphi} \right)^{1-\zeta}$. Although the utility specification accommodates an arbitrary income effect γ, we focus on values between zero (corresponding to the GHH case) and one (the KPR case), which also represent the limiting cases considered by Jaimovich and Rebelo (2009).

The parameter ζ determines the degree of complementarity between consumption and hours worked by impacting $\kappa \equiv \frac{U_{CN}C}{-U_N}$. Specifically, consumption and hours worked are Edgeworth complements – or equivalently, consumption and leisure are Edgeworth substitutes – when $\kappa > 0$, which occurs if the cross-derivative U_{CN} is positive. Conversely, when $\kappa < 0$, consumption and hours worked are Edgeworth substitutes, implying that consumption and leisure are Edgeworth complements. By substituting the expressions for the marginal disutility of hours worked, U_N, the cross derivative U_{CN}, and the steady-state values of C_* and N_* (discussed below) into the definition of κ, we obtain

$$\kappa = \frac{\zeta(1+\varphi)}{\gamma+\varphi}.$$

To ensure that utility is concave and quasiconcave, and that consumption and leisure are normal goods, the following parameter restrictions must be satisfied: $\varphi \geq 0$, $\gamma \geq 0$, $\kappa \geq -\gamma\varphi/(\gamma+\varphi)$ (Bilbiie, 2020a). The last inequality limits the degree of substitutability between labor and consumption.

The expression for κ illustrates that the degree of complementarity between consumption and hours worked is shaped by the parameters ζ, γ, and φ. However, for a given value of ζ, the parameters γ and φ affect the magnitude of complementarity (or substitutability) but not its sign. The sign of ζ alone dictates whether consumption and hours worked are complements or substitutes.

2.2 Households

Savers, or asset holders, have unrestricted access to financial markets and are the sole owners of firms, receiving profits in the form of dividends. A representative saver household maximizes its expected lifetime utility, $E_0 \sum_{t=0}^{\infty} \beta^t U(C_{S,t}, N_{S,t})$, by choosing consumption, bond holdings, and hours worked, subject to the following sequence of per-period budget constraints:

$$C_{S,t} + B_{S,t} = W_t N_{S,t} + \frac{R_{t-1}}{\Pi_t} B_{S,t-1} + \frac{D_t}{1-\lambda}.$$

Here, $\beta \in (0,1)$ is the subjective discount factor, $B_{S,t}$ denotes the real value of bond holdings at end of period t, W_t is the real wage, R_{t-1}/Π_t is the gross real return to bonds with R_t being the gross nominal interest rate and Π_t being gross inflation. The term $D_t/(1-\lambda)$ represents dividend payments to the representative saver household.

Hand-to-mouth households lack access to financial markets. A representative hand-to-mouth household maximizes its utility $U(C_{H,t}, N_{H,t})$ by choosing consumption and hours worked, constrained by the budget equation $C_{H,t} = W_t N_{H,t}$.

2.3 Firms

A unit mass of intermediate goods firms, indexed by j, use labor to produce differentiated intermediate goods. Each intermediate good, $Y_t(j)$, is produced by a monopolist firm with technology $Y_t(j) = AN_t(j) - F$, where the constant productivity shifter, A, and the fixed cost, F, are common to all firms.

Intermediate goods are used by a final good firm to produce a final good under perfectly competitive conditions. The production of the final good is characterized by: $Y_t = \left(\int_0^1 Y_t(j)^{(\varepsilon-1)/\varepsilon} di\right)^{\varepsilon/(\varepsilon-1)}$, where ε is the elasticity of substitution between intermediate goods. The demand for each intermediate input is given by: $Y_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\varepsilon} Y_t$, where $P_t(j)$ is the price of intermediate good j, and P_t is the price of the final good.

Intermediate goods firms operate under monopolistic competition in the goods market, perfect competition in the labor market, and face quadratic price adjustment costs. Each firm j maximizes its profits

$$E_0 \sum_{t=0}^{\infty} \Lambda_{0,t} \left(\frac{P_t(j)}{P_t} Y_t(j) - MC_t Y_t(j) - \frac{\xi}{2} \left(\frac{P_t(j)}{P_{t-1}(j)} - 1 \right)^2 Y_t + ac_t \right),$$

where $\Lambda_{0,t} \equiv \beta^t U_{C,S,t}/U_{C,S,0}$ denotes the stochastic discount factor for real payoffs, and $MC_t = W_t/A$ are real marginal costs, common to all firms. The term $\frac{\xi}{2}\left(\frac{P_t(j)}{P_{t-1}(j)} - 1\right)^2 Y_t$ represents the costs of price adjustment, where ξ measures the degree of nominal price rigidity. The costs are rebated to the firm as a lump-sum transfer ac_t that is not taken into account by the firm j when choosing its optimal price.

2.4 Monetary policy

The monetary policy decision by the central banks follows the forward-looking Taylor-type policy rule $\frac{R_t}{R} = \left(\frac{E_t \Pi_{t+1}}{\Pi}\right)^{\phi_\pi} \exp(\upsilon_t)$, where ϕ_π represents the sensitivity of the nominal interest rate to changes in expected inflation, and υ_t is an AR(1) monetary policy shock.

2.5 Aggregation, market clearing, and the steady state

Achieving equilibrium in the labor market requires that labor demand equals labor supply: $N_t \equiv \int_0^1 N_t(j)dj = \lambda N_{H,t} + (1-\lambda) N_{S,t}$. Similarly, the goods market clears when output equals aggregate consumption: $Y_t = C_t$, where $C_t \equiv \lambda C_{H,t} + (1-\lambda) C_{S,t}$. For the bonds market to clear, it must be that $B_{S,t} = 0$. Aggregate production is given by $Y_t = AN_t - F$. Total profits, consolidated across all firms, are $D_t = (1 - (1 + F/Y_t) MC_t) Y_t$. The full set of equilibrium conditions can be found in Appendix A.1.

Regarding the steady state, we adopt the same assumptions as Bilbiie (2008). The steady-state interest rate is derived from the Euler equation as $R = \beta^{-1}$. The steady-state net markup is given by $\mu = (\varepsilon - 1)^{-1}$. Additionally, we assume that the share of fixed costs to output in the steady state equals the net markup, i.e., $F/Y = \mu$. Consequently, profits are zero in the steady state, allowing us to rewrite the budget constraints in the steady state for both types of households as $C_S = WN_S$ and $C_H = WN_H$. Steady-state consumption is uniform for all households and, as a result, equal to output ($C_S = C_H = C = Y$). To simplify the analysis, we normalize output to one and set the steady-state technology level, A, to $1 + \mu$. This normalization allows us to derive hours worked for both agents as $N_S = N_H = \omega^{-\frac{1}{1+\varphi}}$.

A log-linear approximation is performed around this steady state. Throughout this paper, small-case letters represent the log-linearized variable, indicating log deviations from their steady-state value. However, profits are calculated as a fraction of steady-state output since they are zero in the steady state. Appendix A.2 provides the log-linearized equilibrium conditions.

3 Results

In this section, we first explore how the proportion of hand-to-mouth households, the magnitude of the wealth effect, and the degree of consumption-hours complementarity affect the slope of the IS curve, thereby determining whether the economy operates under standard aggregate demand logic or inverted aggregate demand logic. Subsequently, we examine the underlying mechanisms by presenting impulse responses to a monetary policy shock under the SADL and IADL regimes.

