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The Anatomy of Amplification: A Frisch-System Approach to Shock Transmission*

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Abstract

Elasticities governing consumption and labor choices are central to macroeconomic shock transmission, with existing work emphasizing the intertemporal elasticity of substitution and the Frisch labor-supply elasticity. We highlight the role of a third object: the Frisch consumption-wage elasticity, which captures consumption-labor complementarity. Embedding a nonparametric Frisch demand system in a New Keynesian model, we map these three micro elasticities to aggregate dynamics, clarifying how each elasticity shapes the amplification of monetary, fiscal, markup, and productivity shocks and why consumption-labor complementarity can matter more than Frisch labor-supply elasticity. Quantitatively, in representative-agent and heterogeneous-agent New Keynesian models, we show that consumption-labor complementarity is a dominant amplification channel, often generating responses an order of magnitude larger than those induced by varying the Frisch labor-supply elasticity. These results underscore the value of a framework that allows macroeconomic models to match micro estimates of consumption-labor complementarity, a key determinant of shock amplification

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1. Introduction

A central theme in macroeconomics is the transmission and amplification of shocks. These are tightly linked to microeconomic elasticities that govern households' consumption and labor-supply decisions. A common approach in studying these processes is to specify a structural general-equilibrium (GE) model and impose a restrictive *parametric utility function* that hard-wires particular behavioral elasticities. This practice has led the literature to emphasize the elasticity of intertemporal substitution (EIS) and the Frisch wage elasticity of labor supply.

In this paper, we show that this emphasis is incomplete: the Frisch consumption-wage elasticity, which captures consumption-labor complementarity, matters at least as much for the transmission and amplification of shocks. Our starting point is to replace the utility function with a *nonparametric Frisch demand system* (Browning et al., 1985), which allows us to embed empirically measured Frisch elasticities directly into otherwise standard macroeconomic environments. The framework nests canonical utility specifications as special cases and provides an empirically disciplined structure that is straightforward to implement in quantitative models.

Using this setup in a simple New Keynesian (NK) model, we derive analytical results that map the key micro elasticities to the transmission of monetary, fiscal, markup, and productivity shocks. We show that a higher Frisch labor-supply elasticity strengthens two forces that work in *opposite* directions in shock transmission-the substitution effect and the wealth effect on labor supply. By contrast, consumption-labor complementarity unambiguously dampens the wealth effect, and thus, potentially plays a greater amplification role compared to the Frisch labor supply elasticity. To quantify the relative importance of the different elasticities, we then study both a representative-agent NK (RANK) model and a heterogeneous-agent NK (HANK) model. Across both environments, consumption-labor complementarity emerges as a dominant amplification channel. Specifically, moving from separability to a degree of consumption-labor complementarity consistent with micro-level evidence implies substantially larger responses to monetary, productivity, and markup shocks-often an order of magnitude larger than the effect of varying the Frisch labor-supply elasticity within its empirically relevant range.

To fix ideas, Section 3 considers the standard Representative Agent New Keynesian (RANK) model without capital, so that output moves one-for-one with productivity and aggregate hours. In this environment, we show that the elasticity of output, Y, with respect to any shock s, $\Omega_{Y,s}$, admits a transparent three-part structure:

$$\Omega_{Y,s} = \eta_{x,\lambda}\,\Omega_{\lambda,s} \,+\, \eta_{x,w}\,\Omega_{w,s} \,+\, \mathbb{1}_{\{s=A\}}. \tag{1}$$

The first term, $\eta_{x,\lambda}\Omega_{\lambda,s}$, captures the *wealth-effect channel*: the general-equilibrium effect of the shock s on that marginal utility, $\Omega_{\lambda,s}$, scaled by by the sensitivity of hours, x, to the marginal utility of wealth, λ, denoted by $\eta_{x,\lambda}$. The second term, $\eta_{x,w}\Omega_{w,s}$, reflects the *substitution-effect channel*: the general-equilibrium wage response, $\Omega_{w,s}$, scaled by the Frisch elasticity of hours to wages, w, denoted by $\eta_{x,w}$. For shocks that raise consumption, the wealth effect is negative, while the substitution effect is typically positive. The final term, $\mathbb{1}_{\{s=A\}}$, captures the direct productivity effect, which is present only for technology shocks. Crucially, the sensitivity of hours to the marginal utility, $\eta_{x,\lambda}$, and the two general-equilibrium objects $\Omega_{\lambda,s}$ and $\Omega_{w,s}$ can be written in closed form as functions of the three Frisch elasticities: the EIS, the Frisch wage elasticity of labor supply, and the Frisch wage elasticity of consumption.

Our closed-form representation allows us to identify how the Frisch elasticities drive amplification in GE and why their roles differ across shocks. We show that, in this simple model, consumption-labor complementarity acts as an amplification mechanism for expansionary monetary, productivity, and markup shocks (though not necessarily for fiscal shocks). In contrast, the Frisch elasticity of labor supply can either dampen or magnify the aggregate response. As shown in Section 3, the reason is that consumption-labor complementarity unambiguously dampens the sensitivity of hours to the marginal utility, $\eta_{x,\lambda}$, and in turn, the wealth effect of expansionary shocks, $\eta_{x,\lambda}\Omega_{\lambda,s}$. Instead, the Frisch elasticity of labor supply strengthens *both* the wealth effect, $\eta_{x,\lambda}\Omega_{\lambda,s}$, and the substitution effect, $\eta_{x,w}\Omega_{w,s}$.[1]

We then embed, in Section 4, the nonparametric system into a standard quantitative RANK model, demonstrating how the Frisch demand system can be incorporated into workhorse macroeconomic environments. We calibrate this full RANK model and, in Section 5, assess how the Frisch elasticities shape the transmission of monetary, productivity, markup, and government-spending shocks. Such an exercise is impossible under standard parametric specifications that hardwire elasticities. The flexibility of the nonparametric framework allows us to evaluate how empirically disciplined elasticities govern both the magnitude and the sign of aggregate responses. Importantly, the forces highlighted in Section 3 remain central in the richer model. In particular, we show that for

[1]For example, under separable preferences the wealth effect on hours satisfies $\eta_{x,\lambda} = \eta_{x,w}$.

the empirically relevant range of parameters, consumption-labor complementarity is as important as the EIS in magnifying shocks, and substantially more so than the Frisch labor-supply elasticity.

We extend the analysis to an incomplete-markets Heterogeneous-Agent New Keynesian (HANK) environment in Section 6. Because the HANK model is solved nonlinearly, we employ a flexible parametric utility specification with sufficient degrees of freedom—adopted from Hall and Milgrom (2008)—that matches the same three Frisch elasticities exactly.[2] This enables us to assess the generality of the results obtained in the RANK model. Importantly, despite the well-known differences between RANK and HANK transmission mechanisms—especially the role of high marginal propensities to consume (MPCs) and liquidity channels in HANK—the comparative statics of amplification with respect to the three Frisch elasticities coincide across both classes of models. In both environments, the sign and ranking of the amplification effects of the three Frisch elasticities are the same, indicating that these elasticities play a similar role in driving amplification within a wide class of macro models.

Related Literature. We contribute to two literatures: *(i)* the amplification and transmission of shocks in DSGE models, and *(ii)* the role of flexible intratemporal preferences across consumption and leisure for macroeconomic analysis.

With respect to the amplification and transmission literature, prior work has identified a range of mechanisms that magnify aggregate disturbances including on the production side (e.g., capacity utilization as in King and Rebelo (1999)), nominal frictions (e.g., sticky prices and wages as in Gali (2015)), endogenous markups (e.g. Rotemberg and Woodford (1991)), financial frictions (e.g. Bernanke and Gertler (1989)), distribution of marginal propensity to consume, and liquidity channels (e.g. Bilbiie (2008) and Kaplan et al. (2018)). Within this agenda, our paper is closest in spirit to the extensive literature that studies the role of the Frisch labor supply elasticity in amplifying shocks (e.g., see the discussion in Rogerson (1988), Hansen (1985), King and Rebelo (1999), Chetty et al. (2011), Chetty (2012)). We contribute to this literature by studying the amplification role of *all* three micro Frisch elasticities that govern household consumption-leisure choices. Analytically, this enables us to isolate the theoretical channels through which each elasticity operates. Quantitatively, it allows us to compare their relative contributions, showing that for empirically relevant ranges of micro elasticities, both in HANK and RANK environments, consumption-labor complementarity is

[2]For recent work employing alternative flexible utility functions in NK models, see Auclert et al. (2023) and Bilbiie et al. (2025).

quantitatively as important as the EIS and more important than the Frisch labor-supply elasticity in driving the amplification of shocks.

The second strand relaxes separability in preferences to align macro behavior with micro evidence on consumption-labor non-separability.[3] Applications include unemployment dynamics (e.g. Hall and Milgrom (2008)), the labor wedge (e.g. Hall (2009) and Shimer (2009)), fiscal multipliers (Linnemann, 2006; Bilbiie, 2009, 2011), Laffer-curve calculations (Trabandt and Uhlig, 2011), and, more generally, work that employs the Greenwood et al. (1988) preferences to eliminate the wealth effect on labor supply. Within this strand of the literature, the two most closely related papers to ours, in terms of emphasizing the macroeconomic implications of consumption-labor complementarity are Auclert et al. (2023) and Bilbiie et al. (2025). Specifically, these papers study the challenges in reconciling micro-level evidence on marginal propensity to consume and earn together with moderate multipliers of government spending. Both papers analyze qualitatively and quantitatively the link between consumption-labor complementarity, the wealth effects on labor supply, and government spending multipliers. Our paper differs from this recent work along two important dimensions. First, by incorporating the Frisch demand system nonparametrically into an NK model, we provide a transparent mapping from micro elasticities to general-equilibrium elasticities. Second, whereas the main focus of these papers is the government multiplier, we apply our framework systematically to multiple shocks—including monetary, productivity, markup, and fiscal shocks—allowing us to speak more broadly to the amplification mechanisms emphasized in the literature discussed above.

2. Household Problem: Frisch Demand System

In this section we introduce a *Frisch demand system* that is nonparametric in consumption and leisure and allows for time non-separability. Our approach follows Browning et al. (1985) and, more recently, Blundell et al. (2016), and extends earlier results by explicitly incorporating external habits, which are commonly used in macroeconomic models.[4] This enables us to make explicit how

[3]Flexible preferences over consumption and leisure play an important role also in the labor literature, see for example: Blundell et al. (1994), Ziliak and Kniesner (2005), and Blundell et al. (2016). We return to some estimates from this literature when discussing the calibration of our model. In addition, a separate literature explores the role of flexible preferences over goods in driving macro dynamics. See for example Olivi et al. (2025) for a recent contribution in the context of NK models.

[4]Blundell et al. (2016) derive the Frisch system for a case with more than one earner in a household, which we abstract from here.

micro elasticities map into general-equilibrium elasticities.

Specifically, consider a household choosing consumption and hours at every period (c_t and x_t) to maximize expected discounted lifetime utility

$$E\sum_{t=0}^{\infty}\beta^t U(c_t, x_t, \bar{c}_{t-1}),$$

subject to the period-by-period real budget constraint

$$c_t + b_{t+1} \;=\; w_t x_t \;+\; d_t \;-\; \tau_t \;+\; (1+r_t) b_t,$$

where c_t denotes real consumption, x_t denotes hours worked, and $\bar{c}_{t-1}$ is real aggregate consumption taken as given (to allow for external habit or preference externalities). In the budget constraint, w_t is the real wage, r_t the real interest rate, b_t the amount of bonds the household enters the period with, d_t non-labor income (e.g., dividends from firm ownership), and τ_t lump-sum taxes. Letting λ_t denote the Lagrange multiplier on the real budget constraint (the marginal utility of wealth),[5] the first-order conditions are

$$U_c(c_t, x_t, \bar{c}_{t-1}) = \lambda_t, \tag{2}$$

$$U_x(c_t, x_t, \bar{c}_{t-1}) = -w_t\,\lambda_t, \tag{3}$$

which define implicit functions $c_t = c(w_t, \lambda_t, \bar{c}_{t-1})$ and $x_t = x(w_t, \lambda_t, \bar{c}_{t-1})$. Log-linearizing around the steady state yields the following Frisch system in $(\widehat{\lambda}_t, \widehat{w}_t, \widehat{\bar{c}}_{t-1})$:

$$\begin{pmatrix} \widehat{c}_t \\ \widehat{x}_t \end{pmatrix} = \begin{pmatrix} \eta_{c,\lambda} & \eta_{c,w} & \eta_{c,\bar{c}} \\ \eta_{x,\lambda} & \eta_{x,w} & \eta_{x,\bar{c}} \end{pmatrix} \begin{pmatrix} \widehat{\lambda}_t \\ \widehat{w}_t \\ \widehat{\bar{c}}_{t-1} \end{pmatrix}, \tag{4}$$

where a circumflex denotes percentage deviations from steady state. Appendix A derives these Frisch elasticities in terms of the first and second derivatives of the utility function, as well as the steady state levels of c, x and $\bar{c}$.

[5] We discuss the intertemporal condition in the next section.

2.1. The Frisch Elasticities

This section introduces the micro-Frisch elasticities that govern household behavior in our framework: the intertemporal elasticity of substitution ($-\eta_{c,\lambda}$), the Frisch labor-supply elasticity with respect to wages ($\eta_{x,w}$), consumption-labor complementarity ($\eta_{c,w}$), and the effect of marginal utility of wealth on labor ($\eta_{x,\lambda}$), as well as the elasticities associated with external habits.

The EIS $\eta_{c,\lambda}$ is the elasticity of c with respect to λ (holding w and $\bar{c}$ fixed). It equals the *negative* of the elasticity of intertemporal substitution (EIS), i.e., $\eta_{c,\lambda} = -\text{EIS}$.[6] Hence, $\eta_{c,\lambda}$ captures the responsiveness of consumption to changes in the real interest rate.

The Wage Substitution Effect The elasticity $\eta_{x,w}$ denotes the Frisch elasticity of labor supply. It measures the substitution effect of a wage change on labor supply, holding λ and $\bar{c}$ constant. A larger $\eta_{x,w}$ indicates that households are more willing to adjust hours in response to wage changes.

Consumption-Labor non-Separability The elasticity $\eta_{c,w}$ denotes the cross elasticity of consumption with respect to the wage, holding λ and $\bar{c}$ constant. This captures consumption-labor non-separability in utility. Since

$$\eta_{c,w} = -\frac{U_x U_{cx}}{c\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)},$$

if preferences are separable (i.e., $U_{cx} = 0$), then $\eta_{c,w} = 0$. In contrast, if utility is non-separable in consumption and labor, a change in the wage influences consumption even when the marginal utility of wealth is held constant. For example, when consumption and hours are complements ($\eta_{c,w} > 0$), a higher wage that raises hours (holding λ fixed- i.e., no change in lifetime resources) also raises consumption.

The Marginal Utility Effect on Labor The elasticity $\eta_{x,\lambda}$ denotes the responsiveness of labor supply with respect to the marginal utility of wealth, holding w and $\bar{c}$ constant. This parameter captures the wealth effect of changes in λ on labor supply and, as long as leisure is a normal good, satisfies $\eta_{x,\lambda} > 0$. As discussed in Appendix A, $\eta_{x,\lambda}$ is *not* an independent parameter; rather, the

[6] To see that $\eta_{c,\lambda} = -\text{EIS}$, recall that by definition, the EIS is the elasticity of consumption growth to the real interest rate. Then, starting from $\lambda_t = \beta R_t \lambda_{t+1} \Rightarrow \widehat{\lambda}_t - \widehat{\lambda}_{t+1} = \widehat{R}_t$. Using the linearized intra-Euler, $\widehat{c}_t = \eta_{c,\lambda}\widehat{\lambda}_t + \eta_{c,w}\widehat{w}_t$, we get (keeping wage constant): $\widehat{c_{t+1}} - \widehat{c}_t = \eta_{c,\lambda}\left(\widehat{\lambda}_{t+1} - \widehat{\lambda}_t\right) = -\eta_{c,\lambda}\widehat{R}_t$.

structure of the Frisch demand system implies the following identity

$$\eta_{x,\lambda} = \eta_{x,w} - s_c\,\eta_{c,w}, \tag{5}$$

where $s_c \equiv \frac{c}{wx}$ is the ratio of consumption to labor income in the steady state. Thus, $\eta_{x,\lambda}$ is determined jointly by the Frisch elasticity of labor supply, the consumption-labor cross elasticity, and the consumption to labor-income ratio. For future reference, note that, holding $\eta_{x,w}$ fixed, stronger consumption-labor complementarity ($\eta_{c,w} > 0$) dampens the wealth effect. Intuitively, when consumption and labor are complements, an increase in consumption raises the household's desired hours, counteracting the wealth effect.

