



BANCA D'ITALIA
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ARTIFICIAL INTELLIGENCE, THE NATURAL RATE OF INTEREST, AND MONETARY POLICY

by Lucia Esposito*, Andrea Fabiani*, Elia Moracci*, Andrea Papetti*
and Massimiliano Pisani*

Abstract

This paper evaluates the macroeconomic effects of artificial intelligence-driven productivity gains under alternative monetary policy rules by using a New Keynesian model calibrated to the euro area. AI-driven productivity gains raise output but have ambiguous effects on inflation. A sudden productivity increase is generally disinflationary, as supply expands faster than demand, whereas gradual productivity gains or stronger investment demand tend to be inflationary because aggregate demand responds more intensely. Across various scenarios, monetary policy achieves better inflation and output stabilization when it tracks the evolution of the natural rate of interest, r^* , or responds more strongly to inflation, rather than reacting to the long-run value of r^* . The results suggest that, because the evolution of r^* is difficult to assess during periods of AI-driven structural change, inflation may provide more reliable guidance for policy decisions.

JEL Classification: E32, E52, O33, O40.

Keywords: artificial intelligence, technology shock, monetary policy, New Keynesian model, simulations, euro area.

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1 Introduction¹

The rapid adoption of artificial intelligence (AI) and the prospect of a significant acceleration in productivity have sparked a lively policy debate on the implications for inflation and the appropriate stance of monetary policy (MP). Drawing a parallel with the productivity gains associated with the diffusion of information technologies in the late 1990s, some commentators — including Fed Chair Kevin Warsh — argue that, if AI were to generate sustained productivity gains, the economy could expand more rapidly without triggering renewed inflationary pressures, potentially creating room for lower policy rates.² Others caution, however, that stronger growth expectations may stimulate current demand, both in terms of consumption and investment.³ Moreover, they could put upward pressure on the natural interest rate, r^* , thereby requiring tighter — rather than looser — monetary conditions to preserve price stability.⁴

The central question is whether AI primarily operates as a positive supply shock, exerting disinflationary effects by expanding productive capacity, or whether it also raises the natural rate of interest and aggregate demand sufficiently to require a change in the MP stance. While productivity shapes the economy’s real capacity, inflation ultimately reflects also MP

¹The views expressed are those of the authors and do not necessarily reflect those of the Banca d’Italia. We thank Giuseppe Ferrero and Alessandro Notarpietro for helpful comments. All errors are ours.

²According to Fernald and Wang (2015), from the early 1970s through 1995, U.S. productivity rose about 1.5% per year. Between 1995 and 2003, that pace more than doubled to a rate that was comparable to its fast pace before 1973. In an op-ed published in *The Wall Street Journal* on November 16, 2025, Kevin Warsh argued that “AI will be a significant disinflationary force, increasing productivity [...]”.

³Several Fed officials have expressed skepticism on Kevin Warsh’s statement. On November 7, 2025, Fed Vice Chair Philip Jefferson, in a speech on *AI and the Economy*, cautioned that “AI’s effect on inflation is not solely downward pressure. [While it] will likely help the economy achieve higher growth through increased productivity, it could put upward pressure on certain price categories as many firms push to scale up the technology”. Similarly, on February 17, 2026, in a speech entitled *What Will Artificial Intelligence Mean for the Labor Market and the Economy?*, Fed Governor Michael Barr said “I expect that the AI boom is unlikely to be a reason for lowering policy rates”. The recent debate has been summarized by Harvard Professor Jason Furman in the *Financial Times* on February 12, 2026. Furman argues inflationary demand effects may already be materializing: “What we do have today is extraordinarily high expectations of productivity growth, already reflected in equity prices and business investment, boosting demand well ahead of any realized supply gains”.

⁴We refer to r^* as the real interest rate that prevails in an economy without nominal (price and wage) frictions. This is the standard definition adopted in the New Keynesian framework used throughout this paper. See Woodford (2003).

choices. More broadly, AI may affect both inflation and the natural rate of interest through multiple channels, making it difficult for policymakers to assess the appropriate stance of MP in real time. Since r^* is not directly observable, uncertainty surrounding its evolution makes the appropriate policy stance difficult to assess in real time during periods of rapid technological change.

This paper studies how AI-driven technological change may affect inflation, economic activity, and the natural rate of interest within a medium-scale New Keynesian model calibrated, without loss of generality, to the euro area (EA). Particular attention is devoted to the implications of alternative MP rules when AI-induced shocks alter the equilibrium real interest rate. The analysis focuses not only on the long-run effects of AI-related productivity gains, but also on the transition dynamics of the natural rate of interest and the challenges they pose for MP implementation.

We consider four illustrative scenarios designed to capture the main channels through which AI may affect the economy: (i) a sudden permanent increase in Total Factor Productivity (TFP), (ii) a gradual permanent increase in TFP, (iii) a gradual permanent technology shock that (permanently) raises the growth rate of labour productivity — which, unlike the previous two cases, leads to a permanent increase in r^* , and (iv) a sudden temporary increase in demand for investment in physical capital because of a persistent increase in the marginal efficiency of investment (i.e., the marginal efficiency of turning investment into productive capital). The first scenario (sudden increase in productivity) may correspond to an abrupt materialization of productivity gains from past AI investments, temporarily boosting economic activity above what can be accommodated by aggregate demand adjustments. This scenario is consistent with the hypothesis put forward by Kevin Warsh. The second and the third scenarios (gradual increase in productivity) represent the case of an economy that gradually adopts newly developed AI technologies. The fourth scenario represents the case of an increase in investment due to AI adoption.

Each scenario is simulated under three alternative MP rules that differ in terms of the

central bank (CB)’s responsiveness to r^* and deviations of inflation from the target.

The main findings emerging from the simulations are as follows. AI-driven productivity gains raise output but have ambiguous effects on inflation because they stimulate both aggregate supply and aggregate demand. A sudden increase in productivity is generally disinflationary, as supply expands faster than demand, whereas gradual productivity gains or stronger investment demand tend to be inflationary because demand reacts more strongly. Across all scenarios, MP performs better when it responds to the evolving natural rate of interest r^* or places a stronger weight on inflation stabilization, rather than reacting only to the long-run value of r^* . Moreover, when AI raises productivity growth and, therefore, the long-run level of r^* , adjusting the MP rate immediately to its new steady-state value, while disregarding its transition path and contemporaneous inflation developments, may generate significant disinflationary and recessionary effects during the transition.

This paper relates to two strands of literature. The first studies the macroeconomic effects of productivity shocks and their implications for inflation and MP. In New Keynesian models, technology shocks affect both aggregate supply and aggregate demand, implying potentially ambiguous effects on inflation and output dynamics. Seminal contributions include Galí (1999) and subsequent work emphasizing the transmission of technology shocks through nominal rigidities and MP. More recently, the debate has resurfaced in the context of AI-driven productivity gains, with growing attention to the extent and timing of their macroeconomic effects. Evidence on AI adoption suggests that productivity gains are gradually emerging across firms and industries, although their magnitude and persistence remain uncertain (Filippucci et al. 2024). Aldasoro et al. (2024) study the economic impact of AI using a multi-sector macroeconomic model calibrated to an index of industry exposure to AI. AI, by spurring productivity growth, significantly raises aggregate output. The effects of AI on inflation are uncertain. On the one hand, by raising productivity, AI adoption boosts supply, which is disinflationary. On the other hand, firms need to make substantial investments to take full advantage of AI. As in our case, the net effect hinges on the timing of these forces,

which in turn depends on households' and firms' readiness to act.

The second strand focuses on the natural rate of interest and its role in MP. Theoretical and empirical contributions, including Laubach and Williams (2003), Holston et al. (2017), and Billi et al. (2024), highlight the importance of the natural rate for the design and implementation of MP. Recent studies suggest that AI-driven investment and productivity dynamics may place upward pressure on equilibrium real interest rates (Melina and Villa 2025).