3.1 The IS curve's slope, determinacy, and the Taylor principle

To analyze the aggregate dynamics, we follow Bilbiie (2008) and use the log-linearized equilibrium conditions to derive the aggregate Euler equation, or IS curve, which is expressed as:

$$y_t = E_t y_{t+1} - \Delta^{-1}(r_t - E_t \pi_{t+1}), \tag{1}$$

where

$$\Delta \equiv \frac{\kappa}{1+\eta}\left(1 - \frac{(1+\lambda\varphi)(1-\eta\mu)}{(1-\lambda)(1+\mu)}\right) + \gamma\left(1 - \frac{\lambda\varphi(1-\eta\mu)}{(1-\lambda)(1+\mu)}\right), \tag{2}$$

and $\eta \equiv \frac{1-\gamma}{\gamma+\varphi}$, with $\eta \in [0, \varphi^{-1}]$ for $\gamma \in [0, 1]$.

The parameter Δ represents the inverse elasticity of aggregate demand with respect to the real interest rate and can be either positive or negative in this model. The sign of Δ determines whether we are in what Bilbiie (2008) has termed the standard or inverted aggregate demand logic region. In the standard aggregate demand logic (SADL) case, where Δ is positive, an increase in the real interest rate leads to a reduction in aggregate demand. In contrast, in the inverted aggregate demand logic (IADL) case, characterized by a negative Δ, increases in the real interest rate have an expansionary effect on aggregate demand.

The economy's position in either the standard or inverted aggregate demand region affects the determinacy properties of interest rate rules. In the SADL case, the Taylor principle dictates that the central bank must raise the nominal interest more than proportionally to increases in inflation ($\phi_\pi > 1$) to ensure determinacy. Conversely, under the IADL case, the central bank should adopt a more passive policy stance, increasing the nominal interest rate less than proportionally to inflation ($\phi_\pi < 1$). Moreover, even in the SADL case, the central bank should avoid excessively aggressive responses to inflation, and in the IADL case, ϕ_π cannot be too small. The precise lower and upper bounds for ϕ_π depend on Δ, as detailed in Appendix B.

The classification of the model as either a standard aggregate demand logic economy or an inverted aggregate demand logic economy – i.e., whether Δ is positive or negative – depends on several key factors: the share of hand-to-mouth households, λ, the complementarity between consumption and hours worked in the utility function, κ, and the parameterization of the income effect on labor supply, γ, as indicated by equation 2. In what follows, we will explore these factors in detail. By examining the two limiting cases, $\kappa = 0$, $\gamma > 0$ and $\kappa > 0, \gamma = 0$, we can derive analytical insights from equation 2. For the more general case, we will turn to numerical simulations.

First, we consider the limiting case where utility is additively separable and the wealth effect on labor supply is positive ($\kappa = 0$ and $\gamma > 0$), consistent with the utility specification examined by Bilbiie (2008). In this scenario, the sign of Δ is primarily determined by the share of hand-to-mouth households, λ. Specifically, $\Delta > 0$ when $\lambda < \lambda^*|_{\kappa=0,\gamma>0} = (1 + \varphi(1 - \eta\mu)/(1 + \mu))^{-1}$. In other words, the economy falls within the SADL region if the share of hand-to-mouth households remains below the threshold $\lambda^*|_{\kappa=0,\gamma>0}$. Conversely, if λ exceeds $\lambda^*|_{\kappa=0,\gamma>0}$, the economy operates under inverted aggregate demand logic.

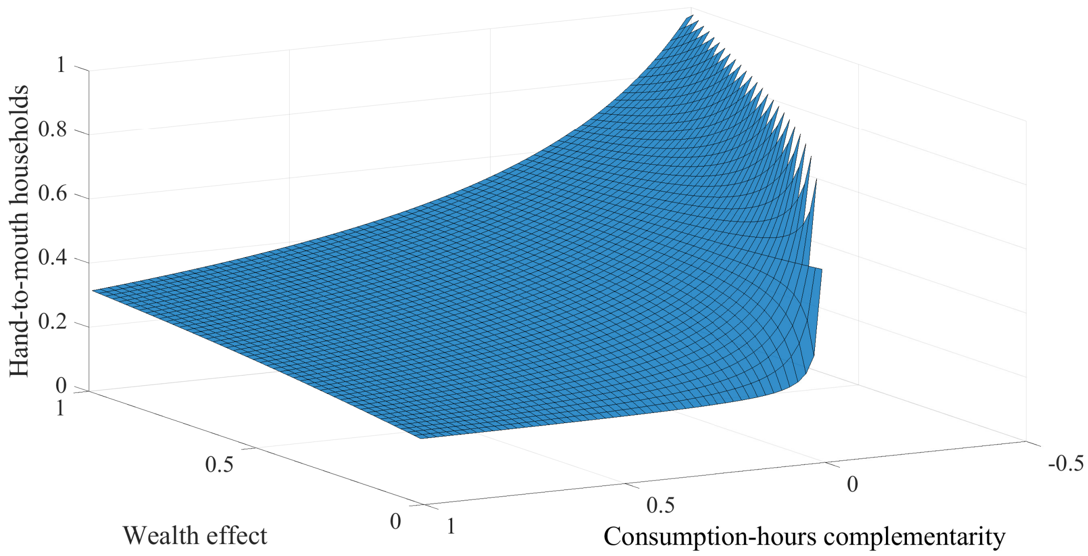
For values of $\gamma \in (0, 1]$, the threshold $\lambda^*|_{\kappa=0,\gamma>0}$ falls within the interval $\left(\frac{1+\mu}{1+\varphi}, \frac{1+\mu}{1+\mu+\varphi}\right]$, assuming the mild condition $\varphi > \mu$ to ensure the lower bound of this range is within the feasible parameter space. Notably, as γ increases from values just above zero up to 1, $\lambda^*|_{\kappa=0,\gamma>0}$ decreases. This indicates that a reduction in the wealth effect on labor supply contracts the parameter space where the IADL regime applies, provided preferences are separable.

Now, consider the limiting case where the wealth effect on labor supply is zero ($\gamma = 0$), which necessitates that κ be non-negative. As indicated by equation 2, the sign of Δ depends solely on the sign of the term in the first parenthesis, assuming $\kappa > 0$.[1] Thus, $\Delta > 0$ when $\lambda < \lambda^*|_{\kappa>0,\gamma=0} = \mu/\varphi$. Notably, this threshold value for the share of hand-to-mouth households is independent of the degree of complementarity between consumption and hours worked.

When preferences are nonseparable, and the wealth effect is positive ($\kappa \neq 0$ and $\gamma > 0$), the threshold value for λ is critically dependent on the sign of κ, as can be seen from equation 2. Specifically, the threshold $\lambda^*|_{\kappa\neq0,\gamma>0}$ decreases when κ is positive and increases when κ is negative. In other words, for a given threshold under separable preferences, $\lambda^*|_{\kappa=0,\gamma>0}$, the introduction of consumption-hours complementarity ($\kappa > 0$) makes it more likely for the economy to enter the IADL region. Conversely, if consumption and hours worked are Edgeworth substitutes ($\kappa < 0$), the economy is more likely to remain in the SADL region, given $\lambda^*|_{\kappa=0,\gamma>0}$. This implies that consumption-hours complementarity expands the parameter space where the IADL regime applies, whereas consumption-hours substitutability contracts it.

[1] In the special case where $\gamma = 0$ and $\kappa = 0$, Δ equals zero, which indicates that the elasticity of aggregate demand with respect to the real interest rate approaches infinity.

