The Dampened Automation Buffer: Monetary Policy and Household Heterogeneity*

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Abstract

This paper embeds endogenous automation into a Two-Agent New Keynesian (TANK) model to analyze how restricted financial participation alters monetary transmission. In representative-agent frameworks, contractionary shocks induce an aggressive "de-automation buffer" as firms substitute machines for workers, generating a medium-term employment boom. I show this anomaly is an artifact of the representative-agent assumption. Breaking the feedback loop between corporate profits and worker income causes firms to de-automate significantly less. Consequently, standard models overstate labor substitution during a monetary tightening, artificially exaggerating both the initial employment collapse and its subsequent rebound.

Keywords: Monetary Policy, Endogenous Automation, Household Heterogeneity, Business Cycles, Employment Dynamics

JEL codes: E12, E32, E52, O33

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1 Introduction

Endogenous automation introduces a novel margin for monetary policy: the firm's choice between machines and human labor. In standard Representative-Agent New Keynesian (RANK) frameworks, a monetary contraction raises the cost of capital, inducing firms to "de-automate" and substitute machines with workers (Wolf and Fornaro, 2021). This shift acts as a macroeconomic buffer, softening the initial decline in aggregate employment. However, this mechanism implies that during the recovery phase, employment can rebound past its steady state, generating a medium-term labor market "boom" even as output remains depressed.

This paper argues that this labor buffer is largely an artifact of the representative-agent assumption. By assuming a single household both supplies labor and owns all corporate equity, RANK models inherently conflate wage income with corporate profits. I embed endogenous automation into a Two-Agent New Keynesian (TANK) model to break this unrealistic feedback loop. I depart from the standard benchmark by dividing the economy into "capitalists," who accumulate physical capital and absorb dividend fluctuations, and "workers," who rely on wage income.

I show that restricted financial participation fundamentally alters monetary policy transmission. In a TANK economy, workers do not suffer the negative wealth effect of falling corporate profits, allowing them to demand relatively higher wages to smooth consumption. Facing these higher labor costs, capitalists de-automate significantly less aggressively. Stripped of this de-automation buffer, the medium-term labor boom vanishes. Instead, the absence of this aggressive buffer leads to a shallower initial decline in employment but a more persistent contraction overall. This reveals that standard representative-agent frameworks structurally overstate labor substitution, systematically exaggerating the volatility of employment by artificially amplifying both the initial shock and the ensuing recovery.

2 The Model

The model is composed of households, a production sector, and a central bank. This section outlines the key features of the framework to provide the main intuition. The full set of equations and derivations is reported in Appendix A, while the parameter calibration is presented separately in Appendix B.

2.1 Households

Households are divided into two types, capitalists (C) and workers (W), following the framework of Cantore and Freund (2021). Consistent with empirical estimates, the share of pure workers is predominant, whereas capitalists represent a smaller fraction of the population, which I set to 20%, a value also used in Klein and Krause (2020). The two groups differ in both their utility functions and budget constraints, reflecting the distinct nature of their economic roles.

Capitalists do not supply labor, therefore they derive utility exclusively from consumption. They can save (or borrow) in liquid bonds, rent capital to firms, and earn firms' dividends, given their ownership of the production sector. In addition, they undertake capital stock accumulation and capital refurbishing. This implies that they are also subject to a law of motion for capital.

On the other hand, workers derive utility from consumption and experience disutility from labor. They earn labor income from working and can also borrow or save in bonds. I assume that workers supply differentiated labor services and face a Rotemberg-type nominal wage adjustment cost, which introduces wage stickiness. This feature is essential for generating pro-cyclical dividends in DSGE models, a property that becomes particularly important in frameworks with household heterogeneity.[1]

[1] For a detailed discussion of the implications of counter-cyclical dividends in heterogeneous-agent models, see Broer et al. (2020).

2.2 Production Sector

The production sector follows the framework of Fueki et al. (2023), who incorporate the production-task approach of Acemoglu and Restrepo (2018) into a DSGE setting. This segment of the economy is populated by final-good producers, intermediate-good producers, task aggregators, and task producers.

Final-good producers purchase differentiated intermediate goods to produce a single final good, as is standard in the literature. Intermediate-good producers, in turn, supply a unique intermediate good in a monopolistically competitive environment by employing an aggregated task. I assume that they face a Rotemberg-type price adjustment cost, which introduces price stickiness into the economy.

The key difference between this production sector and more standard setups lies in the task-production framework. A perfectly competitive task aggregator f produces a unique aggregated task $y_t(f)$ by combining a unit measure of tasks $y_{f,t}(i)$ according to the production function:

$$y_t(f) = \zeta \left(\int_{N-1}^{N} y_{f,t}(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where $i \in [N-1, N]$ with N denoting the range of tasks, $\zeta > 0$ is a scale parameter, and σ represents the elasticity of substitution across tasks.

