Qeios

Why Do Contemporary Scholars Lack Fenggu (Strength of Character)?

--Impact of Technological Progress on Demand for Human Capital and Talents

Qing-Ping Ma

Department of Finance, Accounting and Economics, Nottingham University Business School China, University of Nottingham Ningbo China

Abstract

Human capital has been considered an important factor in driving modern economic growth. It is generally believed that innovation and technological progress hold the key to future economic growth and require more talented people. The present study investigates how technological progress influences the demand for human capital and talent by establishing a theoretical framework of differential talent distribution, demand for talent, and enabling technologies.

Without formal education or training, only a few individuals with higher levels of intelligence could perform complex or innovative tasks and would be highly sought after. Education and professional training enable less talented people to become skilled in using advanced tools and machines developed by more intelligent people. The less talented but skilled people with advanced tools and machines can match the performance of the talented people, making them more dispensable. Moreover, it is almost impossible to distinguish the talented from the skilled without incurring high costs. The expansion of higher education has dramatically increased the supply of skills, so the talented tend to be less well-treated than before. It is also true for those in higher education and scientific research jobs regarding academic freedom and career opportunities. Technological progress also makes it more difficult for truly outstanding people to stand out and get appreciated by society. Networking and communicating skills become more important than intelligence and professional skills in career success.

Progress in AI will on the one hand erase the impact of different intelligence on performance in most professions except for competitions barring machine assistance. On the other hand, fully automated intelligent machines might no longer need employees.

Keywords: human capital; talent; skill; technological progress; artificial intelligence.

https://doi.org/10.32388/XNMLPD

1. Introduction

"Human capital" refers to the stock of knowledge, habits, and social and personality attributes embodied in the ability to perform labor to produce economic value. Jacob Mincer investigated the relationship between investment in human capital and personal income distribution and used the term for the first time in the modern neoclassical economic literature (Mincer 1958). Gary Becker further popularized the term with his book *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education,* first published in 1964 (Becker 2009). Human capital has generally been considered an important factor in driving modern economic growth (Mincer 1984; Galor and Tsiddon 1997; Pelinescu 2015; Fukao, Makino, and Settsu 2021). Accumulation of human capital may also have contributed to China's economic growth (Wang and Yao 2003).

A concept in human resource management closely related to human capital is talent (De Vos and Dries 2013; Boudreau and Ramstad 2007), which refers to ability, aptitude, or faculty well above average ability. The term also refers to a person or a group of people with such ability, aptitude, or faculty. Talent is often viewed as a key quality of people who have made important discoveries and inventions. Talent may be considered the most important fraction of human capital. The Chinese phrase "A thousand soldiers are easy to obtain, but one general is hard to find" has illustrated the importance of talent and the relationship between talent and human capital. The rise of a global economy has led to increased competition among nations and companies to attract and retain top talent (Björkman et al. 2013).

Although talent is often considered an innate ability, the debate over whether talent is innate or developed through environmental factors has been far from settled. Various studies have provided evidence for both sides. The "nature" argument posits that talent is a product of genetic inheritance (Simonton 2001; Galton 1865a, b). Studies in this area often involve identical twins, where researchers have found that even when raised apart, twins can exhibit similar aptitudes and abilities, suggesting a genetic component to talent. Additionally, research into prodigies and individuals who display exceptional abilities from a young age with minimal training further supports the idea that certain talents are innate. If talent is entirely innate and determined by genetics, there will be little room for organizations and countries to nurture and cultivate talent. The talent supply will completely depend on the nature or biology of humans.

The "nurture" perspective argues that talent is primarily the result of environmental influences, education, and deliberate practice (MacKinnon 1962; Meyers, Van Woerkom, and Dries 2013; Papierno et al. 2005; Amabile 2001). Research by scholars like Dr. Anders Ericsson has shown that extensive, focused practice over time can lead to high performance, as detailed in the "10,000-Hour Rule" (Ericsson, Krampe, and Tesch-Romer 1993). This rule suggests that talent can be developed through sufficient and effective training. Studies in developmental psychology and education have also demonstrated that early exposure to enriching environments, encouragement, and targeted instruction can significantly influence the development of talents (Papierno et al. 2005). The role of socio-economic factors in providing access to resources and opportunities also suggests that talent can be cultivated (Amabile 2001). The consensus in the scientific community is that talent is likely a combination of both nature and nurture, with the interaction between genetic predispositions and environmental conditions shaping an individual's abilities. The nurture component of talent formation implies that certain policies and socioeconomic environments may increase talent supply.