Figure 1: Threshold values.



Notes: The surface illustrates combinations of λ, γ, and κ for which $\Delta = 0$. Points above the surface correspond to $\Delta < 0$, while points below indicate $\Delta > 0$.

We conduct numerical simulations to examine the impact of varying the wealth effect in the general case of non-separable preferences ($\kappa \neq 0$). We adopt a standard parameterization for these simulations, assuming a steady-state net markup of $\mu = 0.2$ and a constant-consumption labor supply elasticity of $\varphi = 1$. Figure 1 illustrates how the wealth effect, consumption-hours complementarity, and the share of hand-to-mouth households collectively influence the sign of Δ.

The y-axis represents values for consumption-hours complementarity, denoted by $\kappa = \frac{\zeta(1+\varphi)}{\gamma+\varphi}$, which is a function of the two novel parameters ζ and γ from the quasi-separable utility function. Moving along the y-axis involves changing ζ to examine different levels of complementarity (κ) while keeping the wealth effect γ constant. Recall that κ must be equal to or greater than $-\gamma\varphi/(\gamma+\varphi)$, implying that the feasible degree of substitutability (in absolute value) increases as the income effect γ rises. The x-axis shows the income effect on labor supply, γ, ranging from 0.01 (small wealth effect on labor supply) to 1 (unit wealth effect on labor supply). To focus solely on the impact of changes in the wealth effect, κ is held constant by recalibrating ζ accordingly. The z-axis varies the share of hand-to-mouth households.

The surface represents parameter combinations for which the model is located on the threshold between SADL and IADL. In other words, every point on the surface plot aligns with a Δ equal to 0. Points, or parameter combinations, above the surface lead to a model located in the IADL region ($\Delta < 0$). Parameterizations below the surface impose the model to be situated in the SADL region ($\Delta > 0$).

Figure 1 highlights several key insights, some of which we have already derived analytically. First, the model is always situated in the SADL region when all households have unlimited access to financial markets (as long as κ and γ are not both zero). Second, when a significant share of the population lacks access to asset markets (when the parameter λ is sufficiently large), the model shifts into the IADL region, all else being equal. These results mirror those put forward by Bilbiie (2008), as previously discussed. Third, maintaining all other parameters fixed, a high degree of complementarity between consumption and labor hours decreases the probability of the model remaining in the SADL region. Conversely, if consumption and labor hours are Edgeworth substitutes, the model is more likely to stay within the SADL region. Fourth, when consumption and labor hours are Edgeworth complements ($\kappa > 0$), a stronger wealth effect on labor supply increases the likelihood of the model being in the SADL region; the reverse is true for weaker wealth effects. However, when consumption and labor hours are substitutes ($\kappa < 0$), an increase in the wealth effect reduces the probability that the economy will operate under standard aggregate demand logic. Finally, when comparing the impact of these novel channels, it is evident that shifting from consumption-hours substitutability to complementarity significantly decreases the likelihood of the model ending up in the

SADL region. This effect is more pronounced than the changes observed when varying the wealth effect on labor supply between values slightly above zero and 1.

To put this into perspective, empirical evidence shows that the share of hand-to-mouth households lies between 0.25 and 0.5 (Aguiar et al., 2024; Campbell & Mankiw, 1989; Kaplan et al., 2014; Vissing-Jørgensen, 2002). Estimates of the wealth effect on labor supply often find it to be near zero (Cesarini et al., 2017; Picchio et al., 2017; Schmitt-Grohé & Uribe, 2012). Furthermore, hours worked and consumption appear to be Edgeworth complements (Hall, 2009; Hall & Milgrom, 2008; Kimball & Shapiro, 2008). This evidence suggests that our model economy likely operates under inverted aggregate demand logic, indicating that monetary policymakers should adopt a passive approach to stabilize the economy.

3.2 The mechanism

Having shown that changes in the share of hand-to-mouth households, the degree of complementarity between consumption and hours worked, and the magnitude of the wealth effect can make interest rate hikes expansionary by reversing the sign of the interest elasticity of aggregate demand, we now seek to provide intuition for the underlying mechanism. To illustrate this, we present impulse response functions for a contractionary monetary policy shock, considering various parameterizations of the share of hand-to-mouth households, the wealth effect, and consumption-hours complementarity.

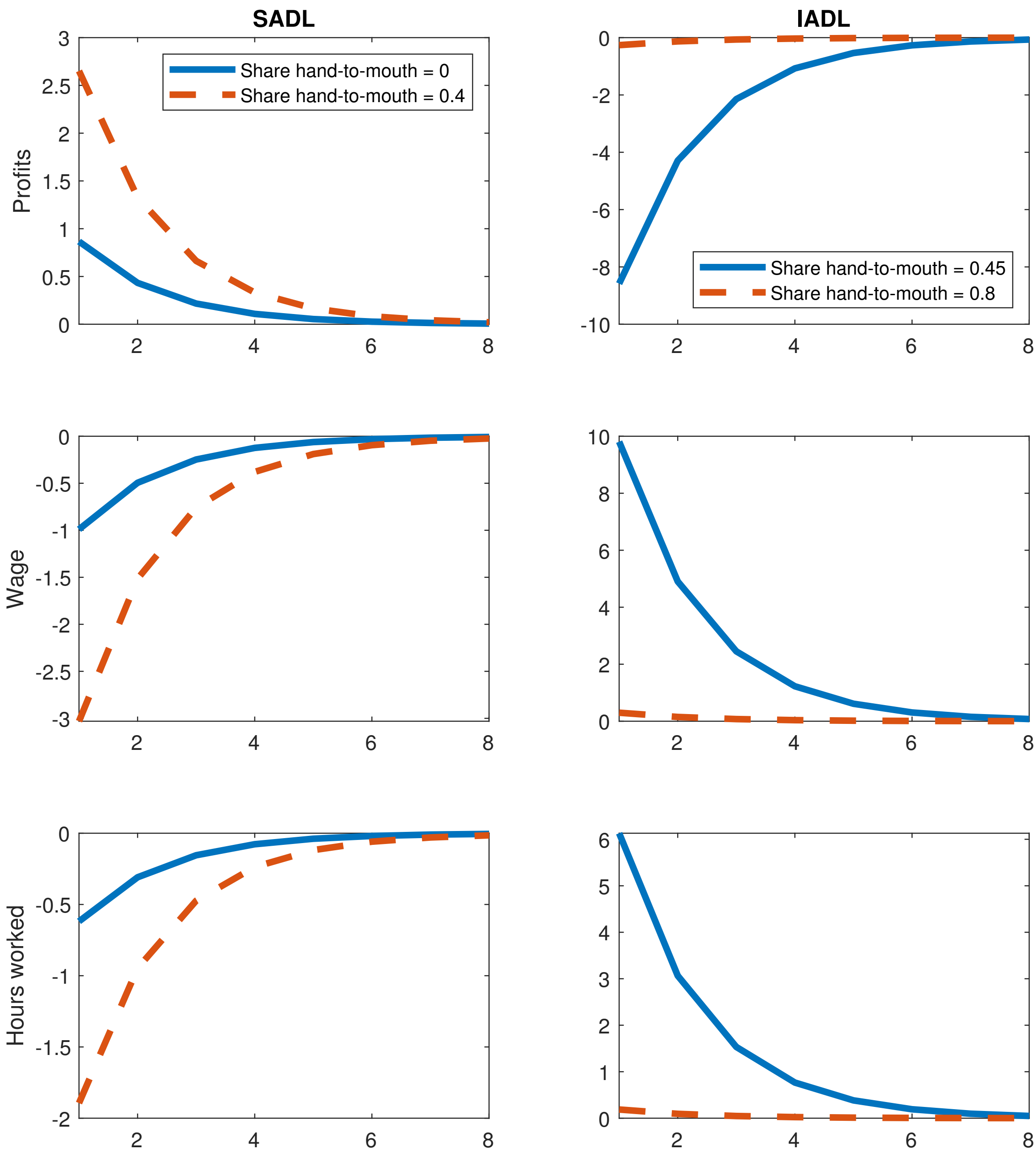
Our model calibration assumes a constant-consumption labor supply elasticity of $\varphi = 1$ and sets the discount factor β to 0.99, implying a steady-state annual interest rate of 4%. The disutility weight of working, ω, is set at 1. The Rotemberg adjustment cost parameter, ξ, is chosen to correspond with an average Calvo price duration of one year. We set the steady-state net markup to $\mu = 0.2$. The central bank's response coefficient is set to $\phi_\pi =$