Task producers also operate under perfect competition. Each task producer i supplies a unique task $y_{f,t}(i)$ to the task aggregator f, using capital services $k_{f,t}(i)$ and labor $l_{f,t}(i)$. Following Acemoglu and Restrepo (2018), a technological constraint on automation is present, $A \in [N-1, N]$, such that tasks $i \leq A$ are technologically automated and can therefore be produced with capital, while the remaining tasks are not automated and must be produced with labor. The production function of task producer i is given by:

$$y_{f,t}(i) = \begin{cases} k_{f,t}(i) + \gamma(i) l_{f,t}(i) & (i \leq A) \\ \gamma(i) l_{f,t}(i) & (i > A) \end{cases}, \tag{2}$$

where $\gamma(i)$ denotes labor productivity in task i. I assume that $\gamma(i)$ is strictly increasing in i, which implies that human labor has a strict comparative advantage in tasks with a higher index.

While the full profit maximization problem for task producers is presented in Appendix A, it leads to the following condition:

$$r_t^K = \frac{w_t}{\exp(\mu A_t^*)} \;, \tag{3}$$

where r^K and w are real rental cost of capital and real wage, respectively, and $\mu > 0$ is a parameter governing the curvature of $\gamma(i)$. Equation (3) identifies a unique threshold task A^*, at which task producers are indifferent between using capital or labor for producing tasks with $i \leq A^*$. Following Acemoglu and Restrepo (2018), I assume that producers employ capital services whenever they are indifferent between the use of capital and labor.

Most importantly, A^* serves as a proxy for the degree of automation in production. An increase in A^* indicates a shift toward a more automated economy, since a larger share of tasks is then produced exclusively with capital. In line with Fueki et al. (2023), A^* can therefore be interpreted as the "automation rate".[2]

Equation (3) thus shows that the automation rate is determined by the arbitrage between the real rental cost of capital and the real wage. If an exogenous shock increases real wages more than the real rental cost of capital, capital becomes relatively cheaper than labor. As a result, the automation rate rises.

2.3 Central Bank

The central bank functions as the monetary authority. It sets the nominal interest rate according to a Taylor rule that incorporates interest rate inertia and inflation targeting. The only exogenous shock in the model originates from this sector, as I will illustrate by examining the effects of an increase in the nominal interest rate implemented by the central bank.

[2]Note that Fueki et al. (2023) study two cases: one in which the technological constraint on automation does not bind, and another in which an upper bound exists. I abstract from this distinction and consider only the case in which the automation rate is not subject to any upper-bound limitation.

