General Intelligence and Social Welfare

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Abstract

I develop a model to investigate the impact of general intelligence on the allocation of resources to ideas requiring different field-specific knowledge combinations. I show that general intelligence can improve resource allocation efficiency and social welfare by reducing underinvestment in complex, cross-field ideas. However, I also provide a cautionary tale about the potential issues arising from the concentration of decision-making power among general intelligence agents, such as reduced competition and rent extraction. I discuss policy implications for harnessing the benefits of general intelligence while mitigating its drawbacks.

1 Introduction

In today's rapidly advancing world, human knowledge has become increasingly specialized and segregated into distinct fields, much like islands that rarely communicate with each other [Hoffman et al., 2017, Jones, 2009]. This specialization has led to significant progress within each field but has also created challenges for the evaluation and allocation of resources to ideas and projects that require cross-field knowledge [Agrawal et al., 2018, Boudreau et al., 2016]. The cognitive uncertainty perceived by agents with specialized knowledge when assessing cross-field ideas can result in underinvestment and welfare loss for society [Dixit and Pindyck, 1994, Pastor and Veronesi, 2009].

The emergence of general intelligence, either in the form of artificial intelligence (AI) or humans acquiring cross-field knowledge, has the potential to mitigate these inefficiencies [Aghion et al., 2017, Cockburn et al., 2018]. General intelligence agents possess knowledge spanning multiple fields, enabling them to evaluate cross-field ideas with lower variance compared to specialist agents. This improved evaluation accuracy can enhance social welfare by facilitating the allocation of resources to valuable cross-field ideas that might otherwise be overlooked.

It is important to note that the economic insights from this analysis extend beyond the financing of projects. The "projects" in our model can be interpreted as any ideas in life, and the invested resources can include not only money but also other scarce resources such as time and energy. This generalizability makes the implications of our findings relevant to a wide range of decision-making contexts, from personal resource allocation to organizational strategy and public policy.

Given the welfare gains and positive externalities associated with general intelligence, governments may consider subsidizing its development [Bloom et al., 2020, Van Reenen, 2021]. However, it is crucial to approach this with caution, as the rise of general intelligence in decision-making may also lead to new challenges, such as reduced competition and the extraction of informational rents [Hellmann and Puri, 2000, Hsu, 2004]. Policymakers must carefully design mechanisms to harness the benefits of general intelligence while mitigating its potential drawbacks.

In this paper, I present a model to analyze the impact of general intelligence on the allocation of resources to ideas requiring different combinations of field-specific knowledge. I demonstrate how the presence of general intelligence agents can improve resource allocation efficiency and social welfare by reducing the underinvestment in complex, cross-field ideas. I also discuss the potential issues arising from the concentration of decision-making power among general intelligence agents and provide policy recommendations to address these challenges. Furthermore, I extend the model to consider the strategic interactions between investors and entrepreneurs, examining how the informational structure affects the division of surpluses.

2 Model Setup

Consider an economy with two fields of knowledge, denoted by A and B. There are three types of ideas: Idea A, which requires only field A knowledge; Idea B, which requires only field B knowledge; and Idea C, which requires both A and B knowledge. Each idea requires a scarce resource (e.g., time, energy, or capital) $K > 0$ to implement and generates a return $R > 0$ upon success. The success probabilities for Ideas A, B, and C are given by p_A, p_B, and p_C, respectively.

Agents in this economy are risk-averse, with utility function $U(w) = -e^{-\rho w}$, where $\rho > 0$ is the coefficient of absolute risk aversion and w is the agent's wealth. Agents can be categorized into three types: Specialist A, who is knowledgeable only in field A; Specialist B, who is knowledgeable only in field B; and Generalist, who is knowledgeable in both fields A and B, possessing general intelligence (GI).

3 Information Structure and Resource Allocation Decisions

Specialists observe noisy signals of idea success probabilities in their respective fields. For Specialist A, the signal is given by $s_A = p_A + \varepsilon_A$, where ε_A is normally distributed with mean zero and variance σ_A^2. Similarly, for Specialist B, the signal is given by $s_B = p_B + \varepsilon_B$, where ε_B is normally distributed with mean zero and variance σ_B^2. Specialists face higher uncertainty when evaluating Idea C, as it requires knowledge from both fields. The signals for Idea C are given by $s_{AC} = p_C + \varepsilon_{AC}$ and $s_{BC} = p_C + \varepsilon_{BC}$ for Specialist A and Specialist B, respectively, where ε_{AC} and ε_{BC} are normally distributed with mean zero and variances $\sigma_{AC}^2 > \sigma_A^2$ and $\sigma_{BC}^2 > \sigma_B^2$.