1.5 in the SADL case and $\phi_\pi = 0.8$ in the IADL case to focus on determinate equilibria. We vary the key parameters – the share of hand-to-mouth households (λ), the wealth effect (γ), and the degree of consumption-hours complementarity (κ) – one at a time while holding the others constant at $\gamma = 0.5$, $\lambda = 0.4$, and $\kappa = 0.25$. This choice implies a moderate wealth effect, with 40% of households living hand-to-mouth, and consumption and hours worked being Edgeworth complements. We consider a contractionary monetary policy shock of 25 basis points in all scenarios, modeled as an AR(1) process with a persistence parameter of $\rho = 0.5$.

Varying the share of hand-to-mouth households. To begin, we follow Bilbiie (2008) and examine how variations in the share of hand-to-mouth households influence the effects of monetary policy shocks. The left column of Figure 2 illustrates the impulse responses of profits, wages, and aggregate employment (the latter being proportional to output and consumption) for the case of no hand-to-mouth households ($\lambda = 0$, solid lines) and for a scenario where 40 percent of households are hand-to-mouth (dashed lines). Given the other parameter choices, both values are below the threshold λ^*, indicating that the economy operates under standard aggregate demand logic. Conversely, the right column presents the impulse response functions when the model is under the inverted aggregate demand logic regime. This regime occurs when λ exceeds the threshold λ^*, as shown for $\lambda = 0.45$ (solid lines in the right column) and $\lambda = 0.8$ (dashed lines in the right column).

Let us first focus on the SADL case. A contractionary monetary policy shock leads to an increase in the real interest rate. This impacts asset holders by prompting them to decrease their current consumption and increase their labor supply. The reduction in aggregate demand induces firms to lower their labor demand due to sticky prices. This adjustment results in a new equilibrium with decreased employment, output, consump-

Figure 2: Varying the share of hand-to-mouth households.



Notes: Impulse responses to a contractionary monetary policy shock for different shares of hand-to-mouth households (λ). The left panel displays responses within the SADL region, while the right panel illustrates responses within the IADL region. Horizontal axes show quarters after the shock.

tion, and lower real wages. As marginal costs (wages) decline, profits rise. In a scenario with no hand-to-mouth households and only savers, the redistribution effect from labor earnings to profits is neutral since the same agents suffer the earnings loss and benefit from the rise in profits.

However, redistribution effects become significant and amplify the impact of monetary policy shocks when there are households that lack access to financial markets (and their share is not too large, thus keeping the economy in the SADL region). Hand-to-mouth households, whose labor income is reduced, cut back their consumption. Due to their higher marginal propensity to consume, this leads to a more substantial decline in aggregate demand compared to the full-participation scenario. This results in a more pronounced decrease in labor demand, leading to a new equilibrium characterized by a more significant fall in output, consumption, employment, and real wages. Simultaneously, profits rise more significantly, which, in isolation, boosts savers' consumption and encourages them to supply less labor. However, this positive income effect on savers is insufficient to offset the initial intertemporal substitution effect of higher interest rates.

As asset market participation becomes more restricted – up to the threshold – the contractionary effects of monetary policy shocks intensify. However, once λ exceeds this threshold, the results reverse: monetary contractions begin to have expansionary effects. This shift occurs because, when $\lambda > \lambda^*$, profits would increase significantly enough that the positive income effect on savers would outweigh the initial intertemporal substitution effect of higher interest rates. In this scenario, the only consistent equilibrium is one where an unexpected increase in the nominal interest rate leads to a rise in aggregate demand, wages, and employment. At the same time, profits decline. The effects on all variables are more pronounced for values of λ just above the threshold. However, as λ

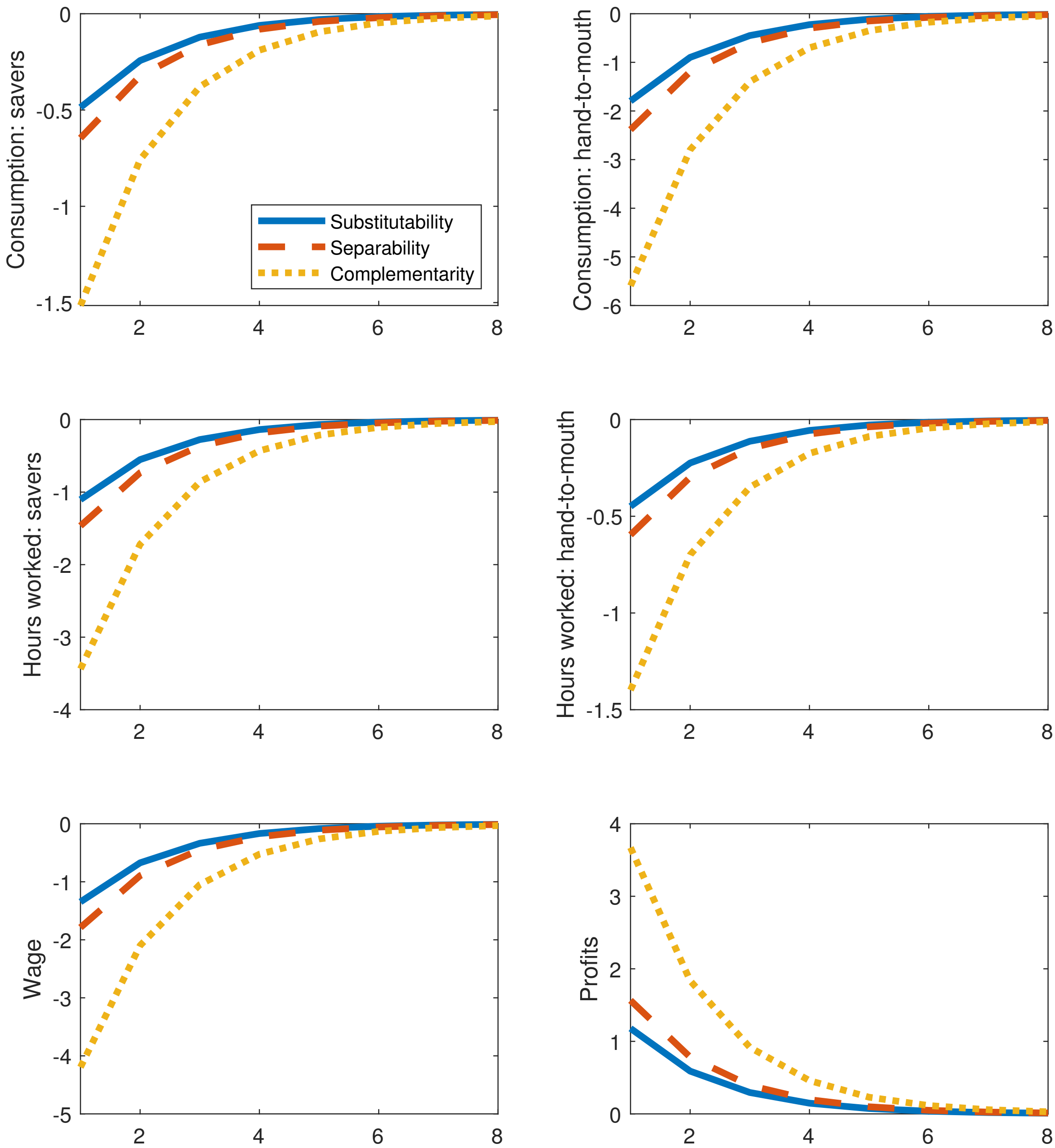
increases beyond this point, the effects become less pronounced.