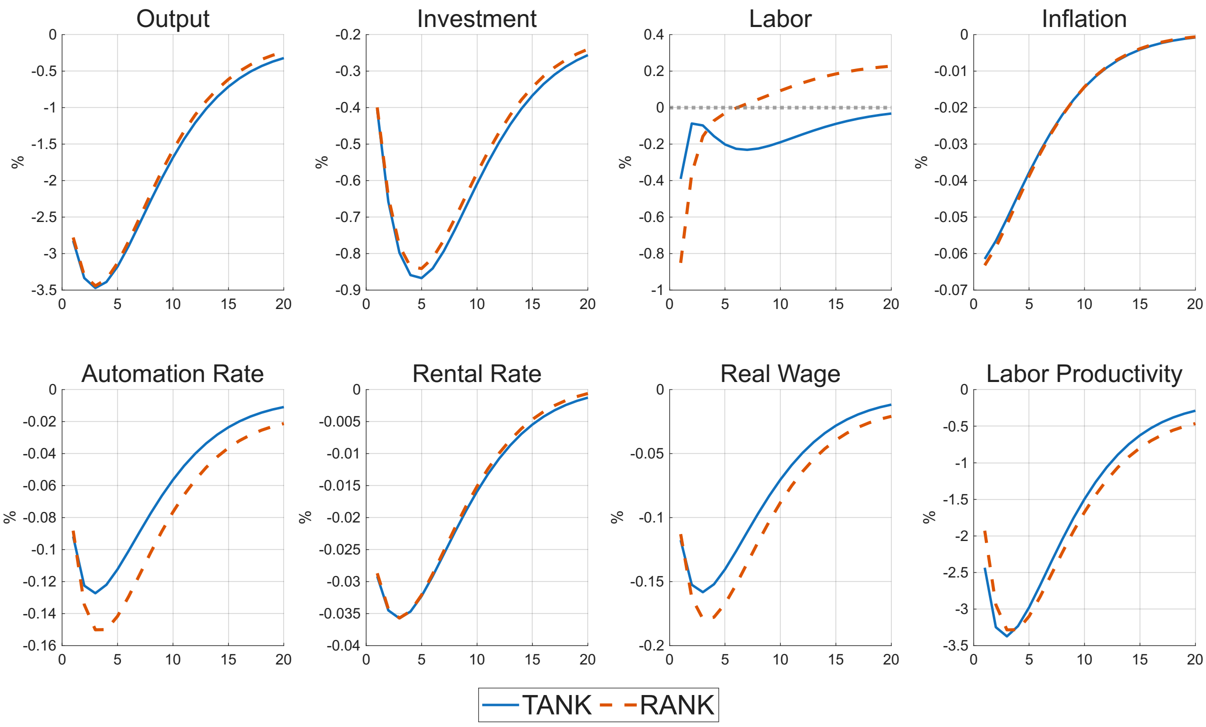

Figure 1: Impulse response to a monetary contraction for aggregate variables
Increase in the nominal interest rate of 25 b.p. The blue solid line refers to an economy with heterogeneous households. The red dashed line refers to the case of a representative household.

3 Results

To illustrate the implications of household heterogeneity in an environment with automation in production, I compare the outcomes of the model described in the previous section (the TANK model) with those of the same model featuring a representative household (the RANK model), which is therefore closer to the frameworks in Wolf and Fornaro (2021) and Fueki et al. (2023). I report the impulse responses of selected variables to a 25-basis-point increase in the nominal interest rate set by the central bank in Figure 1. Apart from the specification of household heterogeneity, the calibration is identical across the two model variants.

In terms of economic activity, the results are broadly similar across scenarios and consistent with the existing literature. An increase in the interest rate generates an economic contraction, leading to a decline in output and investment. If anything, the TANK specification produces a somewhat more persistent reduction in these variables. The responses of inflation and the rental rate of capital are also comparable across models and align with standard findings in the literature.

Household heterogeneity nevertheless plays a central role in shaping the response of the automation rate. Within the TANK framework, its decline is comparatively smaller, and this difference reflects the distinct economic positions of capitalists and workers. In particular, since the rental rate of capital displays very similar dynamics across the two models, the discrepancy in automation levels primarily originates from differences in labor market adjustments.

In standard representative-agent frameworks with endogenous automation, a monetary contraction can theoretically generate a medium-term overheating of the labor market, as pointed out by Wolf and Fornaro (2021). When a contractionary shock hits the economy, aggregate demand declines and corporate profits fall. Because the household simultaneously serves as both worker and capitalist, this loss of income produces a strong negative wealth effect, prompting the household to reduce consumption and accept a lower wage in order to limit the decline in employment. Since the same household owns the firms, it benefits from this cheaper labor, resulting in a stronger de-automation response. The sharp drop in A^* operates as a macroeconomic buffer: as labor productivity persistently drops, firms must increase their demand for human labor to meet production needs. This causes employment to recover much faster than output, a dynamic clearly visible in the RANK scenario in Figure 1 (red dashed line), where aggregate labor rebounds into positive territory shortly after the initial shock.

However, introducing household heterogeneity demonstrates that this medium-term "labor boom" is an artifact of the representative-agent assumption. The TANK framework eliminates the feedback mechanism between corporate profits and worker income. Workers have no interest in dividends and are therefore unaffected by the negative impact of falling profits; they react solely to the decline in labor income. To smooth consumption, they increase their indebtedness and reduce their hours worked even further, but at a relatively higher wage level compared to the RANK baseline. Capitalists, by contrast, do not receive labor income. Facing these relatively higher labor costs, they find it optimal to reduce de-automation by a significantly smaller amount. Stripped of this aggressive de-automation buffer, the medium-term labor market overheating vanishes. Interestingly, the short-run dynamics reveal a nuanced trade-off. In the immediate aftermath of the shock, the TANK economy experiences a shallower initial drop in aggregate employment compared to the RANK baseline. However, this early mitigation is short-lived. Without the strong, sustained de-automation push that characterizes the representative-agent model, TANK employment fails to rebound into a boom, instead suffering a persistent contraction that remains below its steady state throughout the recovery phase (blue solid line in Figure 1). Furthermore, although production in the TANK framework becomes relatively more capital-intensive than in the RANK case, this shift does not translate into relatively higher capital investment.

4 Concluding Remarks

This paper demonstrates that when automation is an endogenous choice, the distribution of financial assets is crucial for monetary transmission. While aggregate output and inflation dynamics remain largely invariant to household heterogeneity, the underlying adjustments in factor markets tell a different story. By breaking the link between corporate profits and worker wealth, household heterogeneity eliminates the aggressive de-automation buffer found in representative-agent models. Consequently, restricted financial participation fundamentally alters the employment dynamics of monetary policy, dampening the initial shock but prolonging the overall labor contraction. For macroeconomic modeling, the implication is that standard frameworks structurally overstate firms' willingness to substitute toward human labor during monetary tightenings. By doing so, they generate an artificial labor boom and systematically overstate the true volatility of employment over the business cycle.

