

AI and Human Capital Accumulation: Aggregate and Distributional Implications*

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Abstract

This paper examines how anticipated advances in artificial intelligence (AI) – which compress middle-skill wage premia but increase returns to high-level expertise – reshape human capital investment, labor supply, saving, and inequality. We build an incomplete-markets model with endogenous human capital and asset accumulation in general equilibrium, featuring three skill sectors and uninsurable idiosyncratic risk. We characterize household's behavior using a two-period version, then calibrate an infinite-horizon model to U.S. data. Our findings reveal that AI induces a *voluntary job polarization* through both human capital investment and labor supply choices, reallocating workers away from the middle toward both tails. Human capital adjustments amplify AI's positive effects on aggregate output and consumption while dampening its impact on employment. These adjustments also raise income and consumption inequality but mitigate the rise in wealth inequality that AI advancements would otherwise generate.

Keywords: AI, Job Polarization, Human Capital, Inequality

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¹ 1 Introduction

² A defining feature of recent AI advancements is their ability to perform complex,
³ cognitive, non-routine tasks – capacities that once required substantial education
⁴ and expertise. This fundamental difference sets AI apart from earlier waves of au-
⁵ tomation or computerization, which primarily replaced manual or routine labor.¹ In
⁶ this paper, we make a central assumption – supported by a growing body of evidence
⁷ – that AI adoption reduces the premium for middle-level skills while increasing the
⁸ value of high-level expertise. Based on this assumption, we construct an incomplete
⁹ markets economy with endogenous asset accumulation and general equilibrium to
¹⁰ study how AI’s effects on skill premia interact with households’ human capital in-
¹¹ vestment, and their subsequent impact on aggregate and distributional outcomes of
¹² the economy.

¹³ 1.1 *Evidences for AI’s effects on skill premia*

¹⁴ Recent labor market data highlight the disproportionate impact of AI on entry-level
¹⁵ employment opportunities. Bloomberg (2025) reports that, in the words of Matt
¹⁶ Sigelman, president of the Burning Glass Institute, “Demand for junior hires in
¹⁷ many college-level roles is already declining, even as demand for experienced hires
¹⁸ in the same jobs is on the rise.” According to Revelio Labs (2025), postings for
¹⁹ entry-level jobs in the US declined by about 35% since January 2023, with roles
²⁰ more exposed to AI experiencing even steeper reductions.

²¹ Recent experimental evidence reviewed by Calvino *et al.*, (2025) shows that
²² workers’ productivity gains from AI depend on their skill levels and experience. On
²³ simpler tasks where AI performs well, the technology can narrow the productivity
²⁴ gap between experienced and less experienced workers. However, for more complex
²⁵ tasks that AI cannot yet perform effectively, those with greater digital proficiency
²⁶ or task-specific experience achieve higher productivity gains, as successful use of AI
²⁷ in these settings requires more advanced skills and experience that involves under-
²⁸ standing AI’s capabilities and limitations.

²⁹ Firm-level evidence reveals similar patterns. Aghion *et al.*, (2019) documents
³⁰ that the average worker in low-skilled occupations receives a significant wage pre-
³¹ mium when employed by a more innovative firm. Souza (2025) finds that the adop-
³² tion of AI in Brazilian firms increases employment for low-skilled production workers
³³ but reduces employment and wages for middle-wage office workers. Asam and Heller
³⁴ (2025) report that GitHub Copilot enables software startups to raise initial funding
³⁵ 19% faster with 20% fewer developers, and that these productivity gains dispropor-
³⁶ tionately benefit startups with more experienced founders.

¹For example, AI tools in medical diagnostics now assist radiologists in analyzing medical images, potentially reducing demand for entry-level radiologists while simultaneously increasing the productivity of senior professionals.

37 In anticipation of these changes, households are likely to adjust their human cap-
38 ital investments. A 2022 report by Higher Education Strategy Associates finds that
39 following decades of growth, dropping student enrollment in higher education has
40 become a major trend in the Global North (Higher Education Strategy Associates,
41 2022). In the U.S., the public across the political spectrum has increasingly lost
42 confidence in the economic benefits of a college degree.²

43 On the other hand, demand for sector-based training and reskilling opportunities
44 has been rising. The Oliver Wyman Forum (2024) study documents widespread and
45 significant gaps between employees' desire for reskilling in generative AI and the
46 opportunities their employers are willing to offer. The study estimates that, over
47 the coming decade, billions of workers will need upskilling and millions may require
48 complete reskilling.

49 *1.2 Overview of our model and results*

50 We consider an economy with three sectors, each requiring low, middle, or high levels
51 of skill (human capital) and exhibiting increasing labor productivity. Households
52 can invest in human capital to move up to more productive sectors; without such
53 investment, their skills depreciate, causing them to shift toward less productive
54 sectors over time. Human capital investment occurs at two levels: a basic level
55 achievable while working, and a higher level that demands full-time commitment,
56 such as pursuing higher education or reskilling training. Households face uninsurable
57 idiosyncratic productivity shocks, affecting both their labor productivity and the
58 returns to human capital investment.

59 We model AI advancements as increasing the productivity for the low and high
60 sectors but not for the middle sector so that the skill premium of the middle sector
61 decreases and the skill premium of the high sector increases.

62 Using a two-period partial equilibrium model, we show that the effects of AI
63 on skill premia discourage human capital investment for households in the low sec-
64 tor and encourage human capital investment for households in the middle sector,
65 thereby increasing human capital inequality. Human capital investment via full-
66 timing training crowds out households' labor supply so that households in the low
67 sector supplies more labor whereas households in the high sector supplies less labor,
68 in response to the AI advancements.

69 We also examine how human capital investment interacts with saving decisions.
70 When households are able to adjust their human capital, changes in skill premia
71 affect their exposure to idiosyncratic risk, since moving between sectors alters the
72 level of their labor income. As AI reduces the skill premium for the middle sector,

²Pew Research Center reports that about half of Americans say having a college degree is less important today than it was 20 years ago in a survey conducted in 2023 (Pew Research Center, 2024). A 2022 study from Public Agenda (2022), a nonpartisan research organization, shows that young Americans without college degrees are most skeptical about the value of higher education.

73 households in the low sector face less idiosyncratic risk and consequently decrease
74 their precautionary saving. In contrast, because AI increases the skill premium for
75 the high sector, households in the high sector become more exposed to risk and
76 therefore increase their saving. For households in the middle sector, the effect of AI
77 on saving is ambiguous.

78 At the economy level, the effects of AI advancements depend on the sectoral re-
79 distribution of households and the general equilibrium effects via wage and capital
80 return responses. We quantify these effects using a fully-fledged dynamic quanti-
81 tative model that incorporates an infinite horizon, endogenous asset accumulation,
82 and general equilibrium. The model is calibrated to reflect key features of the U.S.
83 economy, capturing realistic household heterogeneity. The steady state distribution
84 of human capital without AI advancements pins down the sectoral distribution of
85 households. We then introduce fully anticipated AI advancements happening in the
86 near future and study the transition dynamics from the current state of the economy
87 to the eventual new steady state.

88 Our quantitative model demonstrates that AI induces a *voluntary job polarization*
89 through both human capital investment and labor supply choices. A substan-
90 tial share of middle-sector households voluntarily reallocate to either the low or
91 high sectors in the new steady state via human capital adjustments. During the
92 transition, human capital accumulation becomes increasingly concentrated among a
93 smaller segment of the population, reflecting growing inequality in skill acquisition.
94 In addition to these population shifts, labor supply dynamics further contribute to
95 job polarization: many middle-sector households reduce their labor supply as they
96 engage in full-time training to upskill more rapidly, while labor supply in the low
97 sector rises more than in the high sector.

98 Building on these labor dynamics, our model investigates how AI shapes the
99 economy's aggregate and distributional outcomes through both its direct impact on
100 sectoral productivity and the endogenous adjustments in human capital investment.
101 To highlight these mechanisms, we compare the transition dynamics of our bench-
102 mark model – where households can adjust their human capital – with those of a
103 counterfactual model where human capital remains fixed at its initial steady state.

104 Our findings reveal that human capital responses to AI amplify its positive effects
105 on aggregate output and consumption, but mitigate its positive effect on employ-
106 ment. While AI's direct effect on sectoral productivity reduces income and con-
107 sumption inequalities, job polarization resulting from human capital adjustments
108 reverses this effect and increases both inequalities.

109 Regarding households' saving, the indirect effect of AI through human capital
110 adjustments has little impact on aggregate savings – both in terms of steady state
111 and during the transition. However, these adjustments have a substantial impact
112 on the distribution of wealth: while AI's direct effect increases wealth inequality,

113 the indirect effect from human capital responses partially offsets this increase.

114 1.3 Related Literature

115 This paper relates to the literature on how technological change, including AI and
116 robotics, drives job polarization and affects the demand and supply of labor. Studies
117 find that rising employment in both high- and low-wage occupations – at the expense
118 of middle-skill jobs – characterizes job polarization across the UK, US, and Western
119 Europe (Goos and Manning, 2007; Autor and Dorn, 2013; Goos *et al.*, 2014). Robots
120 and automation have also been shown to reduce employment and wages across US
121 regions (Acemoglu and Restrepo, 2020), with automation-induced job losses and
122 declining labor force participation especially concentrated among vulnerable workers
123 in highly automated sectors (Lerch, 2021; Faber *et al.*, 2022). Wang and Wong
124 (2025) models AI as a learning-by-using technology and predicts large productivity
125 gains and employment loss in the long-run.

126 Technological disruption also influences human capital accumulation. Faced with
127 employment risks caused by automation, many affected workers invest in further
128 education as a form of self-insurance, rather than relying solely on increases in the
129 college wage premium (Atkin, 2016; Beaudry *et al.*, 2016). Consistent with this,
130 Di Giacomo and Lerch (2023) and Dauth *et al.*, (2021) find that the adoption of
131 industrial robots in the U.S. and Germany, respectively, has led to increased college
132 and university enrollments.

133 Building on this literature, our paper develops a model that explicitly allows for
134 a trade-off between labor supply and human capital investment. In our framework,
135 job polarization emerges as a voluntary response to AI advancements: households in
136 the middle sector may choose to either downskill to the low sector or upskill to the
137 high sector, while an increasing number of middle-sector households opt for full-time
138 training to accelerate their upskilling.

139 This paper also relates to the literature that studies human capital and physical
140 capital in a unified framework. Chanda (2008) shows that the rise in returns to
141 education reduces household savings. Waldinger (2016) finds that human capital
142 is much more important than physical capital for innovation in both the short and
143 long-run. Huggett *et al.*, (2011) develops a risky human capital model with incom-
144 plete markets to estimate the source of lifetime inequality. Park (2018) investigates
145 whether capital and human capital are over-accumulated in an incomplete market
146 economy. Our model is most similar to Huggett *et al.*, (2011) in that human capital
147 is risky and there is a trade-off between human capital investment and labor supply.
148 Our analysis sheds light on the effect of AI-induced human capital adjustments on
149 households labor supply and saving.

150 A growing body of literature suggests that AI and automation may contribute to
151 rising inequality across income, consumption, and wealth (e.g., Sachs and Kotlikoff,

152 2012; Berg *et al.*, 2018; Prettner and Strulik, 2020; Hémous and Olsen, 2022).
153 Our model confirms that AI advancements indeed increase inequality in all three
154 dimensions. However, we find that the endogenous human capital responses to
155 AI amplify the rise in income and consumption inequality, while at the same time
156 mitigating the increase in wealth inequality.

157 The rest of the paper is organized as follows. Section 2 describes the model envi-
158 ronment. Section 3 solves the household’s problem using a two-period version of the
159 model. Section 4 solves the fully-fledged quantitative model and calibrates it to fit
160 key features of the U.S. economy, including employment rate, human capital invest-
161 ment, and household heterogeneity. Section 5 incorporates AI into the quantitative
162 model and examines its impacts on human capital adjustments. Section 6 analyzes
163 the aggregate and distributional effects of AI. Section 7 concludes.

164 2 Model Environment

165 Time is discrete and infinite. There is a continuum of households. Each house-
166 hold is endowed with one unit of indivisible labor and faces an idiosyncratic labor
167 productivity shock, z , and an idiosyncratic learning-ability shock, y . The labor
168 productivity shock follows an AR(1) process in logs:

$$\ln z' = \rho_z \ln z + \varepsilon_z, \varepsilon_z \stackrel{\text{iid}}{\sim} N(0, \sigma_z^2) \quad (1)$$

169 The learning-ability shock follows an AR(1) process in logs:

$$\ln y' = \rho_y \ln y + \varepsilon_y, \varepsilon_y \stackrel{\text{iid}}{\sim} N(0, \sigma_y^2) \quad (2)$$

170 Households observe (z_t, y_t) at the beginning of each period before making decisions.
171 The asset market is incomplete following Aiyagari (1994), and the physical capital,
172 a , is the only asset available to households to insure against idiosyncratic labor
173 income risk. Households can also invest in human capital, h , which allows them to
174 work in sectors with different human capital requirement.

175 2.1 Production Technology

176 The production technology in the economy is a constant-returns-to-scale Cobb-
177 Douglas production function:

$$F(K, L) = K^{1-\alpha} L^\alpha \quad (3)$$

178 K represents the total physical capital accumulated by households, while L denotes
179 the total effective labor supplied by households, aggregated across three sectors: low,

180 middle, and high. The marginal products of capital and effective labor determine
 181 the economy-wide wage rate, w , and interest rate, r .

182 These sectors differ in their technologies for converting labor into effective labor
 183 units and in the levels of human capital required for employment. The middle sector
 184 employs households with human capital above h_M and converts one unit of labor
 185 to one effective labor unit. The high sector, requiring human capital above h_H ,
 186 converts one unit of labor to $1 + \lambda$ effective units, while the low sector, with no
 187 human capital requirement, converts one unit into $1 - \lambda$ effective units. This implies
 188 a sectoral labor productivity $x(h)$ that is a step function in human capital:

$$x(h) = \begin{cases} 1 - \lambda & \text{low sector if } h < h_M \\ 1 & \text{middle sector if } h_M < h < h_H \\ 1 + \lambda & \text{high sector if } h > h_H \end{cases} \quad (4)$$

189 A household i who decides to work thus contributes $z_i x(h_i)$ units of effective labor,
 190 where z_i is his idiosyncratic productivity. Denote $n_i \in \{0, 1\}$ as the indicator that
 191 takes one if the household works and zero if the household does not. The aggregate
 192 labor is

$$L = \int n_i z_i x(h_i) di, \quad (5)$$

193 assuming perfect substitutability of effective labor across the three sectors.

194 2.2 Household's Problem

195 Households derive utility from consumption, incur disutility from labor and effort of
 196 human capital investment. A household maximizes the expected lifetime utility by
 197 optimally choosing consumption, saving, labor supply and human capital investment
 198 each period, based on his idiosyncratic shocks (z_t, y_t):

$$\max_{\{c_t, a_{t+1}, n_t, e_t\}_{t=0}^{\infty}} E_0 \left[\sum_{t=0}^{\infty} \beta^t (\ln c_t - \chi_n n_t - \chi_e e_t) \right] \quad (6)$$

199 where c_t represents consumption, a_{t+1} represents saving, $n_t \in \{0, 1\}$ is labor supply,
 200 and e_t is the effort of human capital investment.