Relative to this literature, our contribution is twofold. First, we distinguish between several AI-related shocks, namely permanent increases in the level of TFP, increases in labour productivity growth, and shocks that stimulate investment demand through higher investment efficiency. Second, we assess how alternative MP rules perform when the natural rate of interest follows different transition paths. In particular, we compare a MP rule that responds to the contemporaneous natural rate with one that reacts only to its long-run level, allowing us to evaluate the importance of tracking the transition of r^* following AI-driven structural changes.⁵

Our findings indicate that the key policy challenge is not only whether AI is inflationary or disinflationary per se. It is also whether MP can appropriately respond to changes in the natural rate of interest during the transition to a more productive economy. Because the natural rate is unobservable and subject to considerable uncertainty especially during periods of structural change, MP rules that place greater weight on observed inflation developments may outperform rules that rely heavily on estimates of its long-run level.

The paper is organized as follows. Section 2 illustrates the model, with emphasis on the TFP shock and on the Taylor rule. Section 3 describes the simulated scenarios and the transmission mechanism of the considered shocks. Section 4 reports the results. Section 5 concludes.

⁵See Bartocci et al. (2026) for an evaluation of the the impact of AI on EA inflation and macroeconomic activity via the induced changes in international relative prices and trade.

2 The model

Our analysis is based on a standard medium-scale New Keynesian model of a closed economy. In the following, we provide a brief description of the model.

There is a continuum of households of mass one that maximize an intertemporal utility function that is separable in consumption and labour, subject to a budget constraint.⁶ Households supply labour and physical capital to firms operating in the intermediate sector. Each household is the monopolistic supplier of a specific type of labour and sets her wage taking demand for her type of labour as given. Household consumption is subject to external habits, while households' physical capital accumulation is subject to quadratic adjustment costs on changes in investment. Households hold a riskless bond paying the MP rate. The bond is in zero net supply.

For firms, there is an intermediate and a final good sector. In the intermediate sector, there is a continuum of firms of mass one. Each firm produces an intermediate good according to a Cobb-Douglas production function in capital and labour. Moreover, each firm operates under monopolistic competition and, taking demand as given, sets the nominal price of the product. In the final sector, there is a continuum of firms of mass one that under perfect competition combine intermediate goods to produce final goods for private consumption, public consumption, and investment.

The model features nominal wage and price stickiness. Households and firms producing intermediate goods set nominal wages and prices, respectively, subject to quadratic adjustment costs.⁷ Both wages and prices are indexed to previous-period consumer price inflation and to the central bank inflation target, with corresponding weights between zero and one and summing to one.

There is a fiscal authority that in every period finances public consumption with lump-sum taxes paid by households. The level of public consumption is kept constant across all

⁶The assumption of a cashless economy holds.

⁷See Rotemberg (1982).

simulations. It is introduced in the model for calibration purposes.

Finally, the central bank sets the MP according to a Taylor-type rule.

We consider a symmetric equilibrium where (i) both the representative firm in the final production sector and the representative firm in the intermediate production sector maximize their corresponding profits subject to their (technology and demand) constraints, (ii) the representative household maximizes her intertemporal utility function subject to the budget constraint and the demand for her labour services, (iii) the central bank follows the Taylor rule, (iv) the government budget constraint holds, and (v) all markets clear.

In what follows we illustrate the production function (Section 2.1), the accumulation law of physical capital (Section 2.2), the natural rate of interest (Section 2.3), and the MP rules (Section 2.4). These equations are key for the transmission of the “AI-like” technology shocks.

Finally we present the calibration of the model (Section 2.5). The remaining equations are reported in the Appendix.

2.1 The production function

Each firm i in the intermediate sector minimizes production costs with respect to capital K and labour L subject to the following technology constraint and taking prices as given:

$$Y_{i,t} = A_t K_{i,t-1}^\alpha (A_{L,t} L_{i,t})^{1-\alpha}, \quad (1)$$

where Y is output, $0 < \alpha < 1$ is a parameter, A_t is the TFP shock and $A_{L,t}$ is the labour-augmenting technology. The two shocks are common across all firms.

In every period, the trend-growth rate of the economy is equal to the growth rate of the labour-augmenting technology shock, that is, in gross terms,

$$gr_t \equiv A_{L,t}/A_{L,t-1}. \quad (2)$$

Our simulations are based on these two technology shocks (A_t and $A_{L,t}$), which can be

interpreted as reflecting the introduction and diffusion of AI technologies in the economy.

2.2 Capital accumulation

The household j invests in physical capital according to the following law of accumulation:

$$K_{j,t} = (1 - \delta)K_{j,t-1} + \left[1 - \frac{\psi}{2} \left(\frac{I_{j,t}}{I_{j,t-1}} - 1 \right)^2 \right] Z_{I,t} I_{j,t}, \quad (3)$$

where $0 < \delta < 1$ is the depreciation rate, I is investment, and changes in investment are subject to a quadratic adjustment cost ($\psi > 0$ is a parameter measuring the cost of adjustment). The accumulation is subject to an investment-specific technology shock $Z_{I,t}$ common to all households. A positive shock increases the efficiency with which investment is transformed into physical capital.

2.3 The natural rate of interest

A permanent labour-augmenting technology shock affects the long-run value of the gross (real) natural rate, $\bar{R}^*$, because in the steady-state equilibrium the following relation holds:

$$\bar{R}^* = \frac{\bar{g}\bar{r}}{\beta}, \quad (4)$$

where $0 < \beta < 1$ is the (representative) household's discount factor and $\bar{g}\bar{r}$ is the long-run gross growth rate of the economy. A permanent increase in labour-augmenting technology raises $\bar{g}\bar{r}$ and therefore increases $\bar{R}^*$. Throughout the paper, $1 + i^*$, R^* , and r^* denote the gross natural nominal interest rate, the gross (real) natural rate, and the net (real) natural rate (the latter is equal to $R^* - 1$). The nominal natural rate ($1 + i_t^*$) is equal to the (gross) natural rate augmented by the value of inflation target. In particular, in steady state,

$$1 + \bar{i}^* = \frac{\bar{g}\bar{r}\bar{\pi}}{\beta}, \quad (5)$$

where $\bar{\pi}$ is the gross inflation target of the central bank. As the latter is assumed to be always constant, in every period

$$1 + i_t^* = R_t^* \bar{\pi}. \quad (6)$$

2.4 MP rules

We assume three alternative MP rules. The first one is:

$$\frac{1 + i_t}{1 + i_t^*} = \left(\frac{1 + i_{t-1}}{1 + i_t^*} \right)^{\rho_r} \left(\frac{\pi_t}{\bar{\pi}} \right)^{(1-\rho_r)\rho_\pi} \left(\frac{y_t}{y_{t-1}} \right)^{(1-\rho_r)\rho_y}. \quad (7)$$

$1 + i_t$ denotes the gross MP rate (i_t is the net counterpart) in period t , while $1 + i_t^*$ denotes the gross nominal natural rate of interest. The parameters $0 \leq \rho_r \leq 1$, $\rho_\pi > 0$, and ρ_y measure the sensitivity of the policy rate to its lagged value, to the domestic (quarterly) gross inflation rate (in deviation from the target $\bar{\pi}$), and to the quarterly gross growth rate of the cyclical component of domestic output y (y_t/y_{t-1}), respectively. The lagged interest rate ensures that the policy rate is adjusted smoothly and captures the idea that the central bank prefers to avoid large sudden changes in its policy instrument.

The second is:

$$\left(\frac{1 + i_t}{1 + i_t^*} \right) = \left(\frac{1 + i_{t-1}}{1 + i_t^*} \right)^{\rho_r} \left(\frac{\pi_t}{\bar{\pi}} \right)^{(1-\rho_r)\rho_\pi} \left(\frac{y_t}{y_{t-1}} \right)^{(1-\rho_r)\rho_y}. \quad (8)$$

Unlike Equation (7), in Equation (8) the MP rate responds to the long-run value of the nominal natural rate of interest, instead of responding to its period-by-period value. This means that the central bank, in its policy decisions, ignores the transition of r^* towards its long-run (steady-state) value and considers only the latter.

Finally, the third specification consists in the Taylor rule as in Equation (8), but with a higher value of the inflation-response coefficient ρ_π (see Section 2.5 for details on the calibration).

Note that the net nominal natural rate i^* follows the same path as the (net real) natural rate r^* , up to a constant equal to the inflation target. Therefore, for simplicity, we refer to r^* throughout the discussion of the results.