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Appendix

A Model Details

This appendix section provides the complete model introduced in Section 2. To build it, I adopt the simplest possible framework in order to maximize transparency and focus exclusively on the qualitative implications of household heterogeneity for automation. Despite its simplicity, the model remains rich in features, given the nature of the analysis.

Within the model, expressions such as $X_{x,t}$ indicate per-capita variables, whereas X_t refers to aggregate values. Moreover, $\bar{X}$ represents the steady-state level of the corresponding variable.

The economy consists of three main blocks: households, firms (that is, the production sector), and a central bank. Time is discrete and infinite. The behavior of each agent is described in detail below.

A.1 Households

Household heterogeneity is incorporated in the simplest possible way. Following Cantore and Freund (2021), I rely on a TANK structure that separates households into two groups, capitalists (C) and workers (W).[3]

A.1.1 Capitalists

Capitalists do not supply labor and derive utility exclusively from consumption. The utility function for a representative capitalist j is:

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{C_{c,t}(j)^{1-\xi}}{1-\xi} \,, \tag{A1}$$

where $C_{c,t}(j)$ is the capitalist consumption, β is the discount factor, and ξ is the coefficient of relative risk aversion.

Capitalist j can save (or borrow) in liquid bonds, rent capital to firms, and earn firms'

[3] A similar structure is also employed in Klein and Krause (2020).

dividends, given her ownership of the production sector. In addition, she undertakes capital stock accumulation and capital refurbishing. Therefore, her budget constraint is:

$$\begin{aligned} C_{c,t}(j) + B_{c,t}(j) + I_{c,t}(j) + \Psi\left\{u_{c,t}(j)\right\}\tilde{K}_{c,t-1}(j) = \\ r_t^K u_{c,t}(j)\tilde{K}_{c,t-1}(j) + \frac{R_{t-1}}{\pi_t}B_{c,t-1}(j) + D_{c,t}(j) + \frac{Tr}{\lambda}\ , \end{aligned} \tag{A2}$$

where $B_{c,t}(j)$ denotes the level of bonds in capitalist j's portfolio, $I_{c,t}(j)$ represents investment expenditures in capital, $\tilde{K}_{c,t}(j)$ is the capital stock holding, $u_{c,t}(j)$ is the capital utilization rate, $D_{c,t}(j)$ are dividends stemming from firms' operations, Tr represents the transfers between household types introduced to ensure zero consumption inequality in the steady state, and λ is the share of capitalists among households. r^K and R denote the real interest rate on capital and the nominal interest rate on bonds, respectively, while π is the inflation rate, defined later in Section A.2.2.

The term $\Psi\left\{u_{c,t}(j)\right\}$ is a capital utilization cost function which, in line with Christiano et al. (2010), is defined as:

$$\Psi(u_{c,t}(j)) = 0.5\,\sigma_a\sigma_b u_{c,t}(j)^2 + \sigma_b(1-\sigma_a)u_{c,t}(j) + \sigma_b\left(\frac{\sigma_a}{2} - 1\right)\ , \tag{A3}$$

where σ_a is the parameter governing the curvature of the cost function, and σ_b is calibrated such that $\Psi(u) = \Psi'(u) = 0$ at the steady state.

Since capitalist j undertakes capital stock accumulation and capital refurbishing, she is also subject to the following law of motion for capital:

$$\tilde{K}_{c,t}(j) = (1-\delta)\tilde{K}_{c,t-1}(j) + \left\{1 - \frac{\phi}{2}\left(\frac{I_{c,t}(j)}{I_{c,t-1}(j)} - 1\right)^2\right\} I_{c,t}(j)\ , \tag{A4}$$

where δ is the depreciation rate of capital, and ϕ denotes the investment adjustment costs.

Capitalist j rents the capital service $K_{c,t}(j)$ to firms at the rental rate r^K, and she can adjust the amount of capital service by choosing the utilization rate $u_{c,t}(j)$. The capital service is therefore defined as:

$$K_{c,t}(j) = u_{c,t}(j)\tilde{K}_{c,t-1}(j) \ . \tag{A5}$$

Capitalist j chooses $C_{c,t}(j)$, $B_{c,t}(j)$, $I_{c,t}(j)$, $u_{c,t}(j)$, and $\tilde{K}_{c,t}(j)$ to maximize the expected lifetime utility given in equation (A1), subject to equations (A2) and (A4). Since all capitalists behave identically, I can ignore the superscript j and derive the following First Order Conditions (FOC):

- w.r.t. $C_{c,t}$ → Lagrangian multiplier for capitalist consumption:

$$\Lambda_{c,t} = C_{c,t}^{-\xi} \ . \tag{A6}$$

- w.r.t. $B_{c,t}$ → Capitalist Euler equation:

$$\Lambda_{c,t} = \beta E_t \left[\Lambda_{c,t+1} \frac{R_t}{\pi_{t+1}} \right] \ . \tag{A7}$$