Generalists, on the other hand, observe noisy signals for all ideas with lower variance compared to specialists. For Idea A, the signal is given by $s_{GA} = p_A + \varepsilon_{GA}$, where ε_{GA} is normally distributed with mean zero and variance $\sigma_{GA}^2 < \sigma_A^2$. For Idea B, the signal is given by $s_{GB} = p_B + \varepsilon_{GB}$, where ε_{GB} is normally distributed with mean zero and variance $\sigma_{GB}^2 < \sigma_B^2$. Finally, for Idea C, the signal is given by $s_{GC} = p_C + \varepsilon_{GC}$, where ε_{GC} is normally distributed with mean zero and variance $\sigma_{GC}^2 < \min(\sigma_{AC}^2, \sigma_{BC}^2)$.

Agents make resource allocation decisions based on their posterior beliefs about idea success probabilities, derived using Bayes' rule [DeGroot, 1970, Morris and Shin, 2002]. The posterior belief for an agent of type $j \in \{A, B, G\}$ about the success probability of an idea of type $i \in \{A, B, C\}$ is given by:

$$E[p_i|s_j] = \frac{\sigma_0^2 p_i + \sigma_j^2 s_j}{\sigma_0^2 + \sigma_j^2}, \tag{1}$$

where σ_0^2 is the prior variance of the idea success probability.

4 Equilibrium without General Intelligence

In an equilibrium without general intelligence, Specialist A allocates resources to Idea A if $E[U(w + R - K)|s_A] > U(w)$, and Specialist B allocates resources to Idea B if $E[U(w + R - K)|s_B] > U(w)$. However, due to the lack of field-specific knowledge, Specialist A and B may underinvest in Idea C, even if it has a positive net present value (NPV), because of the higher uncertainty in their posterior beliefs about p_C, as $\sigma_{AC}^2 > \sigma_A^2$ and $\sigma_{BC}^2 > \sigma_B^2$ [Dixit and Pindyck, 1994, Pastor and Veronesi, 2009]. This underinvestment in Idea C leads to inefficient resource allocation and a potential shortage of resources for complex, cross-field ideas.

5 Equilibrium with General Intelligence

In the presence of general intelligence, Generalists can accurately evaluate all three types of ideas, as they possess knowledge in both fields A and B. A Generalist allocates resources to Idea A if $E[U(w+R-K)|s_{GA}] > U(w)$, Idea B if $E[U(w+R-K)|s_{GB}] > U(w)$, and Idea C if $E[U(w+R-K)|s_{GC}] > U(w)$. The presence of Generalists improves the efficiency of resource allocation by enabling the allocation of resources to all positive NPV ideas, including complex, cross-field ideas like Idea C, as $\sigma^2_{GC} < \min(\sigma^2_{AC}, \sigma^2_{BC})$.

However, the concentration of decision-making power among Generalists may lead to new issues. First, Generalists may extract informational rents, reducing incentives and surplus for other agents [Hellmann and Puri, 2000, Hsu, 2004]. Second, the market power of Generalists may lead to a less competitive environment, potentially distorting resource allocation decisions and reducing overall welfare [Rajan, 1992, Petersen and Rajan, 1995].

6 Strategic Interactions between Investors and Entrepreneurs

To further understand the implications of general intelligence on the division of surpluses, I extend the model to consider the strategic interactions between investors (Specialists and Generalists) and entrepreneurs who propose ideas.

Suppose that entrepreneurs have private information about the quality of their ideas, which can be either high (H) or low (L), with success probabilities $p_H > p_L$. The proportion of high-quality ideas is given by $\phi \in (0, 1)$. Entrepreneurs propose their ideas to investors, who then decide whether to allocate resources based on their posterior beliefs about the idea quality.

In the absence of general intelligence, Specialist A and B may not be able to accurately distinguish between high-quality and low-quality ideas in field C, leading to a pooling equilibrium where all ideas in field C receive the same funding. This results in underinvestment in high-quality cross-field ideas and overinvestment in low-quality ones [Akerlof, 1970].

In contrast, the presence of Generalists allows for a separating equilibrium, where high-quality ideas in field C receive more funding than low-quality ones. Generalists can use their superior information to design contracts that incentivize entrepreneurs to reveal their idea quality, such as offering a higher share of the returns to entrepreneurs with high-quality ideas [Rothschild and Stiglitz, 1976, Tirole, 2010]. This leads to a more efficient allocation of resources and a higher overall surplus.

However, the improved information of Generalists also enables them to extract a larger share of the surplus from entrepreneurs, particularly those with high-quality ideas. This can reduce the incentives for entrepreneurs to propose innovative cross-field ideas, potentially hampering long-run innovation and growth [Aghion et al., 2005, Rajan, 2012].

7 A Model of Informational Rent Extraction

To formally analyze the cautionary tale of informational rent extraction by Generalists, I introduce a simple model that builds upon the main framework.