The Habit Effect Finally, $\eta_{c,\bar{c}}$ and $\eta_{x,\bar{c}}$ capture the effect of aggregate consumption on individual choices. These elasticities are zero in the absence of external habit or preference externalities.

2.2. Implications for Commonly Used Utility Functions

The elasticities in (4) are, in principle, estimable from micro data without imposing a functional form. Conversely, assuming a particular utility form imposes specific values for these elasticities. For example, the textbook NK model often assumes log consumption utility and separable disutility of labor, implying an EIS of one (so $\eta_{c,\lambda} = -1$), a specific Frisch elasticity ($\eta_{x,w}$), and no consumption-labor complementarity ($\eta_{c,w} = 0$). Another popular functional form is the GHH specification (Greenwood et al., 1988), which implies no wealth effect on hours, $\eta_{x,\lambda} = 0$, and thus, by Equation (5), hardwires a specific relation between two of the Frisch elasticities, $\frac{\eta_{x,w}}{\eta_{c,w}} = s_c$. In contrast, the approach here keeps things general—writing the linearized system in terms of elasticities—to explicitly track how different micro-elasticities influence macro outcomes. In the next section, we embed this general framework into an otherwise standard RANK model.

3. Analytical Results: The Role of Frisch Elasticities

In this section, we study an analytically tractable sticky-price, general-equilibrium macro framework. This allows us to isolate the mechanisms through which the Frisch demand system shapes aggregate dynamics. Importantly, the forces highlighted here remain central in the richer quantitative model discussed in the next section.

We first present our tractable sticky price model in 3.1. We then follow in 3.2 with a simple decomposition that highlights the direct impact of η_{cw} and η_{xw} on the output elasticities with respect to the different shocks we consider. We end this section with a full characterization of the GE responses in terms of the Frisch demand system parameters in 3.3.

3.1. Simple Model

We work with a textbook sticky-price New Keynesian benchmark—flexible wages, no capital, and time-separable preferences without habits—and introduce two tractability modifications: (i) shocks are i.i.d.; and (ii) following Broer et al. (2020), a "capitalist" sector receives all profits and supplies no labor.[7]

Household Block In this linearized model, we replace the two household intratemporal optimality conditions directly with the linear Frisch system:

$$\widehat{c}_t = \eta_{c,\lambda}\,\widehat{\lambda}_t + \eta_{c,w}\,\widehat{w}_t, \tag{6}$$

$$\widehat{x}_t = \eta_{x,\lambda}\,\widehat{\lambda}_t + \eta_{x,w}\,\widehat{w}_t. \tag{7}$$

In this system, $\widehat{w}_t$ and $\widehat{\lambda}_t$ are determined in GE, while $\widehat{c}_t$ and $\widehat{x}_t$ are household choices. Equilibrium requires that these choices coincide with the aggregate outcomes implied by the general-equilibrium system. This modular replacement yields a linear system in endogenous variables that is otherwise standard.

The final equation on the household side (in the i.i.d. case) is the linearized Euler equation, where we have already substituted in the Taylor rule:

$$\widehat{\lambda}_t = \phi_\pi \pi_t - \widehat{m}_t,$$

with ϕ_π denoting the Taylor coefficient on inflation π_t, and $\widehat{m}_t$ an expansionary monetary policy shock.[8]

[7] With i.i.d. shocks and no predetermined states (no capital, no habits, flexible wages), the on-impact elasticities suffice to characterize the equilibrium response.

[8] For simplicity, we do not consider a Taylor coefficient on the output gap.

Firm Block Production is linear in hours, $Y = Ax$, where A denotes total factor productivity (TFP). Firms face Calvo pricing frictions, which yield the familiar New Keynesian Phillips curve (with expectations absent in the i.i.d. case):

$$\pi_t = \kappa \widehat{mc_t} - \widehat{\mu}_t = \kappa \widehat{w}_t - \kappa \widehat{A}_t - \widehat{\mu}_t,$$

where κ is the slope of the Phillips curve. This formulation replaces marginal cost, mc_t, with $\frac{w_t}{A_t}$, and it incorporates a negative markup shock, $\widehat{\mu}_t$.

3.2. Direct impact of η_{cw} and η_{xw} on Output Elasticities

Let $\Omega_{\lambda,s}$ and $\Omega_{w,s}$ denote the GE elasticities of λ and w with respect to the shock $s \in \{m, A, \mu, G\}$ (monetary, productivity, markup, and government spending, respectively).[9] In this simplified model, as in the canonical NK model, log changes in output map one-to-one into the sum of log changes in productivity and aggregate labor. It then follows that the GE elasticity of output with respect to any shock s, denoted $\Omega_{Y,s}$, can be written as in equation (1), reproduced here for convenience:

$$\Omega_{Y,s} = \eta_{x,\lambda}\Omega_{\lambda,s} + \eta_{x,w}\Omega_{w,s} + \mathbb{1}_{\{s=A\}}. \tag{8}$$

The impact of a shock on output therefore decomposes into three components. First, the wealth-effect channel, $\eta_{x,\lambda}\Omega_{\lambda,s}$: given the GE response of λ to a shock, this term captures the response of hours to changes in marginal utility (holding w constant). Second, the substitution-effect channel, $\eta_{x,w}\Omega_{w,s}$: given the GE response of w to a shock, this term captures the response of hours to the change in wages (holding λ constant). Finally, $\mathbb{1}_{\{s=A\}}$ is an indicator equal to one in the case of a productivity shock, which directly affects output.

It is useful to re-write (8) using the decomposition in Equation (5):

$$\Omega_{Y,s} = \eta_{x,w}\left(\Omega_{\lambda,s} + \Omega_{w,s}\right) - s_c \eta_{c,w}\Omega_{\lambda,s} + \mathbb{1}_{\{s=A\}}. \tag{9}$$

Since for expansionary shocks (other than fiscal shocks) the marginal utility of wealth decreases with a shock, i.e., $\Omega_{\lambda,s} < 0$, it follows that $\partial\Omega_{Y,s}/\partial\eta_{c,w} = -s_c\Omega_{\lambda,s} > 0$. That is, holding constant the GE responses, $\Omega_{\lambda,s}$, and $\Omega_{w,s}$, the direct impact of an increase in the consumption-labor complementarity *magnifies* the output response to a shock, highlighting the first-order role played

[9] By "GE elasticities" we refer to the full elasticity, taking into account all endogenous responses.

by non-separability in driving the transmission of shocks. The intuition, which follows directly from the discussion in 2.1, is that a higher $\eta_{c,w}$ (scaled by s_c) lowers the wealth effect on hours one-for-one. Because s_c reflects the share of consumption in earnings, policies or environments that reduce this share weaken this channel: with a smaller consumption share, changes in consumption translate into smaller movements in labor through non-separability. In contrast to the unambiguous first-order effect of $\eta_{c,w}$, varying the Frisch labor-supply elasticity, $\eta_{x,w}$, scales both the substitution channel and the wealth channel in opposite directions.

Taken together, these patterns preview our central message: non-separability plays a first-order role in amplification, whereas the role of labor-supply curvature is more ambiguous. This underscores the value of specifications that allow researchers to calibrate the three Frisch elasticities independently and directly. As we show in the next section, this intuition is present even after taking into account the impact of the Frisch elasticities on the GE elasticities, $\Omega_{\lambda,s}$ and $\Omega_{w,s}$.

3.3. The GE response in Terms of the Frisch elasticities

Turning to the GE elasticities, $\Omega_{\lambda,s}$ and $\Omega_{w,s}$, in Appendix B we show that they are given by

$$\Omega_{\lambda,m} = \frac{-1}{1-\phi_\pi\kappa\Gamma_1} < 0, \quad \Omega_{w,m} = -\frac{\Gamma_1}{1-\phi_\pi\kappa\Gamma_1} > 0 \tag{10}$$

$$\Omega_{\lambda,A} = \frac{-\phi_\pi\kappa}{1-\phi_\pi\kappa\Gamma_1} < 0, \quad \Omega_{w,A} = -\frac{\phi_\pi\kappa\Gamma_1}{1-\phi_\pi\kappa\Gamma_1} > 0 \tag{11}$$

$$\Omega_{\lambda,\mu} = \frac{-\phi_\pi}{1-\phi_\pi\kappa\Gamma_1} < 0, \quad \Omega_{w,\mu} = -\frac{\phi_\pi\Gamma_1}{1-\phi_\pi\kappa\Gamma_1} > 0 \tag{12}$$

$$\Omega_{\lambda,G} = \frac{\phi_\pi\kappa\Gamma_2}{1-\phi_\pi\kappa\Gamma_1} > 0, \quad \Omega_{w,G} = \frac{\Gamma_2}{1-\phi_\pi\kappa\Gamma_1} > 0, \tag{13}$$

where Γ_1 and Γ_2 are defined as follows:

$$\Gamma_1 = -\frac{s_c EIS + \eta_{x,\lambda}}{1+\eta_{x,\lambda}} < 0, \quad \Gamma_2 = \frac{1-s_c}{1+\eta_{x,\lambda}} > 0. \tag{14}$$

We note that $\Omega_{w,s} > 0$ for all s: all expansionary shocks raise the wage in equilibrium, generating a positive substitution effect. Turning to the wealth effect, monetary, productivity, and negative markup shocks make households wealthier and therefore reduce the marginal utility of wealth, λ, whereas a government-expenditure shock, funded by lump-sum taxes, makes households poorer, raising the marginal utility of wealth.

The following proposition formally summarizes the sensitivity of the general-equilibrium response to the Frisch elasticities. Our analytical results focus on the empirically relevant region, which, as discussed in Section 5.1.2, is characterized by $0 < \text{EIS} < 1$ and $\eta_{c,w} < 1$. For convenience, we also concentrate on the case in which κ is positive and finite (i.e., there is at least some degree of price stickiness, which may be arbitrarily small).

Proposition 1. *In the empirically relevant range for the EIS and for $\eta_{c,w}$, the following results hold:*

- *For $\eta_{c,w}$:* $\frac{\partial \Omega_{Y,m}}{\partial \eta_{c,w}} > 0 \quad \frac{\partial \Omega_{Y,A}}{\partial \eta_{c,w}} > 0 \quad \frac{\partial \Omega_{Y,\mu}}{\partial \eta_{c,w}} > 0 \quad \frac{\partial \Omega_{Y,G}}{\partial \eta_{c,w}} \lesseqgtr 0.$
- *For EIS:* $\frac{\partial \Omega_{Y,m}}{\partial EIS} > 0 \quad \frac{\partial \Omega_{Y,A}}{\partial EIS} > 0 \quad \frac{\partial \Omega_{Y,\mu}}{\partial EIS} > 0 \quad \frac{\partial \Omega_{Y,G}}{\partial EIS} < 0.$
- *For $\eta_{x,w}$:* $\frac{\partial \Omega_{Y,m}}{\partial \eta_{x,w}} < 0 \quad \frac{\partial \Omega_{Y,A}}{\partial \eta_{x,w}} < 0 \quad \frac{\partial \Omega_{Y,\mu}}{\partial \eta_{x,w}} < 0 \quad \frac{\partial \Omega_{Y,G}}{\partial \eta_{x,w}} > 0.$

While the proof in Appendix B contains the full set of derivations, the discussion below highlights the key first-order effects of the Frisch elasticities on the transmission of shocks.

Nonseparability ($\eta_{c,w}$) Greater consumption-labor complementarity increases the transmission of monetary, productivity, and markup shocks. Intuitively, as discussed in Section 2.1 and evident in Equation (9), a rise in $\eta_{c,w}$ reduces the wealth effect. As a result, the increase in consumption induced by a lower real interest rate generates a weaker offset to hours. Although there exists a counteracting effect of $\eta_{c,w}$ through the general-equilibrium response of wages, captured by $\eta_{x,w}\Omega_{w,\lambda}$, the first-order wealth-effect channel dominates. For a fiscal expansion, the mechanism is more nuanced. An increase in G reduces private consumption, making households poorer and increasing labor supply (the wealth effect). With sticky prices, the fall in consumption is smaller than the rise in G, so the real wage must increase in equilibrium. As discussed above, stronger consumption-labor complementarity dampens the wealth effect, thereby reducing the labor-supply response. At the same time, higher complementarity implies that consumption declines by even less in response to the fiscal shock, which amplifies the positive wage response and therefore strengthens the substitution effect. Because these two forces operate in opposite directions, the overall effect of $\eta_{c,w}$ on output in response to a fiscal shock cannot be signed.[10]

The Elasticity of Intertemporal Substitution (EIS) An increase in the EIS raises the transmission of monetary, productivity, and markup shocks. As evident from $\Omega_{\lambda,s\in\{m,A,\mu\}}$, a higher EIS dampens

[10]This result differs from Proposition 2 of Auclert et al. (2023), which shows that the multiplier is unambiguously increasing in consumption-labor complementarity. A key difference is that their result assumes monetary policy sets a constant real interest rate, whereas we assume a Taylor rule. In Appendix B we show that, in our environment as well, imposing a constant real interest rate implies that the output response to G is unambiguously increasing in consumption-labor complementarity.

the impact of these shocks on the marginal utility of wealth, thereby weakening the wealth effect term $\eta_{x,\lambda}\Omega_{\lambda,s}$ in equation (8). For government expenditure shocks, the logic reverses: because a higher EIS dampens the wealth effect, an increase in G generates a *smaller* expansionary response in output as the EIS increases.

Frisch Labor Supply Elasticity ($\eta_{x,w}$) As evident in the proposition, the effect of the Frisch labor-supply elasticity on the transmission of monetary, productivity, and markup shocks depends on the relative strength of the negative wealth component ($\Omega_{\lambda,s}$) and the positive substitution component ($\Omega_{w,s}$). For the empirically relevant parameter region discussed above, one can show that the wealth component dominates. Consequently, an increase in $\eta_{x,w}$ *dampens* the transmission of these shocks.[11] For fiscal shocks, by contrast, the wealth component ($\Omega_{\lambda,G}$) is positive and therefore operates in the same direction as the substitution component ($\Omega_{w,G}$). As a result, $\eta_{x,w}$ always *amplifies* the transmission of government-expenditure shocks.

4. RANK Model

This section embeds the nonparametric Frisch demand system into an otherwise standard quantitative RANK framework. We deliberately keep the surrounding environment identical to that of benchmark models to highlight the generality of our approach. Specifically, we follow the production setup in Sims and Wu (2021), which features capital in production, unionized labor with nominal wage rigidity, and sticky prices.

The model consists of: (i) a goods block with monopolistic competition and Calvo pricing (final-retail-wholesale chain); (ii) a capital block with variable utilization and investment adjustment costs; (iii) a labor block with unions, Calvo wage setting, and a labor packer; (iv) external habits in preferences (entering through $\bar{c}_{t-1}$ in the Frisch system); and (v) monetary and fiscal policy (a Taylor rule and a balanced-budget fiscal authority financed by lump-sum taxes). We replace the household's intratemporal optimality conditions with the linear Frisch system, mapping $(\hat{\lambda}_t, \hat{w}_t, \widehat{\bar{c}}_{t-1})$ into $(\hat{c}_t, \hat{x}_t)$ while preserving the standard intertemporal Euler equation. The monetary (m_t), productivity (A_t), markup (μ_t), and government spending (G_t) shocks enter their respective blocks, and all remaining

[11] This may appear puzzling in light of the real business cycle (RBC) literature, where $\eta_{x,w}$ typically amplifies fluctuations. The RBC intuition, however, relies critically on intertemporal consumption smoothing via capital accumulation. In the next two sections, we explore the role of $\eta_{x,w}$ in a quantitative model that includes consumption-smoothing channels.

equilibrium conditions are unchanged.