2.5 Calibration

The model is calibrated at quarterly frequency in line with the New Keynesian literature, to match EA great ratios (consumption- and investment-to-GDP ratios) and the responses of prices and real variables to a standard MP shock in line with the EA New Area Wide Model (NAWM, see Coenen et al. 2018).

Table 1 reports the matched great ratios (private consumption, public consumption, and investment in physical capital, all as a percentage of GDP) in the steady-state equilibrium. Long-run inflation is set to 2% in net annual terms, a value representing the target of the central bank. The long-run growth rate is set to 1% in net annual terms. The nominal natural rate of interest is set to 3.4% in net annual terms. The (real) natural rate of interest is set to 1.4%. Table 2 contains the calibration of the parameters, chosen in line with the literature and to match quantities reported in Table 1. The discount factor is set close to 1, in order to obtain a relatively low level of the natural rate of interest. The intertemporal elasticity of substitution is set to one (equivalent to log-utility). The consumption habit persistence parameter and the disutility of labor supply are respectively set to 0.6 and 2 (therefore, the Frisch elasticity of labour supply is 1). The elasticity of output with respect to capital in the Cobb-Douglas production function is set to 0.25 to match the investment-to-GDP ratio. The depreciation rate of capital is set to 0.025.

Table 3 contains markups and corresponding elasticities of substitution. Gross markups in the goods and labour markets are set to 1.2 and 1.3, respectively (the corresponding elasticities of substitution among goods and labour services varieties to 6 and 4.3, respectively).

Table 4 reports the adjustment costs. The adjustment cost of investment in physical capital is set to 4.5. Nominal price and wage rigidities parameters are set to 200 and 250,

respectively. Indexation to the previous-period consumer price inflation rate is set to 0.3 for both prices and wages.

Table 5 contains the calibration of the benchmark MP rule. The interest rate smoothing parameter is set to 0.85, the response to inflation to 1.5 and the response to output growth to 0.1. Similar values are reported in Coenen et al. (2018). Thus, the coefficient of response to the nominal natural rate of interest $1 + i_t^*$ is 0.15. The same value holds in the Taylor rule (Equation 8) where the MP rate responds to the long-run value of the nominal natural rate of interest $(1 + \bar{i}_t^*)$. The coefficient of response to inflation ρ_π is set to 5 in Equation 8 if the MP rate responds more strongly to inflation when also responding to the long-run value of the nominal natural rate.

3 Scenarios and transmission mechanism

We describe initially the simulated scenarios and, thereafter, the transmission of the shocks.

3.1 Scenarios

We simulate four “AI-like” technology-based scenarios, consistent with the shocks reported in Sections 2.1 and 2.2.

In the first scenario, there is a sudden and permanent increase in the level of TFP, that is, TFP immediately rises to its new long-run level (+1% above its initial level). This pattern may correspond to an abrupt materialization of productivity gains from past AI investments, temporarily boosting economic activity above what can be accommodated by aggregate demand adjustments. This scenario is broadly consistent with the hypothesis put forward by Kevin Warsh. The idea is that productivity gains materialize rapidly once a sufficient stock of complementary AI investments has been accumulated

In the second scenario, the TFP gradually increases to a level 1% above its initial value over five years up to the new permanent long-run level. This shock can be interpreted as

affecting an economy that gradually adopts newly developed AI technologies.

In the third scenario, the growth rate of labour productivity gradually increases over five years by 0.3 pp, from the current 1% to a new long-run growth rate of 1.3% in annualized terms. This pattern of productivity dynamics can be associated with the active development of AI technologies: sustained innovation and production of new AI tools boost the productivity growth rate, rather than just shifting its level. Unlike the other scenarios, such a change permanently increases the long-run value of r^* (from 0.35% to 0.42% in quarterly terms, that is, from 1.4% to 1.7% in annualized terms).⁸

Finally, the fourth scenario considers a sudden 1% increase in the marginal efficiency of investment in physical capital. The resulting investment-specific technology shock generates a persistent increase in investment demand. The shock follows an AR(1) process with a persistence parameter equal to 0.95. This scenario is consistent with the prolonged investment efforts required for the adoption and deployment of AI technologies.

In each scenario we consider three alternative specifications of the Taylor rule, as illustrated in Section 2.

All scenarios are simulated under perfect foresight, that is, households and firms know the future path of the shocks and are surprised by the shocks only in the initial period of the simulation.⁹

3.2 The transmission of AI-induced shocks

The transmission of AI-induced technology shocks operates through four main channels.

First, positive TFP and labour-augmenting technology shocks increase production efficiency, thereby expanding aggregate supply. By contrast, a positive investment-specific

⁸The literature seems to agree that AI increases labor productivity growth, by fostering both total factor productivity and capital deepening (as well as the share of AI-based sectors). However, the range of estimates for advanced economies over the next decade is wide, going from almost a nihil impact based on a purely “task-based” approach that assesses the production cost reduction via labor-saving (Acemoglu 2025) to a figure of more than 2.5 percentage points per annum when a potential acceleration in innovation is considered (Baily et al. 2023). For a review, see Filippucci et al. (2024).

⁹Therefore, our simulations do not account for the uncertainty associated with the diffusion of AI. Greater uncertainty would induce precautionary saving, thereby limiting the increase in the natural rate of interest.

technology shock directly stimulates investment demand by increasing the expected return on investment and increasing the profitability of capital accumulation.

Second, TFP and labour-augmenting shocks also affect aggregate demand. Higher expected productivity raises households' permanent income, encouraging consumption and investment. The adjustment of aggregate demand is gradual, however, due to habit formation in consumption and adjustment costs in investment. Similarly, an investment-specific shock boosts output indirectly through capital accumulation, a process that unfolds gradually because capital is a stock variable and investment is subject to adjustment costs.

Third, the relative speed at which supply and demand respond determines the inflationary consequences of the shock. If productivity gains materialize rapidly, aggregate supply tends to expand more than aggregate demand, putting downward pressure on inflation, because consumption and investment adjust gradually in the presence of habit formation and adjustment costs. Conversely, when productivity improvements are expected to occur only gradually, demand may respond more strongly in the short run, generating upward pressure on inflation.

Fourth, MP also plays an important role for the equilibrium responses. Under the Taylor rule, the stance of MP depends on the relationship between the MP rate and the natural rate of interest. Consistent with the literature, MP is restrictive when the policy rate remains persistently above the natural rate. Because households and firms form expectations taking the MP rule into account, a restrictive stance dampens aggregate demand, leading to lower inflation and weaker economic activity relative to the baseline. In particular, the performance of MP depends on the extent to which policymakers can correctly infer the contemporaneous evolution of the natural rate of interest, which is not directly observable in real time.

Overall, the equilibrium responses of inflation and economic activity depend on both the characteristics of the AI-induced technology shock and the MP reaction.

4 Results

We now discuss the results of the simulations. We first consider a sudden increase in TFP (Section 4.1), followed by a gradual increase in TFP (Section 4.2), a gradual increase in labour productivity growth (Section 4.3), and a sudden persistent increase in the marginal efficiency of investment (Section 4.4). Finally, we illustrate the lessons obtained from the simulations (Section 4.5).

4.1 Sudden TFP increase

Figure 1 reports the results in the case of a sudden TFP increase to its new long-run level. Under all three MP rules inflation decreases and output increases. This is consistent with the expansion of the aggregate supply. Aggregate demand also rises, because of the permanent increase in consumption and investment in physical capital. Households increase consumption because of higher permanent income, firms raise investment because capital is more productive. Both increases are due to the higher TFP level. For the same reason firms also raise their demand for labour, inducing real wages to increase. Labour initially decreases, because nominal rigidities in the short run constrain the negative response of prices and, thus, the increase in aggregate demand, limiting the incentive for firms to raise production and hire.¹⁰ Off-equilibrium, the expansion of aggregate demand is smaller than that of aggregate supply, because consumption and investment increase gradually, due to the presence of habit formation in consumption and investment adjustment costs. Thus, inflation decreases to favor the equilibrium between demand and supply.¹¹ Output increases more in the economy with nominal rigidities than its counterpart in the economy without nominal rigidities. Therefore, the output gap (equal to the difference between the two outputs) increases.