- w.r.t. $I_{c,t}$ → Optimality condition for investment

$$\begin{aligned} q_t \left\{ 1 - \phi \left(\frac{I_{c,t}}{I_{c,t-1}} - 1 \right) \frac{I_{c,t}}{I_{c,t-1}} - \frac{\phi}{2} \left(\frac{I_{c,t}}{I_{c,t-1}} - 1 \right)^2 \right\} \\ = 1 - E_t \left[\Omega^c_{t,t+1} q_{t+1} \phi \left(\frac{I_{c,t+1}}{I_{c,t}} - 1 \right) \left(\frac{I_{c,t+1}}{I_{c,t}} \right)^2 \right] \ , \end{aligned} \tag{A8}$$

  where q is Tobin's q, derived from the Lagrange multiplier associated with the constraint (A4), and $\Omega^c_{t,t+1} = \beta \left(\Lambda_{c,t+1} / \Lambda_{c,t} \right)$ is the stochastic discount factor for capitalists.

- w.r.t. $\tilde{K}_{c,t}$ → Optimality condition for capital stock:

$$q_t = E_t \left[\Omega^c_{t,t+1} \left\{ u_{c,t+1} r^k_{t+1} - \Psi(u_{c,t+1}) + (1 - \delta) q_{t+1} \right\} \right] \ . \tag{A9}$$

- w.r.t. u_t → Optimality condition for utilization rate:

$$r_t^K = \sigma_a \sigma_b (u_{c,t} - 1) + \sigma_b \ . \tag{A10}$$

A.1.2 Workers

Workers derive utility from consumption and experience disutility from labor. The utility function for a representative worker j is:

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{C_{w,t}(j)^{1-\xi}}{1-\xi} - \frac{L_{w,t}(j)^{1+\eta}}{1+\eta} \ , \tag{A11}$$

where $C_{w,t}(j)$ is worker consumption, β is the discount factor, and ξ is the coefficient of relative risk aversion (the last two parameters are identical across workers and capitalists). $L_{w,t}(j)$ denotes the labor supplied by worker j, and η is the inverse Frisch elasticity of labor supply.

Worker j earns labor income from working and can also borrow or save in bonds. I assume that workers supply differentiated labor services and face a Rotemberg-type nominal wage adjustment cost, which introduces wage stickiness. Therefore, her budget constraint is:

$$\begin{aligned} C_{w,t}(j) + B_{w,t}(j) + \frac{\psi_w}{2} \left(B_{w,t}(j) - \bar{B}_w(j)\right)^2 = w(j)_t L_{w,t}(j) \left[1 - \frac{\phi_w}{2} \left(\pi_t^w - 1\right)^2\right] \\ + \frac{R_{t-1}}{\pi_t} B_{w,t-1}(j) + f_t - \frac{Tr}{1-\lambda} \ , \end{aligned} \tag{A12}$$

where $B_{w,t}(j)$ denotes the level of bonds in worker j' portfolio, $w(j)$ is her real wage, and Tr represents the transfers between household types introduced to ensure zero consumption inequality in the steady state. The term $\frac{\psi_w}{2} \left(B_{w,t}(j) - \bar{B}_w(j)\right)^2$ is a convex portfolio adjustment cost function which, following Schmitt-Grohé and Uribe (2003), is introduced to ensure stationarity. The parameter ψ_w therefore captures the strength of this adjustment cost. Following Cantore and Freund (2021), and to rule out any wealth effects, these costs are rebated to workers as a lump-sum payment, f_t, which workers do not internalize when making their savings decisions.

To introduce sticky wages, I assume that worker j supplies differentiated labor services, $L_{w,t}(j)$, according to the following labor demand equation:

$$L_{w,t}(j) = \left(\frac{W_t(j)}{W_t}\right)^{-\epsilon_w} L_t \ , \tag{A13}$$

where $W_t(j)$ is the nominal wage of worker j, W_t is the nominal aggregate wage, L_t is aggregate labor, and ϵ_w is the elasticity of substitution across differentiated labor services. The term $(\phi_w/2)\left(\pi_t^w - 1\right)^2$ in the worker budget constraint represents the nominal wage adjustment cost à la Rotemberg (1982), where ϕ_w is the parameter governing the strength of this adjustment cost. The variable π^w represents the nominal wage inflation rate, defined as: $\pi_t^w = W_t(j)/W_{t-1}(j) = \left[w_t(j)/w_{t-1}(j)\right]\pi_t$

Worker j chooses $C_{w,t}(j)$, $B_{w,t}(j)$, and $W_t(j)$ to maximize the expected lifetime utility specified in equation (A11), subject to equations (A12) and (A13). Since all workers behave identically, I can omit the superscript j and derive the following First Order Conditions (FOC):