The impact of non-separability between consumption and hours worked. To explore the impact of consumption-hours non-separability, Figure 3 presents the impulse responses of consumption (for both savers and rule-of-thumb households), employment (for both types of households), wages, and profits in response to a contractionary monetary policy shock within the SADL region. The figure shows responses for three different values of κ: -0.2 (solid lines) for consumption-hours substitutability, 0 (dashed lines) for separability, and 0.35 (dotted lines) for complementarity.

The results reveal that consumption-hours complementarity exacerbates the adverse effects of an increase in the real interest rate on consumption (equivalent to output), hours worked and wages, compared to the separability case. This more pronounced decline in wages results in a larger profit increase, increasing the likelihood of moving into the IADL region. In contrast, consumption-hours substitutability leads to smaller responses across all variables, decreasing the likelihood that monetary contractions will produce expansionary effects.

The intuition behind this result is that consumption-hours complementarity leads to a stronger co-movement between consumption and hours worked. When consumption and labor hours are Edgeworth complements, a reduction in hours worked lowers savers' marginal utility of consumption, prompting these households to reduce their consumption in tandem with their hours worked. This effect amplifies the initial impact of a contractionary monetary policy shock. Conversely, when consumption and hours worked are Edgeworth substitutes, a decrease in hours worked raises the marginal utility of consumption for savers, which, in isolation, leads them to increase their consumption. This offsetting effect dampens the initial impact of the contractionary monetary policy shock.

Figure 3: Varying the relationship between labor hours and consumption in preferences.



Notes: Impulse responses to a contractionary monetary policy shock for three different values of κ: $\kappa = -0.2$ (consumption-hours substitutability), $\kappa = 0$ (consumption-hours separability), and $\kappa = 0.35$ (consumption-hours complementarity). Parameters are selected to ensure that the economy operates under standard aggregate demand logic. Horizontal axes show quarters after the shock.

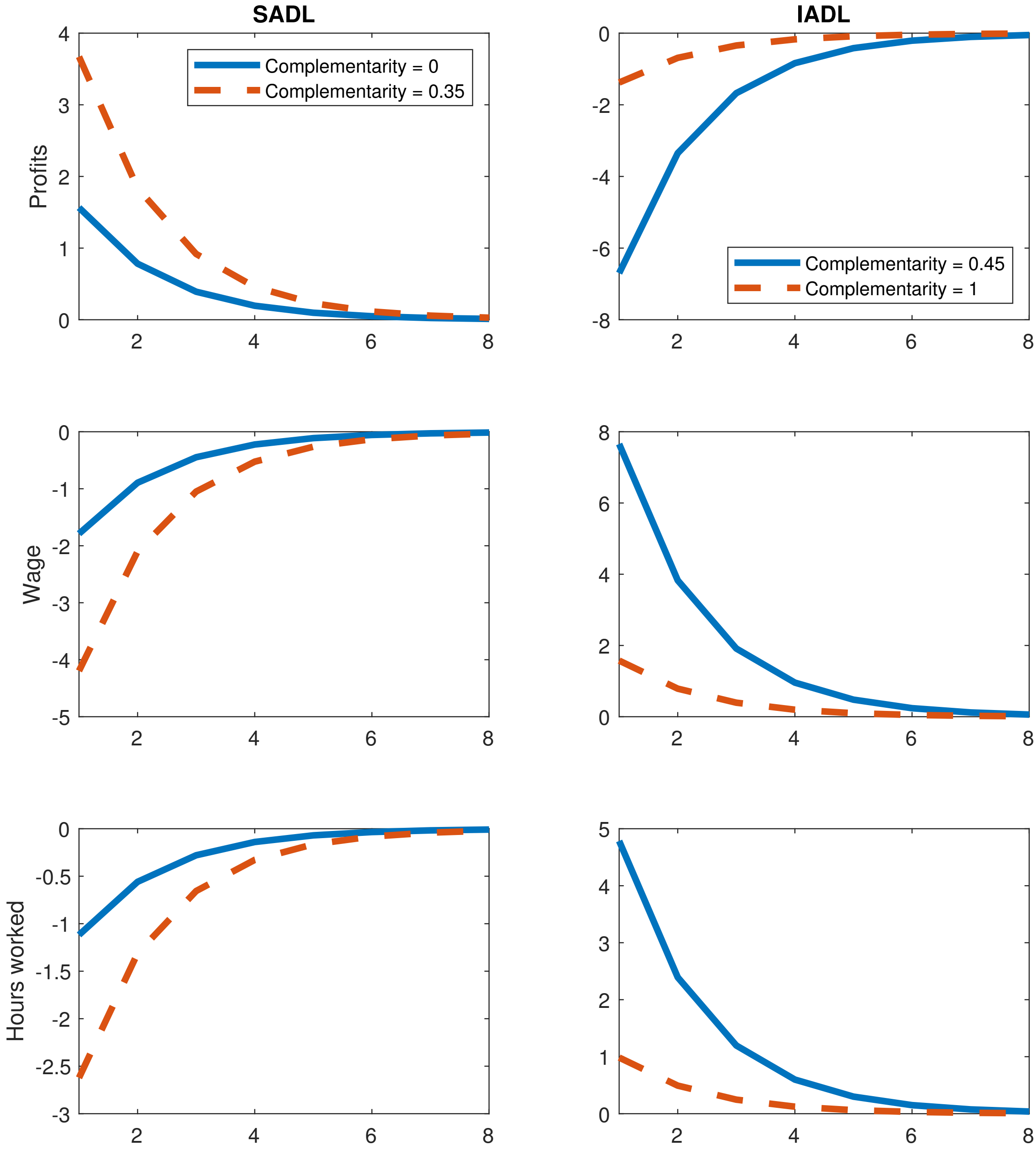
It is important to note that it is the nonseparability in savers' preferences that either amplifies (in the case of complementarity) or dampens (in the case of substitutability) the initial impact of monetary policy. This altered initial response in savers' consumption – and, consequently, in aggregate demand – triggers more pronounced (or smaller) shifts in labor demand. As a result, all households experience greater (or smaller) changes in employment, wages, and disposable income. The more significant (or muted) decline in disposable income for hand-to-mouth households amplifies (or dampens) their consumption responses.