¹⁰Therefore, the model does not account for the possibility that the positive response of consumption to AI may be dampened in the short run by AI-induced redistributive effects through the labor market. In particular, AI-driven job displacement may temporarily increase the number of unemployed workers with a relatively high marginal propensity to consume out of labor income, thereby weakening the aggregate consumption response.

¹¹Disinflationary effects would be smaller in cases of smaller consumption's habit and smaller adjustment costs on investment.

The MP rate decreases in all cases, consistent with lower inflation. It decreases to a larger extent if, following Equation (7), it responds to the period-by-period changes in the natural rate of interest r^* , (black continuous line in the charts). The latter initially decreases (in the economy without nominal rigidities), reflecting the temporary excess of saving over investment generated by investment adjustment costs.¹² The larger decline in the MP rate further stimulates output in the short run (in the economy with nominal rigidities). Consistently, the output gap rises relatively more.

Instead, differently from the previous Taylor rule, the MP rate decreases less if it responds to the long-run value of the natural rate, $\bar{r}^*$ and does not react to the values of r_t^* along the transition (see Equation 8). The long-run value of r^* does not change, because the permanent change in the TFP level does not affect it. Therefore, the central bank has no incentive to reduce the MP rate because of the reduction in r^* . The incentive to reduce the MP rate is due only to lower inflation. Relative to the previous case, consumption, investment, and output rise less in the short run equilibrium (red dashed line). Consistently, labour increases less as well. The lower increase in aggregate demand causes inflation to decline more in the short run. The output gap increases to a lesser extent. Interestingly, inflation rises relatively more in the medium run, because the smaller initial increase in investment and labour implies a smaller rise of the supply side of the economy in the medium run.

Additional stimulus can be obtained when the MP rate responds to the long-run value of the natural rate, $\bar{r}^*$, if the coefficient ρ_π is set to a larger value (5 instead of 1.5) in Equation 8, so that the MP rate responds in a stronger way to the lower inflation (green line with crosses). The MP rate declines as much as under the Taylor rule responding to r_t^* , i.e., period by period (black continuous line). The output response is somewhat smaller but closer to the output response under the Taylor rule responding to the natural rate period by period. Similarly, responses of consumption and investment are smaller but closer to their counterparts. The smaller increase in aggregate demand implies that inflation rate continues to decline by more

¹²The natural rate of interest would rise in absence of adjustment costs on investment.

in the initial periods, as much as in the case of Taylor rule where the MP rate responds to the long-run value of the natural rate and to inflation with a relatively low coefficient (red dashed lines). Interestingly, but not surprisingly, in the medium run the inflation rate is better stabilized under the Taylor rule with higher response coefficient to inflation.

Overall, after a sudden permanent increase in TFP level, inflation decreases. The central bank stabilizes inflation and favors economic activity by tracking r_t^* on a period-by-period basis or, if it reacts to the long-run level of the natural rate (ignoring the graduality of its transition), by placing a greater weight on inflation stabilization.

4.2 Gradual TFP increase

Figure 2 shows the responses to a gradual increase in TFP. Under all three MP rules output gradually increases, driven by the increase in consumption and, in the medium run, investment. Households and firms initially postpone investment, allowing consumption to adjust more smoothly. Investment increases when the TFP gains are sufficiently large.

Inflation can decrease or increase. Inflation decreases if the MP rate follows the Taylor rule (Equation 7) that responds to r^* period by period (black continuous line). The natural rate of interest increases in the short run, to absorb the excess of investment relative to saving in the economy without nominal rigidities. The higher MP rate induces (in the economy with nominal rigidities) households and firms to limit their spending increase due to higher expected income and productivity. Thus, inflation initially decreases, as aggregate supply shifts outwards more than aggregate demand. In equilibrium the MP rate rises to a limited extent, because of the decrease in inflation and the contained short-run increase in output. Consistently, labour mildly and persistently declines. The output gap does not greatly increase because of the contained rise of output in the economy with nominal rigidities relative to its version without nominal rigidities.

Inflation increases substantially if the MP rate does not respond to r^* period by period but only to its long-run value (red dashed line). The latter, in this scenario, does not change.

Thus, households and firms expect a more contained increase in the MP rate and raise the aggregate demand more than in the previous case, favoring an additional short-run increase in output. In equilibrium the MP rate rises further than in the previous case, to stabilize inflation and output. The output gap greatly increases.

Finally (green line with crosses), inflation increases to a small extent if the MP rate responds more strongly to inflation when responding to the long-run value of the natural rate of interest $\bar{r}_t^*$ (instead of the period-by-period r_t^*). Households and firms anticipate a large increase in the MP rate and, thus, limit the rise in aggregate demand. In equilibrium, the increase in the MP rate is limited, because of the relatively small increase in output and inflation. The increase in output gap is contained.

Overall, after a gradual permanent increase in TFP level, inflation can increase or decrease depending on the MP response. As in the case of sudden TFP increase, the central bank stabilizes inflation more effectively by tracking r_t^* on a period-by-period basis or, if it responds only to its long-run level, by systematically reacting relatively more to inflation.

4.3 Gradual increase in the growth rate of labour-augmenting technology

Figure 3 shows the responses to a gradual permanent increase in labour productivity growth (i.e., the growth rate of labour-augmenting technology). Long-run output growth permanently rises and, thus, r^* in the new final steady-state is higher than in the initial one.¹³ The latter initially rises, declines during the transition, and then converges toward its higher long-run level.

In the case of the central bank responding to r^* period by period, the MP rate gradually increases (black continuous line), following the graduality of the increase in r_t^* . Consumption growth rises, supported by the permanent increase in income and financed by the reduction

¹³We report growth rates rather than levels because real variable levels are non-stationary. The only exception is labor, which is stationary and, therefore, reported in level.

in short- and medium-run investment growth. Firms postpone investment to gain from the higher productivity growth. Similarly, labour declines in the short and medium run. The output gap is positive, because the output growth of the sticky-price-and-wage output is larger than the output growth in the economy without nominal rigidities. The latter decreases initially, because of the drop in labour and investment.

The short-run effects of the shock are recessionary (red dashed line) if the MP rate adjusts to the new higher long-run value of the natural rate, $\bar{r}_t^*$, disregarding the gradual nature of the transition of r_t^* (towards its new long-run value). Households and firms anticipate a relatively large increase in the MP rate, consistent with the Taylor rule (equation 8) and greatly reduce their aggregate demand. Thus, the output growth is negative in the short run and inflation decreases. Consistently, the central bank reduces the MP rate. The output gap is negative, as the decrease in output of the economy with nominal rigidities is larger in absolute terms than the decrease in output of the economy without nominal rigidities.

The effects are not recessionary when the central bank responds to the long-run level of r^* (neglecting its transition) if it reacts more strongly to the inflation rate, according to the Taylor rule in equation 8 with a larger coefficient ρ_π (green line with crosses). Households and firms anticipate a much lower increase in the MP rate and, thus, raise aggregate demand. Output growth does not decrease in the short run, and inflation mildly decreases.

Overall, consistent with the previous experiments, inflation stabilization and output performance are improved when MP either tracks the transition path of r^* or responds more strongly to inflation, rather than focusing exclusively on the long-run level of the natural rate.

4.4 Sudden persistent increase in the marginal efficiency of investment

Figure 4 shows the effect of a persistent increase in demand for investment in physical capital, driven by a sudden positive investment-specific technology shock (i.e., an increase in the

marginal efficiency of investment). Output increases, because of higher investment. The increase is gradual because of the investment adjustment costs. Consumption initially declines slightly, as higher savings are needed to finance the increase in investment. Labour and real wage also increase, driven by the higher demand for labour by firms. Inflation rises, consistent with the increase in aggregate demand.

The natural rate of interest initially declines, reflecting the temporary excess of saving over investment generated by investment adjustment costs. As investment gradually accelerates, however, r^* rises persistently in response to stronger investment demand.

The Taylor rules that respond either (i) to r^* period by period or (ii) to its long-run value (which does not change) and more strongly to inflation better stabilize inflation and output. The latter rule implies a smaller increase in output, because of the larger increase in the MP rate. The rule that responds to the long-run value of r^* and less strongly to inflation generates a larger temporary increase in inflation and a larger and more persistent expansion in output, by inducing a larger increase in aggregate demand. In equilibrium the MP rate increases more sharply in the initial period, to limit the large positive responses of inflation and economic activity.