4.1. Production

A competitive final-good firm produces final output using a CES technology that aggregates intermediate goods purchased from retail firms. Retail firms set the prices of the goods they sell and purchase wholesale output from a representative wholesaler that hires labor and capital to produce. The wholesaler owns the capital stock, purchases new investment goods from an investment-good producer, and hires labor services from a labor packer. What follows describes the details of each stage of production.

4.1.1. Final Good Producer

A competitive final-good firm aggregates the output of a continuum of retail varieties $Y_t(j)$, $j \in [0,1]$, via a CES technology to a final good:

$$Y_t = \left(\int_0^1 Y_t(j)^{\frac{\xi_t^p - 1}{\xi_t^p}} \, dj \right)^{\frac{\xi_t^p}{\xi_t^p - 1}}, \tag{15}$$

where the final good price is given by

$$P_t = \left(\int_0^1 P_t(j)^{1-\xi_t^p} \, dj \right)^{\frac{1}{1-\xi_t^p}}. \tag{16}$$

We allow the elasticity of substitution across varieties, ξ_t^p, to vary over time, generating markup shocks that are commonly used in the literature.

4.1.2. Retail Production

Retailers purchase wholesale output for a price $P_{w,t}$ and repackage it; hence their production function is $Y_t(j) = Y_{w,t}(j)$. A retailer sets the price it charges the final-good firm, $P_t(j)$, and earns nominal profits

$$D_{R,t}(j) = P_t(j)Y_t(j) - P_{w,t}Y_{w,t}(j). \tag{17}$$

We assume that retailers can adjust their prices with probability $(1 - \phi_p)$, as standard in Calvo price-setting models.

4.1.3. Wholesale Production

A representative wholesale firm uses capital K_t and labor $L_{d,t}$ and produces according to

$$Y_{w,t} = A_t (u_t K_t)^\alpha L_{d,t}^{1-\alpha}, \tag{18}$$

where u_t denotes capital utilization, which in turn affects the capital depreciation rate $\delta(u_t)$. Following Sims and Wu (2021), we assume

$$\delta(u_t) = \delta_0 + \delta_1 (u_t - 1) + \delta_2 \frac{1}{2} (u_t - 1)^2, \tag{19}$$

such that $\delta'(u) > 0, \delta''(u) > 0$.[12]

The firm purchases new capital I_t^{produced} from the investment-good producer. As such, capital evolves according to

$$K_{t+1} = (1 - \delta(u_t)) K_t + I_t^{\text{produced}}. \tag{20}$$

The wholesaler hires labor $L_{d,t}$ from the labor packer at a nominal wage per unit W_t^{packed}. The wholesaler's profits are then given by

$$D_{W,t} = P_{w,t} Y_{w,t} - W_t^{\text{packed}} L_{d,t} - P_{K,t} I_t^{\text{produced}} \tag{21}$$

4.1.4. Investment Good Producer

The investment-good producer uses I_t units of the final good to produce new capital I_t^{produced}, subject to investment adjustment costs $S\left(\frac{I_t}{I_{t-1}}\right) = \frac{\psi_K}{2}(\frac{I_t}{I_{t-1}} - 1)^2$ as in Christiano et al. (2005), using the production technology

$$I^{\text{produced}} = \left(1 - S\left(\frac{I_t}{I_{t-1}}\right)\right) I_t. \tag{22}$$

New capital is sold to the wholesale firm at price $P_{K,t}$, and nominal profits are given by

$$D_{K,t} = P_{K,t} I^{\text{produced}} - P_t I_t. \tag{23}$$

[12] The parameter δ_1 is chosen such that, without loss of generality, the steady-state utilization of capital is equal to $u_{ss} = 1$. The parameter δ_0 denotes the baseline depreciation of capital in steady state, and δ_2 regulates the volatility of capital utilization. Their calibration follows Sims and Wu (2021).

4.2. Labor Markets

A labor packer buys differentiated labor services $L_{d,t}(i)$ from unions at the wage $W_t^U(i)$ and aggregates them into final labor:

$$L_{d,t} = \left(\int_0^1 L_{d,t}(i)^{\frac{\xi^w - 1}{\xi^w}} di \right)^{\frac{\xi^w}{\xi^w - 1}}, \tag{24}$$

which is then sold to the wholesale firm at price

$$W_t^{\text{packed}} = \left(\int_0^1 W_t^{\text{U}}(i)^{1-\xi^w} di \right)^{\frac{1}{1-\xi^w}}. \tag{25}$$

A continuum of labor unions purchases labor $x_t(i)$ from households for a nominal wage W_t and repackages it into $L_{d,t}(i) = x_t(i)$. Each union earns nominal profits

$$D_{U,t}(i) = W_t^U(i) L_{d,t}(i) - W_t x_t(i). \tag{26}$$

Unions can adjust the wage $W_t^U(j)$ with probability $(1 - \phi_w)$ each period, as standard in Calvo wage-setting models.

4.3. Monetary and Fiscal Authorities

The monetary authority sets the interest rate according to a Taylor rule with a positive weight on deviations of inflation from its steady state and monetary policy shocks, $\widehat{m}_t$:[13]

$$\tilde{i}_t = \phi_\pi \pi_t - \widehat{m}_t, \tag{27}$$

where $\tilde{i}_t$ is the percentage point deviation of the nominal interest rate from its steady state level, and we assume zero inflation rate in steady state. The government spends G_t in period t and balances its budget every period by levying a lump-sum tax,

$$\tau_t = G_t. \tag{28}$$

[13] For convenience, we define the monetary shock with a negative sign, making a positive realization expansionary.

4.4. Household Problem

The representative household is choosing consumption and hours at every period (c_t and x_t) to maximize expected discounted lifetime utility

$$E\sum_{t=0}^{\infty}\beta^t U(c_t, x_t, \bar{c}_{t-1}), \tag{29}$$

subject to the period-by-period real budget constraint:

$$c_t + b_{t+1} = w_t x_t + \nu d_t - \tau_t + (1+r_t)b_t, \tag{30}$$

where $\nu \in [0,1]$ is the share of total profits rebated to workers (the remainder, as in Broer et al. (2020), accruing to "capitalists" who do not supply labor). Overall nominal profits, D_t, are the sum of (i) the union profits, $D_{U,t} = \int_0^1 D_{U,t}(i)di$, (ii) the investment-good producer's profits, $D_{K,t}$, (iii) the wholesale producer's profits, $D_{W,t}$, and (iv) the retail production profits, $D_{R,t} = \int_0^1 D_{R,t}(j)dj$. Real profits are then $d_t = \frac{D_t}{P_t}$.

4.5. The Shocks

The model features four exogenous shocks. We normalize the steady state level of TFP to equal one, and hence the log of TFP follows

$$\log(A_t) = \rho_A \log(A_{t-1}) + \sigma_A \varepsilon_t^A. \tag{31}$$

The log of government spending follows

$$\log(G_t) = \rho_G \log(G_{t-1}) + (1-\rho_G)\log(\bar{G}) + \sigma_G \varepsilon_t^G, \tag{32}$$

where $\bar{G}$ denotes the steady state level of government expenditures. The log of the monetary policy instrument m_t follows

$$\log(m_t) = \rho_m \log(m_{t-1}) + \sigma_m \varepsilon_t^m. \tag{33}$$

Time-varying markups are introduced through the elasticity of substitution ξ_t^p. Noting that the net markup satisfies $\log(\mu_t - 1) = -\log(\xi_t^p - 1)$, the process follows:

$$\log\left(\xi_t^p - 1\right) = \log\left(\bar{\xi}^p - 1\right) + z_{\xi_p,t}, \tag{34}$$

with

$$z_{\xi_p,t} = \rho_{\xi_p} z_{\xi_p,t-1} + \sigma_{\xi_p} \varepsilon_t^{\xi_p} \tag{35}$$

where $\bar{\xi}^p > 1$ denotes the steady-state elasticity.

4.6. Equilibrium

An equilibrium in this model is the standard NK equilibrium and consists of a set of prices and allocations that are consistent with household, firm, and union optimization given nominal frictions, and in which all markets clear.

4.7. Incorporating the Frisch System into a RANK

This section embeds the nonparametric Frisch demand system into the RANK model by replacing the household's intratemporal first order conditions while keeping all other optimality conditions and equilibrium relations intact. The approach treats the marginal utility of wealth, the real wage, and external habits as the relevant intratemporal states that determine consumption and hours through the matrix of Frisch elasticities defined in Equation (4). All other components of the standard RANK framework—pricing, capital accumulation, wage setting, and policy—are retained, ensuring that the aggregate structure remains unchanged in GE.

Two implementations are useful. First, in linearized models we simply substitute the Frisch system into the RANK framework. This modular replacement applies to *any* linearized RANK model with preferences of the form $U(c_t, x_t, \bar{c}_{t-1})$, in which the household equates the real wage to its marginal rate of substitution between consumption and hours. This allows us to study how the EIS, the Frisch labor-supply elasticity, and consumption-labor complementarity feed into amplification without imposing a parametric utility specification. Second, for models that must be solved nonlinearly, including our HANK analysis in Section 6, we use a flexible utility function that has enough degrees of freedom to match the same three elasticities in steady state. This produces a nonlinear analogue of the Frisch system, which can be calibrated to the same triplet of elasticities and used in environments where log-linearization is not available.

4.7.1. Linearized Systems

As in the analytical model, in the linearized RANK environment we replace the two household intratemporal optimality conditions directly with the linear Frisch system:

$$\widehat{c}_t = \eta_{c,\lambda}\,\widehat{\lambda}_t + \eta_{c,w}\,\widehat{w}_t + \eta_{c,\bar{c}}\,\widehat{\bar{c}}_{t-1}, \tag{36}$$

$$\widehat{x}_t = \eta_{x,\lambda}\,\widehat{\lambda}_t + \eta_{x,w}\,\widehat{w}_t + \eta_{x,\bar{c}}\,\widehat{\bar{c}}_{t-1}, \tag{37}$$

where we now allow for the presence of external habits. As before, in this system $\widehat{w}_t$, $\widehat{\lambda}_t$, and $\widehat{\bar{c}}_{t-1}$ are determined in GE, while $\widehat{c}_t$ and $\widehat{x}_t$ are household choices.

Before turning to the nonlinear systems, we discuss welfare assessment in the linearized model. Our aim is to quantify welfare implications while imposing as few functional-form restrictions on preferences as possible. To do so, we take a first-order approximation of the general utility function $U(c_t, x_t, \bar{c}_{t-1})$ around the steady state, which yields the following consumption-equivalent welfare measure, $\widehat{c_t^W}$, for a given period t:

$$\widehat{c_t^W} = \widehat{c}_t - \frac{1}{s_c}\widehat{x}_t + \frac{U_{\bar{c}}}{U_c}\,\widehat{\bar{c}_{t-1}}.$$

In the case without habits, this approach allows us to compare welfare across shocks and specifications without imposing any particular functional form on preferences. With habits, however, additional assumptions are required to determine $U_{\bar{c}}/U_c$. Under the standard macro formulation of habits (e.g., Christiano et al. (2005)), preferences of the form $U(c_t - \gamma\bar{c}_{t-1}, x_t)$ imply that the consumption-equivalent welfare measure becomes:[14]

$$\widehat{c_t^W} = \widehat{c}_t - \frac{1}{s_c}\widehat{x}_t - \gamma\widehat{\bar{c}}_{t-1}. \tag{38}$$

Finally, to account for the cumulative welfare impact of shocks, we construct overall welfare as the discounted sum of the per-period measures in (38).

[14] One can show that, up to a separable term in $\bar{c}$, $U(c_t - \gamma\bar{c}_{t-1}, x_t)$ is the only functional form that satisfies $\eta_{x,\bar{c}} = 0$ and yields a constant $\eta_{c,\bar{c}}$ in the steady state.

4.7.2. Non-Linear Systems

To extend this approach to models that cannot be linearized, we employ a flexible utility function with sufficient degrees of freedom to match the Frisch elasticities in steady state. Specifically, we adopt the formulation in Hall and Milgrom (2008) and extend it to incorporate external habits, continuing to use the macro formulation of external habits discussed above:

$$U(c_t, x_t, \bar{c}_{t-1}) = \frac{(c_t - \gamma \bar{c}_{t-1})^{1-\sigma}}{1-\sigma} - \psi \frac{x_t^{1+\varsigma}}{1+\varsigma} - \chi (c_t - \gamma \bar{c}_{t-1})^{1-\sigma} x_t^{1+\varsigma}, \tag{39}$$

This utility function introduces three parameters (σ, ς, and χ), where we note that the parameter χ controls the strength of the non-separability between consumption and labor supply. For $\chi = 0$ and without habits, *i.e.* $\gamma = 0$, this specification nests standard separable preferences.[15] There exists a closed-form nonlinear mapping from these three utility parameters to the corresponding Frisch elasticities.[16]

5. RANK: Quantitative Results

In this section, we evaluate how variations in the Frisch elasticities affect the amplification of shocks in the fully quantitative RANK model.[17]

5.1. Calibration

5.1.1. Standard Model Parameters

A model period corresponds to one quarter. Baseline parameters for technology, pricing, wage setting, policy, the capital block, and the household block (excluding the Frisch system) follow the quantitative RANK literature and are reported in Table 1. We keep these blocks fixed across experiments; only the Frisch elasticities vary by design.[18]

[15] For alternative utility specifications that allow three degrees of freedom, see Auclert et al. (2023) and Bilbiie et al. (2025).

[16] The fourth parameter ψ serves only as a normalization that pins down steady-state labor supply.

[17] Naturally, the first-order (linear) approximation of the parametric utility specification yields results identical to those under the nonparametric formulation, since the linearized system depends only on steady-state elasticities. At the second-order approximation, the parametric version delivers outcomes that are essentially identical to the nonparametric benchmark.

[18] We keep the Frisch elasticities associated with external habits fixed at the common values used in the RANK literature.

Table 1: Calibration: Baseline Parameters by Block

Block	Parameter	Value	Notes
Technology			
	α	0.33	capital share
	ρ_A	0.9	TFP persistence
	σ_A	0.01	TFP s.d.
Pricing (Final/Retail/Wholesale)			
	$\bar{\xi}^p$ (demand elasticity)	4.5	implies $\mu = \xi^p/(\xi^p - 1)$
	ρ_{ξ^p}	0.9	markup shock persistence
	σ_{ξ^p}	0.01	markup shock s.d.
	ϕ_p	0.7	Calvo price stickiness
Wage Setting / Labor Packer			
	ξ^w	4.5	labor demand elasticity
	ϕ_w	0.7	Calvo wage stickiness
Policy (Monetary & Fiscal)			
	ϕ_π	1.5	Taylor coefficient on Π
	ρ_m	0.5	policy shock persistence
	σ_m	0.005	policy shock s.d.
	$\bar{\pi}$	0	steady state inflation
	$\bar{G}/\bar{Y}$	0.2	steady state govt. spending share
	ρ_G	0.9	govt. spending persistence
	σ_G	0.01	govt. spending s.d.
Capital Block (Investment & Utilization)			
	δ_0	0.025	steady state depreciation
	δ_1	0.0351	utilization-depr. slope
	δ_2	0.01	utilization-depr. curvature
	ψ_K	2.48	investment adj. cost
Household Block (Excluding Frisch System)			
	β	0.99	discount factor
	ν	0.319	worker profit share, implies $s_c = 0.83$

Notes: Baseline parameters are held fixed across experiments in Section 5.2

5.1.2. Empirically Relevant Range for the Frisch Elasticities

In this section we focus our discussion on the empirically relevant range of *micro-level* elasticities.

EIS Micro and macro evidence points to modest intertemporal substitution. In a meta-analysis of EIS estimates, Havranek (2015) reports that micro estimates for asset holders are consistent with an EIS of 0.3-0.4 and do not exceed 0.8. Using quasi-experimental variation, Best et al. (2020) find an EIS of around 0.1 in the UK. Following this literature, we target a benchmark EIS of 0.5 and, in light of the popularity of EIS = 1 (log preferences) in macroeconomics, we also report results under this calibration.