201 If a household decides to work in period t , he will be employed into the appro-
 202 priate sector according to his human capital h_t and receive labor income $w_t z_t x(h_t)$.
 203 The household's budget constraint is

$$c_t + a_{t+1} = n_t (w_t z_t x(h_t)) + (1 + r_t) a_t \quad (7)$$

$$c_t \geq 0 \text{ and } a_{t+1} \geq 0 \quad (8)$$

204 We prohibit households from borrowing $a_{t+1} \geq 0$ to simplify analysis.³

³According to Aiyagari (1994), a borrowing constraint is necessarily implied by present value

205 Human capital investment can take three levels of effort: $\{0, e_L, e_H\}$. A non-
 206 working household is free to choose any of the three effort levels but a working
 207 household cannot devote the highest level of effort e_H , reflecting a trade-off between
 208 working and human capital investment. Hence:

$$e_t \in \{0, e_L, (1 - n_t)e_H\}. \quad (9)$$

209 Its contribution to next-period human capital is subject to the learning-ability shock:

$$h_{t+1} = y_t e_t + (1 - \delta_h) h_t \quad (10)$$

210 where δ_h is human capital's depreciation rate. We interpret $y_t e_t$ as effective human-
 211 capital investment, with y_t capturing a learning-ability shock.⁴

212 3 Household Decisions in a Two-Period Model

213 In this section, we solve the household's problem with two periods to gain intuition.

214 **Period-2 decisions** Households do not invest in human capital or physical capital
 215 in the last period. The only relevant decision is whether to work.

216 The household works $n = 1$ if and only if $z \geq \bar{z}(h, a)$, with $\bar{z}(h, a)$ defined as

$$\ln(w\bar{z}(h, a)x(h) + (1 + r)a) - \chi_n = \ln((1 + r)a) \quad (11)$$

217 The household faces a trade-off between earning labor income and incurring the
 218 disutility of working. Given the sector-specific productivity $x(h)$ specified in (4),
 219 the threshold for idiosyncratic productivity, $\bar{z}(h, a)$, takes on three possible values:

$$\bar{z}(h, a) = \begin{cases} \bar{z}(a)^{\frac{1}{1-\lambda}} & \text{if } h < h_M \\ \bar{z}(a) & \text{if } h_M \leq h < h_H \\ \bar{z}(a)^{\frac{1}{1+\lambda}} & \text{if } h > h_H \end{cases} \quad (12)$$

$$\text{where } \bar{z}(a) := \frac{(\exp(\chi_n) - 1)(1 + r)a}{w} \quad (13)$$

220 Households with higher human capital is more likely to work, whereas households
 221 with higher physical capital is less likely to work.

222 **Period-1 decisions** In addition to labor supply, period-1 decisions include saving
 223 and human capital investment, both of which are forward-looking and affected by

budget balance and nonnegativity of consumption. Since the borrowing limit is not essential to our analysis, we set it to zero for simplicity.

⁴Separating y_t from the labor productivity shock z_t introduces an additional state variable relative to the special case in which learning ability is perfectly correlated with labor productivity. In the quantitative model, we discretize (z_t, y_t) jointly (allowing for correlation if desired).

224 the idiosyncratic risk associated with the productivity shock z' . Our model also
 225 features a trade-off between human capital investment and labor supply as a working
 226 household cannot devote the highest level of effort e_H in human capital investment.
 227 Therefore, human capital investment grants households the possibility of a discrete
 228 wage hike in the future but may entail a wage loss in the current period.

229 To see the implication of this trade-off and how it interacts with uninsured
 230 idiosyncratic risk, we proceed in two steps. We first derive the period-1 decisions
 231 without uncertainty by assuming that z' is known to the household at period 1 and
 232 z' is such that the household will work in period 2. We then reintroduce uncertainty
 233 in z' and compare the decision rules with the case without uncertainty.

234 *3.1 Period-1 Labor Supply and Human Capital Investment*

235 **3.1.1 Consumption and saving without uncertainty**

236 The additive separability of household's utility implies that labor supply n and
 237 human capital investment e enters in consumption and saving choices only via the
 238 intertemporal budget constraint:

$$c + \frac{c'}{1+r'} = (1+r)a + n(wzx(h)) + \frac{w'z'x(h')}{1+r'} \\ \text{with } h' = ye + (1-\delta)h.$$

239 The log utility in consumption implies the optimality condition:

$$c' = \beta(1+r')c. \quad (14)$$

240 Combining it with the budget constraint, we obtain the optimal consumption as a
 241 function of labor supply n and human capital investment e :

$$c(n, e) = \frac{1}{1+\beta} \left[(1+r)a + n(wzx(h)) + \frac{w'z'x(h' = ye + (1-\delta)h)}{1+r'} \right]. \quad (15)$$

242 **3.1.2 Labor supply and human capital investment**

243 The optimal consumption rules in (15) and (14) allow us to express the household's
 244 problem as the maximization of an objective function in labor supply n and human
 245 capital investment e :⁵

$$\max_{n,e} (1+\beta) \ln c(n, e) - \chi_n n - \chi_e e \quad (16)$$

246 This maximization depends critically on the household's current human capital and
 247 achievable next-period human capital. Accordingly, we partition households into

⁵This follows since $c' = \beta(1+r')c$, so $\ln c' = \ln \beta + \ln(1+r') + \ln c$.

248 three ranges of h : $[0, h_M(1-\delta)^{-1}]$, $[h_M(1-\delta)^{-1}, h_H(1-\delta)^{-1}]$, and $[h_H(1-\delta)^{-1}, h_{\max}]$.

249 We now derive the decision rules for households $h \in [0, h_M(1-\delta)^{-1}]$ in detail, as the
250 decision rules for the other two ranges are similar. Conditional on a given learning
251 ability y , we define two cutoffs in human capital:

$$\underline{h}_M(y) := \frac{h_M - ye_H}{1 - \delta}, \quad \bar{h}_M(y) := \frac{h_M - ye_L}{1 - \delta} \quad (17)$$

252 These cutoffs divide households into three groups based on their ability to be em-
253 ployed in the middle sector in the next period. **Non-learners** are households with
254 $h < \underline{h}_M(y)$. They cannot achieve $h' > h_M$ with either e_L or e_H level of human
255 capital investment today. **Slow learners** are households with $h \in (\underline{h}_M(y), \bar{h}_M(y))$.
256 These households can reach $h' > h_M$ in the next period only by investing $e = e_H$
257 today. **Fast learners** are households with $h > \bar{h}_M(y)$. They can achieve $h' > h_M$
258 in the next period if they invest $e = e_L$ today.

259 Conditional on y and learner type, the optimal choices of labor supply and human
260 capital investment are characterized by cutoffs in z . The cutoff formulae varies with
261 households' current sectoral productivity, i.e, if $h < h_M$ or not.

262 **Non-learners** will not invest in human capital, $e = 0$, and their future sectoral
263 productivity will be $x(h') = 1 - \lambda$. Non-learners work $n = 1$ if and only if:

$$z \geq \bar{z}_{non}^L(a, h) = \frac{(\exp(\frac{\chi_n}{1+\beta}) - 1) \left[(1+r)a + \frac{w'z'(1-\lambda)}{1+r'} \right]}{w(1 - \mathbb{1}_{h < h_M} \lambda)} \quad (18)$$

264 **Slow learners** choose between $e = 0$ and $e = e_H$, since $e = e_L$ incurs a cost
265 without any future benefit. Slow learners must trade off between working and human
266 capital investment: choosing $e = e_H$ requires not working today ($n = 0$), while
267 opting to work means forgoing investment in human capital ($n = 1, e = 0$).⁶

268 Slow learners prefer $(n = 1, e = 0)$ to $(n = 0, e = e_H)$ if and only if:

$$z \geq \bar{z}_{slow}^L(a, h) = \frac{(\exp(\frac{\chi_n - \chi_e e_H}{1+\beta}) - 1) [(1+r)a + \frac{w'z'}{1+r'}] + \lambda \frac{w'z'}{1+r'}}{w(1 - \mathbb{1}_{h < h_M} \lambda)} \quad (19)$$

269 **Fast learners** do not exert high effort e_H in human capital investment. They
270 choose among three options: $(n = 1, e = 0)$, $(n = 1, e = e_L)$, and $(n = 0, e = e_L)$,⁷

⁶The choice between $(n = 0, e = e_H)$ and $(n = 0, e = 0)$ does not depend on z . For e_H to be relevant, λ must be large enough so that $(n = 0, e = e_H)$ is preferred to $(n = 0, e = 0)$. See Appendix A.2 for details on the lower bound for λ .

⁷Similar to the case of slow learners, the choice between $(n = 0, e = e_L)$ and $(n = 0, e = 0)$ does not depend on z . Moreover, since our model is set up so that $(n = 0, e = e_H)$ dominates $(n = 0, e = 0)$, it implies that $(n = 0, e = e_L)$ dominates $(n = 0, e = 0)$.

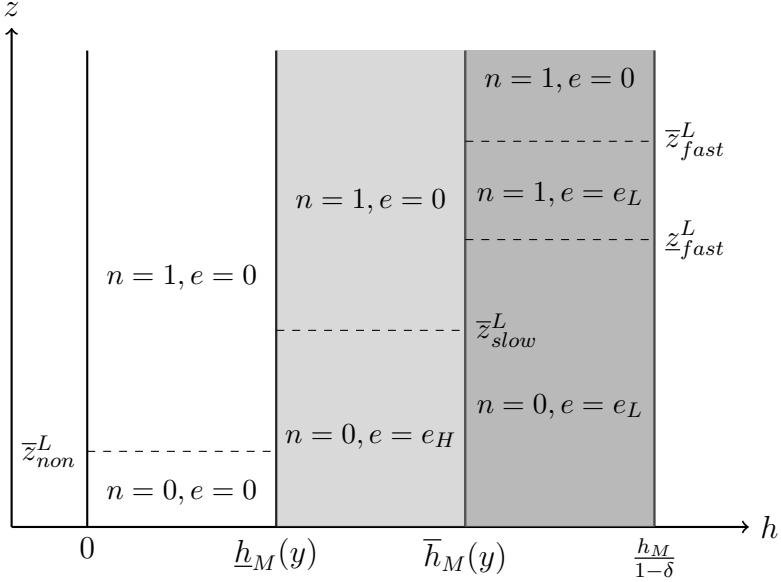


Figure 1: Decision Rule Diagram for $0 \leq h < h_M(1 - \delta)^{-1}$

Conditional on a given learning ability y , the figure illustrates the decision rule (n, e) as a function of states (z, h, a) for households with $0 \leq h < h_M \frac{1}{1-\delta}$. The human capital h changes along the horizontal axis and the labor productivity shock z changes along the vertical axis. The two vertical lines $h_M(y)$ and $\bar{h}_M(y)$ defined in (17) separate the state space into non-learners, slow learners, and fast learners. Within each learner type, labor supply and investment choices vary with z .

²⁷¹ with the decision rule as follows:

$$n(z, h, a), e(z, h, a) = \begin{cases} n = 1, e = 0 & \text{if } z \geq \bar{z}_{fast}^L(a, h) \\ n = 1, e = e_L & \text{if } \underline{z}_{fast}^L(a, h) \leq z < \bar{z}_{fast}^L(a, h) \\ n = 0, e = e_L & \text{if } z < \underline{z}_{fast}^L(a, h) \end{cases} \quad (20)$$

²⁷² where

$$\bar{z}_{fast}^L(a, h) = \frac{\left\{ \exp(\frac{\chi_e e_L}{1+\beta}) \lambda \left[\exp(\frac{\chi_e e_L}{1+\beta}) - 1 \right]^{-1} - 1 \right\} \frac{w' z'}{1+r'} - (1+r)a}{w(1 - \mathbb{1}_{h < h_M} \lambda)} \quad (21)$$

²⁷³

$$\underline{z}_{fast}^L(a, h) = \frac{(\exp(\frac{\chi_n}{1+\beta}) - 1)[(1+r)a + \frac{w' z'}{1+r'}]}{w(1 - \mathbb{1}_{h < h_M} \lambda)} \quad (22)$$

²⁷⁴ We set up our model so that $\bar{z}_{fast}^L(a, h) > \underline{z}_{fast}^L(a, h)$.⁸

²⁷⁵ **Decision rule diagram:** Figure 1 illustrates how the decision rules of labor supply
²⁷⁶ n and human capital investment e vary with (z, h, a) for households with $h < h_M \frac{1}{1-\delta}$
²⁷⁷ conditional on a given y . The human capital h changes along the horizontal axis

⁸Appendix A.2 provides the parameter restrictions such that the condition for $(n = 0, e = e_H)$ to dominate $(n = 0, e = 0)$ is sufficient for $\bar{z}_{fast}^L(a, h) > \underline{z}_{fast}^L(a, h)$.

278 and the labor productivity shock z changes along the vertical axis. The two vertical
 279 lines $\underline{h}_M(y)$ and $\bar{h}_M(y)$ defined in (17) separate the state space into non-learners
 280 (unshaded area), slow learners (lightly shaded area), and fast learners (darkly shaded
 281 area). Within each learner type, labor supply and investment choices vary with z
 282 and the dashed horizontal lines represents the cutoffs in z .

283 Households with $h_M \frac{1}{1-\delta} \leq h < h_H \frac{1}{1-\delta}$ have a decision rule analogous to those with
 284 $h < h_M \frac{1}{1-\delta}$. Conditional on y , the boundaries for learner type change to:

$$\underline{h}_H(y) := \frac{h_H - ye_H}{1 - \delta}; \quad \bar{h}_H(y) := \frac{h_H - ye_L}{1 - \delta} \quad (23)$$

285 The four cutoffs in z that partition the decision regions change to $\bar{z}_{non}^M(a, h)$, $\bar{z}_{slow}^M(a, h)$,
 286 $\underline{z}_{fast}^M(a, h)$, and $\bar{z}_{fast}^M(a, h)$ (see Appendix A.1 for the explicit formulae).

287 Households with $h \geq h_H \frac{1}{1-\delta}$ are always non-learners, since their human capital
 288 guarantees high-sector employment next period without further investment. For
 289 them, only the cutoff $\bar{z}_{non}^H(a)$ matters.

290 3.2 The Effects of Uninsured Idiosyncratic Risk

291 We now reintroduce the idiosyncratic risk to households in period 1 by assuming
 292 that z' follows a log-normal distribution with mean \bar{z}' and variance σ_z^2 .

293 Our previous analysis without uncertainty is a special case with $\sigma_z^2 = 0$. The
 294 effects of uninsured idiosyncratic risk can be thought as how households' decisions
 295 change when the distribution of z' undergoes a mean-preserving spread in the sense
 296 of second-order stochastic dominance.

297 From a consumption-saving perspective, the uncertain z' is associated with future
 298 labor income risk. It is well understood in the literature that idiosyncratic future
 299 income risk raises the expected marginal utility of future consumption for households
 300 with log utility and makes them save more. In our model, households can also supply
 301 more labor to mitigate the effect of idiosyncratic income risk on the marginal utility
 302 of consumption.

303 From the perspective of human capital investment, the uncertain z' is associated
 304 with risk in the return to human capital. Conditional on working, households'
 305 income increases with z' : $c' = (1 + r')a' + w'x(h')z'$. $\ln(c')$ is increasing and concave
 306 in z' , and a higher $x(h')$ increases the concavity.⁹ Consider two levels of h' , $\bar{h}' > \underline{h}'$, a
 307 mean-preserving spread of z' distribution reduces the expected utility at both levels
 308 of h' but the reduction is larger for the higher level \bar{h}' . Hence, the expected utility

⁹The marginal effect of z' on $\ln(c')$ is

$$\frac{\partial \ln(c')}{\partial z'} = \frac{w'x(h')}{(1 + r')a' + w'x(h')z'} > 0$$

309 gain of moving from h' to \bar{h}' is smaller due to the idiosyncratic risk. Human capital
 310 investment is discouraged.