- w.r.t. $C_{w,t} \rightarrow$ Lagrangian multiplier for worker consumption:

$$\Lambda_{w,t} = C_{w,t}^{-\xi} \ . \tag{A14}$$

- w.r.t. $B_{w,t} \rightarrow$ Worker Euler equation:

$$\Lambda_{w,t}\left[1 + \psi_w\left(B_{w,t} - \bar{B}_w\right)\right] = \beta E_t\left[\Lambda_{w,t+1}\frac{R_t}{\pi_{t+1}}\right] \ . \tag{A15}$$

- w.r.t. $W_t(j) \rightarrow$ Wage NKPC:

$$\begin{aligned} &\epsilon_w \frac{1}{w_t}\frac{L_{w,t}^{\eta}}{\Lambda_{w,t}} - \left(\frac{\phi_w}{2}\left\{(3-\epsilon_w)(\pi_t^w)^2 - 2(2-\epsilon_w)\pi_t^w + (1-\epsilon_w)\right\} - (1-\epsilon_w)\right) \\ &\qquad + E_t\left[\Omega_{t,t+1}^w \phi_w\left\{\pi_{t+1}^w - 1\right\}\pi_{t+1}^w\left(\frac{L_{w,t+1}}{L_{w,t}}\right)\right] = 0 \ , \end{aligned} \tag{A16}$$

where $\Omega_{t,t+1}^w = \beta\left(\Lambda_{w,t+1}/\Lambda_{w,t}\right)$ is the stochastic discount factor for workers.

A.2 Production Sector

The production sector incorporates the production-task approach of Acemoglu and Restrepo (2018) into a DSGE framework, following the specification of Fueki et al. (2023). This part of the economy is populated by final-good producers, intermediate-good producers, task aggregators, and task producers.

A.2.1 Final-Good Producers

Final-good producers purchase differentiated intermediate goods, $Y_t(f)$, $f \in [0,1]$, to produce a single final good, Y_t, according to the following production function:

$$Y_t = \left(\int_0^1 Y_t(f)^{\frac{\epsilon_p - 1}{\epsilon_p}} df \right)^{\frac{\epsilon_p}{\epsilon_p - 1}}, \tag{A17}$$

where ϵ_p denotes the elasticity of substitution across intermediate goods. The final-good producer solves the following profit maximization problem:

$$\max_{Y_t(f)} \quad P_t Y_t - \int_0^1 P_t(f) Y_t(f) df \ , \tag{A18}$$

subject to equation (A17), and where P_t and $P_t(f)$ denote the prices of the final good and of intermediate good f, respectively. Profit maximization leads to the following demand function for intermediate good f:

$$Y_t(f) = \left(\frac{P_t(f)}{P_t} \right)^{-\epsilon_p} Y_t. \tag{A19}$$

A.2.2 Intermediate-Good Producers

Intermediate-good producer f supplies a unique intermediate good, $Y_t(f)$ under monopolistic competition, by employing an aggregated task, $y_t(f)$, at price $p_t(f)$. Its production function is:

$$Y_t(f) = y_t(f) \ . \tag{A20}$$

I assume that she face a Rotemberg-type price adjustment cost, which introduces price stickiness into the economy. Therefore, the profit maximization problem of producer f is the following:

$$\max_{P_t(f)} E_t \sum_{k=0}^{\infty} \Omega^c_{t,t+k} \left[P_{t+k}(f) Y_{t+k}(f) - p_{t+k}(f) y_{t+k}(f) - \frac{\phi_p}{2} \left(\pi_t(f) - 1 \right)^2 P_{t+k} Y_{t+k} \right], \quad \text{(A21)}$$

where $\Omega^c_{t,t+k}$ denotes the stochastic discount factor of capitalists, who own the entire production sector, and the term $(\phi_p/2)\left(\pi_t(f)-1\right)^2$ captures the adjustment costs introduced by Rotemberg (1982). The parameter ϕ_p measures the intensity of these costs, and price inflation for intermediate good f is defined as $\pi_t(f) = P_t(f)/P_{t-1}(f)$.

All intermediate-goods firms face the same optimization problem, which leads them to choose identical prices and quantities. Consequently, the first-order condition of the profit maximization problem yields the nonlinear price NKPC:

$$(1-\epsilon_p) + \epsilon_p MC_t - \phi_p(\pi_t - 1)\pi_t + \phi_p E_t \left[\Omega^c_{t,t+1} (\pi_{t+1} - 1) \pi_{t+1} \frac{Y_{t+1}}{Y_t} \right] = 0 \,, \quad \text{(A22)}$$

where MC is the real marginal cost, defined as $MC_t = p_t/P_t$.