Historically, technological advancements have created a demand for new skill sets and, hence new talent. Society's emphasis on talent demand is usually placed on identifying, developing, and harnessing talent across various domains to ensure economic prosperity, innovation, and a competitive edge in an increasingly interconnected world. The education sector is pushed to identify and nurture gifted and talented students. Educational systems in the world are investing in specialized programs to cultivate the next generation of talents. Companies' talent management strategies include talent acquisition, development, and retention, to ensure they have the human capital necessary to succeed in a competitive marketplace. Talented individuals are often actively sought in many fields, such as science, technology, engineering, mathematics, creative industries, finance, and consultancy. As technology evolves, so does the need for talent that can adapt to and leverage these changes.

China has made finding and cultivating talented people a priority since 1977, to accelerate its modernization. Governments at different levels have implemented many policies and measures to attract and train talent. Two interesting phenomena have emerged since then. First, more and more people, mainly researchers and engineers, are paid hundreds of thousands or even millions of Chinese yuan as talents at various government levels, far above what their average peers earn for similar jobs (Qiu 2009). China's talent pool now is certainly much larger than at any time in its history. Second, people often lament contemporary intellectuals' lack of the strength of character or dignity (风骨 fenggu) that traditional Chinese scholars are thought to have. In China, there are many stories of how scholars in the past kept their pride in the face of powerful monarchs and warlords or how monarchs and senior officers begged scholars to serve their regimes. The great ancient thinker Mencius best summarized this dignity: "He cannot be led astray by riches and honor, moved by poverty and privation, or deflected by power or force" (Bloom and Philip 2009).

Why do Chinese scholars no longer have the dignity that characterized their predecessors in ancient times or even during the Republic of China period? We hypothesize that the changing supply and demand of talent as society progresses is the cause of this phenomenon. The development of education and training programs increases the supply of talent, and technological progress leads to technologies that enable people to perform tasks that they could not perform in the past. The increase in technology-enabled people (defined as skilled people in this study) enhances talent supply equivalently. When employers and leaders have a much larger talent or skill pool for choosing a person who can perform a job competently, the balance of power tips more toward the demand side such that employers and leaders can afford to be arrogant, so scholars and talented people are less able to afford strong characters. Rapid progress in artificial intelligence (AI) and robotics will further expand the talent pool. The demand for talent is likely to be reduced by AI programs such as Watson (Gleason 2014), AlphaGo (Silver et al. 2017), ChatGPT (Kirmani 2022; Gordijn and Have 2023; Stokel-Walker 2022), Midjourney (Roose 2022), etc. This will further strengthen the position of owners or managers and weaken the position of talented employees. How AI and robots will affect society's demand and supply for talent has become a topic for investigation.

The present study aims to develop a framework for analyzing and discussing how technological progress will affect the demand and supply of talent and why intellectuals no longer have the strength of characters in contemporary China. The framework is based on ideas proposed by Ma (2023b). The rest of the paper is organized as follows: Section 2 presents the model specifications; Section 3 analyzes the equilibrium issues; Section 4 discusses the implications of the current framework; and Section 5 concludes this paper.

2. Model specifications

In the present study, we propose a framework that consists of talent supply, talent demand, education, and enabling technologies. Education and enabling technologies can increase talent supply by training employees with the right approaches and providing employees with helpful tools respectively.

2.1. Natural talent supply

In the present study we assume that without education and training, talent is determined by intelligence or intellect, which follows the normal distribution with the probability density function (PDF)

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right) \tag{1}$$

and the cumulative distribution function (CDF)

$$F(x) = \frac{1}{\sqrt{\pi}} \int_{-\infty}^{x} \exp\left(-\frac{(u-\mu)^2}{2\sigma^2}\right) du \tag{2}$$

In Equations (1) and (2), x is the intelligence value, μ the expectation of x, and σ the standard deviation; $f(x)$ and $F(x)$ are PDF and CDF, respectively.

Or we can assume a logistic distribution for better tractability with the PDF

$$f(x) = \frac{e^x}{1+e^x}\left(1 - \frac{e^x}{1+e^x}\right) \tag{3}$$

and the CDF

$$F(x) = \frac{e^x}{1+e^x} \quad (4)$$

Variables in Equations (3) and (4) have similar meanings as those in Equations (1) and (2).