311 Taking into account endogenous labor supply reinforces the discouragement of
 312 human capital investment by the idiosyncratic risk. Recall from Section 3.1.2 that
 313 households with z' lower than a cutoff do not work. The endogenous labor supply
 314 therefore provides insurance against the lower tail risk of the idiosyncratic z' . More-
 315 over, the cutoff in z' is lower for those with higher human capital h' . This makes
 316 households with higher h' more exposed to the lower tail risk than those with lower
 317 h' , further reducing the gain of human capital investment.

318 **Proposition 1.** *The uninsured idiosyncratic risk in z' makes households in period
 319 1 save more, work more and invest less in human capital.*

320 3.3 Period-1 Saving and Human Capital Investment

321 In this section, we study the impact of endogenous human capital investment on
 322 households' saving decisions. Specifically, we compare optimal saving behavior in
 323 two scenarios: one in which households can choose to invest in human capital, and
 324 an alternative scenario in which human capital is exogenously fixed. To facilitate the
 325 comparison, we assume in this section that there is no human capital depreciation.¹⁰

326 When the optimal choice of human capital investment is zero, optimal saving is
 327 identical in both scenarios. When the optimal human capital investment is either e_L
 328 or e_H , we compare the household's optimal saving to the case where human capital
 329 investment is exogenously fixed at zero, i.e., $(n = 1, e = 0)$.¹¹

330 To make the human capital relevant, we assume that $n' = 1$ in period 2. The
 331 additive separability of work and human capital investment effort from consumption
 332 allows us to consider the optimal saving conditional on a given choice of labor supply
 333 and human capital investment.

334 In particular, the household maximizes expected lifetime utility:

$$\max_{a'} : \ln(c) + \beta \mathbb{E}_{z'}[\ln(c')], \quad (24)$$

The second derivative is

$$\frac{\partial^2 \ln(c')}{(\partial z')^2} = - \left[\frac{w'x(h')}{(1+r')a' + w'x(h')z'} \right]^2 < 0$$

and is more negative if $x(h')$ is higher.

¹⁰If depreciation is allowed, the analysis proceeds similarly but involves more comparison pairs.

¹¹Why not compare to $(n = 0, e = 0)$? Such a comparison is not meaningful when considering $(n = 1, e = e_L)$ because the two scenarios involve different state spaces. To see it, suppose conditions are such that $(n = 1, e = e_L)$ is optimal. If we were to fix $e = 0$ exogenously, the household's lifetime income would fall, and as a result the household would have a greater incentive to work. Thus, it is not possible for the household to deviate from choosing $n = 1$ when human capital is held fixed at $e = 0$. The comparison between $(n = 0, e = 0)$ and $(n = 0, e = e_L \text{ or } e_H)$ is similar to the comparison between $(n = 1, e = 0)$ to $(n = 1, e = e_L)$, since human capital investment does not affect period-1 labor income in either case.

³³⁵ subject to the budget constraints

$$c + a' = (1 + r)a + n(wzx(h)), \quad (25)$$

$$c' = (1 + r')a' + w'z'x(h'), \quad (26)$$

$$\text{with } h' = ye + (1 - \delta)h, e \in \{0, e_L, (1 - n)e_H\} \quad (27)$$

³³⁶ 3.3.1 Effect of on-job-training on saving

³³⁷ We now compare the optimal saving between $(n = 1, e = e_L)$ and $(n = 1, e = 0)$,
³³⁸ where e_L allows households to move to a higher sector in period 2 with higher
³³⁹ sectoral productivity $x(h')$.

³⁴⁰ To simplify the notation while maintaining the key economic forces, we normalize
³⁴¹ $(1 + r) = (1 + r') = 1$, $w = w' = 1$, the period-1 productivity shock $z = 1$, the
³⁴² period-1 learning-ability shock $y = 1$, and the period-2 productivity shock z' to
³⁴³ $\ln z' \sim \mathcal{N}(0, \sigma_z^2)$. The budget constraints become:

$$c + a' = a + x, \quad c' = a' + txz' \quad (28)$$

³⁴⁴ where x is the household's period-1 labor income that reflects both productivity and
³⁴⁵ skill. $t \geq 1$ represents the effect of human capital investment on period-2 income:
³⁴⁶ $t > 1$ if $e = e_L$; $t = 1$ if $e = 0$.

³⁴⁷ The optimal saving is determined by the FOC:

$$\frac{1}{a + x - a'} = \beta \mathbb{E}_{z'} \left(\frac{1}{a' + txz'} \right) \quad (29)$$

³⁴⁸ Denoting the mean and variance of z' as μ and Σ , respectively:

$$\mu \equiv \mathbb{E}[z'] = e^{\sigma_z^2/2}, \quad \Sigma \equiv \text{Var}(z') = e^{\sigma_z^2}(e^{\sigma_z^2} - 1). \quad (30)$$

³⁴⁹ The second-order approximate solution to the FOC is:

$$a'^*(x, a; t) = \underbrace{\frac{\beta(a + x) - tx\mu}{1 + \beta}}_{\text{CE}} + \underbrace{\frac{t^2 x^2 \Sigma}{\beta(a + x + tx\mu)}}_{\text{Precautionary}} \quad (31)$$

³⁵⁰ The first term is the *certainty-equivalent* saving, which reflects the consumption
³⁵¹ smoothing motive, increasing in the period-1 resources $a + x$ and decreasing in the
³⁵² period-2 expected labor income $tx\mu$. The second term is the *precautionary* saving,
³⁵³ which is increasing in the variance of period-2 labor income $t^2 x^2 \Sigma$ and decreasing in
³⁵⁴ the expected total resources $a + x + tx\mu$.

³⁵⁵ The effect of on-job-training on saving can be decomposed into two components:

$$\frac{\partial a'^*}{\partial t}(x, a; t) = -\frac{x\mu}{1 + \beta} + \frac{x^2 \Sigma}{\beta} \frac{t[2(a + x) + tx\mu]}{(a + x + tx\mu)^2}. \quad (32)$$

356 The first term being negative captures the *crowd-out* effect on saving via consumption-
 357 smoothing motive as on-job-training increases the expected period-2 labor income
 358 $tx\mu$. The second positive term captures the *crowd-in* effect via precautionary saving
 359 motive as on-job-training exposes households to larger future income risk.

360 To capture the overall impact of on-job-training on saving, we define:

$$\Delta_{\text{on-job}}(x, a; t) = a'^*(x, a; t) - a'^*(x, a; 1) = \int_1^t \frac{\partial a'^*}{\partial u}(x, a; u) du, \quad (33)$$

361 where $a'^*(x, a; t)$ is the optimal saving when households undertake on-job-training,
 362 and $a'^*(x, a; 1)$ is the optimal saving when human capital is kept exogenously fixed.

363 Whether on-job-training increases or decreases saving ultimately depends on
 364 the balance between the crowd-out effect (via higher expected future income) and
 365 the precautionary crowd-in effect (via heightened future income risk). The next
 366 proposition demonstrates that these effects can dominate differently depending on
 367 period-1 income x , so that the overall impact of on-job-training on saving can differ
 368 between low- and high-income households.

369 **Proposition 2.** *If the idiosyncratic risk is large enough, i.e., $\frac{\Sigma}{\mu} > \sigma^*(t)$, on-job-
 370 training crowds out saving for low-income households and crowds in saving for high-
 371 income households: for $x < x^*(a, t)$, $e = e_L$ lowers saving $\Delta_{\text{on-job}}(x, a; t) < 0$; for
 372 $x > x^*(a, t)$, $e = e_L$ raises saving $\Delta_{\text{on-job}}(x, a; t) > 0$.*

373 *Proof.* See Appendix B. □

374 3.3.2 Effect of full-time training on saving

375 We next compare the optimal saving between $(n = 0, e = e_L \text{ or } e_H)$ and $(n =$
 376 $1, e = 0)$. Note that full-time training requires the households to give up their labor
 377 income in period 1, which is not the case for on-job-training. Following the same
 378 normalization and notation as in the previous subsection, we can write the budget
 379 constraints with full-time training and without training as:

$$e = e_H : c + a' = a, \quad c' = a' + txz' \quad (34)$$

$$e = 0 : c + a' = a + x, \quad c' = a' + xz' \quad (35)$$

380 where $t > 1$ captures the effect of full-time training on period-2 income.

381 The second-order approximation to the optimal saving problem yields:

$$e = e_H : \quad a'_{e_H}^*(x, a; t) = \underbrace{\frac{\beta a - tx\mu}{1 + \beta}}_{\text{CE}} + \underbrace{\frac{t^2 x^2 \Sigma}{\beta(a + tx\mu)}}_{\text{Precautionary}} \quad (36)$$

$$e = 0 : \quad a'^*(x, a; 1) = \underbrace{\frac{\beta(a + x) - x\mu}{1 + \beta}}_{\text{CE}} + \underbrace{\frac{x^2 \Sigma}{\beta(a + x + x\mu)}}_{\text{Precautionary}} \quad (37)$$

382 The overall effect of full-time training on saving can be expressed as:

$$\begin{aligned} \Delta_{\text{full-time}}(x, a; t) &= a'_{e_H}^*(x, a; t) - a'^*(x, a; 1) \\ &= \Delta_{\text{on-job}}(x, a; t) + \Delta_H(x, a; t) \end{aligned} \quad (38)$$

$$\text{where } \Delta_H(x, a; t) \equiv x \left[-\frac{\beta}{1 + \beta} + \frac{\Sigma}{\beta} \frac{t^2 x^2}{(a + x + tx\mu)(a + tx\mu)} \right] \quad (39)$$

383 Here, $\Delta_H(x, a; t)$ captures the additional impact of full-time training on saving, over
 384 and above that of on-job-training. The first term reflects a further reduction in
 385 saving due to the need to forgo period-1 labor income. The second term shows
 386 an increase in precautionary saving, as reduced current resources limit households'
 387 ability to self-insure against idiosyncratic risk in period 2.

388 The following lemma establishes some properties of $\Delta_H(x, a; t)$:

389 **Lemma 1.** *If $\frac{\Sigma}{\mu} < \hat{\sigma}(t)$, $\Delta_H(x, a; t) < 0$ and decreases in x . If $\frac{\Sigma}{\mu} > \bar{\sigma}(t)$, $\Delta_H(x, a; t) >$
 390 0 if and only if $x > \hat{x}(a, t)$; moreover, for $x > \hat{x}(a, t)$, $\Delta_H(x, a; t)$ increases in x .*

391 *Proof.* See Appendix B. □

392 Taken together, Proposition 2 and Lemma 1 imply that, when the idiosyncratic risk
 393 is large enough, full-time training *crowds out* saving for low-income households, but
 394 *crowds in* saving for high-income households.

395 **Proposition 3.** *If the idiosyncratic risk is large enough, i.e., $\frac{\Sigma}{\mu} > \max\{\sigma^*(t), \hat{\sigma}(t)\}$,
 396 full-time training *crowds out* saving for low-income households and *crowds in* sav-
 397 ing for high-income households: for $x < \min\{x^*(a, t), \hat{x}(a, t)\}$, $e = e_H$ lowers
 398 saving $\Delta_{\text{full-time}}(x, a; t) < 0$; for $x > \max\{x^*(a, t), \hat{x}(a, t)\}$, $e = e_H$ raises saving
 399 $\Delta_{\text{full-time}}(x, a; t) > 0$.*

400 3.4 The Effects of an Anticipated Period-2 AI Shock

401 Suppose that an AI shock is anticipated to occur in period 2 and to increase the
 402 labor productivity for the low sector and the high sector but not the middle sector.

⁴⁰³ The effect of AI shock on the sectoral productivity is captured by γ with $0 < \gamma < 1$:

$$x(h') = \begin{cases} 1 - \lambda + \gamma\lambda & \text{low sector if } h' < h_M \\ 1 & \text{middle sector if } h_M < h' < h_H \\ 1 + \lambda + \gamma\lambda & \text{high sector if } h' > h_H \end{cases} \quad (40)$$

⁴⁰⁴ In other words, the AI shock increases average labor productivity, reduces the earnings premium for the middle sector, and enlarges the earnings premium for the high sector relative to the middle sector.

⁴⁰⁷ 3.4.1 Effects on human capital investment

⁴⁰⁸ The AI shock lowers the incentive to work in the middle sector in period 2. Consequently, households with $h < h_M/(1 - \delta)$ reduce their human capital investment, while those with $h > h_M/(1 - \delta)$ increase it. More specifically, the upper bounds that determine whether households undertake positive human capital investment – denoted by \bar{z}_{slow}^L and \bar{z}_{fast}^L for $h < h_M/(1 - \delta)$, and \bar{z}_{slow}^M and \bar{z}_{fast}^M for $h > h_M/(1 - \delta)$ – respond in opposite directions to the anticipated shock: the former decrease with γ and the latter increase. This relationship is formalized below.

⁴¹⁵ **Proposition 4.** *An anticipated AI shock decreases human capital investment among households with $h < h_M/(1 - \delta)$, but increases it among those with $h > h_M/(1 - \delta)$. Specifically, \bar{z}_{slow}^L and \bar{z}_{fast}^L decrease with γ , while \bar{z}_{slow}^M and \bar{z}_{fast}^M increase with γ .*

⁴¹⁸ *Proof.* See Appendix B. □

⁴¹⁹ 3.4.2 Effects on labor supply

⁴²⁰ **via income:** The AI shock raises period-2 labor income for households who will work in the low or high sector, leading to a positive income effect that reduces their labor supply in period 1.

⁴²³ **via full-time training:** Because full-time training and labor supply compete for time, the AI shock affects their tradeoff through its impact on human capital investment incentives. For $h > h_M/(1 - \delta)$, where AI makes investing in additional skills more attractive, households are more likely to engage in full-time training and thus reduce period-1 labor supply. In contrast, for $h < h_M/(1 - \delta)$, where the AI shock lowers the payoff to investing in skills, households shift away from full-time training and supply more labor in the first period.

⁴³⁰ 3.4.3 Effects on saving

⁴³¹ The AI shock increases sectoral labor productivity for the low and high sectors in period 2, while leaving the middle sector's labor productivity unchanged. Its effect

433 on saving can be analyzed as if we are varying the parameter t in the functions
434 $\Delta_{\text{on-job}}(x, a; t)$, defined in (33), and $\Delta_H(x, a; t)$, defined in (39).

435 **Proposition 5.** $\Delta_H(x, a; t)$ is increasing in t . $\Delta_{\text{on-job}}(x, a; t)$ is convex in t :

- 436 • If $\Delta_{\text{on-job}}(x, a; t) > 0$ and $t > 1$, $\Delta_{\text{on-job}}(x, a; t') > \Delta_{\text{on-job}}(x, a; t)$ for $t' > t > 1$.
437 • If $\Delta_{\text{on-job}}(x, a; t) > 0$ and $t < 1$, $\Delta_{\text{on-job}}(x, a; t') < \Delta_{\text{on-job}}(x, a; t)$ for $1 > t' > t$.

438 *Proof.* See Appendix B. □

439 **Households who stay in the same sector** For middle-sector households, the
440 AI shock leaves both their incomes and saving unchanged.

441 By contrast, low-sector and high-sector households experience an increase in
442 period-2 labor income x' as a result of the AI shock. If they remain in the same
443 sector without needing additional human capital investment or on-the-job training,
444 their saving behavior in the absence of the AI shock can be compared to the scenario
445 with fixed human capital. Following the AI shock, however, their situation resembles
446 one with on-the-job training that enhances x' (i.e., $t > 1$). Thus, the effect of the
447 AI shock on saving is captured by the on-the-job training impact, $\Delta_{\text{on-job}}(x, a; t)$.