Frisch Labor Supply Keane (2011) surveys the literature on labor-supply elasticities and concludes that most studies obtain small (and imprecise) estimates of the Frisch elasticity for men, with larger elasticities for women. For example, Altonji (1986) estimate values between 0 and 0.35 for men, while Pistaferri (2003) reports a precisely estimated value of 0.7. Blundell et al. (2016) estimate approximately 0.7 for men and close to 1 for women. The meta-analysis in Chetty et al. (2011) suggests Frisch elasticities of 0.54 on the intensive margin and 0.28 on the extensive margin (i.e., 0.82 for aggregate hours). Following this evidence, we adopt a baseline value of $\eta_{x,w} = 0.5$ and consider values up to 0.9 for most of our analysis. We also report results for Frisch elasticities as high as 3 in Section 5.4.

Non-separability There is broad evidence against separability and in favor of consumption-labor complementarity (see, e.g., Blundell et al. (1994) for early evidence). However, in contrast to the other two Frisch elasticities, precise magnitudes are less settled: for example, Ziliak and Kniesner (2005) report a value of 0.1, while Hall (2009) argues for 0.3.[19] Given the centrality of $\eta_{c,w}$ to our analysis, we also infer it from independent evidence on the *wealth effect on labor*. In particular, the marginal propensity to earn (MPE) provides a moment informative about $\eta_{c,w}$. In the non-stochastic steady state of the RANK model one can show that the following condition holds:

$$MPE = -\frac{\eta_{x,\lambda}}{\eta_{x,\lambda} + s_c EIS} = -\frac{\eta_{x,w} - s_c \eta_{c,w}}{\eta_{x,w} - s_c \eta_{c,w} + s_c EIS}. \tag{40}$$

The economic intuition for why the MPE identifies $\eta_{c,w}$ is as follows. The MPE summarizes how a wealth (transfer) shock affects labor earnings in partial equilibrium. As discussed in 2.1, a higher $\eta_{c,w}$ dampens the wealth effect and therefore makes the MPE less negative. Hence, given values for the EIS, $\eta_{x,w}$, and s_c, the MPE can be used to pin down $\eta_{c,w}$. As implied by Equation (5) and

[19] Blundell et al. (2016) is an exception, finding a small negative $\eta_{c,w}$ for men and zero for women.

evident in Equation (40), in addition to the EIS and $\eta_{x,w}$, recovering $\eta_{c,w}$ requires calibrating s_c. We calibrate s_c using the evidence in Golosov et al. (2024) and recover a value of $\eta_{c,w} = 0.33$.[20] Accordingly, in what follows we compare a separable benchmark ($\eta_{c,w} = 0$) with a non-separable benchmark of $\eta_{c,w} = 0.3$.[21]

Habit Elasticities Finally, we need to assign values for $\eta_{c,\bar{c}}$ and $\eta_{x,\bar{c}}$. With regard to former, we follow the evidence in Havranek et al. (2017) setting $\eta_{c,\bar{c}} = 0.3$, and report robustness results with $\eta_{c,\bar{c}} = 0.6$ in the appendix. Due to lack of empirical evidence we assign the latter to 0.

5.2. Shock Magnification

In this section we quantify the impact of the Frisch micro-elasticities on the transmission of aggregate shocks. As discussed above, we focus on the empirically relevant range of micro estimates for the three elasticities. As we show below, consumption-labor complementarity is a dominant driver of amplification, more so than the Frisch labor-supply elasticity, despite the latter's central role in much of the literature.

Figure 1 plots the percentage deviation of output response to unit standard deviation innovation of monetary, productivity, markup, and fiscal shocks. In each panel, the baseline (blue dotted line) corresponds to the separable case ($\eta_{c,w} = 0$) with $EIS = 0.5$ and $\eta_{x,w} = 0.5$. The red-diamond lines show how output changes when one elasticity is increased at a time. The first column varies non-separability $\eta_{c,w}$; the second varies the intertemporal elasticity of substitution (EIS); and the third varies the Frisch labor-supply elasticity $\eta_{x,w}$.

Four main patterns emerge. First, consumption-labor non-separability ($\eta_{c,w}$) is a dominant source of amplification. Raising $\eta_{c,w}$ produces substantially larger responses to monetary, productivity, and markup shocks. For monetary policy in particular, increasing $\eta_{c,w}$ from 0 to an empirically relevant value around 0.3 raises the first-quarter output response from *negative* 0.2 percent to roughly zero, and from zero to about 0.1 percent in the second quarter.

Second, within the empirically relevant range of labor-supply elasticities, changes in $\eta_{x,w}$ exert a

[20] Specifically, Golosov et al. (2024) report that, following a lottery win, the average change in consumption is \$4,862, corresponding to roughly 17% of consumption. Using the earnings reported in their Table 1, we obtain $s_c = 0.83$. For the MPE, we target $MPE = -0.433$ from Table IX, column 4, Panel A of their paper. Setting $\eta_{x,w}$ and EIS to the midpoints of their respective ranges and s_c to its calibrated value, we recover $\eta_{c,w}$ from Equation (40).

[21] As discussed above, GHH corresponds to the extreme case $\eta_{c,w} = \eta_{x,w}/s_c$. In our calibration, this implies $\eta_{c,w}$ of roughly 0.6, well above empirically relevant values.

noticeably smaller quantitative influence than changes in $\eta_{c,w}$. Altering $\eta_{x,w}$ has almost no visible effect on the transmission of monetary and productivity shocks, despite its prominence in the literature.

Third, all three elasticities matter far less for the transmission of government-expenditure shocks than for the other disturbances. The fiscal plots display only modest variation as the Frisch elasticities change, implying that fiscal multipliers are largely robust to alternative preference specifications. Intuitively, because government spending directly crowds out private consumption, the labor–consumption substitution channel plays only a limited role.[22]

Finally, even after incorporating capital, unions, habits, and persistent shocks, the quantitative patterns align closely with the analytical predictions in Proposition 1. This indicates that the central channels identified in the simpler framework remain pivotal in the fully quantitative environment. Taken together, Figure 1 shows that non-separability is a key parameter governing whether shocks amplify or attenuate through the labor–consumption margin.

5.3. Robustness to other Parameter Values

Given the link between $\eta_{c,w}$ and the strength of the wealth effect, an important parameter for evaluating robustness is the share of profits distributed to households versus capitalists. Appendix Figure A.2 reports results for the case in which all profits accrue to households, as in the standard New Keynesian model. Consistent with Broer et al. (2020), the output response to a monetary shock is amplified across all parameter values. Crucially, however, the effect of the Frisch elasticities on these responses remains similar to that in the baseline shown in Figure 1. As additional robustness checks, Appendix Figures A.3 and A.4 report results under lower price rigidity (reducing ϕ_p to 0.5) and stronger habit formation (increasing $\eta_{c,\bar{c}}$ to 0.6), respectively. In both cases, although the magnitudes of the responses change, the way in which variations in the Frisch elasticities affect these responses remains essentially unchanged.

[22]Following the welfare methodology in Section 4.7.1, Figure A.1 reports the consumption-equivalent welfare effects of the four shocks as each elasticity varies. The welfare effects can exhibit the opposite sign of the output responses because larger output responses reflect higher labor supply, which reduces leisure. The extent to which increased consumption offsets this leisure loss depends on the strength of habit formation, since stronger habits (larger γ) dampen the welfare gains from higher consumption.

5.4. Benchmarking the Importance of Non-Separability

Taken together, these results show that, although the literature typically emphasizes the Frisch labor-supply elasticity and the EIS, *consumption–labor complementarity* is at least as important quantitatively for amplification. To gauge the magnitude of this effect, we compare a move from separable preferences to an empirically relevant degree of complementarity, raising $\eta_{c,w}$ from 0 to 0.3, with the increase in the Frisch elasticity required to generate the same amplification in a standard RBC model.

In our baseline RANK calibration, increasing $\eta_{c,w}$ from 0 to 0.3 raises the impact response of output to a one-percent TFP shock from about 0.6 to 0.8 of steady-state output (an increase of roughly 33 percent). We then consider a frictionless RBC benchmark with separable preferences and log consumption;[23] achieving a comparable increase in the impact output response requires raising the Frisch elasticity from 0.5 to 2.5.

This reinforces the message from the analytical results in Section 3: preference non-separability is a pivotal elasticity for understanding the transmission of shocks in RANK models, and the quantitative implications of incorporating empirically relevant consumption–labor complementarity are substantial.

6. HANK

The RANK framework discussed above clarifies how Frisch elasticities amplify shocks in a representative-agent setting but abstracts from the distributional channels central to heterogeneous-agent macroeconomic models. Because the transmission mechanism in HANK differs fundamentally from that in RANK, analyzing a HANK environment allows us to assess whether our earlier conclusions about the role of Frisch elasticities remain valid.

Solving the HANK model in its nonlinear form requires the flexible parametric utility specification introduced in Section 4.7.2, which provides an empirically disciplined interpretation of the underlying elasticities. We then re-examine, elasticity by elasticity, how each parameter shapes the transmission of different shocks and whether consumption-labor complementarity continues to be a dominant amplification force in a heterogeneous-agent economy. As we show below, the direction of the impact of the Frisch elasticities on shock transmission mirrors that observed in the RANK model.

[23] See for example Chapter 4 in King and Rebelo (1999).

6.1. HANK Structure

Households In each period, a continuum of infinitely lived households can trade in a one-period nominal bond subject to a borrowing constraint, choose labor supply and face idiosyncratic income risk. Idiosyncratic labor productivity, e, is stochastic and evolves according to an AR(1) process. As discussed above we use the parametric utility specification introduced in Section 4.7.2,[24]

$$u(c_t,x_t,c^{\text{habit}}(e_t,\bar{c}_{t-1})) = \frac{(c_t-\gamma c^{\text{habit}}(e_t,\bar{c}_{t-1}))^{1-\sigma}}{1-\sigma} - \psi\frac{x_t^{1+\varsigma}}{1+\varsigma} - \chi(c_t-\gamma c^{\text{habit}}(e_t,\bar{c}_{t-1}))^{1-\sigma}x_t^{1+\varsigma}. \tag{42}$$

The Bellman equation associated with the household's problem is then given by

$$V(e,b_-,c^{\text{habit}}(e,\bar{c}_-)) = \max_{c,x,b}\ u(c,x,c^{\text{habit}}(e,\bar{c}_-))) + \beta EV(e',b,c^{\text{habit}}(e',\bar{c})) \tag{43}$$

$$\text{subject to:} \qquad c+b = wxe+(1+r)b_- + \nu(e)d - \tau(e) \tag{44}$$

$$0 \leq b, \tag{45}$$

where b_- and $\bar{c}_-$ represent lagged values. As in Auclert et al. (2021) we let $\tau(e)$ denote the sharing rule for taxes, which is proportional to an individual idiosyncratic productivity, such that the total tax in the economy is the integral over the tax payments of the individuals with the appropriate weighting. Similarly, we let $\nu(e)$ denote the sharing rule for aggregate dividends such that the integral over dividend payments ($\nu(e)d$) sums up to the dividends that accrue to the households. As in the representative-agent model, we assume the presence of a representative capitalist who receives the remainder of the aggregate dividends and simply consumes them.

The remaining parts of the HANK model closely follow the one-asset HANK framework in

[24] Since there are idiosyncratic differences in productivity, which lead to differences in the consumption levels, the habit formulation which uses aggregate lagged consumption, $\bar{c}_{t-1}$, would lead to comparatively large values of reference consumption for households with low productivity and to comparatively small values for high productivity households. Therefore, we posit the following formulation for the habit value of consumption

$$c^{\text{habit}} = \lambda^{id}(e_t)\bar{c}_{t-1}, \tag{41}$$

where $\lambda^{id}(e_t)$ depends on the current exogenous idiosyncratic labor productivity. We chose the simple formulation $\lambda^{id}(e_t) = e_t$, which does not expand the state space. Furthermore, the habit level depends only on the idiosyncratic state and therefore does not complicate the households' optimization problems.

Auclert et al. (2021), summarized below.[25]

Firms We focus on the elasticities that operate on the household side and keep the firm side identical to Auclert et al. (2021). The firm block of the model is characterized by the following four equations:

$$\log(1+\pi_t) = \kappa\left(\frac{w_t}{A_t} - \frac{1}{\mu_t}\right) + \frac{1}{1+r_{t+1}}\frac{Y_{t+1}}{Y_t}\log(1+\pi_{t+1}), \tag{46}$$

$$Y_t = A_t N_t, \tag{47}$$

$$\Psi_t^{\text{adj}} = \frac{\mu_t}{\mu_t - 1}\frac{1}{2\kappa}\log(1+\pi_t)^2 Y_t, \tag{48}$$

$$d_t = Y_t - w_t N_t - \Psi_t^{\text{adj}}, \tag{49}$$

where N_t denotes the aggregate efficiency units of labor, and Ψ_t^{adj} denotes the aggregate price-adjustment costs incurred by intermediate-good producers, who operate in competitive markets and set prices subject to Rotemberg-style quadratic adjustment costs, as in Rotemberg (1982).[26] These quadratic adjustment costs are incurred by the firm and are thus subtracted from the firms' dividends.

Government and Central Bank The government issues a fixed amount of debt, B, has exogenous government expenditures G_t, and raises lump-sum taxes τ_t to maintain a balanced budget:

$$\tau_t = r_t B + G_t. \tag{50}$$

The Taylor rule is as in (27).

Equilibrium The equilibrium consists of a set of prices and allocations that are consistent with household and firm optimization. Markets clearing implies that the labor market (equation (51)) and the asset market (equation (52)) clear, which in turn implies market clearing in the goods market by

[25] As such, unlike the RANK model, our HANK formulation abstracts from capital and unions.

[26] We follow the HANK literature and assume Rotemberg-style frictions.

Walras' law:

$$N_t = \int x_t(e,b_-)\, e\, d\rho_t(e,b_-) \tag{51}$$

$$B = \int b_t(e,b_-) d\rho_t(e,b_-), \tag{52}$$

where $\rho_t(e,b_-)$ is the joint distribution of idiosyncratic productivity and asset holdings.

6.2. Calibration

The calibration of the HANK model mirrors the RANK calibration whenever possible. We discuss only the additional parameters required for the heterogeneous-agent environment. We follow McKay et al. (2016) and Auclert et al. (2021) for most HANK parameters, which we hold fixed across all calibrations. For the idiosyncratic income process, we set $\rho^e = 0.966$ and choose σ^e so that the cross-sectional standard deviation of log productivity equals 0.5.

We then calibrate six parameters to jointly match six steady-state moments. Five of these parameters come from household utility: the discount factor β and the four Hall and Milgrom (2008) utility parameters ψ, χ, σ, and ς. The final parameter is the level of bond supply B. These are chosen so that: (i) aggregate efficiency units of labor are normalized to one; (ii) the model-implied average marginal propensity to consume (MPC) is 0.25; (iii-v) the average values of the three Frisch elasticities match the targets for the EIS, $\eta_{c,w}$, and $\eta_{x,w}$; and (vi) the steady-state quarterly real interest rate equals 1.01%.

In the HANK environment with non-separable preferences between consumption and labor, all of the Frisch elasticities are both household- and state-specific. Consequently, the model generates a full cross-sectional distribution of elasticities around our targeted mean elasticities rather than a single representative value.[27] The top panel of Table 2 reports their dispersion across households for the four sets of targeted average Frisch elasticities. In the baseline separable case, we target means of 0, 0.5, and 0.5 for $\eta_{c,w}$, the EIS, and $\eta_{x,w}$, respectively, and in the subsequent columns we vary each target one at a time. In all cases except the non-separable one, dispersion arises

[27] Specifically, for each household we obtain the elasticities which depend on the household 's idiosyncratic state (e,b_-). Consider a given elasticity $\eta_{l,m}$ (for some l and m). Then, the average elasticity at steady state is given by

$$\eta_{l,m} = \int \eta_{l,m,ss}(e,b_-) d\rho_{ss}(e,b_-), \tag{53}$$

where $\rho_{ss}(e,b_-)$ denotes the joint distribution of households across the idiosyncratic state (e,b_-) at steady state.