Intelligence refers to a general mental capability that involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly, and learn from experience (Gottfredson 1997). Intellect is usually considered a branch of intelligence, reflecting mainly the logical and rational side without emotional and sensitive engagement (Roback 1922). Although intellect or intelligence here is regarded as a continuous variable, talent or ability is usually classified into discrete categories, because for a given technological environment and the training available, there is an intelligence threshold for performing a certain task. In the present study, while acknowledging the multi-dimensionality of talent or ability, we use the ability to learn and perform new skills as the proxy of talent. We classify natural talents into the following categories or levels while acknowledging they are more complicated, intertwined, and diverse in the real world:

> Level A: The ability to think logically and find solutions to problems without formal training on how to think logically and find solutions.
>
> Level B: The ability to think logically and find solutions after formal training without referring to books.
>
> Level C: The ability to think abstractly and use mathematical analysis to solve problems with books after formal training.
>
> Level D: The ability to think logically and use software to solve problems with books after formal training.
>
> Level E: The ability to follow standard operational procedures (SOPs) to perform sophisticated tasks after formal training.
>
> Level F: The ability to follow SOPs to perform tasks of moderate sophistication after formal training.

Level G: The ability to follow SOP to perform relatively simple tasks after training.

Level H: The ability to perform simple tasks.

The people at different levels are not evenly distributed because intelligence is normally distributed. The naturally occurring ability to reason logically especially inductively to find solutions to problems or to organize people for higher efficiency is possessed by only a small percentage (<5% or even <1%) of the population. Most people (>95%) can perform only simple physical labor if they have not been educated or trained for some tasks. Because of the need for education and training, human society initially consisted of a small minority of leaders at level A and the majority who could only perform simple tasks. The progress in technology, culture, and science and the emergence of informal and formal education differentiate people at levels B to G from those at level H who are also a small percentage of the population.

2.2. Society's demand for talent and individual demand for emotional satisfaction

Various factors, including economic growth, technological advancements, and global competitiveness, drive society's demand for talent. Economies demand skilled labor to drive innovation and productivity (Chambers et al. 1998; Guthridge, Komm, and Lawson 2008; Beechler and Woodward 2009). In the present study, we assume that talent demand is determined by jobs available in society, which are determined by the population size and the technological progress altitude. For simplicity, we postulate that for a given technological progress level, the talent demand is a linear function of the population size.

$$Y = Y(N, T) \tag{5}$$

$$\left.\frac{\partial y}{\partial N}\right|_{given\ T} = c \tag{6}$$

In Equations (5) and (6), *Y* is the value of talent demanded, *N* is the population size, *T* is the technology, and *c* is a constant.

Technological progress will lead to the invention of new products and new production processes together with new jobs that demand talents more than performing simple tasks.

$$\boldsymbol{J} = \boldsymbol{J}(N, \boldsymbol{T}, \boldsymbol{S}) \tag{7}$$

In the above equation, $\boldsymbol{J}$ is the vector of jobs, $\boldsymbol{T}$ is the vector of technologies, and $\boldsymbol{S}$ is the vector of accumulated investments in different technologies. Technological progress is accumulative; from cave-dwelling hunter-gatherers using stone and wooden tools to house-dwelling farmers using refined stone and wooden tools and pottery in large communities with administrators many new technologies and corresponding tasks have been invented. Technological progress is realized by inventing new products and novel approaches to making things (inventions) and applying them (innovations). Invention without application will not impact economic growth and social development. When we use the term technology, we refer to the methods of making products and providing services.

Technological progress on the one hand creates new jobs for making new products or increasing outputs of existing products whose demands have not been met, which increases demand for talent even if not demand for labor in general; on the other hand, technological progress may produce human-replacing inventions that reduce demand for labor in general and even for talent. Early technological progress, which provides new categories of products or existing ones with massively unmet demand, tends to increase the demand for talent. Automation and future technological progress in AI and robotics, which increase labor productivity or even replace human workers, will decrease the demand for talent.

While rulers, business owners, and superiors in an organization need people with the talent for performing tasks that benefit society and their organizations, they also want people with skills that satisfy them emotionally. When choosing for promotion between people who make a leader/ruler emotionally comfortable and those who do not, most leaders/rulers will choose the former, ceteris paribus. Currently, the management literature calls such emotional ability or skills emotional intelligence. In the present study, we assume natural emotional ability is uncorrelated with intellect and randomly distributed across people with different intellect/talent levels. For simplicity, we postulate that emotional ability follows a uniform probability distribution (we may also assume a normal distribution or logistic distribution). For a variable x uniformly distributed in an interval [a, b], its PDF is

$$f(x) = \begin{cases} \frac{1}{b-a}, & for\ a \leq x \leq b \\ 0 & elsewhere. \end{cases} \tag{8}$$

Its CDF is

$$F(x) = \begin{cases} 0 & for\ x < a \\ \frac{x-a}{b-a} & for\ a \leq x < b \\ 1 & for\ x \geq b \end{cases} \tag{9}$$

In the above equations, x is the value of emotional intelligence. Emotional skills can be acquired more readily via learning behavior than talent.