Figure 4 shows model responses to a contractionary monetary policy shock for various degrees of consumption-hours complementarity, focusing on $\kappa \geq 0$. The left panel displays again responses within the SADL region, while the right panel illustrates responses within the IADL region.

Increasing the degree of complementarity from 0 (separability in utility, solid lines in the left panels) to 0.35 (dashed lines in the left panels) – keeping all other parameters constant – brings us closer to the threshold value of 0.4 under the chosen parameterization. Here, the economy remains in the SADL region, where increasing the degree of complementarity amplifies the effects of monetary policy shocks. However, this effect is not monotonic. The effect reverses once the threshold is surpassed, making monetary contractions expansionary. Similar to the results for the share of hand-to-mouth households, a degree of complementarity just above the threshold strongly impacts all variables, making monetary policy contractions highly expansionary and inducing a significant decline in profits. However, further increasing the degree of complementarity diminishes this effect.

Varying the wealth effect on labor supply. Finally, Figure 5 presents the results of varying the income effect on labor supply, assuming that consumption and labor hours are

Figure 4: Varying the degree of hours-consumption complementarity.



Notes: Impulse responses to a contractionary monetary policy shock for various degrees of complementarity (κ). The left panel displays responses within the SADL region, while the right panel illustrates responses within the IADL region. Horizontal axes show quarters after the shock.

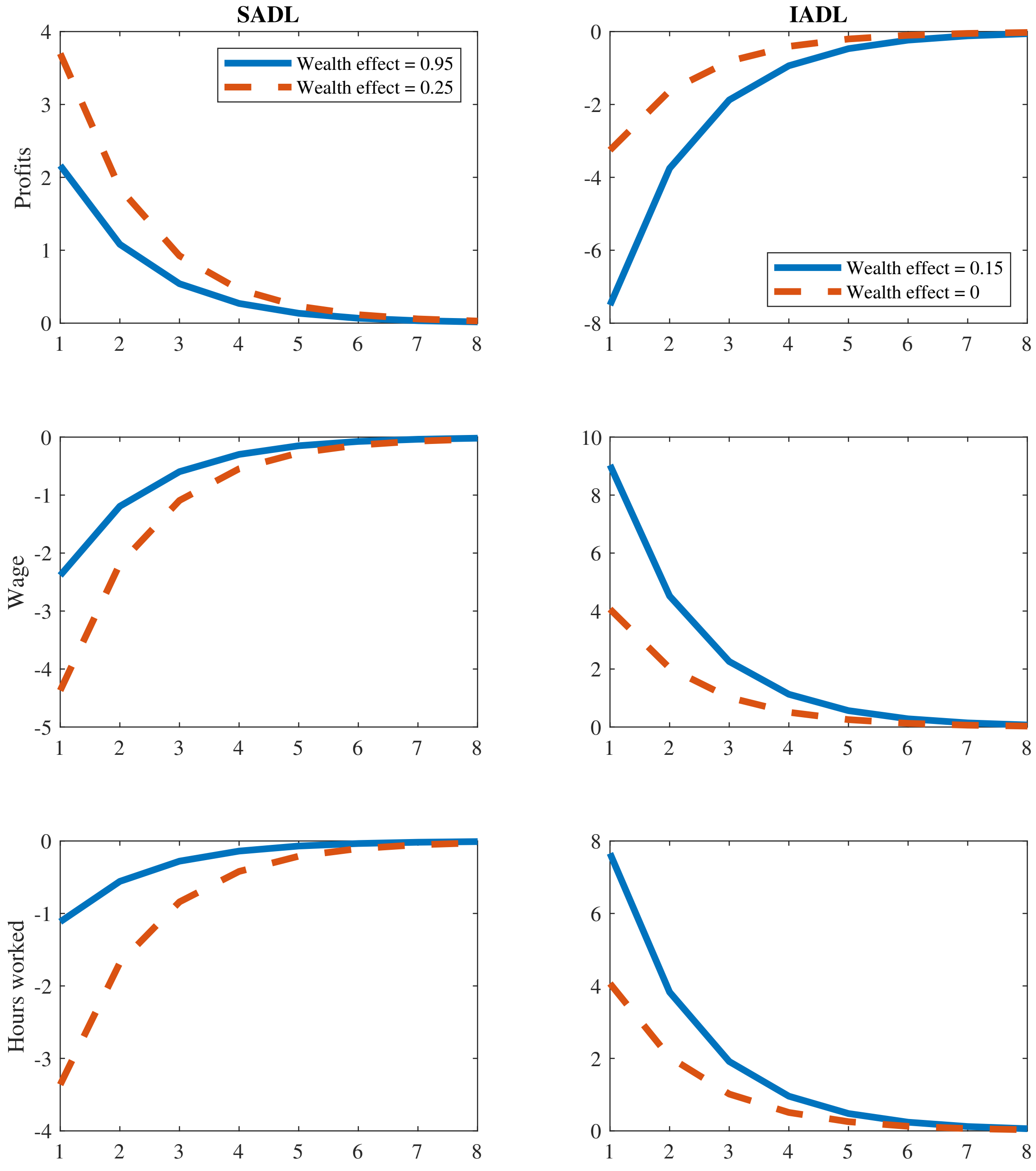
Edgeworth complements, consistent with our baseline parameterization. The left panels show impulse responses for different strengths of the wealth effect on labor supply, with $\gamma = 0.95$ (solid lines) and $\gamma = 0.25$ (dashed lines), where the parameterization keeps the economy in the SADL region. The right panels show responses for $\gamma = 0.15$ (solid lines) and $\gamma = 0$ (dashed lines), where the economy operates under inverted aggregate demand logic. We adjust the parameter ζ when changing γ to maintain a constant degree of consumption-hours complementarity, $\kappa = \frac{\zeta(1+\varphi)}{\gamma+\varphi}$.

Under the SADL regime, a reduction in the wealth effect amplifies the impact of monetary policy when consumption and labor hours are Edgeworth complements. This amplification means a more pronounced decline in output, employment, and marginal costs, the latter of which causes a substantial increase in profits. This increase in profits heightens the probability of transitioning to the IADL region.

With a weaker wealth effect, the reduction in consumption triggered by the monetary policy shock leads to a smaller rightward shift in the labor supply curve. Consequently, hours worked and output decline more sharply, as the leftward shift in labor demand is less counterbalanced. This further decreases savers' consumption due to the complementarity between consumption and hours worked, deepening the drop in aggregate demand. As a result, the labor demand curve shifts further to the left while the labor supply curve remains largely unchanged, leading to an even greater decline in aggregate employment.

These effects suggest that a decrease in the income effect on labor supply would mitigate the decline in real wages following a monetary contraction, as the rightward shift in labor supply becomes smaller. However, Figure 5 shows that, in equilibrium, the real wage decreases more sharply as the income effect diminishes, provided the economy stays in the SADL region. This occurs because a reduced wealth effect leads to a more

Figure 5: Varying the degree of the wealth effect when $\kappa > 0$.



Notes: Impulse responses to a contractionary monetary policy shock for various values of the income effect on labor supply (γ) under consumption-hours complementarity ($\kappa > 0$). The left panel shows responses within the SADL region, while the right panel illustrates responses within the IADL region. Horizontal axes show quarters after the shock.

pronounced leftward shift in labor demand, creating a stronger co-movement between employment and wages.