Table 2: HANK Model Implied Elasticities Distribution

	Baseline			$\overline{\eta}_{c,w} = 0.3$			$\overline{EIS} = 1$			$\overline{\eta}_{x,w} = 0.9$		
	10th	50th	90th	10th	50th	90th	10th	50th	90th	10th	50th	90th
$\eta_{c,w}$	0	0	0	0.18	0.25	0.55	0	0	0	0	0	0
EIS	0.47	0.50	0.52	0.47	0.48	0.55	0.95	0.98	1.07	0.48	0.50	0.52
$\eta_{x,w}$	0.50	0.50	0.50	0.44	0.47	0.63	0.50	0.50	0.50	0.90	0.90	0.90

solely from the introduction of habit formation in preferences and remains modest. In contrast, the non-separable case ($\overline{\eta}_{c,w} = 0.3$) generates more substantial dispersion in the elasticities, particularly for the non-separability parameter. Notably, however, even the 90th percentile of $\eta_{c,w}$ lies just above the upper end of empirical estimates (and remains below the value implied by GHH preferences).[28]

6.3. Comparing the Transmission Mechanism

We study the HANK model in the sequence space, following Auclert et al. (2021) and we consider a perfect-foresight MIT shock. The only departure from a standard one-asset HANK framework is the flexible utility specification; accordingly, the household block is the only part of the model that differs.

To first order, the impact of the household block on model dynamics is fully characterized by its sequence-space Jacobians. In Appendix C, we use these to compare the transmission mechanisms in our HANK specification with those in its RANK counterpart. We verify that, for identical values of the Frisch elasticities across models, the transmission of shocks differs in the expected way: the HANK economy features additional distributional and liquidity-heterogeneity channels that are absent in RANK, whereas the representative-agent benchmark transmits shocks primarily through the Euler equation (or intertemporal-substitution) channel.

Importantly, given the central role of non-separability in our results, we confirm that these differences in transmission mechanisms persist when consumption-labor complementarity is introduced. In particular, Figure A.5 shows that even with $\eta_{c,w} = 0.3$, the intertemporal-substitution channel is muted in HANK relative to RANK.

[28] Recall that in the GHH specification $\eta_{c,w} = \eta_{x,w}/s_c$. This implies consumption–labor complementarities of 0.6 for $\eta_{x,w} = 0.5$ and 1.08 for $\eta_{x,w} = 0.9$.

6.4. Impulse Response Functions: The Role of the Frisch Elasticities

Figure 2 displays the impulse responses of output to the various shocks. First, comparing the baseline case, we confirm that HANK responses are broadly similar to their RANK counterparts, though with somewhat dampened responses to monetary shocks and negative responses to markup shocks.

Second, and more important for our purposes, the direction of the impact of the Frisch elasticities on shock transmission mirrors that observed in the RANK model. This parallelism indicates that our results are not model-specific but instead reflect fundamental forces that remain robust in the presence of household heterogeneity.

Finally, as in the RANK model, consumption-labor complementarity plays at least as important a role as the EIS in magnifying the transmission of shocks, and a considerably more important role than the Frisch labor-supply elasticity.

7. Conclusions

Macroeconomic models often hard-wire utility specifications that dictate how households adjust consumption and hours in response to wages, interest rates, and income. These parametric restrictions frequently conflict with micro evidence. Because amplification in macroeconomic environments operates precisely through these micro-elasticities, such misspecifications carry through to the model's implied amplification.

We embed a nonparametric Frisch demand system that incorporates the key behavioral elasticities—intertemporal substitution, labor-supply responsiveness, and consumption-labor complementarity—directly into a simplified RANK model. This framework clarifies analytically how each elasticity governs the internal magnification of monetary, fiscal, markup, and productivity shocks, and provides an empirically grounded benchmark for quantitative analysis.

In the RANK framework, amplification of shocks is governed by the three micro elasticities, with consumption-labor complementarity being a dominant force. Modest departures from separability generate amplification comparable to that implied by very large increases in the Frisch labor-supply elasticity, whereas empirically relevant variation in the latter has little effect.

Extending the analysis to a nonlinear HANK model using a flexible utility specification as in Hall and Milgrom (2008), we show that, although levels differ across RANK and HANK due to distributional channels, the comparative statics with respect to the elasticities are remarkably robust, with consumption-labor complementarity remaining a dominant amplification channel across shocks.

Calibrating to micro-consistent elasticities is therefore a first-order requirement for credible policy analysis. This paper provides a simple and transparent template for achieving such consistency without relying on restrictive utility forms.

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Figure 1: Output Response to Shocks

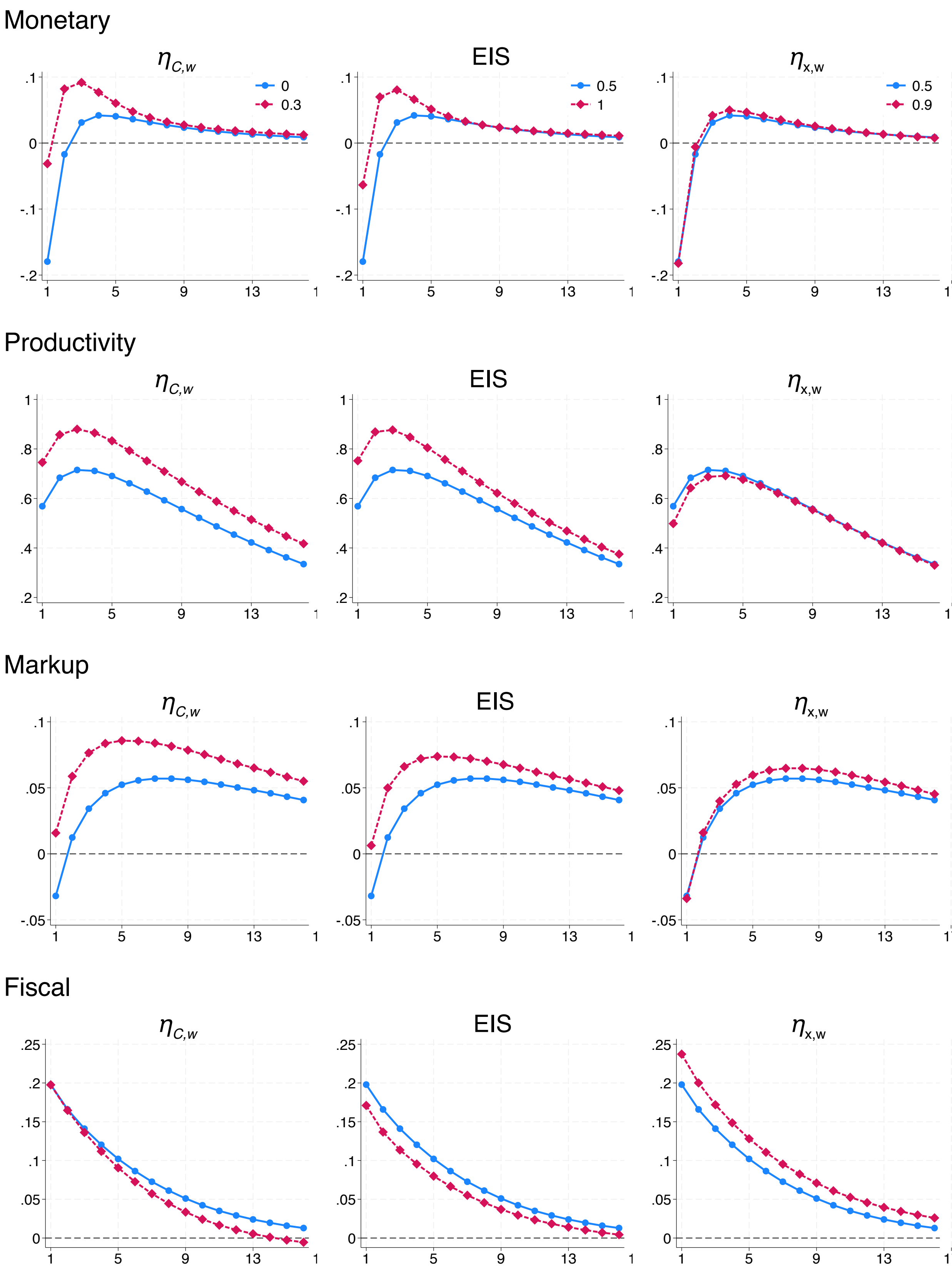
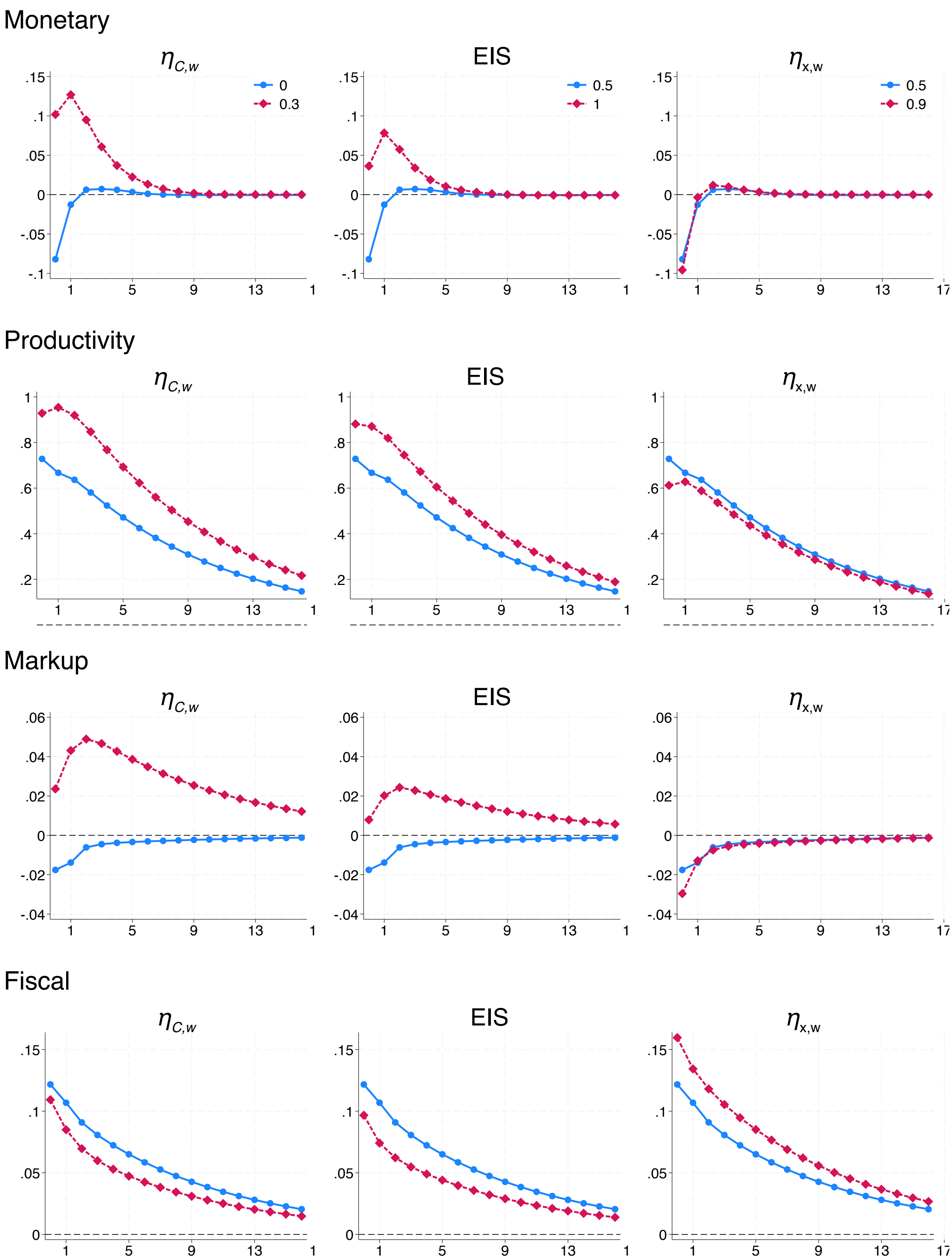


Figure 2: Output Response to Shocks - HANK



Appendix A Frisch System Derivation

Suppose that the general utility function is:

$$U(c_t, x_t, \bar{c}_{t-1}),$$

the budget constraint is

$$c_t + Q_t b_{t+1} = w_t x_t + d_t - \tau_t + b_t,$$

and the general first order conditions hold:

$$\begin{aligned} U_{c_t} =& \lambda_t \\ U_{x_t} =& -\lambda_t w_t. \end{aligned}$$

Denote percent deviations from steady state by "hat" and log-linearize the two first order conditions:

$$U_{cc} c \widehat{c}_t + U_{cx} x \widehat{x}_t + U_{c\bar{c}} \bar{c} \widehat{\bar{c}}_{t-1} = \lambda \widehat{\lambda}_t$$

$$U_{xc} c \widehat{c}_t + U_{xx} x \widehat{x}_t + U_{x\bar{c}} \bar{c} \widehat{\bar{c}}_{t-1} = -w \lambda \widehat{\lambda}_t - \lambda w \widehat{w}_t,$$

where $c, x, \bar{c}, w$, and λ denote the steady state values.

Rearrange:

$$\begin{aligned} \frac{U_{cc} c}{U_c} \widehat{c}_t + \frac{U_{cx} x}{U_c} \widehat{x}_t &= \widehat{\lambda}_t - \frac{U_{c\bar{c}} \bar{c}}{U_c} \widehat{\bar{c}}_{t-1} \\ \frac{U_{xc} c}{U_x} \widehat{c}_t + \frac{U_{xx} x}{U_x} \widehat{x}_t &= \widehat{\lambda}_t + \widehat{w}_t - \frac{U_{x\bar{c}} \bar{c}}{U_x} \widehat{\bar{c}}_{t-1}. \end{aligned}$$