448 As shown in Proposition 2, $\Delta_{\text{on-job}}(x, a; t)$ has opposite signs for low-skill and
449 high-skill households. This implies that the AI shock *crowds out* saving among
450 low-sector households, while it *crowds in* saving for high-sector households.

451 For households who must undertake full-time training to remain in the high
452 sector, $\Delta_H(x, a; t)$ captures the additional effect of such training on saving. In this
453 case, a higher x' —brought about by the AI shock—corresponds to an increase in t ,
454 further boosting $\Delta_H(x, a; t)$ (Proposition 5). Consequently, the AI shock *crowds in*
455 saving for high-sector households in this scenario as well.

456 **Households who upskill** For low-sector households, saving behavior remains
457 unchanged, as the AI shock does not affect their future productivity after upskilling.

458 For the middle-sector households who upskill via on-job-training, the AI shock
459 boosts their future productivity gain from λ to $(1 + \gamma)\lambda$, which corresponds to a
460 higher t in $\Delta_{\text{on-job}}(x, a; t)$ with $t > 1$. According to Proposition 5, if the pre-shock
461 effect of on-the-job training on saving is positive, the AI shock will *raise* saving.
462 However, if this effect is negative, the overall impact of the AI shock on saving
463 becomes ambiguous.

464 For the middle-sector households who upskill via full-time training, there is an
465 *additional positive effect* of the AI shock on their saving, because a higher x' increases
466 $\Delta_H(x, a; t)$ (Proposition 5).

467 **Households who downskill** Downskilling, which reflects human capital depreciation,
468 does not require any new investment in skills. For high-sector households
469 who transition downward, the AI shock leaves their future productivity – and thus
470 their saving – unchanged.

471 For middle-sector households who downskill to the low sector, their saving differs
472 from the fixed human capital scenario by $\Delta_{\text{on-job}}(x, a; t)$ with $t < 1$. The AI shock
473 mitigates their future productivity loss by reducing it from λ to $(1 - \gamma)\lambda$, effectively
474 increasing t to a new value $t' < 1$. According to Proposition 5, if the pre-shock effect
475 $\Delta_{\text{on-job}}(x, a; t)$ is positive, the AI shock will *reduce* saving. If this effect is negative,
476 however, the overall impact of the AI shock on saving is ambiguous.

477 3.5 *Limitations of the two-period model*

478 Up to this point, our analysis has focused on how AI influences household-level
479 decisions regarding human capital investment, labor supply, and saving within the
480 framework of a two-period model. While this provides valuable insights into individual
481 behavioral responses, understanding the broader, economy-wide implications
482 of AI requires moving to a more comprehensive setting – a quantitative model with
483 an infinite time horizon, endogenous asset accumulation, and general equilibrium
484 feedback.

485 **General equilibrium (GE) effects** When households adjust their investment in
486 human capital, labor supply, and savings in response to AI, these changes aggregate
487 up to affect the total supply of effective labor and capital in the economy. As these
488 aggregates shift, they exert downward or upward pressure on the wage rate and
489 the interest rate, feeding back into each household’s optimization problem. Thus,
490 general equilibrium effects capture the intricate loop by which individual decisions
491 shape, and are shaped by, the macroeconomic environment.

492 **Composition effects** Endogenizing human capital investment injects dynamism
493 into how households sort themselves among the three skill sectors. When an AI shock
494 occurs, individuals may choose to retrain, upskill, or even move to lower-skilled work,
495 reshaping the distribution of labor across sectors. This shifting composition changes
496 the relative size of each sector, with significant consequences for both aggregate
497 outcomes and the distributional effects of AI.

498 4 A Quantitative Model

499 We now solve the full dynamic model with infinite horizon, endogenous asset accumulation,
500 and general equilibrium. We calibrate the model to reflect key features of
501 the U.S. economy, capturing reasonable household heterogeneity.

Table I: Parameters for the Calibration

Parameter	Value	Description	Target or Reference
β	0.91795	Time discount factor	Annual interest rate
ρ_z	0.948	Persistence of z shocks	Chang and Kim (2006)
σ_z	0.269	Standard deviation of z shocks	Chang and Kim (2006)
\underline{a}	0	Borrowing limit	See text
χ_n	2.47	Disutility from working	Employment rate
χ_e	1.48	Disutility from HC effort	See text
\bar{n}	1/3	Hours worked	Average hours worked
e_H	1/3	High level of effort	Average hours worked
e_L	1/6	Low level of effort	See text
h_M	0.41	Human capital cutoff for M	See text
h_H	0.96	Human capital cutoff for H	See text
λ	0.2	Skill premium	Earnings Gini
δ_h	0.1	HC depreciation rate	Standard value
α	0.36	Capital income share	Standard value
δ	0.1	Capital depreciation rate	Standard value

502 *4.1 Calibration*

503 We calibrate the model to match the U.S. economy. For several preference pa-
 504 rameters, we adopt values commonly used in the literature. Other parameters are
 505 calibrated to align with targeted moments. The model operates on an annual time
 506 period. Table I summarizes the parameter values used in the benchmark model.

507 The time discount factor, β , is calibrated to match an annual interest rate of 4
 508 percent. We set χ_n to replicate an 80 percent employment rate. We calibrate χ_e to
 509 match the fact that around 30 percent of the population invests in human capital
 510 (**oecd2025adultlearning**).

511 We calibrate parameters regarding labor productivity process as follows. We
 512 assume that z follows the AR(1) process in logs: $\log z' = \rho_z \log z + \epsilon_z$, where $\epsilon_z \sim$
 513 $N(0, \sigma_z^2)$. The shock process is discretized using the **tauchen1986finite** method,
 514 resulting in a transition probability matrix with 11 grids. We set the persistence
 515 parameter to $\rho_z = 0.948$ and the standard deviation to $\sigma_z = 0.269$, following the
 516 estimates reported in Chang and Kim (2006).

517 We deviate from the two-period model by assuming that the labor supply is a
 518 discrete choice between 0 and $\bar{n} = 1/3$. This change only rescales the two-period
 519 model without altering the trade-off facing the households. But such rescaling facil-
 520 itates the interpretation that households are deciding whether to allocate one-third
 521 of their fixed time endowment to work. The high-level human capital accumulation
 522 effort, e_H is assumed to equal \bar{n} . The low-level effort, e_L is set to half of e_H . The skill
 523 premium across sectors, λ , is set at 0.2 to match the earnings Gini coefficient. Hu-
 524 man capital cutoffs, h_M and h_H , are set so that the population shares in low, middle,

Table II: Key Moments

Moment	Data	Model
Employment rate	0.80	0.80
Human capital investment ratio	0.29	0.29
Gini coefficient for wealth	0.78	0.76
Gini coefficient for earnings	0.63	0.62
Gini coefficient for income	0.57	0.58

and high sectors are, respectively, 20, 40, and 40 percent. This population distribution roughly matches the fractions of U.S. workers in 2014 who are employed in routine manual occupations (low sector), routine cognitive and non-routine manual (middle sector), and non-routine cognitive (high sector) (Cortes *et al.*, 2017).

On the production side, we set the capital income share, α , to 0.36, and the depreciation rate, δ , to 0.1. For simplicity, we assume that human capital depreciates at the same rate, i.e., $\delta_h = 0.1$.

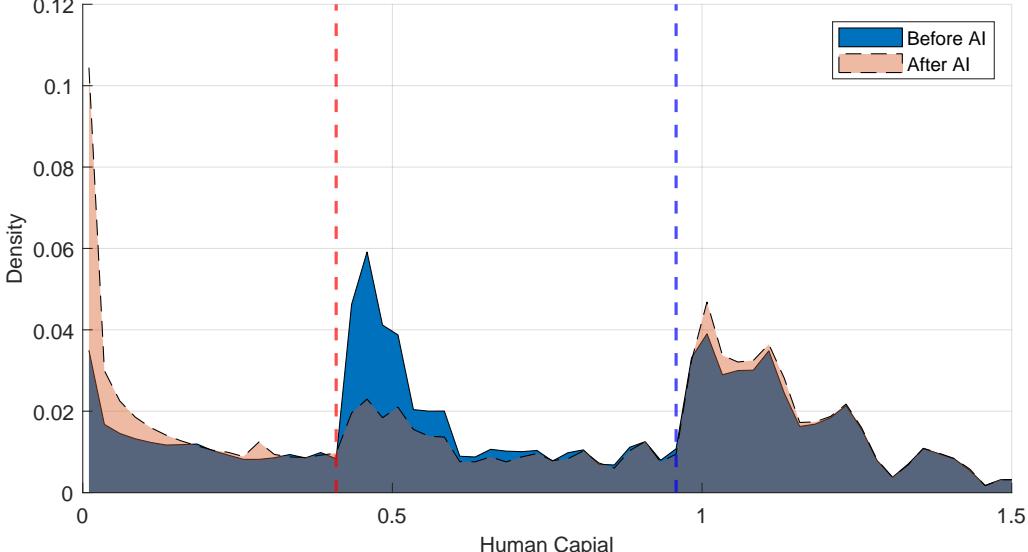
4.2 Key Moments: Data vs. Model

In Table II, we present a comparison of key moments between the model and the empirical data. The model does an excellent job of replicating the 80% employment rate observed in the data. In this context, employment is defined as having positive labor income in the given year, consistent with the common approach used in the literature. According to **oecd2025adultlearning**, the share of the population investing in human capital—those who are actively engaged in skill acquisition or education—is approximately 30%, a figure well matched by the model’s predictions. This is an important metric because it reflects the model’s capacity to capture the dynamics of human capital formation, which plays a critical role in shaping long-run earnings and income inequality. Additionally, the model accurately captures the distribution of income and earnings, aligning closely with observed data. This suggests that the model effectively incorporates the key mechanisms driving labor market outcomes and the corresponding distributional aspects of earnings. Although the model does not explicitly target the wealth Gini coefficient, it achieves a close match to the data: the empirical wealth Gini is 0.78, while the model produces a value of 0.76. This highlights the model’s ability to capture substantial wealth inequality in the economy.

4.3 Steady-state Distribution

Table III presents the steady-state distribution of population, employment, and assets across sectors. The population shares are calibrated to 20%, 40%, and 40% by adjusting the human capital thresholds that define sectors. The shares of employment and assets are endogenously determined by households’ labor supply

Figure 2: Steady-state Human Capital Distribution



Note: The x-axis denotes the level of human capital, while the y-axis indicates the mass of households at each human capital level. The red vertical line marks the cutoff between the low and middle sectors, and the blue vertical line marks the cutoff between the middle and high sectors.

and savings decisions. Notably, the high sector accounts for 46% of total employment—exceeding its population share—indicating that a disproportionate number of households choose to work in that sector. Asset holdings are even more skewed: the high sector holds 68% of total assets, while the low sector holds only 8%.

Table III: Distribution of Population, Employment and Assets

Sectors	Pop. Share (%)	Emp. Share (%)	Assets Share (%)
Low	20.76	18.58	8.07
Middle	38.87	35.35	23.92
High	40.35	46.07	68.01

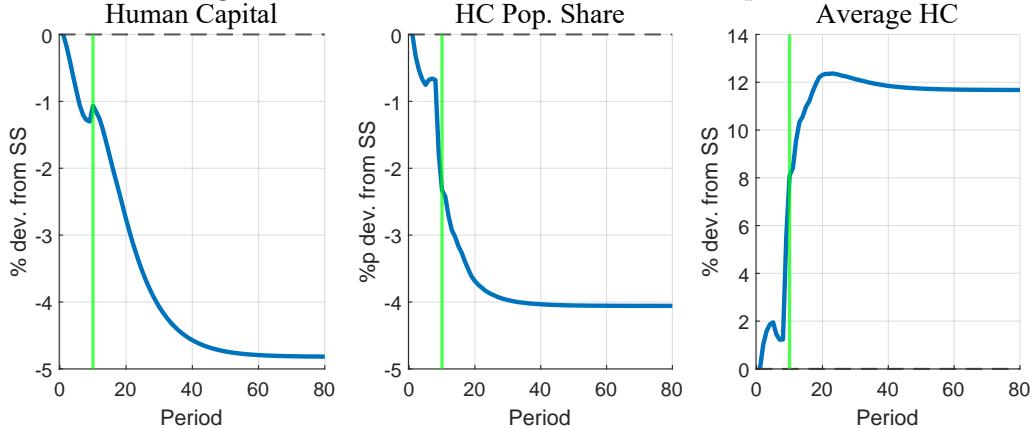
Note: Human capital cutoffs, h_H and h_M , determine the population share across sectors. Employment share and assets share are implied by households labor supply decisions and saving decisions.

5 AI's Impact on Human Capital Adjustments

We now introduce AI technology into the quantitative model, assuming that it will be implemented in 10 years and that households have full information about its arrival. We examine both the transition dynamics and the differences between the initial and new steady states. This framework allows us to analyze how the economy adjusts in anticipation of, and in response to, the adoption of AI.

The effect of AI on the sectorial productivity is modeled as in (40) with $\gamma = 0.3$. That is, AI boosted the productivity of the low sector workers by 7.5% and the productivity of the high sector workers by 5%, leaving the middle sector intact. It captures the key idea that AI increases average labor productivity (Acemoglu and Restrepo, 2019), but reduces the earning premium for the middle sector, and enlarges the earning premium for the higher sector relative the middle sector.

Figure 3: Transition Path for Human Capital Investment



Note: The x-axis represents years, and the y-axis shows the percentage (or percentage point) deviation from the initial steady state. AI introduction is assumed to occur in period 10. “HC Pop. Share” denotes the fraction of households that make positive human capital investments, and “Average HC” denotes average human capital among those investing households.

571 5.1 Human Capital Adjustments

572 Given the employment distribution in the initial steady state, AI is projected to
 573 increase the economy’s labor productivity by 4% on average, assuming households
 574 do not alter their decisions in response. However, changes in earning premiums
 575 incentivize households to adjust their human capital investments.

576 **Steady-state human capital distribution:** Figure 2 illustrates how households
 577 reallocate across sectors in the new steady state relative to the initial one. The x-axis
 578 denotes the level of human capital, while the y-axis indicates the mass of households
 579 at each human capital level. The red vertical line marks the cutoff between the low
 580 and middle sectors, and the blue vertical line marks the cutoff between the middle
 581 and high sectors.

582 The gray shaded area shows the overlap between the two steady-state distri-
 583 butions. Within each sector, the distribution of households is skewed to the left,
 584 reflecting the tendency for human capital investment to be concentrated among
 585 those near the sectoral cutoffs. As shown in the decision rule diagram in Figure ??,
 586 some households seek to upgrade their skills, while others aim to remain in more
 587 skilled sectors. The blue shaded area highlights the mass of households who have
 588 exited the middle sector following the AI shock. The pink areas represent the addi-
 589 tional mass of households in the new steady-state distribution, concentrated at the
 590 lower end of the low sector and the lower end of the high sector.

591 **Transition path** Figure 3 reports the transition dynamics of aggregate human
 592 capital from the initial to the new steady state. The figure also displays its extensive
 593 margin (the share of households making positive human capital investments) and
 594 intensive margin (average human capital per household among those who invest).

595 As households reallocate from the middle sector to the low and high sectors, the

596 net effect is a gradual decline in aggregate human capital along the transition path.
597 This mirrors the steady-state change observed in Figure 2, where the increased mass
598 at the lower end of the low sector outweighs the increase in the high sector.