A.2.3 Task Aggregators

A perfectly competitive task aggregator f produces a unique aggregated task $y_t(f)$ by combining a unit measure of tasks $y_{f,t}(i)$ according to equation (1)

The profit maximization problem of the task aggregator f is the following:

$$\max_{y_{f,t}(i)} \quad p_t(f) y_t(f) - \int_{N-1}^{N} p_{f,t}(i) y_{f,t}(i) di \,, \quad \text{(A23)}$$

subject to the equation (1). Therefore, the demand function for task i is:

$$y_{f,t}(i) = \zeta^{\sigma-1} \left(\frac{p_{f,t}(i)}{p_t(f)} \right)^{-\sigma} y_t(f) \,, \quad \text{(A24)}$$

and price of aggregated task, $p_t(f)$, is given by:

$$p_t(f) = \frac{1}{\zeta}\left(\int_{N-1}^{N} p_{f,t}(i)^{1-\sigma} di\right)^{\frac{1}{1-\sigma}} . \tag{A25}$$

A.2.4 Task Producers

Task producers also operate under perfect competition. Task producer i supplies a unique task $y_{f,t}(i)$ to the task aggregator f, using capital services $k_{f,t}(i)$ and labor $l_{f,t}(i)$. Following Acemoglu and Restrepo (2018), a technological constraint on automation is present, $A \in [N-1, N]$, such that tasks $i \leq A$ are technologically automated and can therefore be produced with capital, while the remaining tasks are not automated and must be produced with labor. The production function of task producer i is given by equation (2)

Task producer i, therefore, solves two different problems, depending on whether $i \leq A$:

Case	Optimization Problem	Constraint
$i \leq A$	$\max\limits_{\{k_{f,t}(i), l_{f,t}(i)\}} p_{f,t}(i) y_{f,t}(i) - \left(R_t^k k_{f,t}(i) + W_t l_{f,t}(i)\right)$	$y_{f,t}(i) = k_{f,t}(i) + \gamma(i) l_{f,t}(i)$
$i > A$	$\max\limits_{l_{f,t}(i)} p_{f,t}(i) y_{f,t}(i) - W_t l_{f,t}(i)$	$y_{f,t}(i) = \gamma(i) l_{f,t}(i)$

where R^k is the nominal rental cost of capital. Since all the tasks are produced in a perfectly competitive manner, their prices are equal to the minimum unit cost of production:

$$p_{f,t}(i) = \begin{cases} \min\left\{R_t^k, \frac{W_t}{\gamma(i)}\right\} & (i \leq A) \\ \frac{W_t}{\gamma(i)} & (i > A) \end{cases} . \tag{A26}$$

Following Acemoglu and Restrepo (2018), the productivity of labor in task i is specified as:

$$\gamma(i) = \exp(\mu i) , \tag{A27}$$

with $\mu > 0$. This formulation leads directly to the fundamental equation (3) for the automation rate presented in the main text.

A.2.5 Aggregation

As stated in Section A.2.2, all intermediate-good firms make identical decisions, which allows me to drop the subscript f.

By combining equations (A20), (A24), (2), and (A26), I obtain the task-level capital demand and labor demand:

$$k_t(i) = \begin{cases} \zeta^{\sigma-1} Y_t R_t^{k\,-\sigma} p_t^{\sigma} & (i \leq A_t^*) \\ 0 & (i > A_t^*) \end{cases}, \qquad l_t(i) = \begin{cases} 0 & (i \leq A_t^*) \\ \zeta^{\sigma-1} Y_t \frac{1}{\gamma(i)} \left(\frac{W_t}{\gamma(i)}\right)^{-\sigma} p_t^{\sigma} & (i > A_t^*) \end{cases}.$$

Combining these equations with the equations with equations $MC_t = p_t/P_t$ and (A27), and aggregating across tasks, I obtain the capital and labor market clearing conditions:

$$r_t^k = MC_t \left[\zeta^{\frac{\sigma-1}{\sigma}} (A_t^* - N + 1)^{\frac{1}{\sigma}} \left(\frac{Y_t}{K_t}\right)^{\frac{1}{\sigma}} \right], \tag{A28}$$

$$w_t = MC_t \left[\zeta^{\frac{\sigma-1}{\sigma}} \left\{ \frac{e^{(\sigma-1)\mu N} - e^{(\sigma-1)\mu A_t^*}}{(\sigma-1)\mu} \right\}^{\frac{1}{\sigma}} \left(\frac{Y_t}{L_t}\right)^{\frac{1}{\sigma}} \right]. \tag{A29}$$

Combining equations $MC_t = p_t/P_t$, (A25), (A26), and (A27), I can express the real marginal cost as:

$$MC_t = \frac{1}{\zeta} \left[(A_t^* - N + 1) r_t^{k\,1-\sigma} + \left\{ \frac{e^{(\sigma-1)\mu N} - e^{(\sigma-1)\mu A_t^*}}{(\sigma-1)\mu} \right\} w_t^{1-\sigma} \right]^{\frac{1}{1-\sigma}}. \tag{A30}$$