Or in matrix form:

$$\begin{pmatrix} \frac{U_{cc} c}{U_c} & \frac{U_{cx} x}{U_c} \\ \frac{U_{xc} c}{U_x} & \frac{U_{xx} x}{U_x} \end{pmatrix} \begin{pmatrix} \widehat{c}_t \\ \widehat{x}_t \end{pmatrix} = \begin{pmatrix} 1 & 0 & -\frac{U_{c\bar{c}} \bar{c}}{U_c} \\ 1 & 1 & -\frac{U_{x\bar{c}} \bar{c}}{U_x} \end{pmatrix} \begin{pmatrix} \widehat{\lambda}_t \\ \widehat{w}_t \\ \widehat{\bar{c}}_{t-1} \end{pmatrix}$$

hence

$$\begin{pmatrix} \widehat{c}_t \\ \widehat{x}_t \end{pmatrix} = \begin{pmatrix} \frac{U_{cc}c}{U_c} & \frac{U_{cx}x}{U_c} \\ \frac{U_{xc}c}{U_x} & \frac{U_{xx}x}{U_x} \end{pmatrix}^{-1} \begin{pmatrix} 1 & 0 & -\frac{U_{c\bar{c}}\bar{c}}{U_c} \\ 1 & 1 & -\frac{U_{x\bar{c}}\bar{c}}{U_x} \end{pmatrix} \begin{pmatrix} \widehat{\lambda}_t \\ \widehat{w}_t \\ \widehat{\bar{c}}_{t-1} \end{pmatrix},$$

where the inverse matrix is:

$$\frac{1}{\frac{U_{cc}c}{U_c}\frac{U_{xx}x}{U_x} - \frac{U_{cx}x}{U_c}\frac{U_{xc}c}{U_x}} \begin{pmatrix} \frac{U_{xx}x}{U_x} & -\frac{U_{cx}x}{U_c} \\ -\frac{U_{xc}c}{U_x} & \frac{U_{cc}c}{U_c} \end{pmatrix}$$

$$\frac{U_cU_x}{U_{cc}cU_{xx}x - U_{cx}xU_{xc}c} \begin{pmatrix} \frac{U_{xx}x}{U_x} & -\frac{U_{cx}x}{U_c} \\ -\frac{U_{xc}c}{U_x} & \frac{U_{cc}c}{U_c} \end{pmatrix}$$

hence

$$\begin{pmatrix} \widehat{c}_t \\ \widehat{x}_t \end{pmatrix} = \frac{U_cU_x}{cx\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)} \begin{pmatrix} \frac{U_{xx}x}{U_x} & -\frac{U_{cx}x}{U_c} \\ -\frac{U_{xc}c}{U_x} & \frac{U_{cc}c}{U_c} \end{pmatrix} \begin{pmatrix} 1 & 0 & -\frac{U_{c\bar{c}}\bar{c}}{U_c} \\ 1 & 1 & -\frac{U_{x\bar{c}}\bar{c}}{U_x} \end{pmatrix} \begin{pmatrix} \widehat{\lambda}_t \\ \widehat{w}_t \\ \widehat{\bar{c}}_{t-1} \end{pmatrix}$$

$$\begin{pmatrix} \widehat{c}_t \\ \widehat{x}_t \end{pmatrix} = \frac{U_cU_x}{cx\left(U_{CC}U_{xx} - U_{cx}U_{xc}\right)} \begin{pmatrix} \frac{U_{xx}x}{U_x} - \frac{U_{cx}x}{U_c} & -\frac{U_{cx}x}{U_c} & -\frac{U_{xx}x}{U_x}\frac{U_{c\bar{c}}\bar{c}}{U_c} + \frac{U_{cx}x}{U_c}\frac{U_{x\bar{c}}\bar{c}}{U_x} \\ -\frac{U_{xc}c}{U_x} + \frac{U_{cc}c}{U_c} & \frac{U_{cc}c}{U_c} & \frac{U_{xc}c}{U_x}\frac{U_{c\bar{c}}\bar{c}}{U_c} - \frac{U_{cc}c}{U_c}\frac{U_{x\bar{c}}\bar{c}}{U_x} \end{pmatrix} \begin{pmatrix} \widehat{\lambda}_t \\ \widehat{w}_t \\ \widehat{\bar{c}}_{t-1} \end{pmatrix}$$

using this matrix, we can express the elasticities as follows:

$$\eta_{c,\lambda} = \frac{U_cU_x}{cx\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)}\left(\frac{U_{xx}x}{U_x} - \frac{U_{cx}x}{U_c}\right) = \frac{U_cU_{xx} - U_xU_{cx}}{c\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)}$$

$$\eta_{c,w} = -\frac{U_cU_x}{cx\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)}\frac{U_{cx}x}{U_c} = -\frac{U_xU_{cx}}{c\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)}$$

$$\eta_{x,\lambda} = \frac{U_cU_x}{cx\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)}\left(-\frac{U_{xc}c}{U_x} + \frac{U_{cc}c}{U_c}\right) = \frac{-U_cU_{xc} + U_xU_{cc}}{x\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)}$$

$$\eta_{x,w} = \frac{U_cU_x}{cx\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)}\frac{U_{cc}c}{U_c} = \frac{U_xU_{cc}}{x\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)}$$

$$\eta_{c,\bar{c}} = \frac{U_c U_x}{cx\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)}\left(-\frac{U_{xx}x}{U_x}\frac{U_{c\bar{c}}\bar{c}}{U_c} + \frac{U_{cx}x}{U_c}\frac{U_{x\bar{c}}\bar{c}}{U_x}\right) = \frac{\bar{c}\left(U_{cx}U_{x\bar{c}} - U_{xx}U_{c\bar{c}}\right)}{c\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)}$$

$$\eta_{x,\bar{c}} = \frac{U_c U_x}{cx\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)}\left(\frac{U_{xc}c}{U_x}\frac{U_{c\bar{c}}\bar{c}}{U_c} - \frac{U_{cc}c}{U_c}\frac{U_{x\bar{c}}\bar{c}}{U_x}\right) = \frac{\bar{c}\left(U_{xc}U_{c\bar{c}} - U_{cc}cU_{x\bar{c}}\right)}{x\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)}.$$

Finally, we need to show that $\eta_{x,\lambda} = \eta_{x,w} - s_c\eta_{c,w}$. Start from the right hand side, using the definitions above:

$$\begin{aligned}
\eta_{x,w} - s_c\eta_{c,w} &= \frac{U_x U_{cc}}{x\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)} + \frac{c}{xw}\frac{U_x U_{cx}}{c\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)} \\
&= \frac{U_x U_{cc}}{x\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)} + \frac{\frac{U_x U_{cx}}{w}}{x\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)} \\
&= \frac{U_x U_{cc} - U_c U_{cx}}{x\left(U_{cc}U_{xx} - U_{cx}U_{xc}\right)} = \eta_{x,\lambda},
\end{aligned}$$

where the third equality stems from the first order conditions: $\frac{U_x}{w} = -\lambda = -U_c$.

Appendix B Transmission Mechanism: Analytics

We start by deriving the expressions for $\Omega_{\lambda,s}$ and $\Omega_{w,s}$ as shown in equations (10)-(14) in the paper.

Log-linearize the resource constraint for the case without profits, under equilibrium zero assets (time subscripts omitted):

$$\begin{aligned}
c &= xw - \tau \\
\widehat{c} &= \frac{xw}{c}\left(\widehat{x} + \widehat{w}\right) - \frac{\tau}{c}\widehat{\tau} \\
\widehat{c} &= \frac{xw}{c}\left(\widehat{x} + \widehat{w}\right) - \left(\frac{wx - c}{c}\right)\widehat{\tau} \\
\widehat{c} &= \frac{1}{s_c}\left(\widehat{x} + \widehat{w}\right) - \frac{1 - s_c}{s_c}\widehat{\tau}.
\end{aligned}$$

Substitute the log-linearized constraint to the system (4) (without habits):

$$\begin{pmatrix} \frac{1}{s_c}\left(\widehat{x} + \widehat{w}\right) - \frac{1-s_c}{s_c}\widehat{\tau} \\ \widehat{x} \end{pmatrix} = \begin{pmatrix} \eta_{c,\lambda} & \eta_{c,w} \\ \eta_{x,\lambda} & \eta_{x,w} \end{pmatrix}\begin{pmatrix} \widehat{\lambda} \\ \widehat{w} \end{pmatrix}$$

Re-arrange:

$$\begin{pmatrix} \widehat{x} \\ \widehat{x} \end{pmatrix} = \begin{pmatrix} s_c\eta_{c,\lambda} & s_c\eta_{c,w}-1 & 1-s_c \\ \eta_{x,\lambda} & \eta_{x,w} & 0 \end{pmatrix} \begin{pmatrix} \widehat{\lambda} \\ \widehat{w} \\ \widehat{\tau} \end{pmatrix}$$

Equate the two lines of the system:

$$s_c\eta_{c,\lambda}\widehat{\lambda} + (s_c\eta_{c,w}-1)\,\widehat{w} + (1-s_c)\,\widehat{\tau} = \eta_{x,\lambda}\widehat{\lambda} + \eta_{x,w}\widehat{w}$$

$$\widehat{w} = \frac{s_c\eta_{c,\lambda}-\eta_{x,\lambda}}{1+\eta_{x,w}-s_c\eta_{c,w}}\widehat{\lambda} + \frac{1-s_c}{1+\eta_{x,w}-s_c\eta_{c,w}}\widehat{\tau}$$

which we can then write as:

$$\widehat{w} = \Gamma_1\widehat{\lambda} + \Gamma_2\widehat{G}$$

with $\Gamma_1 = -\frac{s_c EIS+\eta_{x,\lambda}}{1+\eta_{x,\lambda}}$ and $\Gamma_2 = \frac{1-s_c}{1+\eta_{x,\lambda}}$, where we have used $\widehat{\tau} = \widehat{G}$, $\eta_{c,\lambda} = -\text{EIS}$ and equation (5). Note, that from the budget constraint of this simplified household problem, $\tau > 0$ implies $0 < s_c < 1$. Along with $\eta_{x,\lambda} > 0, EIS > 0$, this ensures $\Gamma_1 < 0, \Gamma_2 > 0$.

Next, substituting for the Taylor rule, the Euler equation is given by (recall we are studying the case of i.i.d shocks)

$$\widehat{\lambda} = \phi_\pi\pi - \widehat{m}, \tag{A.1}$$

and the Phillips curve is given by:

$$\pi = \kappa\widehat{w} - \kappa\widehat{A} - \widehat{\mu}.$$

Combining these last three equations yields:

$$\widehat{\lambda} = \phi_\pi\left[\kappa\left(\Gamma_1\widehat{\lambda} + \Gamma_2\widehat{\tau}\right) - \kappa\widehat{A} - \widehat{\mu}\right] - \widehat{m}$$

$$\widehat{\lambda} = -\frac{1}{1-\phi_\pi\kappa\Gamma_1}\widehat{m} - \frac{\phi_\pi\kappa}{1-\phi_\pi\kappa\Gamma_1}\widehat{A} - \frac{\phi_\pi}{1-\phi_\pi\kappa\Gamma_1}\widehat{\mu} + \frac{\phi_\pi\kappa\Gamma_2}{1-\phi_\pi\kappa\Gamma_1}\widehat{G}$$

Similarly, we can derive the expression of $\widehat{w}$ in terms of the shocks to be given by:

$$\widehat{w} = \Gamma_1\left[\phi_\pi\left(\kappa\widehat{w}_t - \kappa\widehat{A} - \widehat{\mu}\right) - \widehat{m}\right] + \Gamma_2\widehat{G}$$

$$\widehat{w} = -\frac{\Gamma_1}{1-\Gamma_1\phi_\pi\kappa}\widehat{m} - \frac{\Gamma_1\phi_\pi\kappa}{1-\Gamma_1\phi_\pi\kappa}\widehat{A} - \frac{\Gamma_1\phi_\pi}{1-\Gamma_1\phi_\pi\kappa}\widehat{\mu} + \frac{\Gamma_2}{1-\Gamma_1\phi_\pi\kappa}\widehat{G}$$

The coefficients in the last two equations are then $\Omega_{\lambda,s}$ and $\Omega_{w,s}$ in equations (10)-(13). Given $\kappa, \phi_\pi, \Gamma_2 > 0$, and $\Gamma_1 < 0$, all the Ωs can be signed.

Next, we turn to the proof of Proposition 1 in the paper. It is useful to calculate the derivatives of Γ_1 and of Γ_2 w.r.t. the different elasticities, signing these within the empirically relevant range of $0 < EIS < 1, \eta_{c,w} < 1$:

$$\begin{aligned}
\frac{\partial \Gamma_1}{\partial EIS} &= -\frac{s_c}{1+\eta_{x,\lambda}} < 0 \\
\frac{\partial \Gamma_2}{\partial EIS} &= 0 \\
\frac{\partial \Gamma_1}{\partial \eta_{c,w}} &= -\frac{-s_c\left(1+\eta_{x,\lambda}\right)+s_c\left(s_c EIS+\eta_{x,\lambda}\right)}{\left(1+\eta_{x,\lambda}\right)^2} = s_c \frac{1-s_c EIS}{\left(1+\eta_{x,\lambda}\right)^2} > 0 \\
\frac{\partial \Gamma_2}{\partial \eta_{c,w}} &= \frac{s_c(1-s_c)}{\left(1+\eta_{x,\lambda}\right)^2} > 0 \\
\frac{\partial \Gamma_1}{\partial \eta_{x,w}} &= -\frac{\left(1+\eta_{x,\lambda}\right)-\left(s_c EIS+\eta_{x,\lambda}\right)}{\left(1+\eta_{x,\lambda}\right)^2} = -\frac{1-s_c EIS}{\left(1+\eta_{x,\lambda}\right)^2} < 0 \\
\frac{\partial \Gamma_2}{\partial \eta_{x,w}} &= \frac{-(1-s_c)}{\left(1+\eta_{x,\lambda}\right)^2} < 0.
\end{aligned}$$

Before we derive sensitivities of the different equilibrium responses to the Frisch elasticities, note that $\Omega_{Y,A} = \phi\kappa\Omega_{Y,m}+1$, and $\Omega_{Y,\mu} = \phi\Omega_{Y,m}$, hence it is sufficient to derive the sensitivities of $\Omega_{Y,m}$ and of $\Omega_{Y,G}$.

GE responses sensitivity to the EIS Start by simplifying $\Omega_{Y,m}$:

$$\Omega_{Y,m} = -\eta_{x,\lambda}\frac{1}{1-\phi_\pi\kappa\Gamma_1} - \eta_{x,w}\frac{\Gamma_1}{1-\Gamma_1\phi_\pi\kappa} = -\frac{\eta_{x,\lambda}+\eta_{x,w}\Gamma_1}{1-\phi_\pi\kappa\Gamma_1},$$

and calculate derivatives:

$$\frac{\partial \Omega_{Y,m}}{\partial EIS} = -\left(\frac{\eta_{x,w} \frac{\partial \Gamma_1}{\partial EIS} (1 - \phi_\pi \kappa \Gamma_1) + \phi_\pi \kappa \frac{\partial \Gamma_1}{\partial EIS} \left(\eta_{x,\lambda} + \eta_{x,w} \Gamma_1 \right)}{(1 - \phi_\pi \kappa \Gamma_1)^2} \right)$$

$$= -\frac{\partial \Gamma_1}{\partial EIS} \left(\frac{\eta_{x,w} (1 - \phi_\pi \kappa \Gamma_1) + \phi_\pi \kappa \left(\eta_{x,\lambda} + \eta_{x,w} \Gamma_1 \right)}{(1 - \phi_\pi \kappa \Gamma_1)^2} \right)$$

$$= -\frac{\partial \Gamma_1}{\partial EIS} \left(\frac{\eta_{x,w} - \eta_{x,w} \phi_\pi \kappa \Gamma_1 + \phi_\pi \kappa \eta_{x,\lambda} + \phi_\pi \kappa \eta_{x,w} \Gamma_1}{(1 - \phi_\pi \kappa \Gamma_1)^2} \right)$$

$$- \frac{\partial \Gamma_1}{\partial EIS} \left(\frac{\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}}{(1 - \phi_\pi \kappa \Gamma_1)^2} \right) > 0$$

And for $\Omega_{Y,G}$:

$$\Omega_{Y,G} = \eta_{x,\lambda} \frac{\phi_\pi \kappa \Gamma_2}{1 - \phi_\pi \kappa \Gamma_1} + \eta_{x,w} \frac{\Gamma_2}{1 - \Gamma_1 \phi_\pi \kappa} = \Gamma_2 \left(\frac{\eta_{x,\lambda} \phi_\pi \kappa + \eta_{x,w}}{1 - \phi_\pi \kappa \Gamma_1} \right)$$

$$\frac{\partial \Omega_{Y,G}}{\partial EIS} = \Gamma_2 \left(\frac{\phi_\pi \kappa \frac{\partial \Gamma_1}{\partial EIS} \left(\eta_{x,\lambda} \phi_\pi \kappa + \eta_{x,w} \right)}{(1 - \phi_\pi \kappa \Gamma_1)^2} \right) < 0$$

GE responses sensitivity to $\eta_{c,w}$ Substitute for $\eta_{x,\lambda}$ in $\Omega_{Y,m}$:

$$\Omega_{Y,m} = -\frac{\eta_{x,\lambda} + \eta_{x,w} \Gamma_1}{1 - \phi_\pi \kappa \Gamma_1} = -\frac{\eta_{x,w} - s_c \eta_{c,w} + \eta_{x,w} \Gamma_1}{1 - \phi_\pi \kappa \Gamma_1}$$