Overall, consistent with the results obtained for the other shocks, the central bank achieves better inflation and output stabilization when the Taylor rule either tracks the transition path of r^* or responds more strongly to inflation, rather than relying on the long-run value of the natural rate.

4.5 Lessons from simulations

Three main results emerge from the simulations. First, AI-induced technology shocks affect both aggregate supply and aggregate demand. As a result, their effects on inflation are inherently ambiguous and depend on the transmission mechanism under consideration. Second, inflation outcomes depend crucially on the relative speed at which productive capacity and aggregate demand adjust. Rapid productivity gains tend to be disinflationary because

supply expands faster than demand, whereas gradual productivity improvements or stronger investment demand are more likely to generate inflationary pressures. Third, MP performs better when it either tracks the transition of the natural rate of interest or responds more strongly to inflation. This finding is particularly relevant because the natural rate is not directly observable and its adjustment following AI-driven structural changes makes more challenging to infer its evolution. Consequently, placing greater weight on observed inflation developments may help central banks avoid policy mistakes associated with mismeasuring the evolution of the natural rate.

5 Conclusions

Our simulations suggest that AI-driven productivity gains stimulate both aggregate supply and aggregate demand. As a result, output increases, while the effects on inflation depend on the relative strength and timing of supply and demand responses. Moreover, the considerable uncertainty surrounding the pace of AI diffusion and adoption makes it difficult to determine *ex ante* which scenario will prevail and to estimate the natural rate of interest, r^* , with sufficient precision. This uncertainty is particularly relevant because r^* is not directly observable and its response to AI-driven structural changes is inherently difficult to estimate in real time. By contrast, inflation is directly observed and provides timely information on the balance between aggregate demand and aggregate supply.

This paper abstracts from the macroeconomic effects of other AI-induced structural changes, including those affecting financial intermediation and credit markets. It also abstracts from the macroeconomic consequences of the redistributive effects of AI in labor markets, including their impact on unemployment. These implications for MP deserve further investigation.¹⁴

¹⁴A first assessment of these implications is provided in Esposito et al. (2026) and Lenzu (2026).

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Table 1: EA variables: steady-state values

<i>Macroeconomic variable</i>	Value
Household's consumption	60.0
Public consumption	20.0
Investment	20.0
Inflation rate	2.0
Growth rate	1.0
Nominal natural rate of interest	3.4
Natural rate of interest	1.4

Note: Consumption and investment are in % of GDP. Inflation and interest rates are in net % annualized term.

Table 2: Preferences, intermediate and final goods technology

Parameter	Value
<i>Households</i>	
Discount factor β	0.999
Intertemporal elasticity of substitution $1/\sigma$	1.0
Habit b_c	0.6
Disutility of labour supply ζ	2.0
Depreciation rate of physical capital δ	0.025
<i>Firms-intermediate goods</i>	
Bias towards physical capital α	0.254

Table 3: Gross markups (elasticities of substitution among goods and labour varieties)

Intermediate goods	1.2000 ($\theta = 6.0$)
Labour	1.3030 ($\theta_L = 4.3$)

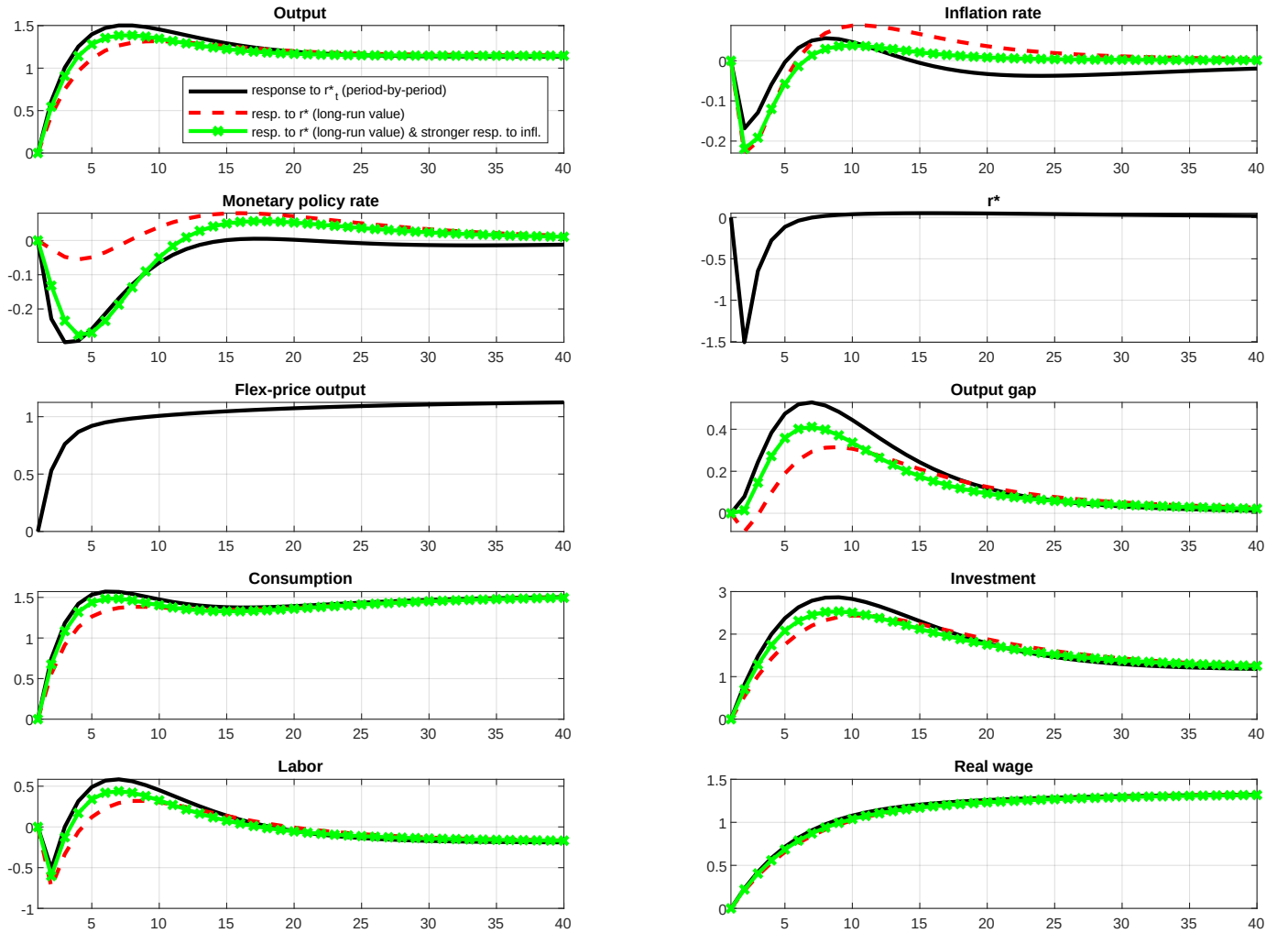
Table 4: Adjustment costs

Parameter	Value
<i>Households</i>	
Investment in physical capital ψ	4.5
Nominal wages κ_W	250
Wage indexation to past inflation ind_W	0.3
<i>Firms</i>	
Price κ_P	200
Price indexation to past inflation ind_P	0.3

Table 5: Monetary policy rule (benchmark calibration)

