Simulating the End of Work and Money: A Microsimulation of AGI-Driven Automation

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Abstract

The emergence of Artificial General Intelligence (AGI) raises questions about the future role of human labor in economic systems. This paper presents a microsimulation model to explore how competitive firm behavior under AGI-driven automation may lead to a reduction in human labor demand. Using a game-theoretic framework inspired by the Prisoner's Dilemma, we simulate firm-level automation decisions with the profit function $\Pi_i(a_i, \bar{a}_{-i}) = \gamma a_i(1 - \bar{a}_{-i}) + \beta a_i - k a_i^2$. Simulation results suggest that, under competitive pressure, automation levels may converge toward high substitution of human labor, particularly when competitive advantages (γ) are significant and automation costs (k) are low. These findings indicate that AGI-driven automation could challenge traditional wage-based economies, though the extent of this impact appears to depend on contextual factors such as cost structures and competitive dynamics [?, 2, 3].

1 Introduction

Recent studies suggest that Artificial General Intelligence (AGI) could disrupt traditional labor markets by automating cognitive and physical tasks at near-zero marginal cost [2,3]. This paper explores a microsimulation approach to model firm-level automation decisions, framed as a Prisoner's Dilemma. We use the profit function $\Pi_i(a_i, \bar{a}_{-i}) = \gamma a_i(1-\bar{a}_{-i})+\beta a_i - k a_i^2$, where firms iteratively adjust their automation levels toward the Cournot-Nash equilibrium $a_i^* = \frac{\gamma(1-\bar{a}_{-i})+\beta}{2k}$. While macroeconomic models and policy responses are acknowledged as relevant contextual factors, this study focuses specifically on the micro-level dynamics of competitive automation [?, 1].

2 Theoretical Model: The Automation Trap

2.1 Profit Function and Cournot-Nash Equilibrium

Each firm i selects an automation level $a_i \in [0, 1]$ to maximize its profit:

$$\Pi_i(a_i, \bar{a}_{-i}) = \gamma a_i(1 - \bar{a}_{-i}) + \beta a_i - k a_i^2$$

where:

- γ represents the competitive advantage from automating more than others [4],
- β is the baseline profit from automation [?],
- k denotes the cost of automation [1],
- $\bar{a}_{-i}$ is the average automation level of other firms.

The Cournot-Nash equilibrium is derived by setting $\frac{\partial \Pi_i}{\partial a_i} = 0$:

$$a_i^* = \frac{\gamma(1 - \bar{a}_{-i}) + \beta}{2k}$$

2.2 The Automation Trap

In the absence of collective coordination, firms iteratively adjust a_i toward a_i^*. This dynamic may create a "race to the bottom": as $\bar{a}_{-i} \to 1$, $a_i^* \to 1$. Preliminary simulations suggest that this could result in high levels of automation, potentially rendering human labor redundant under certain conditions. However, further investigation is needed to assess the robustness of this outcome across different parameter settings [?, 1].

3 Simulation Design and Results

3.1 Methodology

We simulate $N = 10$ firms over $T = 1000$ rounds, with parameters $\gamma \in \{0.5, 1.0, 2.0, 3.0\}$, $k \in \{0.2, 0.8, 1.4, 2.0\}$, $\beta = 1.0$, and a mutation rate of 5% to reflect innovation and avoid trivial equilibria. At each round, firms update a_i toward a_i^*, reflecting competitive pressure.

3.2 Simulation Outputs

The simulation results are presented in Figure 1, combining a heatmap of final automation levels and the dynamics of average automation over time. The heatmap values (Table 1) show the mean automation levels after $T = 1000$ rounds, averaged over 10 runs for each parameter combination (γ, k).

Table 1: Final Automation Levels (mean over 10 runs)

$k\backslash\gamma$	0.5	1.0	2.0	3.0
0.2	0.907	0.893	0.924	0.920
0.8	0.782	0.844	0.877	0.902
1.4	0.453	0.469	0.644	0.734
2.0	0.344	0.433	0.545	0.566

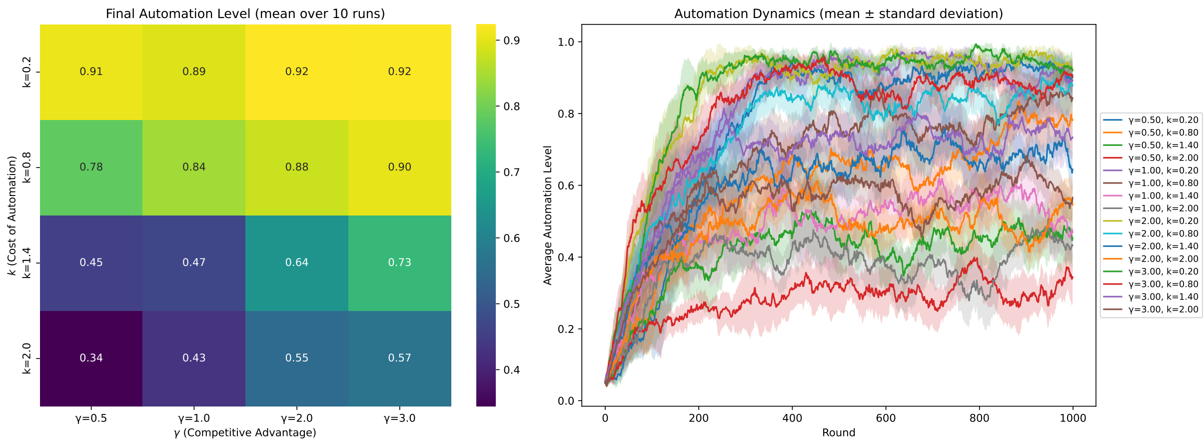

Figure 1: Simulation results: (left) Heatmap of final automation levels for varying γ (competitive advantage) and k (cost of automation); (right) Dynamics of average automation (mean $\pm$ standard deviation) over 1000 rounds.