When the income effect is sufficiently low, the economy transitions into the IADL region, where an increase in the nominal interest rate becomes expansionary. In this region, further reductions in the income effect weaken the expansionary impact of monetary contractions, mirroring the patterns observed with variations in the share of hand-to-mouth households and the degree of consumption-hours complementarity.

The effects of altering the wealth effect on model dynamics are reversed when consumption and hours worked are Edgeworth substitutes, as shown in Figure A.1 in Appendix C. Under the SADL regime, reducing the wealth effect dampens the impact of monetary policy, in contrast to the scenario where $\kappa > 0$. This dampening reduces the likelihood of the economy transitioning into the IADL region.

The rationale for why reducing the wealth effect dampens the impact of monetary policy under substitutability in the standard aggregate demand logic region is as follows: when consumption and labor hours are Edgeworth substitutes, a decrease in employment triggered by a monetary policy shock tends to mitigate the decline in savers' consumption, all else being equal. While overall consumption still falls, the decline is less pronounced due to the substitutability effect, which, in isolation, acts to increase consumption. However, if the wealth effect is significant, this mitigating effect on consumption would lead savers to work less, thereby weakening the overall dampening effect of substitutability. As a result, the dampening effect of substitutability becomes more pronounced when the wealth effect is small.

4 Conclusion

We have set up a New Keynesian model incorporating limited asset market participation and a quasi-separable utility function, enabling separate parameterization of consumption-hours complementarity and income effects on labor supply. This model nests the framework used by Bilbiie (2008) when considering the limiting case of separability between consumption and hours in households' utility function and an income effect on labor supply equal to unity.

Bilbiie (2008) demonstrated that when the share of households without access to financial markets exceeds a certain threshold, the slope of the IS curve may turn positive, leading the economy to operate under an inverted aggregate demand logic where aggregate demand increases with the real interest rate. In this scenario, an inverted Taylor principle is required for a determinate equilibrium: the central bank must lower the real interest rate in response to higher inflation.

Our study has shown that the combination of consumption-hours complementarity and a small income effect on labor supply significantly expands the range of parameters where the IADL holds. Conversely, when consumption and labor hours are Edgeworth substitutes and the wealth effect on labor supply is large, the parameter space for which IADL is valid shrinks considerably. When our model is calibrated according to empirical findings on income effects and consumption-hours complementarity, it situates the economy in the inverted aggregate demand logic region, where monetary policymakers should adopt a passive approach to stabilize the economy.

Our findings support the policy proposal by Holden (2024) advocating using a "real rate rule." He demonstrates that a nominal interest rate rule with a unit response to real rates and more than a unit response to inflation ensures determinacy regardless of the

IS curve's slope. This is crucial because, in our model, the central bank must follow the standard or an inverted Taylor principle, depending on the IS curve's slope, to ensure determinacy under a standard interest rate rule.

Our analysis is conducted within the framework of a highly stylized economy. Specifically, we neglect the role of capital accumulation and assume a frictionless labor market. Furthermore, we utilize a simplified heterogeneous-agent model in which the share of households with limited (or no) asset market participation is exogenous. A potential extension of our analysis could involve a larger-scale heterogeneous-agent model with frictional labor markets and an endogenous share of borrowing-constrained households.

Declaration of generative AI and AI-assisted technologies in the writing Process

During the preparation of this work, the authors used ChatGPT and Grammarly to enhance language and readability. After using these tools, the authors carefully reviewed and edited the content, and they take full responsibility for the content of the publication.

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Appendix A: Model summary

In this appendix, we summarize the non-linear and linearized equilibrium conditions.

A.1 Equilibrium conditions

$U_{C,S,t} = \beta E_t \left\{ U_{C,S,t+1} \frac{R_t}{\Pi_{t+1}} \right\}$	Euler equation S
$U_{C,S,t} = \left(\frac{C_{S,t}^{1-\gamma}}{1-\gamma} - \omega \frac{N_{S,t}^{1+\varphi}}{1+\varphi} \right)^{-\frac{\zeta}{1-\gamma}} C_{S,t}^{-\gamma}$	Marginal utility of consumption S
$\omega N_{S,t}^{\varphi} = W_t C_{S,t}^{-\gamma}$	Labor supply S
$C_{S,t} = W_t N_{S,t} + \frac{D_t}{1-\lambda}$	Budget constraint S
$\omega N_{H,t}^{\varphi} = W_t C_{H,t}^{-\gamma}$	Labor supply H
$C_{H,t} = W_t N_{H,t}$	Budget constraint H
$Y_t = A N_t - F$	Production function
$MC_t = W_t / A$	Real marginal cost
$D_t = (1 - (1 + F/Y_t)\ MC_t)\ Y_t$	Real profits
$(\Pi_t - 1)\,\Pi_t = \beta E_t \left(\frac{U_{C,S,t+1}}{U_{C,S,t}} \Pi_{t+1} (\Pi_{t+1} - 1) \frac{Y_{t+1}}{Y_t} \right) + \frac{\varepsilon}{\xi} \left(MC_t - \frac{\varepsilon - 1}{\varepsilon} \right)$	Philips curve
$N_t = \lambda N_{H,t} + (1-\lambda) N_{S,t}$	Labor market clearing
$C_t = \lambda C_{H,t} + (1-\lambda) C_{S,t}$	Aggregate consumption
$\frac{R_t}{R} = \left(\frac{E_t \Pi_{t+1}}{\Pi} \right)^{\phi_\pi} \exp(\upsilon_t)$	Monetary policy

A.2 Log-linearized model

$u_{C,S,t} = E_t u_{C,S,t+1} + r_t - E_t \pi_{t+1}$	Euler equation S
$u_{C,S,t} = -(\gamma + \kappa) c_{S,t} + \kappa n_{S,t}$	Marginal utility cons. S
$\varphi n_{S,t} = w_t - \gamma c_{S,t}$	Labor supply S
$c_{S,t} = (w_t + n_{S,t}) + \frac{1}{1-\lambda} d_t$	Budget constraint S
$\varphi n_{H,t} = w_t - \gamma c_{H,t}$	Labor supply H
$c_{H,t} = w_t + n_{H,t}$	Budget constraint H

$y_t = (1 + F_Y)n_t$ Production function

$mc_t = w_t$ Real marginal cost

$d_t = -mc_t + \frac{\mu}{1+\mu} y_t$ Real profits

$\pi_t = \beta E_t \pi_{t+1} + \psi mc_t$, where $\psi = (\varepsilon - 1)/\xi$ Philips curve

$n_t = \lambda n_{H,T} + (1 - \lambda) n_{S,t}$ Labor market clearing

$c_t = \lambda c_{H,T} + (1 - \lambda) c_{S,t}$ Aggregate consumption

$r_t = \phi_\pi E_t \pi_{t+1} + \upsilon_t$ Monetary policy

Appendix B: Determinacy properties of the Taylor Rule

Determinacy in our model is assessed by analyzing the eigenvalues of the coefficient matrix $\mathbf{\Gamma}$ in the dynamic system

$$E_t \begin{bmatrix} y_{t+1} \\ \pi_{t+1} \end{bmatrix} = \mathbf{\Gamma} \begin{bmatrix} y_t \\ \pi_t \end{bmatrix} + \mathbf{\Psi} \begin{bmatrix} \upsilon_t \\ 0 \end{bmatrix}.$$

Here, output, y_t, and inflation, π_t, represent the state variables, while υ_t denotes the monetary policy shock.