599 Additionally, human capital accumulation becomes increasingly concentrated
600 among a smaller share of the population. The proportion of households making
601 positive human capital investments steadily declines, ultimately stabilizing at a level
602 4% lower than in the initial steady state. Meanwhile, the average human capital
603 among those who invest rises, reaching a level 12% higher than the initial steady
604 state in the long run.¹²

605 5.2 Job Polarization

606 An important implication of human capital adjustments to the AI shock is job
607 polarization. Figure 4 illustrate the transition paths of population shares and em-
608 ployment rates in each sector. Notably, the middle sector experiences a significant
609 decline, with its population share decreasing by approximately 13%. Additionally,
610 employment within this sector plummets to a level 16% lower than the initial steady
611 state. In contrast, both the low and high sectors see increases in their population
612 shares and employment rates. These dynamics indicate a reallocation of *workers*
613 from the middle sector to the low and high sectors following the introduction of AI.

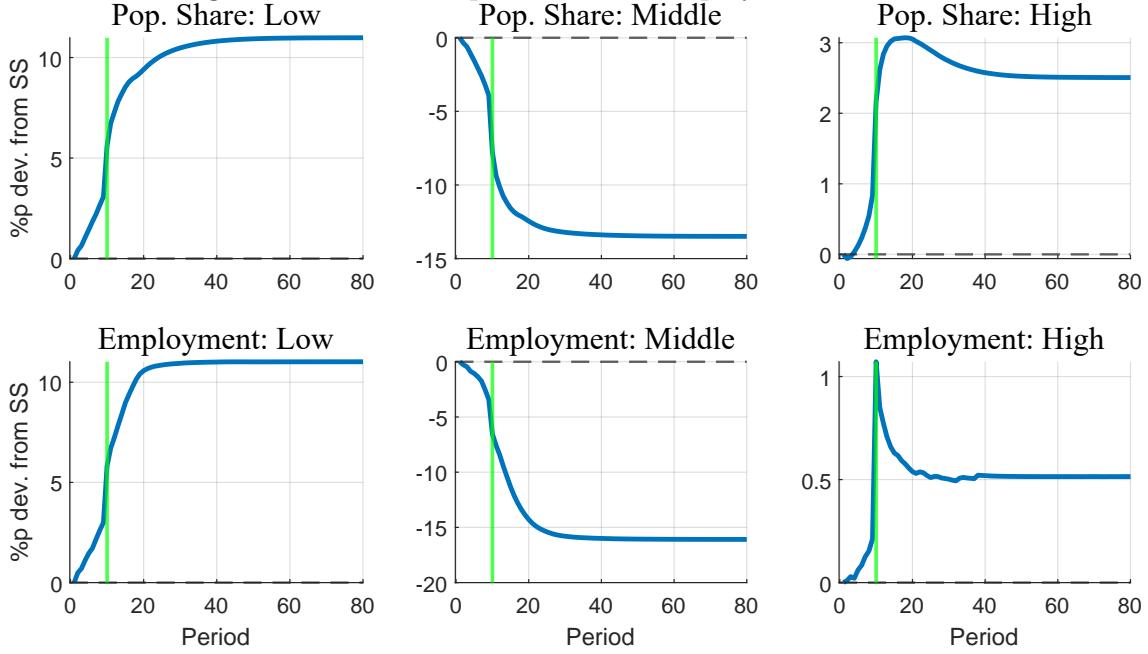
614 **Voluntary job polarization** This worker reallocation aligns with the phenomenon
615 of “job polarization”(Goos *et al.*, 2014), where AI and automation technologies dis-
616 proportionately replace tasks commonly performed by middle-skilled workers. How-
617 ever, our model introduces a complementary mechanism to the conventional under-
618 standing of this reallocation. Specifically, households in our model voluntarily exit
619 the middle sector even before AI implementation by adjusting their human capital
620 investments – many middle-sector workers opt for non-employment to invest in skills
621 that will better position them for the post-AI labor market.¹³ This mechanism is
622 formally characterized in Proposition (4) in the two period model above.

623 **Employment flows more towards the low sector** Another intriguing finding
624 in our model is the more pronounced employment effect in the low sector compared
625 to the high sector. In the new steady state, the employment rate in the low sector
626 increases by 12%, whereas in the high sector, it rises by only 0.5%. This asymmetry
627 in employment rate changes suggests an unbalanced reallocation of workers from the
628 middle sector, with a greater flow toward the low sector.

¹²The only exception to those patterns occurs at period 10 when the positive effects of AI on sectoral productivity are realized.

¹³To emphasize this key difference, our model deliberately abstracts from any direct negative effect of AI on middle-sector workers.

Figure 4: Sectoral Population and Employment Transition



Note: The transition paths within each sector. The x-axis represents years, and the y-axis shows the percentage (or percentage point) deviation from the initial steady state. AI introduction is assumed to occur in period 10. “Pop. Share” denotes the population share within each sector. “Employment” is the percentage of households who are employed in each sector.

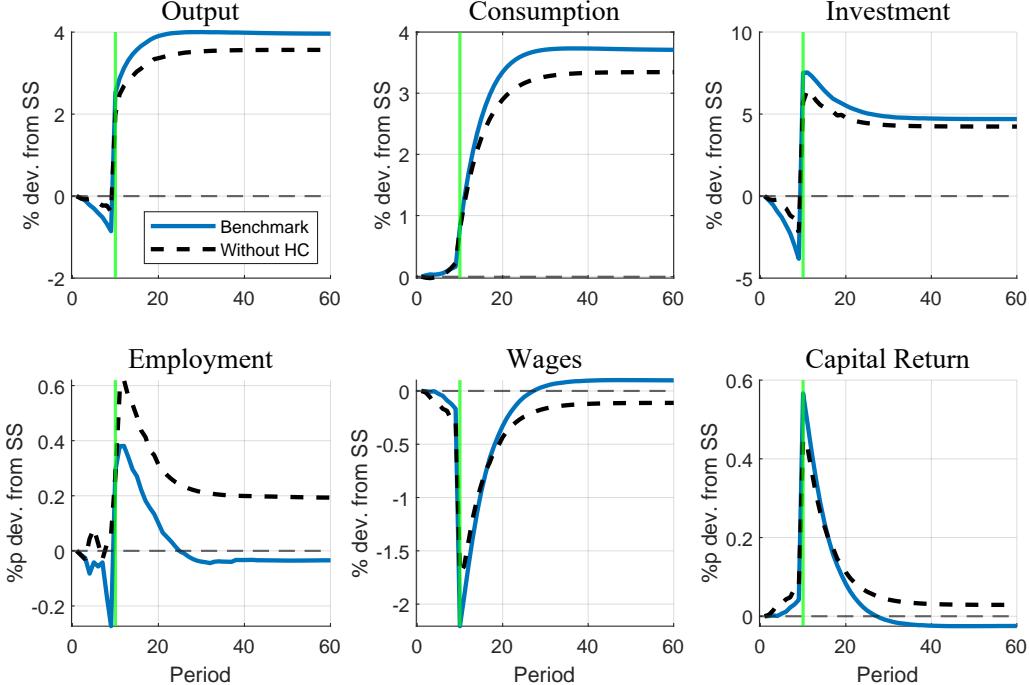
629 This disparity arises from two key factors. First, AI enhances the productivity of
 630 low-sector workers by 7.5% and high-sector workers by 5%. However, this produc-
 631 tivity differential alone does not fully account for the significant asymmetry. The
 632 second factor is the variation in labor supply elasticity across sectors. Compared to
 633 the high sector, the low sector exhibits higher labor supply elasticity, meaning that
 634 the same change in labor earnings triggers larger labor supply responses. This is
 635 because households in the low sector have lower consumption levels, making their
 636 marginal utility of consumption more sensitive to changes in their budget. Con-
 637 sequently, a greater proportion of households in the low sector are at the margin
 638 between employment and non-employment (Chang and Kim, 2006).

639 6 The Aggregate and Distributional Effects of AI

640 The aggregate and distributional effects of AI are shaped by both its direct impact on
 641 sectoral productivity and the endogenous response of human capital accumulation.
 642 By altering sectoral productivity, AI changes labor earnings, which in turn influences
 643 labor supply decisions and savings through income effects. Consequently, AI directly
 644 affects the supply of labor and capital, generating aggregate economic responses.
 645 Because AI’s productivity effects are heterogeneous across sectors, its impact is
 646 inherently distributional.

647 These sectoral differences also induce human capital adjustments, as households
 648 reallocate across sectors in response to changing incentives. This reallocation not

Figure 5: Transition Path of Aggregate Variables: Benchmark vs. No HC Models.



Note: The transition paths of aggregate variables: benchmark vs. No HC models. The x-axis represents years, and the y-axis shows the percentage deviation from the initial steady state. AI introduction is assumed to occur in period 10. The No HC model is an economy in which workers maintain their initial steady-state level of human capital throughout the AI implementation until the new steady state is reached.

only shifts the distribution of labor productivity and aggregate productivity, but also directly shapes distributional outcomes, as households' relative positions in the income and asset distributions are altered by their movement across sectors.

In this section, we examine the importance of endogenous human capital adjustment in shaping both the transitional and long-run effects of AI. To do so, we compare the benchmark economy – where households endogenously adjust their human capital – with an alternative scenario in which households are held fixed at their initial steady-state human capital during the AI transition (“No HC model”). In both cases, households make endogenous decisions about consumption, savings, and labor supply.

By contrasting the transition dynamics across these two economies, we can disentangle the direct and indirect effects of AI. The transition path in the No-HC-model isolates the direct impact of AI on aggregate and distributional outcomes, as it abstracts from any human capital adjustments. The difference in outcomes between the benchmark and the No-HC-model then reveals the indirect effects of AI that operate through households' adjustments in human capital. This decomposition allows us to assess the relative importance of human capital dynamics in driving both the aggregate and distributional consequences of AI.

667 *6.1 Aggregate Implications*

668 Figure 5 shows the transition paths of key macroeconomic variables—output, con-
669 sumption, investment, and employment—as well as factor prices, including the wage
670 rate and capital return. The blue solid lines depict results from the benchmark model
671 with endogenous human capital adjustment, while the black dashed lines represent
672 the No-HC model in which human capital is held fixed.

673 **6.1.1 AI's direct impacts**

674 The No-HC-model isolates the direct effects of AI. In the long run, the introduction
675 of AI leads to higher output, consumption, investment, and employment. However,
676 in anticipation of AI (prior to period 10), output and investment decline, while
677 consumption and employment remain stable.

678 Before the implementation of AI, sectoral productivity is unchanged; the only
679 difference is households' awareness of future increases in productivity in the low and
680 high sectors beginning in period 10. This anticipation raises households' expected
681 lifetime income, prompting them to save less and consume more ahead of the actual
682 productivity gains. As a result, aggregate capital stock falls, which lowers output and
683 reduces the marginal product of labor while raising the marginal product of capital.
684 Employment remains largely unchanged in this period, as sectoral productivity has
685 not yet shifted.

686 Following the AI shock, sectoral productivity in the low and high sectors rises,
687 boosting labor income, employment, and output in these sectors. Because produc-
688 tivity gains are labor-augmenting, the supply of efficient labor units rises sharply,
689 causing wages to decline and capital returns to increase. Employment and invest-
690 ment both adjust to dampen these factor price changes. In the new steady state, the
691 wage rate is slightly below its initial level, while the return to capital is marginally
692 higher.

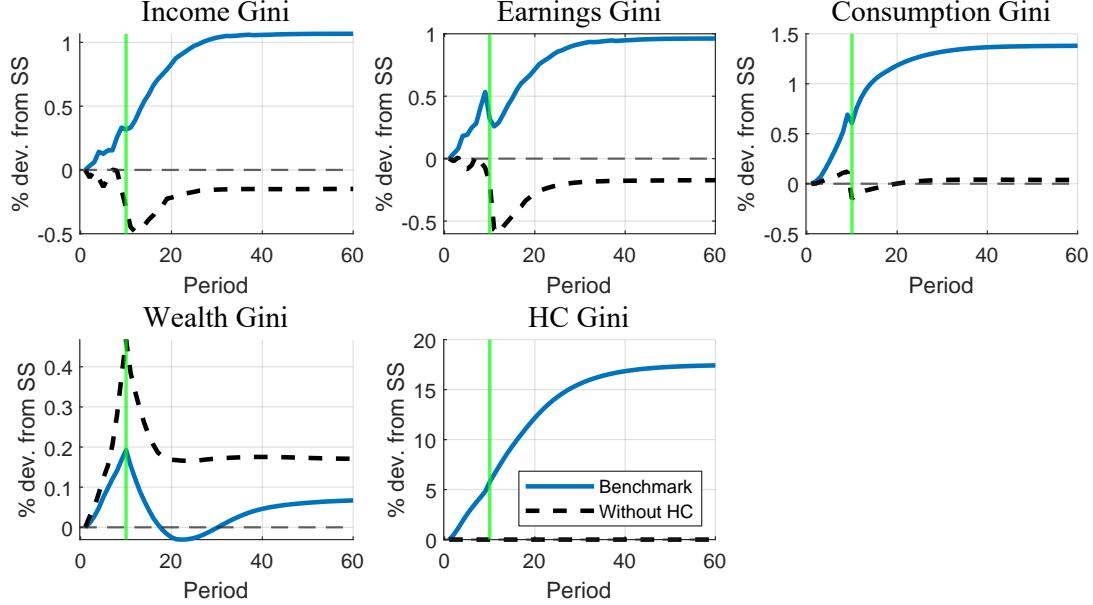
693 **6.1.2 AI's indirect impacts via endogenous human capital adjustments**

694 The difference between the No-HC model and the benchmark model captures the
695 indirect effects of AI operating through endogenous human capital adjustments.
696 Among all macroeconomic variables, this indirect effect is most pronounced for em-
697 ployment.

698 In anticipation of AI, employment declines as some households temporarily exit
699 the labor market to invest in human capital and prepare for the post-AI economy.¹⁴
700 During this period, labor productivity remains unchanged, so the decline in em-
701 ployment directly translates to a reduction in output. Consistent with standard

¹⁴Empirical studies, such as Lerch (2021) and Faber *et al.*, (2022), support the short-term adverse effects of AI adoption on labor markets.

Figure 6: Transition Path of Inequality Measures: Benchmark vs. No HC Models.



Note: The transition paths of inequality measures: benchmark vs. No HC models. The x-axis represents years, and the y-axis shows the percentage deviation from the initial steady state. AI introduction is assumed to occur in period 10. The No HC model is an economy in which workers maintain their initial steady-state level of human capital throughout the AI implementation until the new steady state is reached.

consumption-smoothing behavior, this reduction is mainly absorbed by lower investment. Meanwhile, the drop in employment mitigates the direct effects of AI on both wages and capital returns prior to the AI implementation.

After AI is introduced, employment rebounds as sectoral productivity increases. However, continued human capital investment by middle-sector households keeps employment lower than in the No-HC model, resulting in an almost neutral long-run effect of AI on employment. Despite this, output, consumption, and investment are all higher in the benchmark model because human capital adjustments reallocate more labor to the low and high sectors, thereby better capturing the productivity gains from AI.

This reallocation also reverses the steady-state comparison of factor prices: endogenous human capital adjustment transforms the negative direct effect of AI on the wage rate into a positive net effect, and the positive direct effect on capital returns into a negative net effect.

6.2 Distributional Implications

The findings above underscore the importance of accounting for human capital adjustments when assessing the aggregate impact of AI, as households actively adapt to a rapidly evolving labor market. When it comes to economic inequality, endogenously adjusting human capital plays an even more significant role.

Figure 6 shows the transition paths of Gini coefficients for earnings (labor income), total income (capital and labor income), consumption, wealth (asset holdings), and human capital. The black dashed lines represent results from the No-HC

724 model, capturing the direct impact of AI without human capital adjustment. In
725 contrast, the blue solid lines reflect the benchmark model, where human capital re-
726 sponds endogenously to both anticipated and realized changes in the skill premium
727 induced by AI.