2.3.Education and talent supply

The supply of talent in the workforce is influenced by several key factors, among which the most important is education. Before the appearance of formal school education, knowledge and skills were usually transmitted through family lines. Therefore, many professions and important jobs were hereditary and held by certain families (Li 2004). Basic education provides students with the foundational knowledge and skills for further education and training, which make them the talent needed in society. Professional or occupational training provides standardized procedures for performing tasks that cannot be carried out satisfactorily by untrained people of various natural talent levels. As technology evolves, the demand for new skills emerges, and educational institutions may adapt by offering new programs and courses to meet these needs, thereby affecting the supply of talent in those areas. After level A talent people have worked out the right approach and appropriate procedure to perform a certain difficult task, once the procedure has been standardized, education can train people of other talent levels, who cannot work out the right solutions themselves, to perform the same task satisfactorily.

If we use S to denote education as a function to upgrade a person's ability, then

$$S_{B\to A}(B) \approx A \qquad (10)$$

The subscript $B \to A$ indicates that the education raises a level B person's ability to perform level A tasks. We might distinguish those who can work out solutions without training from those who need education and training by calling the former talented and the latter skilled, respectively. It is almost impossible to separate them in practice without incurring large costs. Therefore, the term talent in this paper denotes both naturally talented people and skilled people from education and training.

Whether a person at a certain talent level can be trained to perform a task using approaches developed by level A talent depends on whether their talent levels meet the minimum requirements for using the approach. If the solution requires the ability for mathematical analysis and abstract thinking (level C), the level C people can be trained to perform the task and they can do it as well as level A people who have developed these approaches. Level D and lower levels of talent would not be able to master the right approach developed by level A people to perform the task because the approach requires mathematic ability which level D and lower levels do not have. Education and training enable people with imitating talent to perform jobs that require innovative abilities without education or training.

2.4. Enabling technologies

Education can teach people the right approaches for carrying out tasks that they cannot work out by themselves. However, learning the right approaches also requires a certain level of talent; thus, people at lower levels of talent might be unable to learn the right approach. Enabling technologies are methods or tools that help people master approaches and knowledge that they would not be able to master without such methods or tools. If we use T to denote an enabling technology as a function to raise a person's ability to perform a task requiring higher levels of intelligence, then

$$T_{D\to B}(D) \approx B \qquad (11)$$

The subscript $D \rightarrow B$ indicates that the technology raises a level D person's ability to perform level B tasks. Enabling technologies and education act synergistically. A level D person may use a $T_{D\rightarrow B}$ technology and receive an $S_{B\rightarrow A}$ education to have the ability to perform level A tasks.

$$S_{B\rightarrow A}(T_{D\rightarrow B}(D)) \approx A \qquad (12)$$

Technologies can be roughly classified into three categories: 1) technologies that enhance or replace human physical power; 2) technologies that replace human control in the production processes; and 3) technologies that enable people to perform tasks that originally required higher levels of intelligence or mental power, hence they are the enabling technologies. Before the invention of the writing system, it was almost impossible for people without a good memory to learn knowledge in depth and apply learned knowledge in practice. Society relied on people with good memory to store and spread knowledge and to preside over rituals. After the invention of a writing system, a good memory was still essential for learning and carrying out such jobs because hand-copied books were rare and expensive and few people could afford to buy books. Only a privileged few have access to books.

The invention of printing especially after the steam power application to the industrial printing processes made books accessible to ordinary people, such that people without an excellent memory can learn and perform academic tasks and tasks that require more knowledge. Printing is a technology that enables people to learn and perform knowledge tasks. However, even after the invention of printing, a good memory like a large RAM (random access memory) in the computer still gives a person an advantage over a person owning a large collection of books, which is at most like a large hard disk of the computer. Searching for information from books was tedious and often impractical before the advent of computers. Many Chinese academic masters in the past were famous for their command (i.e. memorization) of huge literature and knowledge in their fields. Search engines like Google are an enabling technology that makes good memory less relevant in many jobs. The overall effects of enabling technologies are to reduce or remove the ability differences among people who can access them but to increase the ability differences between those who have access and those who do not. Such technologies allow more people qualified to perform previously more challenging jobs, causing involution or rat races at the workplace.