To derive this system, we reduce our model to two equations in terms of output and inflation: an aggregate demand curve and a Phillips curve. By integrating the IS curve with the monetary policy rule, we obtain the aggregate demand relationship:

$$y_t = E_t y_{t+1} - \Delta^{-1}(\phi_\pi - 1) E_t \pi_{t+1} - \Delta^{-1} \upsilon_t\,, \tag{A.1}$$

Rewriting the Phillips curve in terms of inflation and output, we get:

$$\pi_t = \beta E_t \pi_{t+1} + \psi \chi y_t\,, \tag{A.2}$$

where $\chi = \frac{1+\mu+\varphi(1-\eta\mu)}{(1+\eta)(1+\mu)}$.

To proceed, we note that the coefficient matrix Γ takes the following form:

$$\mathbf{\Gamma} = \begin{bmatrix} 1 - \beta^{-1}\Delta^{-1}(\phi_\pi - 1)\psi\chi & \beta^{-1}\Delta^{-1}(\phi_\pi - 1) \\ -\beta^{-1}\psi\chi & \beta^{-1} \end{bmatrix}. \tag{A.3}$$

The equilibrium will be determinate if the eigenvalues of $\mathbf{\Gamma}$ are outside the unit circle. These eigenvalues are influenced by Δ and its sign. Under the policy rule $r_t = \phi_\pi E_t \pi_{t+1} + \upsilon_t$, the equilibrium is determinate if:

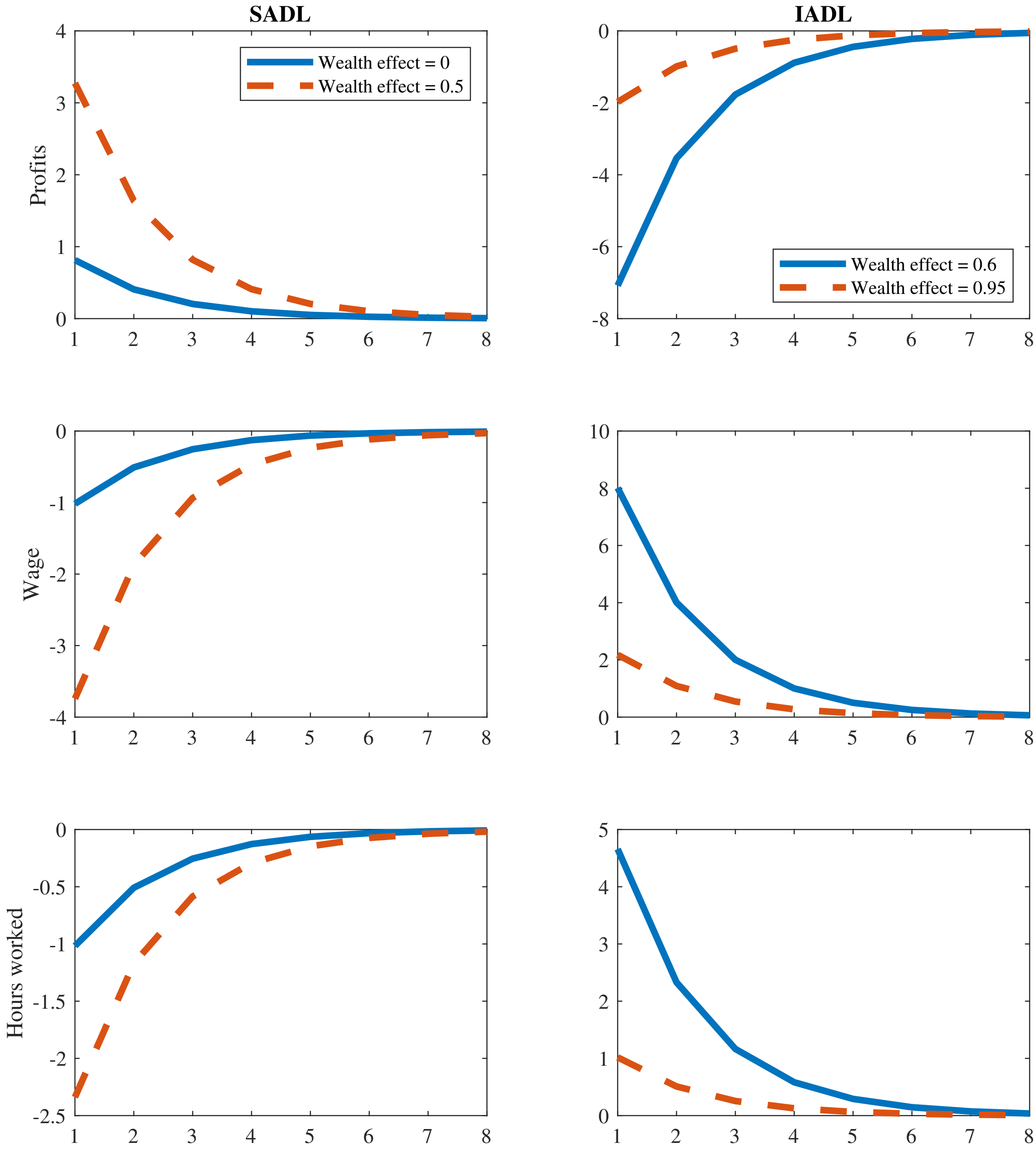
$$\phi_\pi \in \left(1, 1 + \Delta \frac{2(1+\beta)}{\psi\chi}\right) \text{ when } \Delta > 0,$$
$$\phi_\pi \in \left(1 + \Delta \frac{2(1+\beta)}{\psi\chi}, 1\right) \cap [0, \infty] \text{ when } \Delta < 0.$$

The first condition aligns with the standard aggregate demand logic, inducing a standard Taylor principle. The second condition corresponds to the inverted aggregate demand logic, suggesting that the central bank should follow an inverted Taylor principle. It is important to note that the conditions for determinacy echo those presented by Bilbiie (2008); the distinction here lies in the extended determinants of Δ, which now include consumption-hours complementarity κ and the income effect on labor supply γ, alongside the labor supply elasticity φ and the share of hand-to-mouth households λ.

Appendix C: Varying the wealth effect when consumption and labor hours are Edgeworth substitutes

Figure A.1 presents impulse responses to a contractionary monetary policy shock, with varying levels of the income effect on labor supply (γ) under consumption-hours substitutability set at $\kappa = -0.2$. The left panels show impulse responses for $\gamma = 0$ (solid lines) and $\gamma = 0.5$ (dashed lines), where the parameterization is selected to keep the economy within the standard aggregate demand logic region. To achieve this, we set the share of hand-to-mouth households to $\lambda = 0.73$. The right panels illustrate impulse responses for $\gamma = 0.6$ (solid lines) and $\gamma = 0.95$ (dashed lines), where the economy operates under inverted aggregate demand logic given the chosen calibration. As in previous analyses, we adjust the parameter ζ when altering γ to maintain a constant degree of consumption-hours substitutability, ensuring that $\kappa = \frac{\zeta(1+\varphi)}{\gamma+\varphi}$ remains fixed.

Figure A.1: Varying the degree of the wealth effect when $\kappa < 0$.



Notes: Impulse responses to a contractionary monetary policy shock for various values of the income effect on labor supply (γ) under consumption-hours substitutability ($\kappa < 0$). The left panel shows responses within the SADL region, while the right panel illustrates responses within the IADL region. Horizontal axes show quarters after the shock.

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