728 6.2.1 Income, earnings, and consumption inequalities

729 The comparison of transition paths between the No-HC model and the benchmark
730 model reveals that endogenous human capital adjustments fundamentally alter the
731 impact of AI on income, earnings, and consumption inequalities.

732 **AI's direct impacts:** Without any human capital adjustments, AI's impact on
733 inequalities is primarily driven by productivity gains in the low and high sectors
734 – 7.5% and 5%, respectively. As a result, there is little direct impact on income
735 and earnings Gini coefficients in anticipation of AI before period 10. After AI is
736 implemented, both income and earnings inequality decline: higher labor productivity
737 raises earnings in the low sector, while wage declines in the middle sector compress
738 the distribution. Consumption inequality remains largely unchanged throughout
739 the transition.

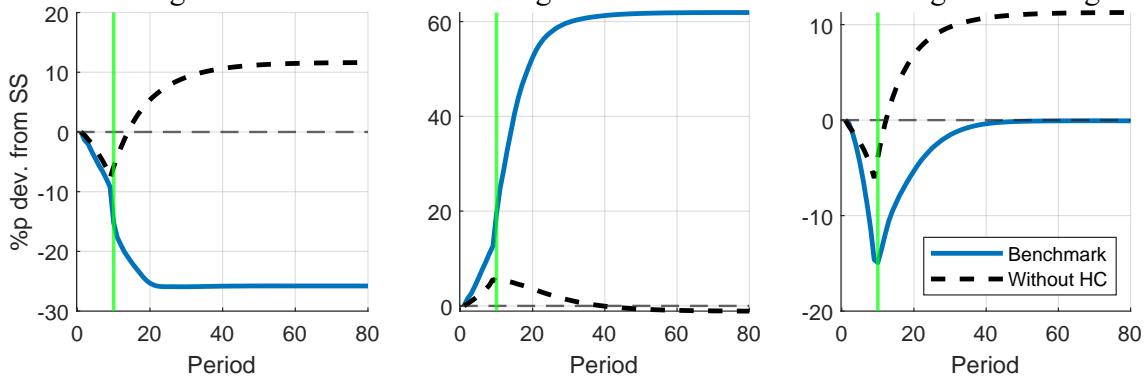
740 **Effects of AI-induced human capital adjustments:** Allowing human capital
741 to adjust endogenously, however, leads to pronounced job polarization, as shown in
742 Section 5.2. Households who would have qualified for middle-sector jobs now tran-
743 sition to either the low or high sector. Those moving to the low sector see reduced
744 labor earnings, while those shifting to the high sector enjoy increased earnings. This
745 polarization drives up earnings and income inequality, both before and after AI is
746 implemented. As income disparities widen, consumption inequality also increases.

747 6.2.2 Wealth inequality

748 In stark contrast to the effects on income and earnings inequality, allowing for en-
749 dogenous human capital adjustment mitigates the negative direct impact of AI on
750 wealth inequality. While AI's direct effect would otherwise widen disparities, human
751 capital responses help dampen the increase in wealth inequality, underscoring the
752 stabilizing role of human capital adjustments in the wealth distribution.

753 As discussed in Section 3.3, the effect of human capital investment on saving
754 is theoretically ambiguous ex ante. On the one hand, higher expected future in-
755 come from on-the-job and full-time training tends to crowd out saving through the
756 standard consumption-smoothing motive. On the other hand, greater exposure to
757 idiosyncratic risk strengthens the precautionary saving motive and can crowd in sav-
758 ing. Propositions 2 and 3 demonstrate that, when idiosyncratic risk is sufficiently
759 large, human capital investment crowds out saving for low-labor-income households

Figure 7: Sectoral Average Asset Transition: Benchmark vs. No HC Models



Note: The transition paths within each sector. “Average Asset” is defined as the total assets in a given sector divided by that sector’s population share. The x-axis represents years, and the y-axis shows the percentage (or percentage point) deviation from the initial steady state. AI introduction is assumed to occur in period 10. The No HC model is an economy in which workers maintain their initial steady-state level of human capital throughout the AI implementation until the new steady state is reached.

760 but crowds in saving for high-labor-income households. As labor income is positively
 761 affected by households productivity, the net effect of human capital investment on
 762 saving is positive precisely for the more productive households.

763 In our quantitative model, this mechanism shows up most clearly in the middle
 764 sector. Figure 7 plots the transition of average assets by sector in the benchmark
 765 economy and in the counterfactual No HC economy. “Average Asset” is defined as
 766 total assets held by households in a given sector divided by that sector’s popula-
 767 tion share, so it reflects both within-sector saving behavior and the composition of
 768 households across sectors.

769 **AI’s direct impacts:** Without any human capital adjustment, AI’s impact on
 770 households’ saving works purely through income effect. In both the low and high
 771 sectors, households reduce their savings in anticipation of AI, expecting higher life-
 772 time labor income. After AI is implemented at period 10, their savings increase
 773 alongside rising labor incomes. In contrast, households in the middle sector, antici-
 774 pating a negative income effect from AI due to a lower wage rate, increase their
 775 savings prior to period 10. Once AI is introduced and the wage rate recovers,
 776 middle-sector households reduce their savings.

777 **Effects of AI-induced human capital adjustments:** Endogenous human cap-
 778 ital responses introduce an additional channel. Relative to the No-HC model, the
 779 benchmark exhibits a pronounced increase in average assets in the middle sector.¹⁵
 780 Middle-sector households are relatively productive in our model, and a composi-

¹⁵In the benchmark model, average assets in the high sector decline due to a composition effect, as relatively low-wealth households move up from the middle sector. In the low sector, average assets also fall, primarily because the scope for precautionary saving is limited, and this effect is reinforced by composition changes.

tion effect further amplifies their asset accumulation: many less productive middle-sector households endogenously move down to the low sector, so the remaining middle-sector population is positively selected on productivity.¹⁶ In addition, as discussed above, some middle-sector households voluntarily exit employment to invest in human capital full-time. Taken together, these households are the “active training” and relatively high-productivity workers in our model; thus, as predicted by Propositions 2 and 3, their human capital investment tends to crowd in saving. Accordingly, AI-induced human capital adjustment strengthens asset accumulation in the middle of the distribution and compresses the gap between the middle and the top. Quantitatively, the increase in wealth inequality in the benchmark economy with endogenous human capital is therefore markedly smaller than in the No HC economy, highlighting the stabilizing role of human capital adjustment in the wealth distribution.

7 Conclusion

Recent studies on AI suggest that advancements are likely to reduce demand for junior-level positions in high-skill industries while increasing the need for roles focused on advanced decision-making and AI oversight. We demonstrate how human capital investments are expected to adapt in response to these shifts in skill demand, highlighting the importance of accounting for these human capital responses when assessing AI’s economic impact.

Our work points to several promising directions for future research on the economic impacts of AI. First, if governments implement redistribution policies to address AI-induced inequality, understanding how these policies influence human capital accumulation, and thus their effectiveness, would be valuable. Second, our model assumes households have perfect foresight when making human capital investments. Relaxing this assumption could reveal new insights into the economic trajectory of AI advancements and offer important policy implications.

References

- Acemoglu, Daron and Restrepo, Pascual (2019). “8. Artificial Intelligence, Automation, and Work”, *The Economics of Artificial Intelligence*. Ed. by Agrawal, Ajay, Gans, Joshua, and Goldfarb, Avi. University of Chicago Press: Chicago, pp. 197–236.
- (2020). “Robots and Jobs: Evidence from US Labor Markets”, *Journal of Political Economy*, Vol. 128 No. 6, pp. 2188–2244.
- Aghion, Philippe *et al.*, (2019). *The Innovation Premium to Soft Skills in Low-Skilled Occupations*, Working papers No. 739. Banque de France.

¹⁶Note that the share of households moving up is relatively small.

- 817 Aiyagari, S. Rao (1994). "Uninsured Idiosyncratic Risk and Aggregate Saving", *The*
818 *Quarterly Journal of Economics*, Vol. 109 No. 3. Publisher: Oxford University
819 Press, pp. 659–684.
- 820 Asam, Dominik and Heller, David (2025). *Generative AI and Firm-level Productivity: Evidence from Startup Funding and Employment Dynamics*, Rochester,
821 NY.
- 823 Atkin, David (2016). "Endogenous Skill Acquisition and Export Manufacturing in
824 Mexico", *American Economic Review*, Vol. 106 No. 8, pp. 2046–85.
- 825 Autor, David H. and Dorn, David (2013). "The Growth of Low-Skill Service Jobs
826 and the Polarization of the US Labor Market", *American Economic Review*, Vol.
827 103 No. 5, pp. 1553–97.
- 828 Beaudry, Paul, Green, David A., and Sand, Benjamin M. (2016). "The Great Reversal
829 in the Demand for Skill and Cognitive Tasks", *Journal of Labor Economics*,
830 Vol. 34 No. S1, S199–S247.
- 831 Berg, Andrew, Buffie, Edward F., and Zanna, Luis-Felipe (2018). "Should we fear the
832 robot revolution? (The correct answer is yes)", *Journal of Monetary Economics*,
833 Vol. 97, pp. 117–148.
- 834 Bloomberg (2025). "AI's Takeover of Entry-Level Tasks Is Making College Grads'
835 Job Hunt Harder", accessed 02 Dec. 2024. URL: <https://www.bloomberg.com/news/articles/2025-07-30/ai-s-takeover-of-entry-level-tasks-is-making-college-grads-job-hunt-harder> (visited on 12/02/2024).
- 838 Calvino, Flavio, Reijerink, Jelmer, and Samek, Lea (2025). *The effects of generative
839 AI on productivity, innovation and entrepreneurship*, OECD Artificial Intelli-
840 gence Papers. Edition: 39 Series: OECD Artificial Intelligence Papers.
- 841 Chanda, Areendam (2008). "The rise in returns to education and the decline in
842 household savings", *Journal of Economic Dynamics and Control*, Vol. 32 No. 2,
843 pp. 436–469.
- 844 Chang, Yongsung and Kim, Sun-Bin (2006). "From Individual to Aggregate Labor
845 Supply: A Quantitative Analysis based on a Heterogeneous Agent Macroecon-
846 omy", *International Economic Review*, Vol. 47 No. 1, pp. 1–27.
- 847 Cortes, Guido Matias, Jaimovich, Nir, and Siu, Henry E (2017). "Disappearing rou-
848 tine jobs: Who, how, and why?", *Journal of Monetary Economics*, Vol. 91. Pub-
849 lisher: North-Holland, pp. 69–87.
- 850 Dauth, Wolfgang *et al.*, (2021). "The Adjustment of Labor Markets to Robots",
851 *Journal of the European Economic Association*, Vol. 19 No. 6, pp. 3104–3153.
- 852 Di Giacomo, Giuseppe and Lerch, Benjamin (2023). "Automation and Human Cap-
853 ital Adjustment", *Journal of Human Resources*,
- 854 Faber, Marius, Sarto, Andres P., and Tabellini, Marco (2022). *Local Shocks and
855 Internal Migration: The Disparate Effects of Robots and Chinese Imports in the
856 US*, Working Paper No. 30048. National Bureau of Economic Research.

- 857 Goos, Maarten and Manning, Alan (2007). “Lousy and Lovely Jobs: The Rising
858 Polarization of Work in Britain”, *The Review of Economics and Statistics*, Vol.
859 89 No. 1, pp. 118–133.
- 860 Goos, Maarten, Manning, Alan, and Salomons, Anna (2014). “Explaining Job Polar-
861 ization: Routine-Biased Technological Change and Offshoring”, *American Eco-*
862 *nomic Review*, Vol. 104 No. 8, pp. 2509–26.
- 863 Hémous, David and Olsen, Morten (2022). “The Rise of the Machines: Automation,
864 Horizontal Innovation, and Income Inequality”, *American Economic Journal:*
865 *Macroeconomics*, Vol. 14 No. 1, pp. 179–223.
- 866 Higher Education Strategy Associates (2022). “World Higher Education: Institu-
867 tions, Students and Funding”, accessed 02 Dec. 2024. URL: <https://higheredstrategy.com/world-higher-education-institutions-students-and-funding/> (vis-
868 ited on 12/02/2024).
- 870 Huggett, Mark, Ventura, Gustavo, and Yaron, Amir (2011). “Sources of Lifetime
871 Inequality”, *The American Economic Review*, Vol. 101 No. 7, pp. 2923–2954.
- 872 Lerch, Benjamin (2021). *Robots and Nonparticipation in the US: Where Have All the*
873 *Workers Gone?*, IdEP Economic Papers No. 2003. USI Università della Svizzera
874 italiana.
- 875 Oliver Wyman Forum (2024). *How Generative AI is Transforming Business and*
876 *Society*,
- 877 Park, Yena (2018). “Constrained Efficiency in a Human Capital Model”, *American*
878 *Economic Journal: Macroeconomics*, Vol. 10 No. 3, pp. 179–214.
- 879 Pew Research Center (2024). “Public Views on the Value of a College Degree”,
880 accessed 02 Dec. 2024. URL: <https://www.pewresearch.org/social-trends/2024/05/23/public-views-on-the-value-of-a-college-degree/> (visited
881 on 12/02/2024).
- 883 Prettner, Klaus and Strulik, Holger (2020). “Innovation, automation, and inequal-
884 ity: Policy challenges in the race against the machine”, *Journal of Monetary*
885 *Economics*, Vol. 116, pp. 249–265.
- 886 Public Agenda (2022). “Young Americans Without College Degrees Are Most Skep-
887 tical About the Value of Higher Education”, accessed 02 Dec. 2024. URL: <https://www.publicagenda.org/research/young-americans-without-college-degrees-are-most-skeptical-about-the-value-of-higher-education/>
888 (visited on 12/02/2024).
- 891 Revelio Labs (2025). “Is AI Responsible for the Rise in Entry-Level Unemploy-
892 ment?”, accessed 02 Dec. 2024. URL: <https://www.reveliolabs.com/news/macro/is-ai-responsible-for-the-rise-in-entry-level-unemployment/>
893 (visited on 12/02/2024).