Mathematical analysis has been a severe obstacle for many who want to engage in scientific and technological research. With mathematics and statistics software such as MATLAB and Mathematica, people can carry out research jobs which they would not be able to do without such software. Similarly, econometrics software such as STATA and E-Views enable many people to perform quantitative empirical economic and business studies. The explosive growth in the number of Ph.D. holders results from both increased funding for Ph.D. programs and the mushrooming of software (as well as hardware) that enables Ph.D. candidates to perform analyses that they would not be able to do otherwise. People with good mathematical skills can no longer stand out because most if not all of them cannot compete with sophisticated mathematical software, so they end up using the same software as those without good mathematical skills.

Writing articles has been a challenging task for many people, probably for the majority of the population. Many jobs require people with good writing skills, and even non-writing jobs are often offered to people with good writing skills because the need to write something arises occasionally. However, AI tools such as ChatGPT will soon enable people who cannot write proper articles to write various works with good quality (Pavlik 2023). This enabling technology narrows the talent differences in writing among people. Those with good writing talent will find it difficult to stand out in the future. Those previously with poor writing ability will be able to compete with those with good writing talent in the job market. The job market for writing skills could shrink dramatically or disappear altogether. Therefore, the ultimate enabling technology is to replace human workers and make human intelligence irrelevant in the workplace.

3. Equilibrium

When humanity evolved into a civilization without education and occupational training, talent was in severe shortage and the ruling class was keen to find talented people. The equilibrium of the talent "market" favored the supply side and the employers competed for talent. With the development of education and enabling technologies, the supply of talent gradually outpaced the demand for talent, such that people with various talent levels have to compete for better-compensated jobs. These developments have changed the behaviors of many talented people.

3.1. Competition among employers of talent

When talent is in short supply, sensible rulers or superiors will try their best to employ these talented people and give them the decision-making rights needed to carry out their jobs as well as the income and status commensurate with their responsibilities. There are many stories in China about how monarchs and rulers were courteous to the wise and respectful to scholars. The most famous one is “Three Visits to the Hut”, a story about how Liu Bei, the future emperor of the Shu Han kingdom tried so hard to get Zhuge Liang, famed for his wisdom, to work for the Liu faction during China’s Three Kingdom Period (Berkowitz 1992).

In a time when there was no formal education system for learning political strategy and administration skills except apprenticeship from some famed sages, level A people who could spontaneously work out such knowledge were highly sought after, even if some of them tried to hide themselves as hermits. The establishment of formal education systems for training future government officials increased the supply of talent for the government, creating a relatively large group of scholars who could use similar terminology, advocate similar criteria, and propose similar policies. The increased supply of talent presented an identification and selection problem for the ruling class, that is, how to identify and appoint the truly talented person when they all speak and behave similarly. Various screening tools could be devised by the ruling class, one of the most enduring had been the Imperial Examination System, which was initiated by the Sui Dynasty Emperor Wen (Yang Jian) in 587 CE, and formalized by Emperor Yang (Yang Guang) in 607 CE (Feng 1995; Gan 2008). People received education and training for such examination. Generally speaking, only highly intelligent people could pass the examination and get selected because of the rarity of books and the lack of other enabling technologies. The current Civil Service Examination System in China, which was adopted by “The Provisional Regulations on

State Civil Servants" in 1993 with the first examination held in 1994, echoes the Imperial Examination System (Lam and Chan 1996).

With the increased talent supply following the establishment of formal education and training programs, the competition among employers for talent started to take a different form from when talent was in short supply. Therefore, employers use proxies or indicators to measure and select talented people because they no longer have time or patience to explore a person's talent in depth. After all, there are too many people appearing to be qualified. Then, the visible signs of potential talent are usually used as proxies of talent and extroverts tend to be better regarded than introverts when they have the same level of intelligence. Accordingly, job candidates would try to be more visible regarding the proxies or indicators used by employers or human resource managers to measure talent, because employers would only compete for those with excellent metrics of the visible signs of talent.