Calculate derivatives:

$$
\begin{aligned}
\frac{\partial \Omega_{Y,m}}{\partial \eta_{c,w}} &= -\left(\frac{\left(-s_c + \eta_{x,w}\frac{\partial \Gamma_1}{\partial \eta_{c,w}}\right)(1-\phi_\pi \kappa \Gamma_1) + \phi_\pi \kappa \frac{\partial \Gamma_1}{\partial \eta_{c,w}}\left(\eta_{x,\lambda} + \eta_{x,w}\Gamma_1\right)}{(1-\phi_\pi \kappa \Gamma_1)^2}\right) \\
&= -\left(\frac{-s_c\left(1-\phi_\pi \kappa \Gamma_1\right) + \eta_{x,w}\frac{\partial \Gamma_1}{\partial \eta_{c,w}} + \phi_\pi \kappa \frac{\partial \Gamma_1}{\partial \eta_{c,w}}\eta_{x,\lambda}}{(1-\phi_\pi \kappa \Gamma_1)^2}\right) \\
&= -\left(\frac{-s_c\left(1-\phi_\pi \kappa \Gamma_1\right) + \frac{s_c(1-s_c EIS)}{\left(1+\eta_{x,\lambda}\right)^2}\left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right)}{(1-\phi_\pi \kappa \Gamma_1)^2}\right) \\
&= -\left(\frac{-s_c\left(1-\phi_\pi \kappa \Gamma_1\right)\left(1+\eta_{x,\lambda}\right)^2 + s_c(1-s_c EIS)\left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right)}{\left(1+\eta_{x,\lambda}\right)^2(1-\phi_\pi \kappa \Gamma_1)^2}\right) \\
&= s_c\left(\frac{\left(1-\phi_\pi \kappa \Gamma_1\right)\left(1+\eta_{x,\lambda}\right)^2 - (1-s_c EIS)\left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right)}{\left(1+\eta_{x,\lambda}\right)^2(1-\phi_\pi \kappa \Gamma_1)^2}\right) \\
&= s_c\left(\frac{\left(1-\phi_\pi \kappa \Gamma_1\right)\left(1+\eta_{x,\lambda}\right)^2 + s_c EIS\left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right) - \left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right)}{\left(1+\eta_{x,\lambda}\right)^2(1-\phi_\pi \kappa \Gamma_1)^2}\right)
\end{aligned}
$$

It remains to show:

$$
\begin{aligned}
\left(1-\phi_\pi \kappa \Gamma_1\right)\left(1+\eta_{x,\lambda}\right)^2 + s_c EIS\left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right) - \left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right) &> 0 \\
\left(1+\eta_{x,\lambda}\right)^2 - \phi_\pi \kappa \Gamma_1\left(1+\eta_{x,\lambda}\right)^2 + s_c EIS\left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right) - \left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right) &> 0 \\
\left(1+\eta_{x,\lambda}\right)^2 + \phi_\pi \kappa\left(s_c EIS + \eta_{x,\lambda}\right)\left(1+\eta_{x,\lambda}\right) + s_c EIS\left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right) - \left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right) &> 0 \\
\left(1+\eta_{x,\lambda}\right)^2 + \phi_\pi \kappa s_c EIS + \phi_\pi \kappa s_c EIS \eta_{x,\lambda} + \phi_\pi \kappa \eta_{x,\lambda}^2 + s_c EIS\left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right) &> \eta_{x,w}
\end{aligned}
$$

Substitute $\eta_{x,w} = \eta_{x,\lambda} + s_c \eta_{c,w}$:

$$
\begin{aligned}
\left(1+\eta_{x,\lambda}\right)^2 + \phi_\pi \kappa s_c EIS + \phi_\pi \kappa s_c EIS \eta_{x,\lambda} + \phi_\pi \kappa \eta_{x,\lambda}^2 + s_c EIS\left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right) &> \eta_{x,\lambda} + s_c \eta_{c,w} \\
1 + 2\eta_{x,\lambda} + \eta_{x,\lambda}^2 + \phi_\pi \kappa s_c EIS + \phi_\pi \kappa s_c EIS \eta_{x,\lambda} + \phi_\pi \kappa \eta_{x,\lambda}^2 + s_c EIS\left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right) &> \eta_{x,\lambda} + s_c \eta_{c,w} \\
1 + \eta_{x,\lambda} + \eta_{x,\lambda}^2 + \phi_\pi \kappa s_c EIS + \phi_\pi \kappa s_c EIS \eta_{x,\lambda} + \phi_\pi \kappa \eta_{x,\lambda}^2 + s_c EIS\left(\eta_{x,w} + \phi_\pi \kappa \eta_{x,\lambda}\right) &> s_c \eta_{c,w}
\end{aligned}
$$

which always holds in the relevant empirical range of $\eta_{c,w} < 1$.

GE responses sensitivity to $\eta_{x,w}$

$$
\begin{aligned}
\frac{\partial \Omega_{Y,m}}{\partial \eta_{x,w}} &= -\left(\frac{\left(1+\Gamma_1+\eta_{x,w}\frac{\partial \Gamma_1}{\partial \eta_{x,w}}\right)\left(1-\phi_\pi \kappa \Gamma_1\right)+\phi_\pi \kappa \frac{\partial \Gamma_1}{\partial \eta_{x,w}}\left(\eta_{x,\lambda}+\eta_{x,w}\Gamma_1\right)}{\left(1-\phi_\pi \kappa \Gamma_1\right)^2}\right) \\
&= -\left(\frac{\left(1+\Gamma_1\right)\left(1-\phi_\pi \kappa \Gamma_1\right)+\eta_{x,w}\frac{\partial \Gamma_1}{\partial \eta_{x,w}}+\phi_\pi \kappa \frac{\partial \Gamma_1}{\partial \eta_{x,w}}\eta_{x,\lambda}}{\left(1-\phi_\pi \kappa \Gamma_1\right)^2}\right) \\
&= -\left(\frac{\left(1-\frac{s_c EIS+\eta_{x,\lambda}}{1+\eta_{x,\lambda}}\right)\left(1+\phi_\pi \kappa \frac{s_c EIS+\eta_{x,\lambda}}{1+\eta_{x,\lambda}}\right)-\eta_{x,w}\frac{1-s_c EIS}{\left(1+\eta_{x,\lambda}\right)^2}-\phi_\pi \kappa \frac{1-s_c EIS}{\left(1+\eta_{x,\lambda}\right)^2}\eta_{x,\lambda}}{\left(1-\phi_\pi \kappa \Gamma_1\right)^2}\right) \\
&= -\left(\frac{\left(1+\eta_{x,\lambda}\right)^2\left(1-\frac{s_c EIS+\eta_{x,\lambda}}{1+\eta_{x,\lambda}}\right)\left(1+\phi_\pi \kappa \frac{s_c EIS+\eta_{x,\lambda}}{1+\eta_{x,\lambda}}\right)-\eta_{x,w}\left(1-s_c EIS\right)-\phi_\pi \kappa\left(1-s_c EIS\right)\eta_{x,\lambda}}{\left(1-\phi_\pi \kappa \Gamma_1\right)^2\left(1+\eta_{x,\lambda}\right)^2}\right) \\
&= -\left(\frac{\left(1-s_c EIS\right)\left(1+\eta_{x,\lambda}+\phi_\pi \kappa s_c EIS+\phi_\pi \kappa \eta_{x,\lambda}\right)-\eta_{x,w}\left(1-s_c EIS\right)-\phi_\pi \kappa\left(1-s_c EIS\right)\eta_{x,\lambda}}{\left(1-\phi_\pi \kappa \Gamma_1\right)^2\left(1+\eta_{x,\lambda}\right)^2}\right).
\end{aligned}
$$

It therefore remains to show that:

$$
\left(1-s_c EIS\right)\left[1+\eta_{x,\lambda}+\phi_\pi \kappa s_c EIS-\eta_{x,w}\right]>0
$$

And given $EIS<1$ we need to show:

$$
1+\eta_{x,\lambda}+\phi_\pi \kappa s_c EIS>\eta_{x,w} \tag{A.2}
$$

Substitute again $\eta_{x,w}=\eta_{x,\lambda}+s_c \eta_{c,w}$:

$$
\begin{gathered}
1+\eta_{x,\lambda}+\phi_\pi \kappa s_c EIS>\eta_{x,\lambda}+s_c \eta_{c,w} \\
1+\phi_\pi \kappa s_c EIS>s_c \eta_{c,w},
\end{gathered}
$$

which always holds in the relevant empirical range of $\eta_{c,w}<1$.

Finally, for $\Omega_{Y,G}$:

$$\Omega_{Y,G}=\Gamma_2\left(\frac{\eta_{x,\lambda}\phi_\pi\kappa+\eta_{x,w}}{1-\phi_\pi\kappa\Gamma_1}\right)=\frac{1-s_c}{1+\eta_{x,\lambda}}\left(\frac{\eta_{x,\lambda}\phi_\pi\kappa+\eta_{x,w}}{1+\phi_\pi\kappa\frac{s_cEIS+\eta_{x,\lambda}}{1+\eta_{x,\lambda}}}\right)$$
$$=\frac{(1-s_c)\left(\eta_{x,\lambda}\phi_\pi\kappa+\eta_{x,w}\right)}{1+\eta_{x,\lambda}+\phi_\pi\kappa\left(s_cEIS+\eta_{x,\lambda}\right)}$$

$$\frac{\partial\Omega_{Y,G}}{\partial\eta_{x,w}}=\frac{(1-s_c)(\phi_\pi\kappa+1)\left[1+\eta_{x,\lambda}+\phi_\pi\kappa\left(s_cEIS+\eta_{x,\lambda}\right)\right]-(1+\phi_\pi\kappa)(1-s_c)\left(\eta_{x,\lambda}\phi_\pi\kappa+\eta_{x,w}\right)}{\left(1+\eta_{x,\lambda}+\phi_\pi\kappa\left(s_cEIS+\eta_{x,\lambda}\right)\right)^2}$$
$$=(1-s_c)(\phi_\pi\kappa+1)\frac{1+\eta_{x,\lambda}+\phi_\pi\kappa s_cEIS-\eta_{x,w}}{\left(1+\eta_{x,\lambda}+\phi_\pi\kappa\left(s_cEIS+\eta_{x,\lambda}\right)\right)^2}$$

Hence, it remains to show that

$$1+\eta_{x,\lambda}+\phi_\pi\kappa s_cEIS>\eta_{x,w},$$

which is identical to (A.2).

Finally, we show that with constant real rate, the sensitivity of $\Omega_{Y,G}$ to $\eta_{c,w}$ is positive (footnote 10). In this case, $\Omega_{\lambda,G}=0$ (direct from equation (A.1)), implying that equation (8) becomes:

$$\Omega_{Y,G}=\eta_{x,w}\Omega_{w,G}.$$

Hence, it is left to check the sensitivity of $\Omega_{w,G}$ to $\eta_{c,w}$. Using the definitions of $\Omega_{w,G},\Gamma_1$, and Γ_2:

$$\Omega_{w,G}=\frac{\Gamma_2}{1-\phi_\pi\kappa\Gamma_1}=\frac{\frac{1-s_c}{1+\eta_{x,\lambda}}}{1+\phi_\pi\kappa\frac{s_cEIS+\eta_{x,\lambda}}{1+\eta_{x,\lambda}}}$$
$$=\frac{1-s_c}{1+(1+\phi_\pi\kappa)\eta_{x,\lambda}+\phi_\pi\kappa s_cEIS}$$
$$=\frac{1-s_c}{1+(1+\phi_\pi\kappa)(\eta_{x,w}-s_C\eta_{c,w})+\phi_\pi\kappa s_cEIS}$$

Hence, $\frac{\partial\Omega_{w,G}}{\partial\eta_{c,w}}>0$ which implies that $\frac{\partial\Omega_{Y,G}}{\partial\eta_{c,w}}>0$.

Appendix C Transmission Mechanism in HANK

In this section we compare the dynamics of the HANK model to those of the corresponding RANK benchmark. For transparency, we shut down consumption habits in both environments. As is well known, to a first-order approximation the contribution of the household block to aggregate dynamics is fully characterized by its sequence-space Jacobians (see, e.g., Boppart et al., 2018; Auclert et al., 2021).

Figure A.5 reports the response of aggregate household consumption (excluding the capitalists' consumption) to changes in the real interest rate, the real wage, and the tax. In each panel, the red lines show the RANK responses to shocks arriving at different horizons (on impact, and anticipated 10 and 20 periods ahead), while the blue lines show the corresponding HANK responses. The left column corresponds to the standard case with separable preferences, and the right column to the case with non-separable preferences under our preferred calibration $\eta_{c,w} = 0.3$.

Both columns display the familiar patterns that emerge when comparing RANK and HANK models. Following a surprise increase in the real interest rate, consumption responds much more in the RANK model than in the HANK model, reflecting the stronger role of intertemporal substitution when households have perfect access to financial markets. By contrast, in response to wage and tax shocks, the RANK model exhibits relatively small consumption responses, as households are able to smooth these disturbances. In the HANK model, imperfect financial markets imply much larger movements in consumption in response to the same shocks. Importantly, these well-known qualitative differences between RANK and HANK carry over to the case of non-separable preferences: introducing empirically relevant consumption-labor complementarity does not overturn the key economic distinctions between the two environments.

Appendix D Appendix Figures

Figure A.1: Welfare Response to Shocks (Consumption Equiv.)