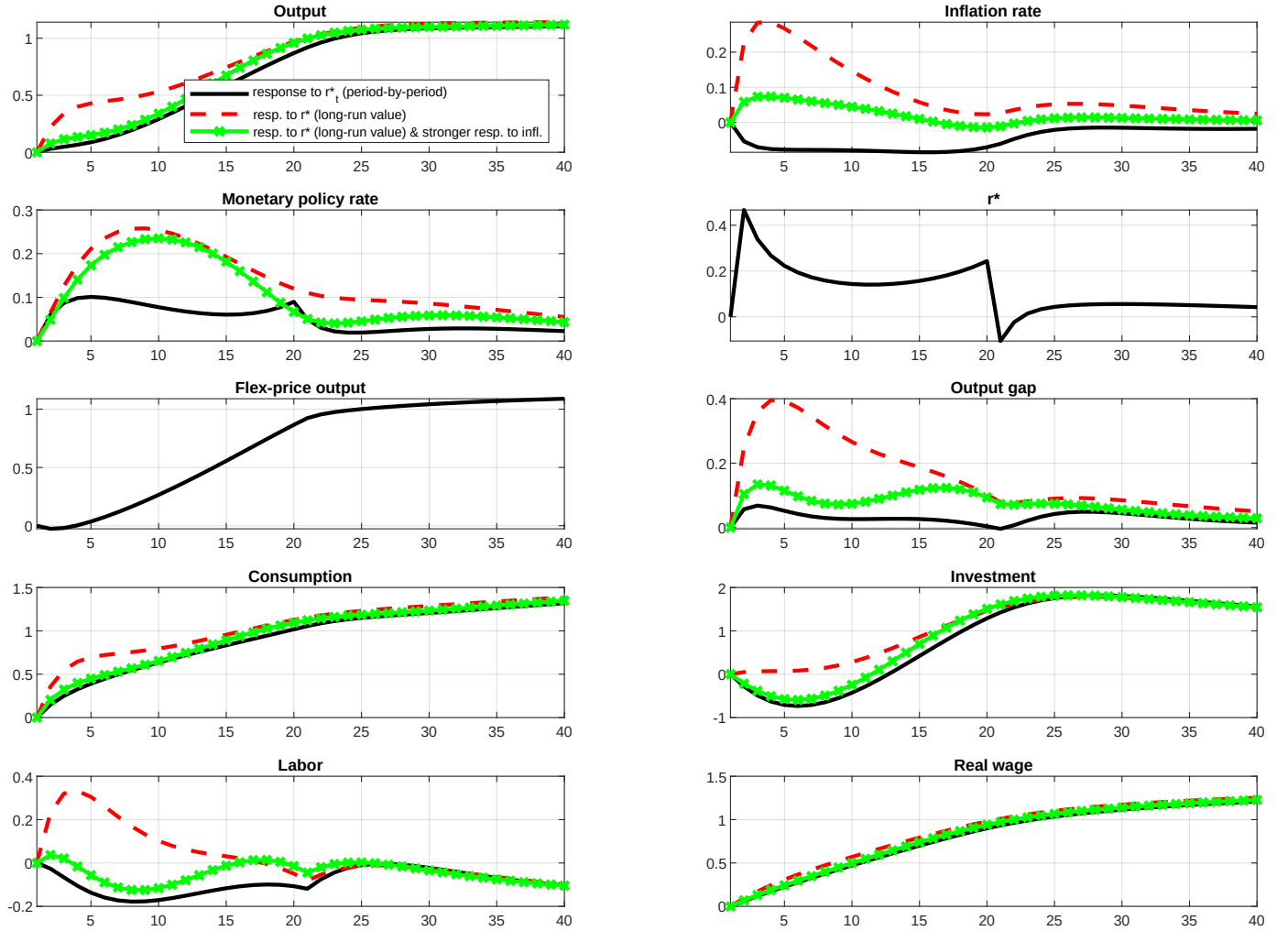
Parameter	Value
Lagged interest rate ρ_R	0.85
Inflation ρ_π	1.50
Output growth ρ_y	0.10

Figure 1: Sudden TFP increase



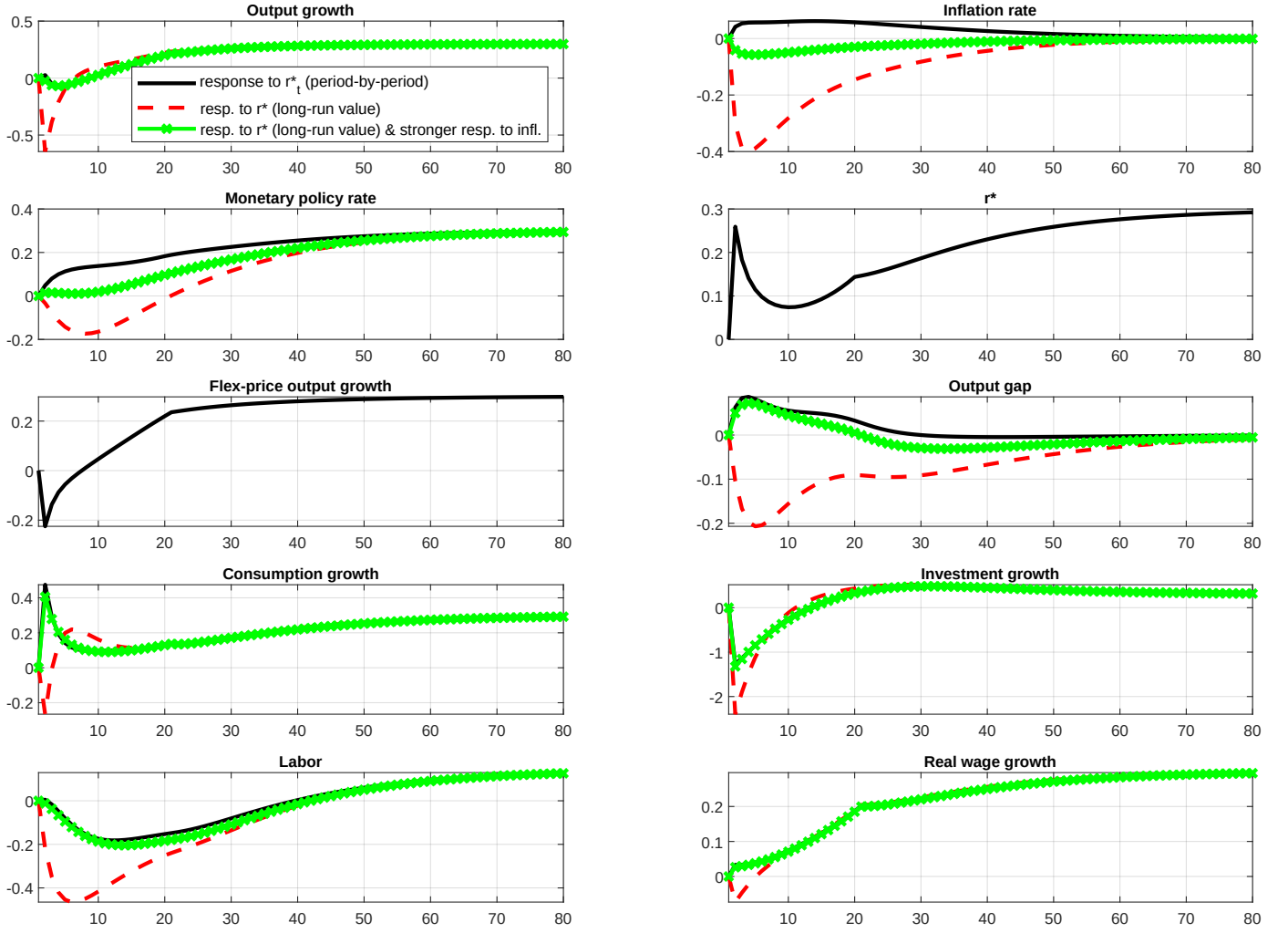
Notes: quarters on the horizontal axis; on the vertical axis, % deviations from the baseline; for interest rates and inflation: annualized percentage-point deviations. r^* is the natural rate of interest.