- 895 Sachs, Jeffrey D. and Kotlikoff, Laurence J. (2012). *Smart Machines and Long-*
 896 *Term Misery*, NBER Working Papers No. 18629. National Bureau of Economic
 897 Research, Inc.
- 898 Souza, Gustavo de (2025). *Artificial Intelligence in the Office and the Factory: Evi-*
 899 *dence from Administrative Software Registry Data*, Rochester, NY.
- 900 Waldinger, Fabian (2016). “Bombs, Brains, and Science: The Role of Human and
 901 Physical Capital for the Creation of Scientific Knowledge”, *The Review of Eco-*
 902 *nomics and Statistics*, Vol. 98 No. 5, pp. 811–831.
- 903 Wang, Ping and Wong, Tsz-Nga (2025). “Artificial Intelligence and Technological
 904 Unemployment”,

905 A Household Decision Rule Cutoffs

906 A.1 Additional cutoffs formulae for households

$$\bar{z}_{non}^M(a, h) := \frac{(\exp(\frac{\chi_n}{1+\beta}) - 1)[(1+r)a + \frac{w'z'}{1+r'}]}{w(1 + \mathbb{1}_{h>h_H}\lambda)} \quad (\text{A.1})$$

$$\bar{z}_{slow}^M(a, h) := \frac{(\exp(\frac{\chi_n - \chi_e e_H}{1+\beta}) - 1)[(1+r)a + \frac{w'z'(1+\lambda)}{1+r'}] + \lambda \frac{w'z'}{1+r'}}{w(1 + \mathbb{1}_{h>h_H}\lambda)} \quad (\text{A.2})$$

$$\underline{z}_{fast}^M(a, h) := \frac{(\exp(\frac{\chi_n}{1+\beta}) - 1)[(1+r)a + \frac{w'z'(1+\lambda)}{1+r'}]}{w(1 + \mathbb{1}_{h>h_H}\lambda)} \quad (\text{A.3})$$

$$\bar{z}_{fast}^M(a, h) := \frac{\left\{ \lambda \left[\exp(\frac{\chi_e e_L}{1+\beta}) - 1 \right]^{-1} - 1 \right\} \frac{w'z'}{1+r'} - (1+r)a}{w(1 + \mathbb{1}_{h>h_H}\lambda)} \quad (\text{A.4})$$

$$\bar{z}_{non}^H(a) := \frac{(\exp(\frac{\chi_n}{1+\beta}) - 1)[(1+r)a + \frac{w'z'(1+\lambda)}{1+r'}]}{w(1 + \lambda)} \quad (\text{A.5})$$

907 A.2 Parameter restrictions for cutoffs ranking

908 To guarantee that $(n = 0, e = e_H)$ dominates $(n = 0, e = 0)$, we need a lower bound
 909 for λ . The slow learners prefer $(n = 0, e = e_H)$ if and only if

$$(1 + \beta) \ln c(n = 0, e = e_H) - \chi_e e_H \geq (1 + \beta) \ln c(n = 0, e = 0)$$

910 or equivalently:

$$\lambda \geq \underline{\lambda}_1 := \frac{(1+r)a + \frac{w'z'}{1+r'}}{\frac{w'z'}{1+r'}} \left(1 - \frac{1}{\exp(\frac{\chi_e e_H}{1+\beta})} \right) \text{ if } h < h_M \frac{1}{1-\delta} \quad (\text{A.6})$$

$$\lambda \geq \underline{\lambda}_3 := \frac{(1+r)a + \frac{w'z'}{1+r'}}{\frac{w'z'}{1+r'}} \left(\exp(\frac{\chi_e e_H}{1+\beta}) - 1 \right) \text{ if } h \geq h_M \frac{1}{1-\delta} \quad (\text{A.7})$$

911 To avoid $(n = 1, e = e_L)$ from being a dominated choice, we need another lower
 912 bound for λ . To see it, recall that $(n = 1, e = 0)$ is better than $(n = 1, e = e_L)$
 913 if $z > \bar{z}_{fast}$, and $(n = 1, e = e_L)$ is better than $(n = 0, e = e_L)$ if $z > \underline{z}_{fast}$.
 914 $(n = 1, e = e_L)$ is therefore the best choice over the interval $(\underline{z}_{fast}, \bar{z}_{fast})$. For such an
 915 interval to exist, it must be the case that when $z = \underline{z}_{fast}$, $z < \bar{z}_{fast}$. $z = \underline{z}_{fast}$ means
 916 that the fast learners are indifferent between $(n = 1, e = e_L)$ and $(n = 0, e = e_L)$ so
 917 that

$$(1+r)a + wzx(h) + \frac{w'z'}{1+r'} = \exp\left(\frac{\chi_n}{1+\beta}\right) \left[(1+r)a + \frac{w'z'}{1+r'} \right] \text{ if } h < h_M \frac{1}{1-\delta} \quad (\text{A.8})$$

$$(1+r)a + wzx(h) + \frac{w'z'(1+\lambda)}{1+r'} = \exp\left(\frac{\chi_n}{1+\beta}\right) \left[(1+r)a + \frac{w'z'(1+\lambda)}{1+r'} \right] \text{ if } h \geq h_M \frac{1}{1-\delta} \quad (\text{A.9})$$

918 For the fast learners to prefer $(n = 1, e = e_L)$ over $(n = 1, e = 0)$, we need

$$(1+\beta) \ln \frac{c(n=1, e=e_L)}{c(n=1, e=0)} \geq \chi_e e_L \quad (\text{A.10})$$

919 If $h < h_M \frac{1}{1-\delta}$, inequality (A.10) is:

$$(1+\beta) \ln \frac{(1+r)a + wzx(h) + \frac{w'z'}{1+r'}}{(1+r)a + wzx(h) + \frac{w'z'(1-\lambda)}{1+r'}} \geq \chi_e e_L$$

920 Evaluating the left-hand-side at $z = \underline{z}_{fast}$ yields:

$$\lambda \geq \underline{\lambda}_2 := \frac{(1+r)a + \frac{w'z'}{1+r'}}{\frac{w'z'}{1+r'}} \left(1 - \frac{1}{\exp\left(\frac{\chi_e e_L}{1+\beta}\right)} \right) \exp\left(\frac{\chi_n}{1+\beta}\right) \quad (\text{A.11})$$

921 If $h > h_M \frac{1}{1-\delta}$, inequality (A.10) is:

$$(1+\beta) \ln \frac{(1+r)a + wzx(h) + \frac{w'z'(1+\lambda)}{1+r'}}{(1+r)a + wzx(h) + \frac{w'z'}{1+r'}} \geq \chi_e e_L$$

922 Evaluating the left-hand-side at $z = \bar{z}_{fast}$ yields:

$$\lambda \geq \underline{\lambda}_4 := \frac{(1+r)a + \frac{w'z'}{1+r'}}{\frac{w'z'}{1+r'}} \frac{\left(\exp\left(\frac{\chi_e e_L}{1+\beta}\right) - 1 \right) \exp\left(\frac{\chi_n}{1+\beta}\right)}{\exp\left(\frac{\chi_e e_L}{1+\beta}\right) + \exp\left(\frac{\chi_n}{1+\beta}\right) - \exp\left(\frac{\chi_e e_L + \chi_n}{1+\beta}\right)} \quad (\text{A.12})$$

923 We have that $\underline{\lambda}_1 > \underline{\lambda}_2$ and $\underline{\lambda}_3 > \underline{\lambda}_4$ if

$$\exp\left(\frac{\chi_e e_H}{1+\beta}\right) > \frac{\exp\left(\frac{\chi_e e_L}{1+\beta}\right)}{\exp\left(\frac{\chi_e e_L}{1+\beta}\right) + \exp\left(\frac{\chi_n}{1+\beta}\right) - \exp\left(\frac{\chi_e e_L + \chi_n}{1+\beta}\right)} \quad (\text{A.13})$$

924 Therefore, the inequality above implies that the conditions (A.6) and (A.7) are
925 sufficient for the conditions (A.11) and (A.12). Furthermore, $\lambda_3 \geq \lambda_1$ so that the
926 condition (A.7) is sufficient for the condition (A.6).

927 We can then conclude that the conditions (A.7) and (A.13) are sufficient for
928 1) the slower learners always prefers $(n = 0, e = e_H)$ over $(n = 0, e = 0)$, and 2)
929 $\bar{z}_{fast} > \underline{z}_{fast}$, i.e., there exists state space where $(n = 1, e = e_L)$ is optimal.

930 A.3 Other cutoffs ranking for the two-period Model

931 For the fast learners, their cutoffs rank as follows

$$\frac{\bar{z}_{fast}^L(a)}{1 - \lambda} > \bar{z}_{fast}^L(a) > \bar{z}_{fast}^M(a) > \frac{\bar{z}_{fast}^M(a)}{1 + \lambda} \quad (\text{A.14})$$

$$\frac{\underline{z}_{fast}^L(a)}{1 - \lambda} > \underline{z}_{fast}^M(a) > \underline{z}_{fast}^L(a) > \frac{\underline{z}_{fast}^M(a)}{1 + \lambda} \quad (\text{A.15})$$

932 For the slow learners, the rank of their cutoffs is

$$\frac{\bar{z}_{slow}^L(a)}{1 - \lambda} > \bar{z}_{slow}^M(a) > \bar{z}_{slow}^L(a) > \frac{\bar{z}_{slow}^M(a)}{1 + \lambda} \quad (\text{A.16})$$

933 For the non-learners, the rank of their cutoffs is

$$\frac{\bar{z}_{non}^L(a)}{1 - \lambda} > \bar{z}_{non}^M(a) > \frac{\bar{z}_{non}^H(a)}{1 + \lambda} > \frac{\bar{z}_{non}^M(a)}{1 + \lambda} \quad (\text{A.17})$$

$$\bar{z}_{non}^M(a) > \bar{z}_{non}^L(a) \quad (\text{A.18})$$

934 B Proof of Proposition

935 B.1 Proof of Proposition 2

936 The derivative of saving with respect to t is

$$\frac{\partial a'^\star}{\partial t}(x, a; t) = -\frac{x\mu}{1 + \beta} + \frac{x^2\Sigma}{\beta} \frac{t[2(x + a) + tx\mu]}{[(x + a) + tx\mu]^2}. \quad (\text{B.1})$$

937 The total effect of on-job-training on saving is

$$\Delta_{\text{on-job}}(x, a; t) = a'^\star(x, a; t) - a'^\star(x, a; 1) = \int_1^t \frac{\partial a'^\star}{\partial u}(x, a; u) du. \quad (\text{B.2})$$

938 Define

$$F(x, a; u) \equiv x \frac{u[2(x + a) + ux\mu]}{[(x + a) + ux\mu]^2}, \quad \bar{F}(x, a; t) \equiv \frac{1}{t - 1} \int_1^t F(x, a; u) du.$$

939 Then equation (B.2) can be written as

$$\Delta_{\text{on-job}}(x, a; t) = x(t-1) \left[\frac{\Sigma}{\beta} \bar{F}(x, a; t) - \frac{\mu}{1+\beta} \right].$$

940 Differentiating $F(x, a; u)$ with respect to x gives

$$\frac{\partial F(x, a; u)}{\partial x} = \frac{2u a (a+x)}{(a+(1+u\mu)x)^3} > 0,$$

941 so $\bar{F}(x, a; t)$ is strictly increasing in x .

942 The sign of $\Delta_{\text{on-job}}(x, a; t)$ is governed by

$$S(x, a; t) \equiv \frac{\Sigma}{\beta} \bar{F}(x, a; t) - \frac{\mu}{1+\beta}.$$

943 Because $\bar{F}(x, a; t)$ is strictly increasing, $S(x, a; t)$ increases monotonically with x .

944 For $x \rightarrow 0$, $F(x, a; u) \rightarrow 0$ and $\bar{F}(x, a; t) \rightarrow 0$ so that $S(x, a; t) \rightarrow -\frac{\mu}{1+\beta} < 0$,
945 implying $\Delta_{\text{on-job}}(x, a; t) < 0$ for small x .

946 For $x \rightarrow \infty$, $F(x, a; u) \rightarrow \frac{u(2+u\mu)}{(1+u\mu)^2}$ and $\bar{F}(x, a; t) \rightarrow \bar{F}_\infty(t) \equiv \frac{1}{t-1} \int_1^t \frac{u(2+u\mu)}{(1+u\mu)^2} du$. If

$$\frac{\Sigma}{\mu} > \sigma^*(t) \equiv \frac{\beta}{1+\beta} \frac{1}{\bar{F}_\infty(t)} \quad (\text{B.3})$$

947 then $S(x, a; t) > 0$ for sufficiently large x , and hence $\Delta_{\text{on-job}}(x, a; t) > 0$.

948 If idiosyncratic risk is large enough, i.e., condition (B.3) is satisfied, there exists
949 a unique threshold $x^*(t)$ at which the sign flips:

$$\Delta_{\text{on-job}}(x, a; t) < 0 \text{ for } x < x^*(a, t), \quad \Delta_{\text{on-job}}(x, a; t) > 0 \text{ for } x > x^*(a, t).$$

950 B.2 Proof of Lemma 1

951 Denote

$$G(x, a; t) \equiv \frac{t^2 x^2}{(a+x+tx\mu)(a+tx\mu)}$$

952 the net additional effect of full-time training on saving can be rewritten as

$$\Delta_H(x, a; t) \equiv x \left[-\frac{\beta}{1+\beta} + \frac{\Sigma}{\beta} G(x, a; t) \right]$$

953 Differentiating $G(x, a; t)$ with respect to x gives

$$\frac{\partial G(x, a; t)}{\partial x} = \frac{t^2 x a (2tx\mu + 2a + x)}{(a+tx\mu)^2 (a+x+tx\mu)^2} > 0,$$

954 so $G(x, a; t)$ is strictly increasing in x .

955 The limits of $G(x, a; t)$ are:

$$G(x, a; t) \rightarrow 0 \quad (x \rightarrow 0),$$

956

$$G(x, a; t) \rightarrow G_\infty(t) \equiv \frac{t}{\mu(1 + t\mu)} \quad (x \rightarrow \infty),$$

957 Therefore, $G(x, a; t) < G_\infty(t)$ for any x .

958 If

$$\frac{\Sigma}{\beta} G_\infty(t) < \frac{\beta}{1 + \beta}, \text{ i.e. } \frac{\Sigma}{\mu} < \hat{\sigma}(t) \equiv \frac{\beta^2}{1 + \beta} \left(\frac{1}{t} + \mu \right). \quad (\text{B.4})$$

959 Then $\Delta_H(x, a; t) < x[-\frac{\beta}{1+\beta} + \frac{\Sigma}{\beta} G_\infty(t)] < 0$ for any x . Furthermore, with some
960 tedious algebra, we can show that for any x

$$G(x, a; t) + x \frac{\partial G(x, a; t)}{\partial x} < G_\infty(t)$$

961 Hence, the inequality (B.6) also implies that

$$\frac{\partial \Delta_H(x, a; t)}{\partial x} = \frac{\Sigma}{\beta} [G(x, a; t) + x \frac{\partial G(x, a; t)}{\partial x}] - \frac{\beta}{1 + \beta} < \frac{\Sigma}{\beta} G_\infty(t) - \frac{\beta}{1 + \beta} < 0. \quad (\text{B.5})$$

962 If

$$\frac{\Sigma}{\beta} G_\infty(t) > \frac{\beta}{1 + \beta}, \text{ i.e. } \frac{\Sigma}{\mu} > \hat{\sigma}(t) \equiv \frac{\beta^2}{1 + \beta} \left(\frac{1}{t} + \mu \right), \quad (\text{B.6})$$

963 since $G(x, a; t)$ is strictly increasing in x , there exists a unique $\hat{x}(a, t)$ such that

$$\Delta_H(x, a; t) = x \left[-\frac{\beta}{1 + \beta} + \frac{\Sigma}{\beta} G(x, a; t) \right] > 0 \Leftrightarrow x > \hat{x}(a, t)$$

964 Moreover, $\Delta_H(x, a; t) > 0$ implies that

$$\frac{\partial \Delta_H(x, a; t)}{\partial x} > 0.$$

965 B.3 Proof of Proposition 4

966 The relevant upper bounds of z for positive human capital investment are functions
967 of γ (to the first order approximation):

$$\begin{aligned} \bar{z}_{slow}^L(a; \gamma) &= \bar{z}_{slow}^L(a; \gamma = 0) - \gamma \lambda \frac{w' z'}{w(1 + r')} \\ \bar{z}_{fast}^L(a; \gamma) &= \bar{z}_{fast}^L(a; \gamma = 0) - \gamma \lambda \frac{w' z'}{w(1 + r')} \frac{\exp(\frac{\chi_e e_L}{1 + \beta})}{\exp(\frac{\chi_e e_L}{1 + \beta}) - 1} \\ \bar{z}_{slow}^M(a; \gamma) &= \bar{z}_{slow}^M(a; \gamma = 0) + \gamma \lambda \frac{w' z'}{w(1 + r')} \exp\left(\frac{\chi_n - \chi_e e_H}{1 + \beta}\right) \\ \bar{z}_{fast}^M(a; \gamma) &= \bar{z}_{fast}^M(a; \gamma = 0) + \gamma \lambda \frac{w' z'}{w(1 + r')} \frac{1}{\exp(\frac{\chi_e e_L}{1 + \beta}) - 1} \end{aligned}$$

968 Therefore, an anticipated AI shock, $\gamma > 0$ makes those with $h < h_M \frac{1}{1-\delta}$ invest less
969 human capital and those with $h > h_M \frac{1}{1-\delta}$ invest more human capital.