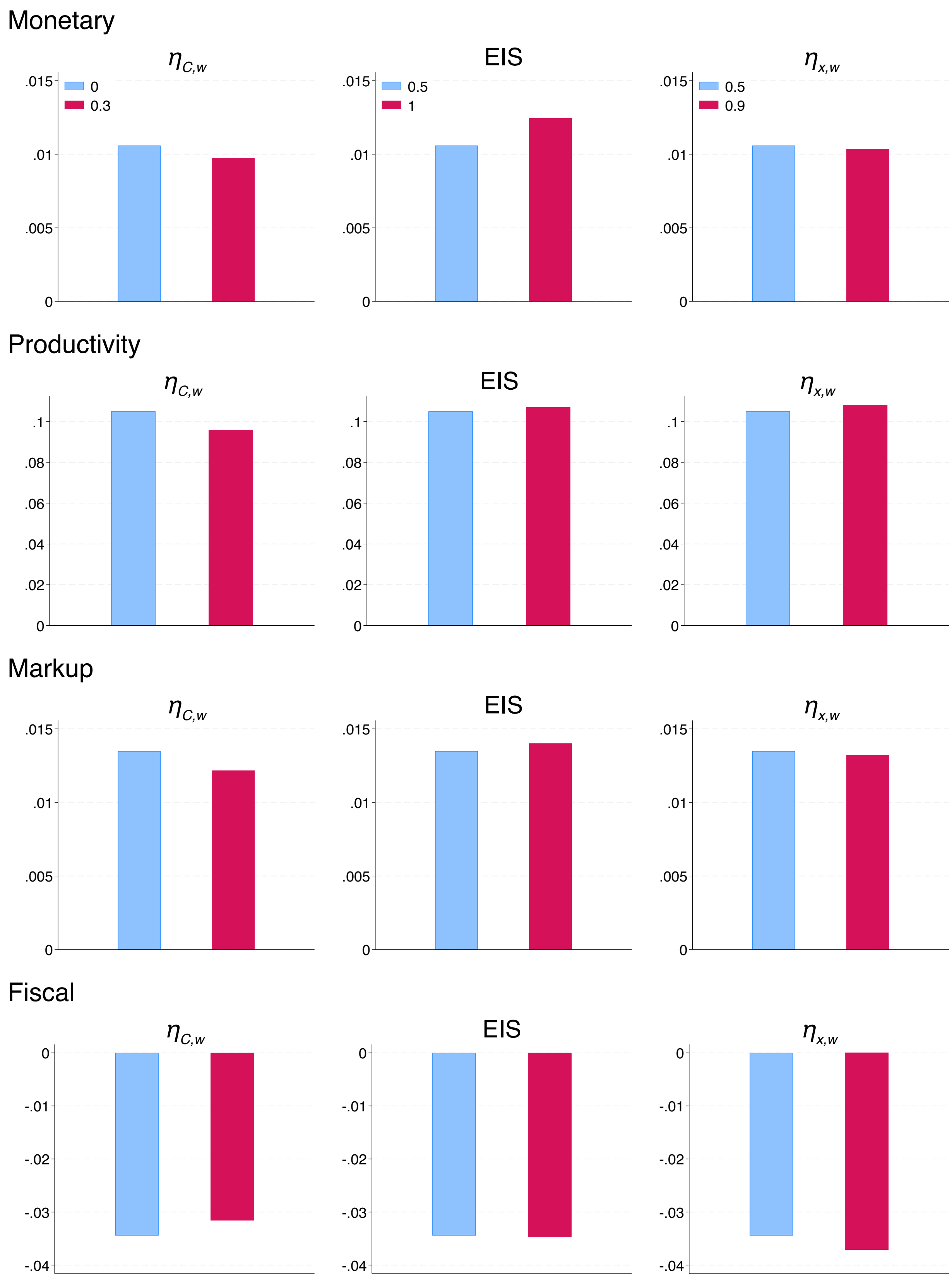
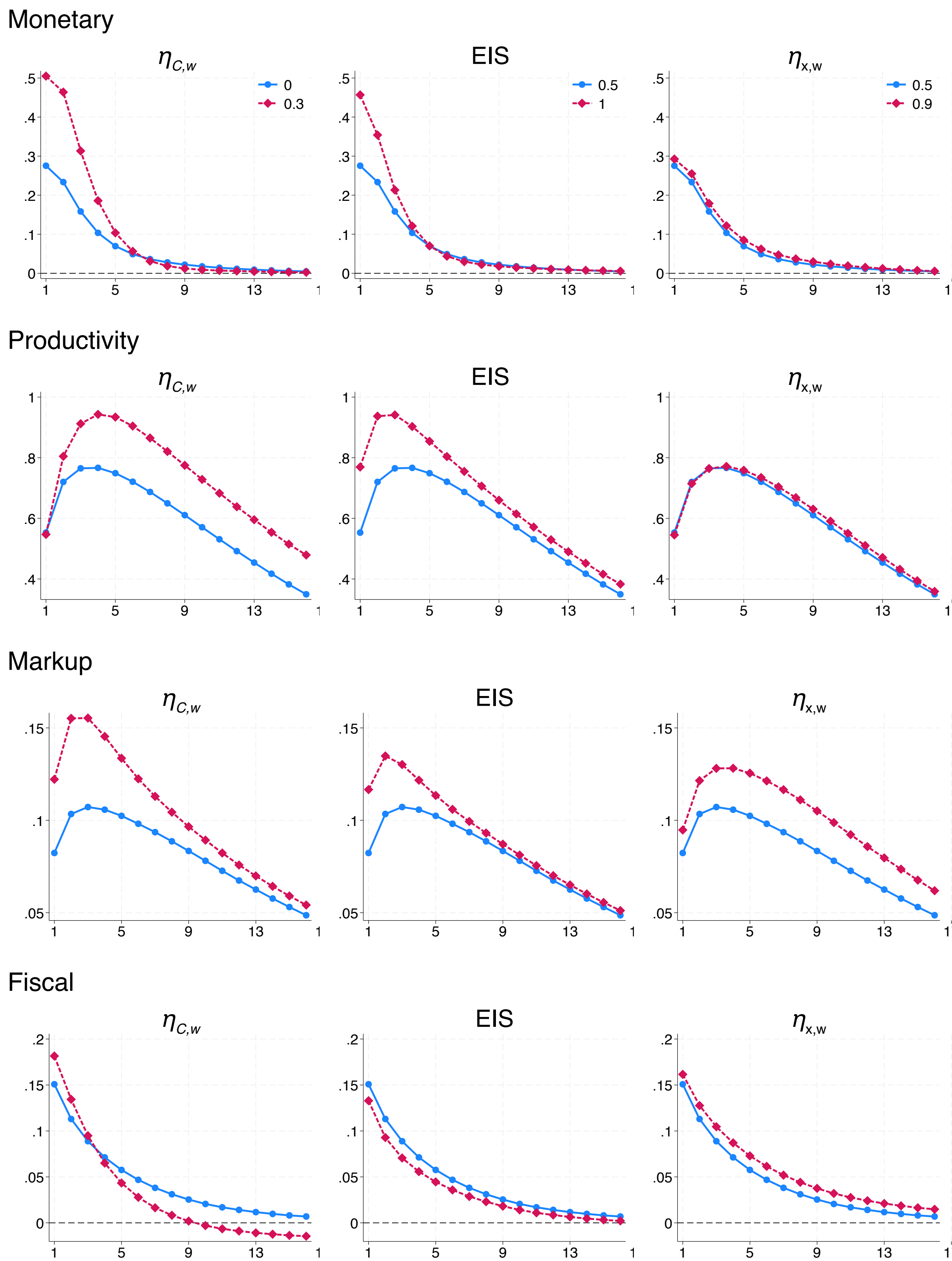
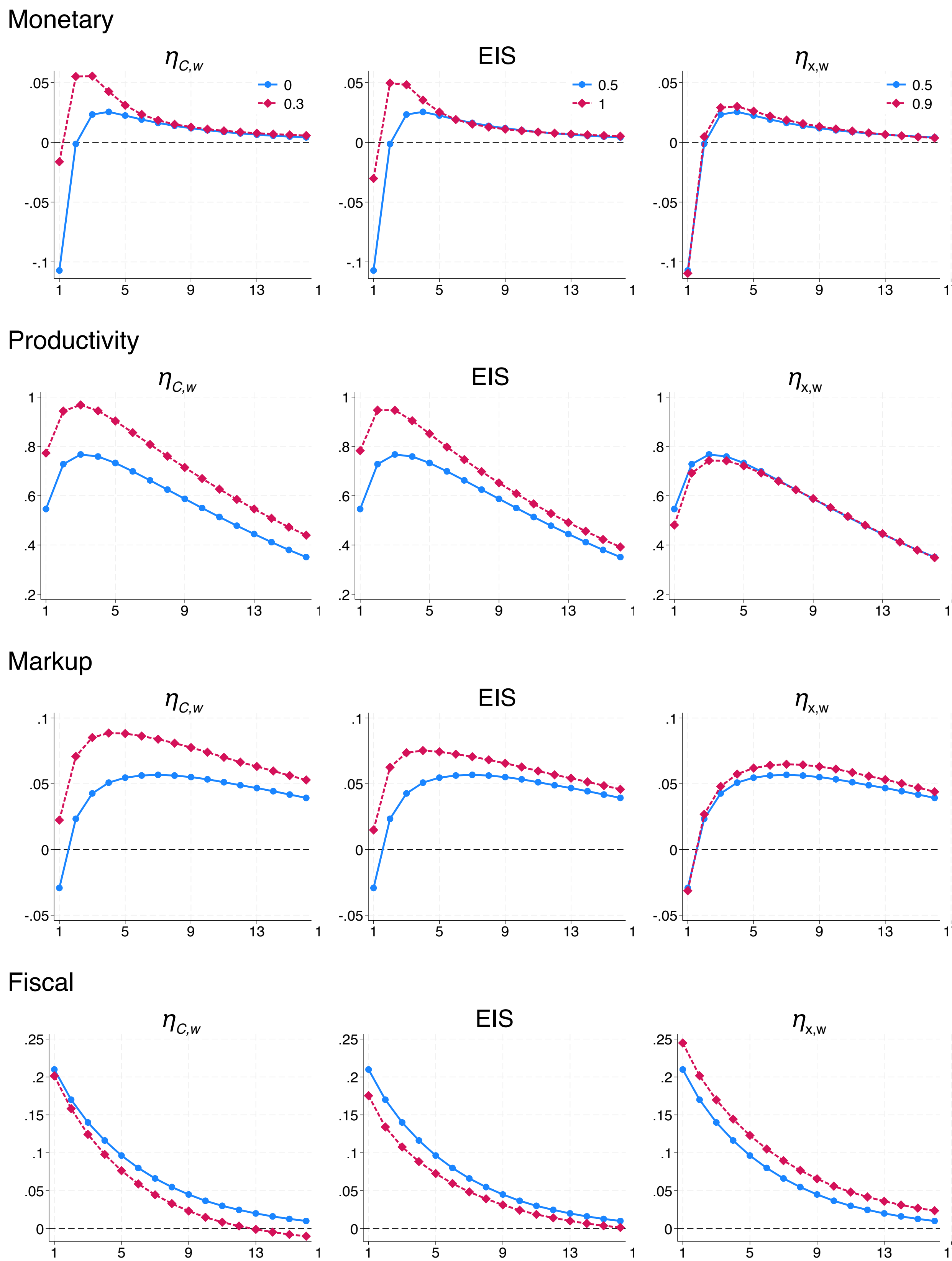


Figure A.2: Output Response to Shocks – No Capitalist



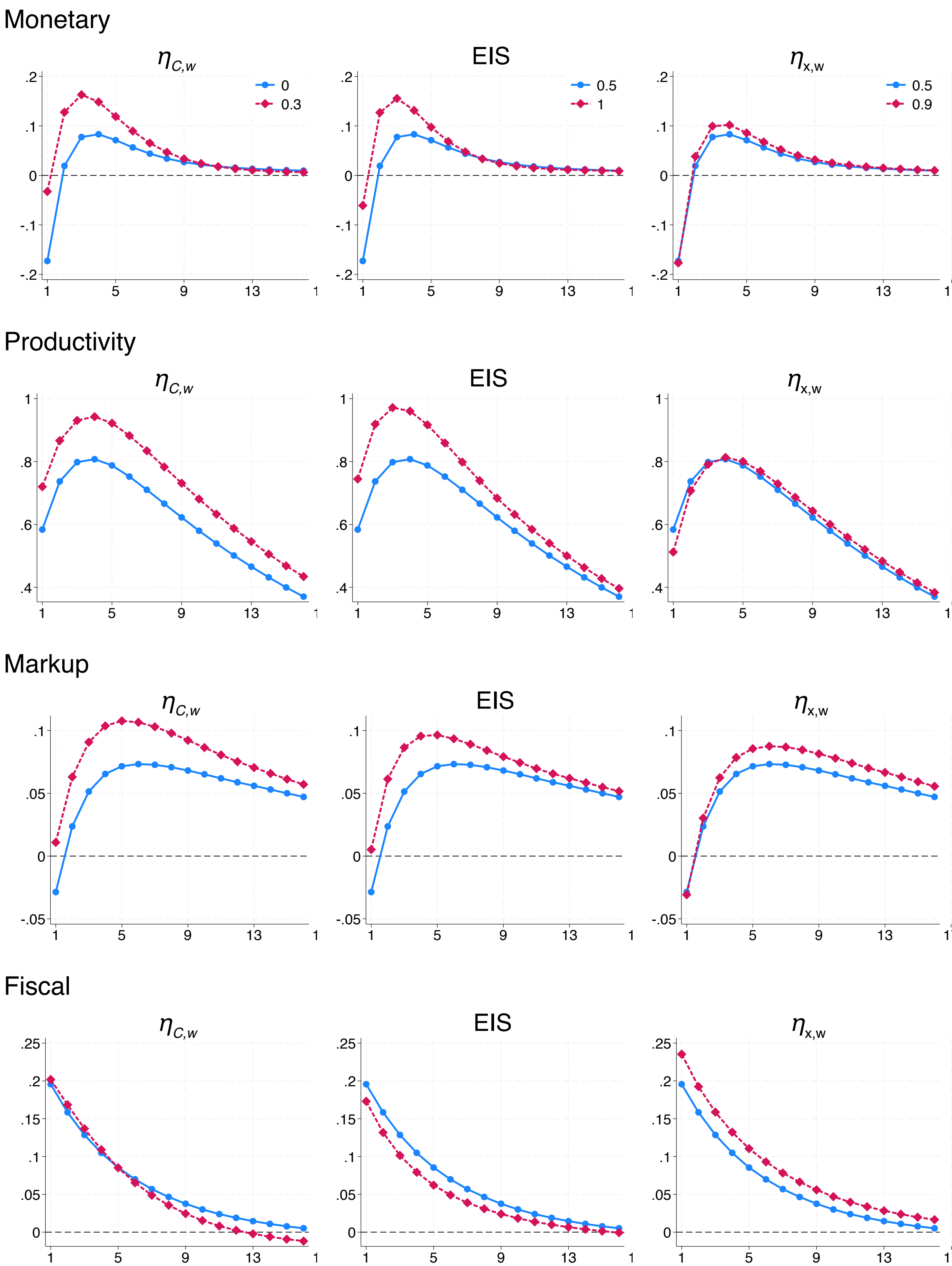
Note: No capitalist case – all profits accrue to workers.

Figure A.3: Output Response to Shocks – Less Price Rigidity



Note: $\phi_p = 0.5$ instead of $\phi_p = 0.7$

Figure A.4: Output Response to Shocks – Stronger Habits



Note: $\eta_{C,\bar{C}} = 0.6$ instead of $\eta_{C,\bar{C}} = 0.3$

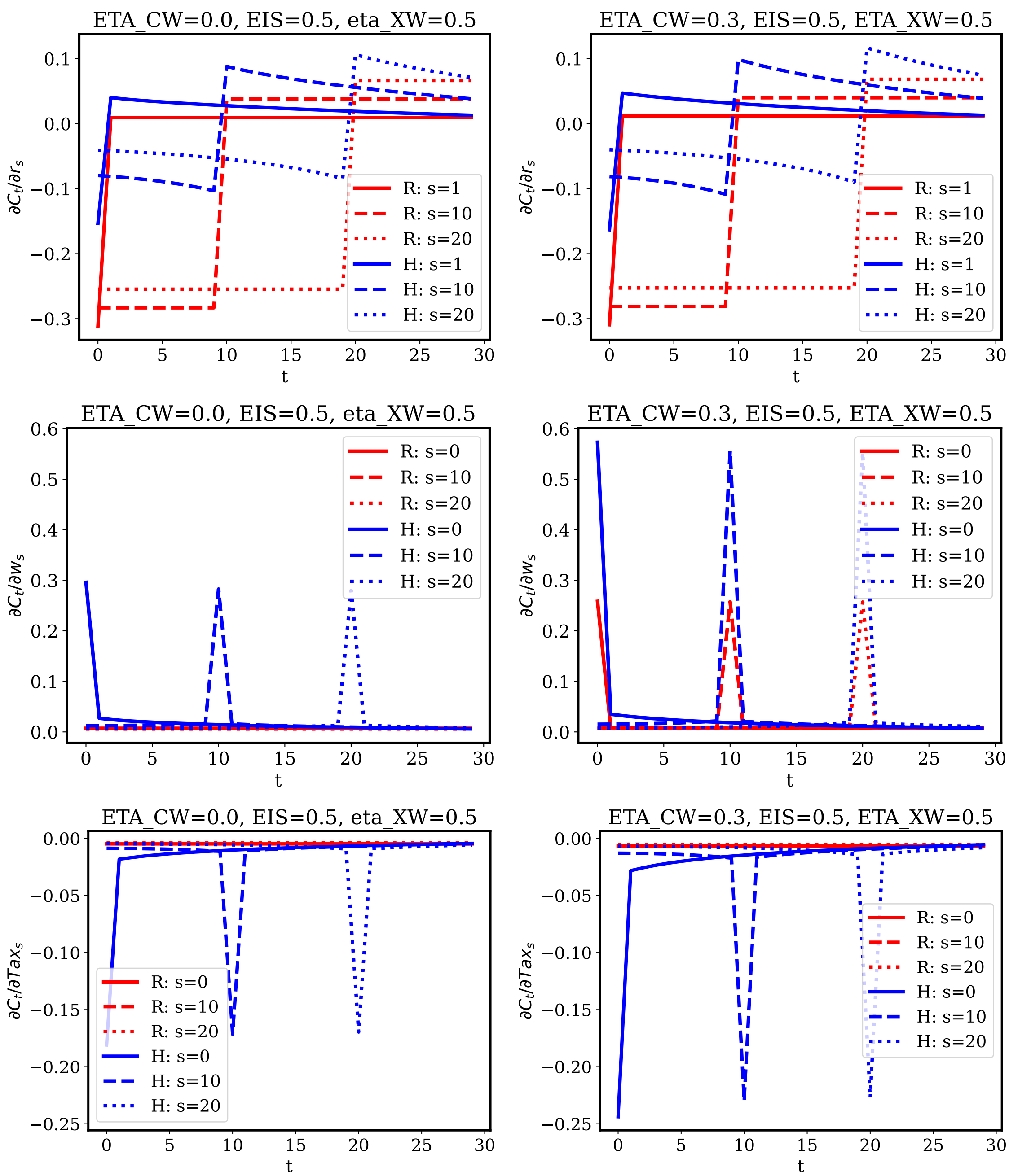


Figure A.5: Sequence-space Jacobians for the heterogeneous agent block. The panels show the response of aggregate household consumption (excluding the capitalist) to changes in the real interest rate r, the real wage w, and the tax.