Figure 2: Gradual TFP increase



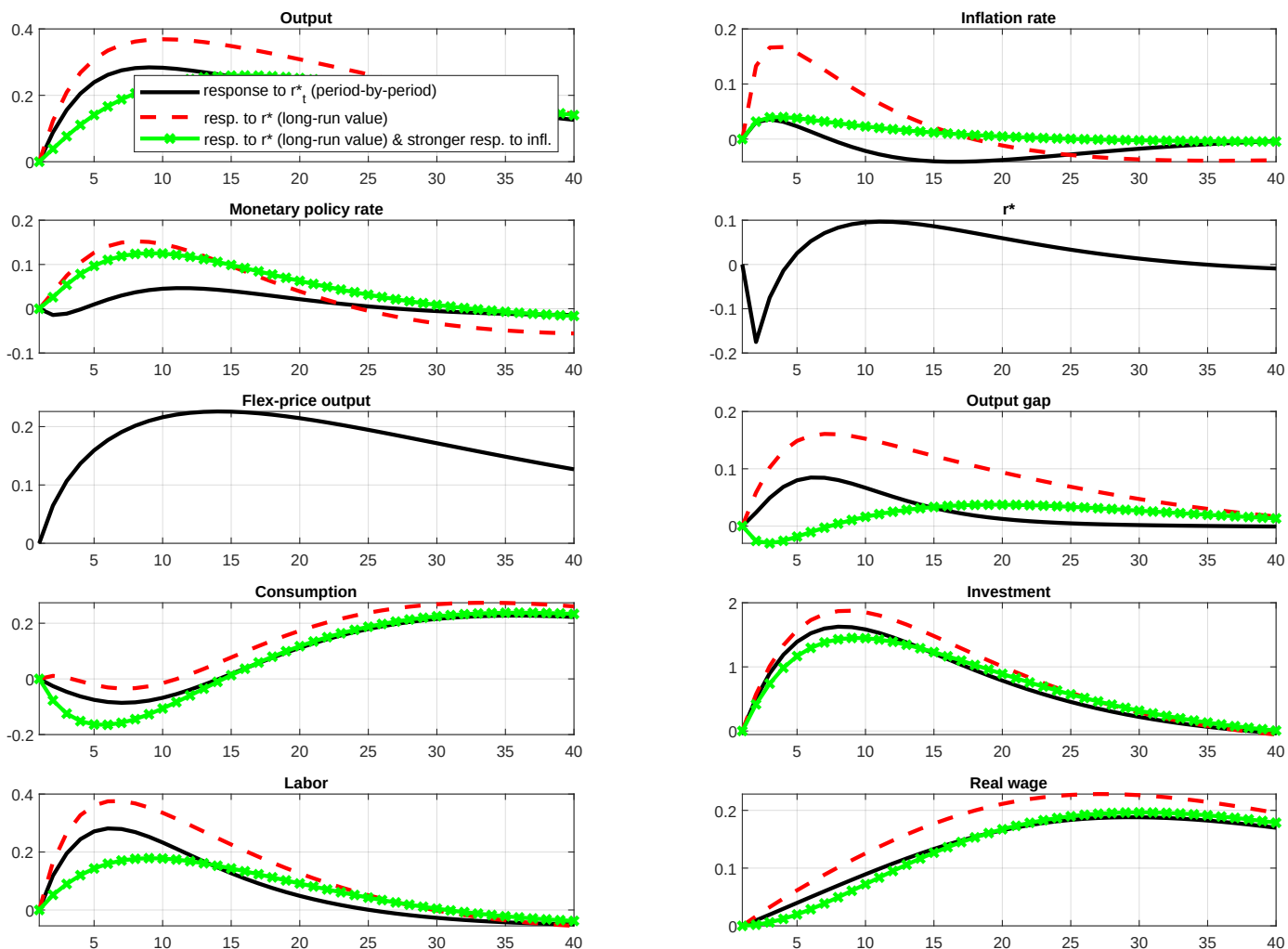
Notes: quarters on the horizontal axis; on the vertical axis, % deviations from the baseline; for interest rates and inflation: annualized percentage-point deviations. r^* is the natural rate of interest.

Figure 3: Gradual increase in the growth rate of labour-augmenting technology



Notes: quarters on the horizontal axis; on the vertical axis, % deviations from the baseline; for interest rates and inflation: annualized percentage-point deviations. r^* is the natural rate of interest.

Figure 4: Increase in investment demand



Notes: quarters on the horizontal axis; on the vertical axis, % deviations from the baseline; for interest rates and inflation: annualized percentage-point deviations. r^* is the natural rate of interest.

Appendix: model equations

In this Appendix we report the equations and the definition of equilibrium of the (closed-economy) New Keynesian model. Similar equations hold for the economy without nominal rigidities, once the adjustment costs on nominal wages and prices are set to zero.

A.1 Final-good production sector

- Production of the representative final good

$$Y_t = \left(\int_0^1 \left(Y_{i,t}^D \right)^{\frac{\theta-1}{\theta}} di \right)^{\frac{\theta}{\theta-1}} \quad (\text{A.1.1})$$

where $\theta > 1$ is the elasticity of substitution between the different brands i . The representative firm maximizes profits with respect to each intermediate good i subject to the above technology constraint and taking prices as given (perfect competition regime). The implied demand and marginal production cost functions are reported in what follows.

- Demand for intermediate good i by the representative firm in the final goods production sector

$$Y_{i,t}^D = \left(\frac{P_{i,t}}{P_t} \right)^{-\theta} Y_t \quad (\text{A.1.2})$$

- Price deflator (marginal production cost)

$$P_t = \left(\int_0^1 P_{i,t}^{1-\theta} di \right)^{\frac{1}{1-\theta}} \quad (\text{A.1.3})$$

A.2 Intermediate production sector

- Production function

$$Y_{i,t} = A_t K_{i,t-1}^\alpha (A_{L,t} L_{i,t})^{1-\alpha}. \quad (\text{A.2.1})$$

Each firm i minimizes production costs with respect to capital and labour subject to the above technology constraint and taking prices and shocks to technology as given. The implied demand curves for capital and labour are reported in in what follows.

- FOC with respect to capital $K_{i,t}$

$$K_{i,t} = \alpha \left(\frac{r_t^K}{rmc_t} \right)^{-1} Y_{i,t} \quad (\text{A.2.2})$$

where r_t^K is the return on capital in real terms (that is, its nominal counterparts divided by the final consumption deflator) and rmc the real marginal cost of production.

- FOC with respect to labour $L_{i,t}$

$$L_{i,t} = (1 - \alpha) \left(\frac{w_t}{rmc_t} \right)^{-1} Y_{i,t} \quad (\text{A.2.3})$$

where

$$w_{j,t} \equiv \frac{W_{j,t}}{P_t} \quad (\text{A.2.4})$$

$$L_{i,t} = \left(\int_0^1 L_{j,t}^{\frac{\theta_L-1}{\theta_L}} dj \right)^{\frac{\theta_L}{\theta_L-1}} \quad (\text{A.2.5})$$

- FOC with respect to labour-type $L_{j,t}$ supplied by household j

$$L_{j,t} = \left(\frac{w_{j,t}}{w_t} \right)^{-\theta_L} L_{i,t} \quad (\text{A.2.6})$$

where

$$w_t \equiv \frac{W_t}{P_t} \quad (\text{A.2.7})$$

$$W_t = \left(\int_0^1 W_{j,t}^{1-\theta_L} dj \right)^{\frac{1}{1-\theta_L}} \quad (\text{A.2.8})$$

Given the marginal cost, each firm i maximizes, under a monopolistic competition regime, its profits with respect to the price of its product i subject to the demand for its good from firms in the final sector and to the following quadratic adjustment cost on prices

$$\frac{\kappa_P}{2} \left(\frac{P_{i,t}/P_{i,t-1}}{\pi_{t-1}^{ind_P} \bar{\pi}^{1-ind_P}} - 1 \right)^2 P_t Y_t \quad (\text{A.2.9})$$

where $\kappa_P > 0$ is a parameter measuring the adjustment cost, π_t is the period-on-period inflation rate, $\bar{\pi}$ is the central bank inflation target, and $0 \leq ind_P \leq 1$ measures the degree of price indexation to past inflation, while $(1 - ind_P)$ measures indexation to the inflation target. The implied supply curve of the product i is reported in what follows.

