TRENOX ADVISORY

DYNAMIC CAPITAL ACCUMULATION UNDER AI AUTOMATION

A stylised model of data, automation, declining capital returns and policy responses

AI	CAPITAL	PRODUCTIVITY	OWNERSHIP

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1. Purpose of the model

This working model translates the qualitative argument into a dynamic framework. It is designed to test how AI-driven productivity, data accumulation, labour displacement, investment and competition can interact over time.

2. State variables and equations

K_t = productive capital stock; A_t = AI/data capability; a_t = automation rate; Y_t = output; L_t = labour income; Π_t = capital income/profit; r_t = return on capital.

A compact representation is:

$$Y_t = B \cdot K_t^{\alpha} \cdot (1 + \gamma A_t) \cdot [1 + \eta a_t]$$

Labour share: $\omega_t = \omega_0 \cdot (1 - \lambda a_t)$. Labour income: $L_t = \omega_t Y_t$. Profit: $\Pi_t = (1 - \omega_t)Y_t - \delta K_t - C(A_t)$.

Capital accumulation: $K_{t+1} = (1 - \delta)K_t + s\Pi_t$. AI/data accumulation: $A_{t+1} = A_t + qI^{AI}_t + \varphi Data_t$. Return: $r_t = \Pi_t / K_t$.

Automation can be represented by a bounded adoption function $a_t = A_t/(A_t + h)$, so automation approaches 100% asymptotically rather than mechanically exceeding it.

3. Illustrative 20-period simulation

Period	Automation	Output	Labour share	Capital K	Profit Π	Return r
0	18.7%	66.1	51.2%	100.0	25.9	25.9%
2	29.2%	77.1	46.3%	111.2	34.2	30.7%
5	41.2%	97.4	40.7%	138.5	48.5	35.0%
10	55.0%	142.9	34.3%	215.0	79.4	36.9%
15	64.2%	204.6	30.0%	336.8	120.8	35.9%
20	70.7%	284.2	26.9%	512.2	173.8	33.9%

Interpretation: in this particular parameterisation, AI capability and automation increase output and initially strengthen profits. Reinvestment enlarges the capital stock. As capital becomes abundant, however, the denominator K grows rapidly and competitive/depreciation effects reduce the incremental return. The model can therefore generate rising productive wealth together with a declining or normalising return on capital.

4. Three long-run regimes

Regime A - AI scarcity: AI capability is scarce and protected. Early adopters earn high rents; capital returns can rise.
Regime B - diffusion and competition: AI becomes standard infrastructure. Capacity expands, margins compress and returns normalise.
Regime C - reproducible capital abundance: AI and robotics increasingly reproduce productive capital. The scarcity premium on ordinary capital falls; rents migrate to irreproducible or institutionally protected assets.

5. The demand-side constraint

A highly automated economy also faces a distributional demand problem. If labour income falls faster than households acquire capital income, consumption demand can lag productive capacity. In the model this can be represented by $C_t = cL \cdot L_t + cK \cdot H_t$, with cL typically greater than cK because lower- and middle-income households tend to consume a larger share of current income. Concentrated capital ownership can therefore weaken aggregate demand even when technological capacity is abundant.

6. Data as an accumulable production factor

Data differs from conventional capital because it can be non-rival, reusable and complementary to AI models. The strategic issue is not merely the quantity of data but exclusive access, quality, feedback loops and the ability to convert information into lower uncertainty. Firms that reduce information asymmetries can improve allocation, pricing, matching and risk assessment - potentially creating measurable productivity gains before competitors replicate the information advantage.

7. Policy and institutional responses

Measure	Economic mechanism	Potential objective
Broad capital ownership	Democratise equity funds, employee ownership, citizen funds	Convert part of capital income into broad household income
Competition policy	Limit durable platform/data monopolies	Prevent temporary AI advantage becoming permanent monopoly rent
Data portability / access	Reduce information lock-in and switching costs	Diffuse productivity and reduce asymmetry
Tax base adaptation	Shift from payroll-only dependence toward robust capital/rent bases	Finance public goods when labour share declines
Investment incentives	Support productive AI, energy, grids and skills	Raise capacity without protecting incumbents
Transition income / negative tax	Stabilise household purchasing power	Reduce demand shortfalls during labour displacement
Education and task redesign	Move people toward complementary tasks	Slow unnecessary displacement and raise human productivity
Public or cooperative AI capital	Collective ownership of selected productive infrastructure	Broaden participation in automation returns

The objective is not to suppress automation. It is to preserve competition, broaden access to productive ownership and maintain effective demand while allowing productivity gains to compound.

8. Strategic implications for companies

Companies should distinguish between temporary AI arbitrage and durable advantage. Durable value is more likely to arise from proprietary workflows, trusted data, distribution, customer relationships, regulatory competence and superior reduction of information asymmetry than from generic access to the same AI models available to competitors.

A useful corporate KPI set would therefore track: automation rate; revenue per employee; AI/data investment; capital intensity; operating margin; return on invested capital; share of revenue from information-asymmetry reduction; customer switching costs; concentration risk; and the distribution of productivity gains among employees, customers and owners.

9. Central conclusion

The dynamic model supports a non-binary interpretation. AI can simultaneously increase output, accelerate capital accumulation and reduce labour's income share. In the early phase this can increase capital returns; in the diffusion phase competition can lower them; and in a mature automation phase reproducible capital may itself lose scarcity value. The long-run institutional question becomes who owns the remaining scarce assets and how the gains from radically higher productivity enter household demand.

Model caveat

This is a stylised conceptual simulation. Parameter choices are illustrative, not empirically calibrated. The model is intended for strategic analysis and scenario development, not as a macroeconomic forecast or investment recommendation.