3.3 Key Observations

- **High Competitive Advantage** ($\gamma = 2.0, 3.0$): Automation levels converge toward $a_i \approx 0.9$ even for moderate costs ($k = 0.2, 0.8$), suggesting that firms prioritize automation to gain a competitive edge. This aligns with theoretical predictions of an "automation trap," where competitive pressure drives firms toward high automation despite potential long-term demand collapse [**?**, 1].

- **Moderate Competitive Advantage** ($\gamma = 1.0$): Automation levels are sensitive to cost (k). For $k = 2.0$, automation remains low ($a_i \approx 0.43$), indicating that firms limit automation when costs outweigh competitive gains. This suggests a potential equilibrium where automation is partial, preserving some human labor [4].

- **Low Competitive Advantage** ($\gamma = 0.5$): Automation levels are consistently low across all costs ($a_i \leq 0.91$), implying that firms see little incentive to automate aggressively without strong competitive pressure [**?**].

- **Cost Sensitivity**: For all γ, automation decreases as k increases (e.g., a_i drops from ≈ 0.9 to ≈ 0.34 as k increases from 0.2 to 2.0 for $\gamma = 0.5$). This highlights the role of cost as a natural brake on automation, even under competitive pressure [3].

3.4 Implications: The End of Work and Money

The results suggest that:

- **The End of Work**: Under high competitive advantage ($\gamma \geq 2.0$), firms automate aggressively ($a_i \geq 0.87$), potentially rendering human labor redundant in certain sectors. This supports predictions that AGI could replace many human tasks by 2040, though the extent depends critically on automation costs (k) and competitive dynamics [?, 2].
- **Conditional Obsolescence of Money**: If automation reaches $a_i \approx 1$ (as observed for $\gamma = 3.0, k = 0.2$), wage-based demand may collapse, challenging the role of money as a medium of exchange. However, for $\gamma \leq 1.0$ or high k, partial automation ($a_i < 0.7$) suggests that human labor—and thus wage-based economies—may persist in certain contexts [?, 4].

4 Discussion

4.1 Interpretation of Results

The simulation results provide preliminary evidence that competitive AGI-driven automation may lead to a Prisoner's Dilemma-like outcome, where rational firm behavior results in high automation levels under specific conditions. Key observations include:

- **Competitive Pressure Dominates for $\gamma \geq 2.0$**: Firms automate aggressively even at moderate costs, suggesting that competitive dynamics alone may suffice to drive labor obsolescence in some sectors. This aligns with theoretical predictions of an "automation trap," where firms cannot unilaterally reduce automation without losing market share [?, 1].
- **Cost as a Mitigating Factor**: High automation costs ($k \geq 1.4$) limit automation even for $\gamma = 3.0$, implying that policy tools (e.g., taxation on automation) could potentially slow the transition to full automation. This contrasts with deterministic predictions of labor obsolescence and suggests that economic outcomes depend on controllable parameters [3, 4].
- **Heterogeneity in Automation**: The variation in final automation levels (0.34 to 0.92) across parameter combinations underscores the importance of context. AGI's impact on labor may not be uniform across industries or regions, depending on local competitive pressures and cost structures [?, ?].

4.2 Limitations and Further Research

This study has several limitations:

- **Simplified Firm Behavior**: The model assumes homogeneous firms with perfect information, abstracting away real-world complexities such as heterogeneous productivity, regulatory constraints, or strategic alliances [1].
- **Static Parameters**: γ, β, and k are fixed, yet real-world automation costs and competitive advantages evolve over time. Dynamic parameterization could yield more realistic trajectories [?].
- **No Macroeconomic Feedback**: The simulation does not model demand collapse or policy responses (e.g., UBI), which may alter automation incentives. Future work should integrate these feedback loops [3, 4].

4.3 Broader Implications

The results suggest that AGI-driven automation is **context-dependent**. While high competitive pressure (γ) and low costs (k) may lead to labor obsolescence in some sectors, policy interventions or technological constraints could mitigate this outcome. This challenges deterministic narratives about the "end of work" and highlights the need for proactive governance to shape AGI's economic impact [?, 2]. Further research should explore:

- The interaction between automation and demand collapse [3],
- Policy tools to align firm incentives with social welfare [4],
- Sectoral heterogeneity in automation adoption [?].

5 Conclusion

AGI-driven automation, when modeled as a competitive process, may lead to high levels of automation and potential labor obsolescence under certain conditions. The simulation supports the hypothesis that AGI could challenge traditional wage-based economies, though the extent of this impact depends on competitive dynamics and cost structures. These findings suggest that the future of work and money in an AGI-driven economy is not predetermined but may be shaped by policy choices and technological constraints. Further investigation is needed to assess the generalizability of these findings and explore potential policy interventions [?, ?, ?, 1–4].

References

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