- FOC with respect to nominal price $P_{i,t}$

$$\begin{aligned} \theta \frac{MC_t}{P_t} \frac{1}{Y_t} + (1 - \theta) \frac{P_{i,t}^{1-\theta}}{P_t^{-\theta}} \frac{1}{Y_t} &= \lambda_{j,t} \kappa_P \left(\frac{P_{i,t}/P_{i,t-1}}{\pi_{t-1}^{ind_P} \bar{\pi}^{1-ind_P}} - 1 \right) \frac{P_{i,t}/P_{i,t-1}}{\pi_{t-1}^{ind_P} \bar{\pi}^{1-ind_P}} \\ &\quad - \beta \lambda_{j,t+1} \kappa_P \left(\frac{P_{i,t+1}/P_{i,t}}{\pi_t^{ind_P} \bar{\pi}^{1-ind_P}} - 1 \right) \frac{P_{i,t+1} P_{t+1} / P_{i,t}^2 Y_{t+1}}{\pi_t^{ind_P} \bar{\pi}^{1-ind_P} Y_t} \end{aligned} \quad (\text{A.2.10})$$

A.3 Household

- Utility function of generic household j

$$E_0 \left\{ \sum_{s=0}^{\infty} \beta^s \left[\frac{(C_{j,s} - b_c C_{s-1})^{(1-\sigma)}}{(1-b_c)(1-\sigma)} - \frac{1}{\zeta} L_{j,s}^{\zeta} \right] \right\} \quad (\text{A.3.1})$$

where we assume external consumption habit ($0 \leq b_c \leq 1$ is a parameter) and that the economy is cashless. The utility is separable in consumption ($1/\sigma > 0$ is the intertemporal elasticity of substitution) and labour supply ($\zeta > 0$ is a parameter, $1/(\zeta - 1)$ is the Frisch elasticity of labor supply). The parameter β ($0 < \beta < 1$) is the discount factor.

- Budget constraint

$$\begin{aligned} \frac{B_{j,t}}{1+i_t} - B_{j,t-1} = & \Pi_t + W_{j,t}L_{j,t} + r_t^K P_t K_{j,t-1} - P_t I_{j,t} - P_t C_{j,t} - Tax_{j,t} \\ & - \frac{\kappa_W}{2} \left(\frac{W_{j,t}/W_{j,t-1}}{\pi_{t-1}^{ind_W} \bar{\pi}^{1-ind_W}} - gr_t \right)^2 W_t L_t \end{aligned} \quad (\text{A.3.2})$$

where B is a riskless bond, paying the MP rate i , exchanged among households and in zero net supply, W_j is the nominal wage set by the household (that supplies labour under monopolistic competition), r^K is the return on physical capital, Π represent profits from firms' ownership (rebated to households in a lump-sum way), Tax_j are lump-sum taxes. The last term on the right-hand side represents quadratic adjustment costs paid by households when setting the nominal wage, where $\kappa_W > 0$ is a parameter measuring nominal rigidities, π is the period-on-period inflation rate, $\bar{\pi}$ is the central bank inflation target, $0 \leq ind_W \leq 1$ measures the degree of wage indexation to past inflation, while $(1 - ind_W)$ measures indexation to the inflation target, and

$$L_t = \int_0^1 L_{i,t} di \quad (\text{A.3.3})$$

is the total labour demand by firms in the intermediate sector. Finally, gr_t is the (gross) growth rate of the economy.

- Capital accumulation law

$$K_{j,t} = (1 - \delta)K_{j,t-1} + \left[1 - \frac{\psi}{2} \left(\frac{I_{j,t}}{I_{j,t-1}} - 1 \right)^2 \right] Z_{I,t} I_{j,t} \quad (\text{A.3.4})$$

where $0 < \delta < 1$ is the depreciation rate and the level of investment is subject to a quadratic adjustment cost and $\psi > 0$ is a parameter measuring the cost of adjustment.

- FOC with respect to consumption $C_{j,t}$

$$\lambda_{j,t} = \frac{(C_{j,t} - b_c C_{t-1})^{-\sigma}}{(1 - b_c)} \quad (\text{A.3.5})$$

- FOC with respect bond $B_{j,t}$

$$\lambda_{j,t} = \beta E_t \left[\lambda_{j,t+1} (1 + i_t) \pi_{t+1}^{-1} \right] \quad (\text{A.3.6})$$

- FOC with respect to the end-of-period capital $K_{j,t}$

$$\lambda_{j,t} Q_{j,t} = E_t \left[\beta \lambda_{j,t} r_{t+1}^K + (1 - \delta) \lambda_{j,t} Q_{j,t+1} \right] \quad (\text{A.3.7})$$

where Q is the Tobin's Q (i.e., the multiplier of the capital accumulation law),

- FOC with respect to investment $I_{j,t}$

$$\begin{aligned} \lambda_{j,t} = Q_{j,t} \lambda_{j,t} Z_{I,t} & \left[1 - \frac{\psi}{2} \left(\frac{I_{j,t}}{I_{j,t-1}} - 1 \right)^2 - \psi \left(\frac{I_{j,t}}{I_{j,t-1}} - 1 \right) \frac{I_{j,t}}{I_{j,t-1}} \right] \\ & + \psi \beta E_t \left[Z_{I,t+1} \lambda_{j,t+1} \left(\frac{I_{j,t+1}}{I_{j,t}} - 1 \right) \frac{I_{j,t+1}^2}{I_{j,t}^2} \right] \end{aligned} \quad (\text{A.3.8})$$

- FOC with respect to nominal wage $W_{j,t}$

$$\begin{aligned} \theta_L \frac{W_{j,t}^{-\theta_L-1}}{W_t^{-\theta_L}} L_{j,t}^{\zeta-1} L_t + (1 - \theta_L) \frac{\lambda_{j,t}}{P_t} L_t \frac{W_{j,t}^{-\theta_L}}{W_t^{-\theta_L}} = - \frac{\lambda_{j,t}}{P_t} \kappa_W \left(\frac{W_{j,t}/W_{j,t-1}}{\pi_{W,t-1}^{ind_W} \bar{\pi}^{1-ind_W}} - gr_t \right) \frac{W_t L_t / W_{j,t-1}}{\pi_{W,t-1}^{ind_W} \bar{\pi}^{1-ind_W}} \\ + \beta E_t \left[\frac{\lambda_{j,t+1}}{P_{t+1}} \kappa_W \left(\frac{W_{j,t+1}/W_{j,t}}{\pi_{W,t}^{ind_W} \bar{\pi}^{1-ind_W}} - gr_{t+1} \right) \frac{W_{j,t+1} W_{t+1} / W_{j,t}^2 L_{t+1}}{\pi_{W,t}^{ind_W} \bar{\pi}^{1-ind_W}} \right] \end{aligned} \quad (\text{A.3.9})$$

A.4 Monetary policy

$$\frac{1 + i_t}{1 + \bar{i}} = \left(\frac{1 + i_{t-1}}{1 + \bar{i}} \right)^{\rho_r} \left(\frac{\pi_t}{\bar{\pi}} \right)^{(1-\rho_r)\rho_\pi} \left(\frac{y_t}{y_{t-1}} \right)^{(1-\rho_r)\rho_y} \quad (\text{A.4.1})$$

A.5 Fiscal policy

- Government budget constraint

In every period public purchases are financed by lump-sum taxes on households

$$P_t G_t = \int_0^1 Tax_{j,t} dj \quad (\text{A.5.1})$$

- Constant (steady-state) public purchases

$$P_t G_t = P_t \bar{G} \quad (\text{A.5.2})$$

A.6 Market clearing conditions

- Generic intermediate good i

$$Y_{i,t}^D = Y_{i,t} \quad (\text{A.6.1})$$

- Final good

$$Y_t = \int_0^1 C_{j,t} dj + \int_0^1 I_{j,t} dj + G_t + \frac{\kappa_P}{2} \int_0^1 \left(\frac{P_{i,t}/P_{i,t-1}}{\pi_{t-1}^{ind_P} \bar{\pi}^{1-ind_P}} - 1 \right)^2 Y_t(i) di \quad (\text{A.6.2})$$

- Bonds

$$\int_0^1 B_{j,t} dj = 0 \quad (\text{A.6.3})$$

- Physical capital

$$\int_0^1 K_{j,t} dj = \int_0^1 K_{i,t} di \quad (\text{A.6.4})$$

- Generic labour j

$$L_{j,t} = \int_0^1 L_{i,j,t} di \quad (\text{A.6.5})$$

A.7 Definition of equilibrium

We consider a symmetric dynamic general equilibrium where, in response to exogenous shocks, the sequence of prices and real variables are such that: (i) both the representative firm in the final production sector and the representative firm in the intermediate production sector maximize their corresponding profits subject to their (technology and demand) constraints; (ii) the representative household maximizes her intertemporal utility function subject to the budget constraint and labour demand; (iii) the central bank follows the Taylor rule; (iv) the government budget constraint holds; (v) all markets clear.