Combining the preceding three equations, aggregate output is given by:

$$Y_t = \zeta \left[(A_t^* - N + 1)^{\frac{1}{\sigma}} K_t^{\frac{\sigma-1}{\sigma}} + \left\{ \frac{e^{(\sigma-1)\mu N} - e^{(\sigma-1)\mu A_t^*}}{(\sigma-1)\mu} \right\}^{\frac{1}{\sigma}} L_t^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}. \tag{A31}$$

Finally, as is standard in New Keynesian models with Rotemberg-type price rigidity, the dividends generated by the production sector are defined as follows:

$$D_t = Y_t \left[1 - MC_t - \frac{\phi_p}{2} (\pi_t - 1)^2 \right] . \tag{A32}$$

A.3 Central bank

The central bank acts as the monetary authority and sets the nominal interest rate according to a Taylor rule with interest rate inertia and inflation targeting, defined as:

$$\frac{R_t}{\bar{R}} = \left(\frac{R_{t-1}}{\bar{R}}\right)^{\rho_R} \left(\frac{\pi_t}{\bar{\pi}}\right)^{(1-\rho_R)\rho_\pi} m_t , \tag{A33}$$

where ρ_R measures the degree of interest rate inertia and ρ_π captures the sensitivity to inflation fluctuations. The exogenous shock to the nominal interest rate, m, follows an AR(1) process of the form:

$$\log(m_t) = \rho_m \log(m_{t-1}) + \epsilon_t^m , \tag{A34}$$

where ρ_m denotes the persistence of the shock, and ϵ_t^m is an i.i.d. monetary policy innovation with standard deviation σ_m.

A.3.1 Market Clearing and Aggregation

The goods market clears according to the following condition:

$$C_t + I_t + \Psi(u_t)\tilde{K}_{t-1} = \left\{1 - \frac{\phi_p}{2}(\pi_t - 1)^2\right\} Y_t - \frac{\phi_w}{2}(\pi_t^w - 1)^2 w_t L_t . \tag{A35}$$

Given the absence of a bond-issuing institution, such as a government, I impose a zero-supply condition for aggregate bonds:

$$B_t = 0 . \tag{A36}$$

The aggregation relationships between aggregate and per-capita variables are reported below:

- Aggregate consumption:

$$C_t = \lambda C_{c,t} + (1 - \lambda) C_{w,t} \ . \tag{A37}$$

- Aggregate Bonds:

$$B_t = \lambda B_{c,t} + (1 - \lambda) B_{w,t} \ . \tag{A38}$$

- Aggregate Labor:

$$L_t = (1 - \lambda) L_{w,t} \ . \tag{A39}$$

- Aggregate Capital Stock:

$$\tilde{K}_t = \lambda \tilde{K}_{c,t} \ . \tag{A40}$$

- Aggregate Capital Services:

$$K_t = \lambda K_{c,t} \ . \tag{A41}$$

- Aggregate Utilization Rate:

$$u_t = u_{c,t} \tag{A42}$$

- Aggregate Investment:

$$I_t = \lambda I_{c,t} \ . \tag{A43}$$

- Aggregate Profits:

$$D_t = \lambda D_{c,t} \ . \tag{A44}$$

B Model Calibration

Table B.1 reports the parameter values used to generate the results shown in Figure 1. Most of the calibration follows standard choices in the literature, while several specific parameter values are drawn from influential related studies.

Table B.1: Baseline model calibration

Description	Param.	Value	Source/target
Households and Preferences			
Discount rate	β	0.99	Standard value
Risk aversion	ξ	2	Standard value
Inverse Frisch elasticity of labor supply	η	1	Standard value
Share of capitalists	λ	0.2	Klein and Krause (2020)
Bond portfolio adjustment cost	ψ_w	0.07	Cantore and Freund (2021)
Capital and Investment			
Depreciation rate	δ	0.025	Standard value
Investment adjustment cost	ϕ	6	Smets and Wouters (2007)
Capital utilization cost curvature	σ_a	0.01	Christiano et al. (2005)
Capital utilization parameter	σ_b	0.0351	$\Psi(u) = \Psi'(u) = 0$
Firm and Production			
Range of tasks	N	1	Normalization
Automation efficiency	μ	1	Normalization
Elasticity of substitution between tasks	σ	0.4	Chirinko and Mallick (2017)
Scale parameter	ζ	0.04	Internal calibration
Nominal Rigidities			
Elasticity of substitution: Goods	ϵ_p	6	Price markup = 20%
Elasticity of substitution: Labor	ϵ_w	6	Wage markup = 20%
Price adjustment cost (Rotemberg)	ϕ_p	29.41	Price duration = 3 quarters
Wage adjustment cost (Rotemberg)	ϕ_w	58.25	Wage duration = 4 quarters
Monetary Policy			
Interest rate smoothing	ρ_R	0.8	Clarida et al. (2000)
Taylor rule inflation coefficient	ρ_π	1.5	Standard value
Monetary shock std. dev.	σ_m	0.025	1% annualized shock
Persistence of monetary shock	ρ_m	0	One-time innovation