Consider a setting where an entrepreneur proposes an idea in field C to a Generalist investor. The entrepreneur has private information about the quality of the idea, which can be either high (H) or low (L), with success probabilities $p_H > p_L$. The Generalist investor observes a noisy signal s_G of the idea quality, where $s_G = p_i + \varepsilon_G$, $i \in \{H, L\}$, and ε_G is normally distributed with mean zero and variance σ_G^2.

The Generalist investor offers a contract (t_H, t_L) to the entrepreneur, where t_i is the transfer payment to the entrepreneur conditional on the success of an idea of quality $i \in \{H, L\}$. The entrepreneur accepts the contract if the expected utility from accepting is greater than or equal to the reservation utility $\bar{U}$.

The Generalist investor's problem is to design a contract that maximizes their expected payoff, subject to the entrepreneur's participation and incentive compatibility constraints:

$$\max_{t_H, t_L} \quad \phi(p_H(R - t_H)) + (1 - \phi)(p_L(R - t_L)) \tag{2}$$

$$\text{s.t.} \quad \phi(p_H t_H) + (1 - \phi)(p_L t_L) \geq \bar{U} \tag{3}$$

$$p_H t_H \geq p_H t_L \tag{4}$$

$$p_L t_L \geq p_L t_H \tag{5}$$

The solution to this problem yields the optimal contract (t_H^*, t_L^*), which satisfies the following conditions:

$$p_H t_H^* = \bar{U} + (p_H - p_L) t_L^* \tag{6}$$

$$p_L t_L^* = \bar{U} \tag{7}$$

The optimal contract shows that the Generalist investor can extract informational rents from the entrepreneur, particularly from those with high-quality ideas. The transfer payment to the entrepreneur with a high-quality idea, t_H^*, is higher than the transfer payment to the entrepreneur with a low-quality idea, t_L^*, by a factor of $(p_H - p_L)$. This informational rent extraction can reduce the incentives for entrepreneurs to propose high-quality cross-field ideas, potentially hindering innovation and growth in the long run.

8 Policy Implications

The analysis of the strategic interactions between investors and entrepreneurs highlights the importance of carefully designing policies to harness the benefits of general intelligence while mitigating its potential drawbacks.

To encourage the efficient allocation of resources to high-quality cross-field ideas, policymakers can consider the following measures:

1. Subsidizing the development of general intelligence: Providing subsidies for education and training programs that foster the acquisition of cross-field knowledge can increase the supply of Generalists in the economy, promoting a more efficient allocation of resources to complex, cross-field ideas [Bloom et al., 2020, Van Reenen, 2021].

2. Encouraging collaboration between Specialists and Generalists: Facilitating collaboration and information sharing between Specialists and Generalists can help mitigate the underinvestment in high-quality cross-field ideas by leveraging the complementary expertise of both types of agents [Aghion et al., 2005, Jones, 2009].

3. Strengthening intellectual property rights: Enhancing the protection of intellectual property rights for cross-field ideas can help reduce the informational rent extraction by Generalists and provide stronger incentives for entrepreneurs to propose innovative ideas [Aghion et al., 1992, Scotchmer, 2004].

4. Promoting alternative funding mechanisms: Encouraging the development of alternative funding mechanisms, such as crowdfunding platforms and decentralized finance (DeFi), can provide entrepreneurs with a wider range of financing options and reduce their dependence on Generalist investors [Agrawal et al., 2014, Yermack, 2017].

By implementing these policies, policymakers can create a more balanced and efficient ecosystem that supports the development and financing of high-quality cross-field ideas while mitigating the potential negative consequences of general intelligence.

9 Conclusion

This paper presents a model to analyze the impact of general intelligence on the allocation of resources to ideas requiring different combinations of field-specific knowledge. I demonstrate how the presence of general intelligence agents can improve resource allocation efficiency and social welfare by reducing the underinvestment in complex, cross-field ideas. However, I also highlight the potential issues arising from the concentration of decision-making power among general intelligence agents, such as reduced competition and the extraction of informational rents.

The extension of the model to consider the strategic interactions between investors and entrepreneurs reveals that general intelligence can lead to a more efficient separating equilibrium, where high-quality cross-field ideas receive more funding than low-quality ones. However, it also enables Generalist investors to extract informational rents from entrepreneurs, particularly those with high-quality ideas, potentially reducing incentives for innovation in the long run.

To harness the benefits of general intelligence while mitigating its potential drawbacks, I propose several policy measures, including subsidizing the development of general intelligence, encouraging collaboration between Specialists and Generalists, strengthening intellectual property rights, and promoting alternative funding mechanisms.

As artificial intelligence and human acquisition of cross-field knowledge continue to advance, further research is needed to understand the long-term implications of general intelligence for innovation, entrepreneurship, and economic growth. By proactively addressing the challenges and opportunities presented by general intelligence, we can work towards creating a more efficient and equitable ecosystem that supports the development of groundbreaking ideas and technologies.

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