970 *B.4 Proof of Proposition 5*

$$\Delta_{\text{on-job}}(x, a; t) = a'^*(x, a; t) - a'^*(x, a; 1) = \int_1^t \frac{\partial a'^*}{\partial u}(x, a; u) du.$$

971 differentiating with respect to t gives

$$\frac{d\Delta_{\text{on-job}}(x, a; t)}{dt} = \frac{\partial a'^*}{\partial t}(x, a; t)$$

972 Since

$$\frac{\partial^2 a'^*(x, a; t)}{\partial t^2} = \frac{\partial}{\partial t} \left(-\frac{x\mu}{1+\beta} + \frac{x^2\Sigma}{\beta} \frac{t[2(x+a)+tx\mu]}{[(x+a)+tx\mu]^2} \right) = \frac{2x^2\Sigma(a+x)^2}{\beta(a+x+tx\mu)^3} > 0. \quad (\text{B.7})$$

973 The slope $\frac{\partial a'^*}{\partial t}(x, a; t)$ is strictly increasing in t . Hence $\Delta_{\text{on-job}}(x, a; t)$ is convex in t .

$$\Delta_H(x, a; t) = x \left[-\frac{\beta}{1+\beta} + \frac{\Sigma}{\beta} G(x, a; t) \right] \text{ with } G(x, a; t) = \frac{t^2 x^2}{(a+x+tx\mu)(a+tx\mu)}$$

974 Differentiating $G(x, a; t)$ with respect to t gives

$$\frac{\partial G(x, a; t)}{\partial t} = \frac{tx^2(2a^2 + 2atx\mu + 2ax + \mu tx^2)}{(a+tx\mu)^2(a+x+tx\mu)^2} > 0,$$

975 so $G(x, a; t)$ is strictly increasing in t , and so is $\Delta_H(x, a; t)$.

976 We now consider the comparison between $\Delta_{\text{on-job}}(x, a; t)$ and $\Delta_{\text{on-job}}(x, a; t')$ for $t' >$
977 t . Given x and a , define

$$f(t) \equiv \frac{\partial a'^*}{\partial t}(x, a; t).$$

978 so $f'(t) > 0$, i.e. $f(t)$ is strictly increasing in t .

979 **Case 1:** $1 < t < t'$

980 Suppose $\Delta_{\text{on-job}}(x, a; t) > 0$. Then

$$\Delta_{\text{on-job}}(x, a; t) = \int_1^t f(u) du > 0.$$

981 Since f is increasing,

$$f(u) \leq f(t) \quad \text{for all } u \in [1, t],$$

982 which implies

$$\Delta_{\text{on-job}}(x, a; t) = \int_1^t f(u) du \leq (t-1) f(t).$$

983 Because $t > 1$, the inequality $\Delta_{\text{on-job}}(x, a; t) > 0$ forces $f(t) > 0$.

984 Now for any $t' > t$,

$$f(u) \geq f(t) > 0 \quad \text{for all } u \in [t, t'],$$

985 and therefore

$$\Delta_{\text{on-job}}(x, a; t') - \Delta_{\text{on-job}}(x, a; t) = \int_t^{t'} f(u) du > 0.$$

986 We then have that:

$$1 < t < t', \Delta_{\text{on-job}}(x, a; t) > 0 \implies \Delta_{\text{on-job}}(x, a; t') > \Delta_{\text{on-job}}(x, a; t) \quad (\text{B.8})$$

987 That is, once $\Delta_{\text{on-job}}(x, a; t)$ becomes positive for $t > 1$, it is strictly increasing in t
988 thereafter.

989 **Case 2:** $t < t' < 1$

990 For $t < 1$,

$$\Delta_{\text{on-job}}(x, a; t) = \int_1^t f(u) du = - \int_t^1 f(u) du.$$

991 Suppose $\Delta_{\text{on-job}}(x, a; t) > 0$. Then

$$-\int_t^1 f(u) du > 0 \implies \int_t^1 f(u) du < 0.$$

992 Since f is increasing

$$f(u) \geq f(t) \quad \text{for all } u \in [t, 1],$$

993 which implies

$$\int_t^1 f(u) du \geq (1-t) f(t).$$

994 Because $t < 1$, the inequality $\Delta_{\text{on-job}}(x, a; t) > 0$ forces $f(t) < 0$.

995 Consider

$$\Delta_{\text{on-job}}(x, a; t') - \Delta_{\text{on-job}}(x, a; t) = \int_t^{t'} f(u) du$$

996 If $f(u) < 0$ for all $u \in [t, t']$, then $\int_t^{t'} f(u) du < 0$.

997 If there exists some $t_s \in [t, t']$ such that $f(t_s) = 0$, so $f(u) < 0$ for $u < t_s$ and
998 $f(u) > 0$ for $u > t_s$. Then $f(u) > 0$ for $u \in [t', 1]$. Hence,

$$\int_{t'}^1 f(u) du > 0$$

999 This implies that

$$\Delta_{\text{on-job}}(x, a; t') = - \int_{t'}^1 f(u) du < 0$$

1000 Together with the inequality $\Delta_{\text{on-job}}(x, a; t) > 0$, we have that

$$\Delta_{\text{on-job}}(x, a; t') < \Delta_{\text{on-job}}(x, a; t)$$

1001 We then have that

$$t < t' < 1, \Delta_{\text{on-job}}(x, a; t) > 0 \implies \Delta_{\text{on-job}}(x, a; t') < \Delta_{\text{on-job}}(x, a; t). \quad (\text{B.9})$$

1002 Thus, for $t < 1$, whenever $\Delta_{\text{on-job}}(x, a; t) > 0$, increasing t toward 0 makes $\Delta_{\text{on-job}}$
1003 strictly decrease.

1004 C Computational Procedure for the Quantitative Model

1005 C.1 Steady-state Equilibrium

1006 In the steady-state, the measure of households, $\mu(a, h, z)$, and the factor prices are
1007 time-invariant. We find a time-invariant distribution μ . We compute the house-
1008 holds' value functions and the decisions rules, and the time-invariant measure of the
1009 households. We take the following steps:

- 1010 1. We choose the number of grid for the risk-free asset, a , human capital, h , and
1011 the idiosyncratic labor productivity, z . We set $N_a = 151$, $N_h = 151$, and
1012 $N_z = 9$ where N denotes the number of grid for each variable. To better
1013 incorporate the saving decisions of households near the borrowing constraint,
1014 we assign more points to the lower range of the asset and human capital.
- 1015 2. Productivity z is equally distributed on the range $[-3\sigma_z/\sqrt{1-\rho_z^2}, \sqrt{1-\rho_z^2}]$. As shown
1016 in the paper, we construct the transition probability matrix $\pi(z'|z)$ of the
1017 idiosyncratic labor productivity.
- 1018 3. Given the values of parameters, we find the value functions for each state
1019 (a, h, z) . We also obtain the decision rules: savings $a'(a, h, z)$, and $h'(a, h, z)$.
1020 The computation steps are as follow:
- 1021 4. After obtaining the value functions and the decision rules, we compute the
1022 time-invariant distribution $\mu(a, h, z)$.
- 1023 5. If the variables of interest are close to the targeted values, we have found the
1024 steady-state. If not, we choose the new parameters and redo the above steps.

1025 *C.2 Transition Dynamics*

1026 We incorporate the transition path from the status quo to the new steady state. We
1027 describe the steps below.

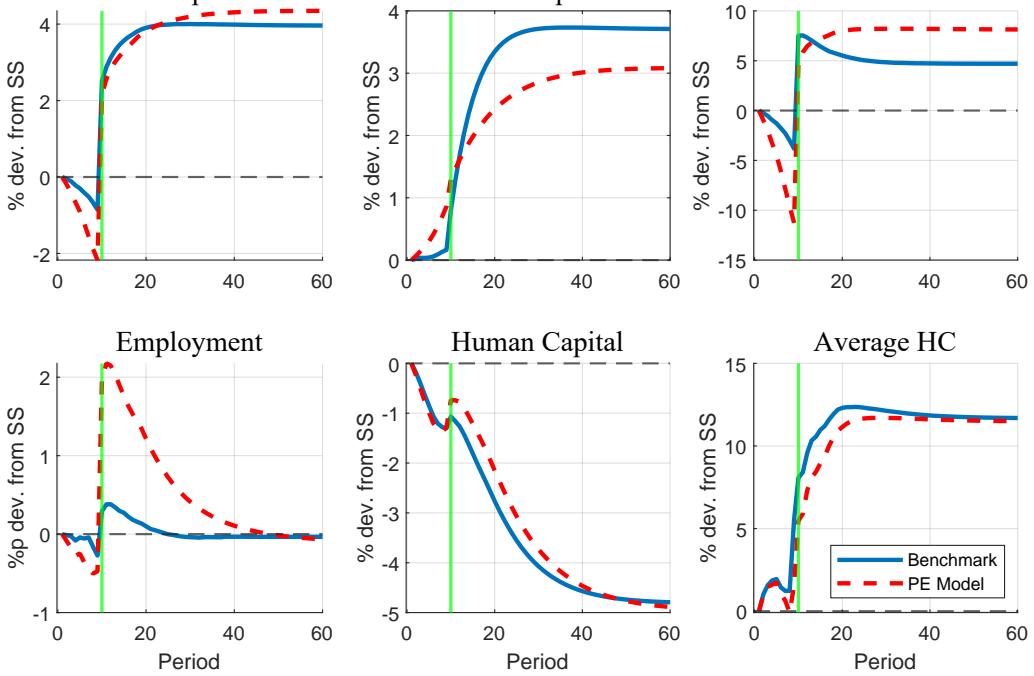
- 1028 1. We obtain the initial steady state and the new steady state.
- 1029 2. We assume that the economy arrives at the new steady state at time T . We
1030 set the T to 100. The unit of time is a year.
- 1031 3. We initialize the capital-labor ratio $\{K_t/L_t\}_{t=2}^{T-1}$ and obtain the associated
1032 factor prices $\{r_t, w_t\}_{t=2}^{T-1}$.
- 1033 4. As we know the value functions at time T , we can obtain the value functions
1034 and the decision rules in the transition path from $t = T - 1$ to 1.
- 1035 5. We compute the measures $\{\mu_t\}_{t=2}^T$ with the measures at the initial steady state
1036 and the decision rules in the transition path.
- 1037 6. We obtain the aggregate variables in the transition path with the decision rules
1038 and the distribution measures.
- 1039 7. We compare the assumed paths of capital and the effective labor with the
1040 updated ones. If the absolute difference between them in each period is close
1041 enough, we obtain the converged transition path. Otherwise, we assume new
1042 capital-labor ratio and go back to 3.

1043 **D Investigating the GE channel of AI's impact**

1044 Figures 8 and 9 compare the transition dynamics in the benchmark general-equilibrium
1045 model with those in a partial-equilibrium (PE) version of the model, where individ-
1046 ual behavior responds to AI adoption but factor prices are held fixed at their initial
1047 steady-state values. The green vertical line marks the date of AI adoption.

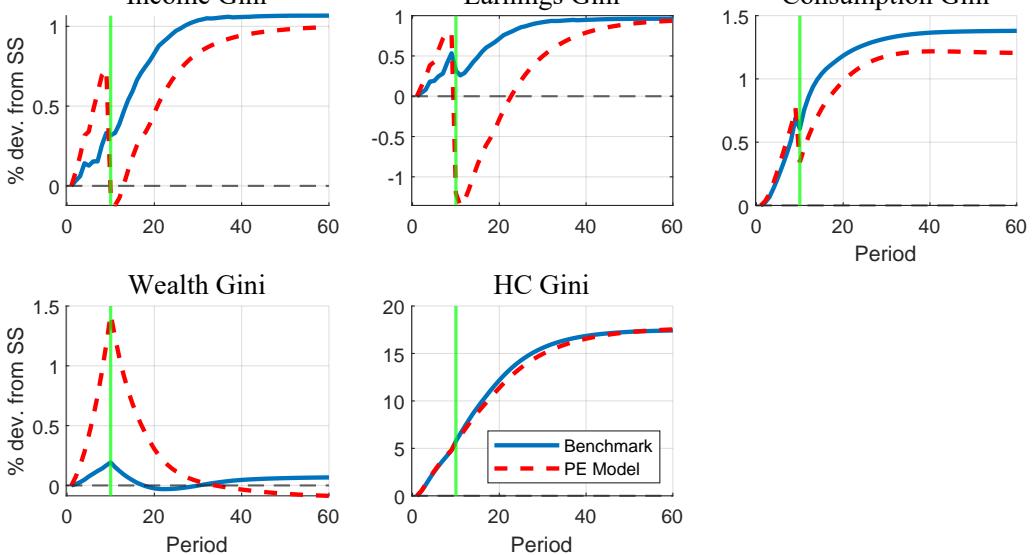
1048 On the aggregate side (Figure 8), both models deliver a long-run expansion in
1049 output, consumption, and investment after AI adoption. In the PE model, GDP
1050 responses are quite similar across the two models, but the composition of that re-
1051 sponse differs. In the PE model, consumption rises by less, while investment rises
1052 by more in the long run. The reason is that, in the benchmark, the long-run re-
1053 turn on capital becomes negative (as shown in Figure 5), whereas in the PE model
1054 there is no such price effect. As a result, households in the PE environment have
1055 stronger incentives to save and invest, tilting the response toward investment rather
1056 than consumption. Even though aggregate human-capital dynamics do not differ
1057 much across the two environments, employment behaves very differently around the
1058 adoption date. In the PE model, employment rises sharply when AI is introduced
1059 because wages do not fall as employment increases.

Figure 8: Transition Path of Aggregate Variables: Benchmark vs. PE Models



Note: The transition paths of aggregate variables: benchmark vs. PE models. The x-axis represents years, and the y-axis shows the percentage deviation from the initial steady state. AI introduction is assumed to occur in period 10. The PE model is an economy in which factor prices are held fixed at their initial steady-state values until the new steady state is reached.

Figure 9: Transition Path of Inequality Measures: Benchmark vs. PE Models



Note: The transition paths of inequality measures: benchmark vs. PE models. The x-axis represents years, and the y-axis shows the percentage deviation from the initial steady state. AI introduction is assumed to occur in period 10. The PE model is an economy in which factor prices are held fixed at their initial steady-state values until the new steady state is reached.

1060 Turning to inequality dynamics (Figure 9), the long-run behavior is similar across
1061 the two environments, but the impact responses differ markedly. As noted above,
1062 employment rises more on impact in the PE model even though output responses
1063 are similar. This implies that the additional employment mainly comes from low-
1064 productivity households. Consequently, the Gini coefficients for income, earnings,
1065 and consumption fall more on impact in the PE model but then move toward levels
1066 similar to those in the benchmark once job polarization and skill reallocation take
1067 hold. The human-capital Gini shows virtually no difference between the two models.
1068 By contrast, the wealth Gini exhibits very different transition dynamics. In the
1069 PE model, it displays a pronounced but short-lived spike early in the transition
1070 because poor households save less, as wages do not fall there in response to AI
1071 adoption, unlike in the benchmark economy. In the long run, however, the wealth
1072 Gini converges to a level similar to the benchmark, mainly because middle-sector
1073 households gradually increase their savings, as discussed in the main text.