3.2. Competition between people at different talent levels

With the increased talent supply and employers' attention focused on (superficially) visible signs or measures of talent, many talented or qualified people have to compete for a few jobs with more decision-making power, higher social status, and better pay. Formal education and training together with advanced enabling technologies make people with different levels of talent indistinguishable in the eyes of employers who are no longer willing to spend more time identifying real and deep talent. Moreover, various advice sources and training services teach people how to decorate themselves to appear more talented, creating more obstacles for employers to identify true talent. Nearly all people can pretend to be highly talented with level A intelligence, while most have intelligence of levels D-F. Information asymmetry in employees' abilities leads to many levels D-F people being employed as levels A-C people, which can be viewed as a weak form of adverse selection. We call it a weak form of adverse selection because the employed level D, E, or F people can still perform the job competently due to enabling technologies. This might be especially relevant to science and technology jobs. More researchers increase overall output, making it impossible for managers to have an in-depth understanding of the potential of their work so managers rely on metrics to evaluate researchers' talent and allocate resources accordingly.

The use of metrics to evaluate researchers' performance increases the competition among researchers and forces them to focus on studies that are less controversial and quick to be published in top-ranking journals and to connect with senior researchers who are influential in their academic disciplines. This leads to increased output with decreased breakthrough inventions and slows scientific and technological progress, as some empirical studies have shown (Chu and Evans 2021; Park, Leahey, and Funk 2023). Ma (2023b) uses the model of biochemical mechanisms of competitive inhibition by partial agonists with low intrinsic activity (Ariens 1954) or dysbiosis (Petersen and Round 2014) to explain why more researchers could slow down scientific progress. Average researchers consume resources that more talented researchers might use for genuine breakthrough research. Ma (2023b) also analyzes how more mediocre research output could consume the scientific community's attention and slow scientific progress with product inhibition mechanisms in biochemistry (Cleland 1963). More mediocre research output buries authentic breakthrough findings in information overloads or information pollution.

Therefore, increased education resources and enabling technologies increase talent supply, and increased talent supply in turn intensifies the competition among people with different levels of talent. The participation of a large number of people with lower levels of talent can competitively inhibit the activity of people with higher levels of talent, leading to slower scientific progress in terms of quality, although it may facilitate scientific progress measured in quantity. Further technological progress will lead to human-replacing technologies, which will compete with human talent rather than enabling human talent to perform tasks and compete with each other. When human-enabling technologies evolve into human-replacing technologies, competition among humans becomes less relevant or even irrelevant.

3.3. Equilibrium between demand and supply of talent

Higher education has expanded phenomenally in many countries since the 1960s and sharply increased the supply of trained talent. The efficient use of talent is to match tasks with the talent needed to complete the tasks. If a task is performed by a talent lower than the level required by the task, its quality will be unsatisfactory. If a task is performed by a talent much higher than the level required by the task, the talent will not be satisfied or inspired, which may lead to low morale and reduced efforts. Performing jobs by overqualified university graduates or postgraduates tends to be a waste of talent from a societal point of view and a waste of time and money from a personal point of view (Caplan 2018). For example, many parcel delivery persons in China hold a Master's degree. Still, delivery persons need not have a Master's degree although they may feel it worthwhile to hold the degree per se. Moreover, oversupply of trained talent makes it more difficult for employers to identify and hire the natural talent with higher levels of intelligence, such that more intelligent people also perform tasks that need no university education.

Before the establishment of formal education and training, society required level-A talent that could invent and innovate spontaneously, and people with talent at other levels were indistinguishable. Since people with level A talent are rare, society has to give them high social status or high (relative) income to get their service. Then, knowledge and skills tended to be transferred within families or through a mentor-disciple relationship, which led to the persistent dominance of some influential families or schools of learning in society. Access by ordinary people to education increases society's talent pool, facilitating socioeconomic development, especially since the first industrial revolution up to the digital revolution in the late twentieth century.

Socioeconomic development increases the demand for talent at various levels. The establishment of formal education and training sharply increased the supply of talent that could properly perform the task after level A talent had developed protocols for it. Level B talent after adequate training might invent and innovate like level A and begin to compete with level A talent in the "job market". Although the demand for level-A talent is always a priority, education and training make it more difficult for them to stand out and get appreciated by society. The normal distribution of intelligence implies that any advancement in enabling technologies will sharply increase the supply of adequate talent. During the machine age, economic growth hugely increased job opportunities and the demand for talent compared with the manual age (Ma 2023c). However, the digital revolution has not provided new categories of consumer products except digital equipment, such that overall job opportunities are not increased (Ma 2023a). Therefore, with the expansion of university education and the progress in enabling technologies, involution or rat races at the workplace become more prevalent.

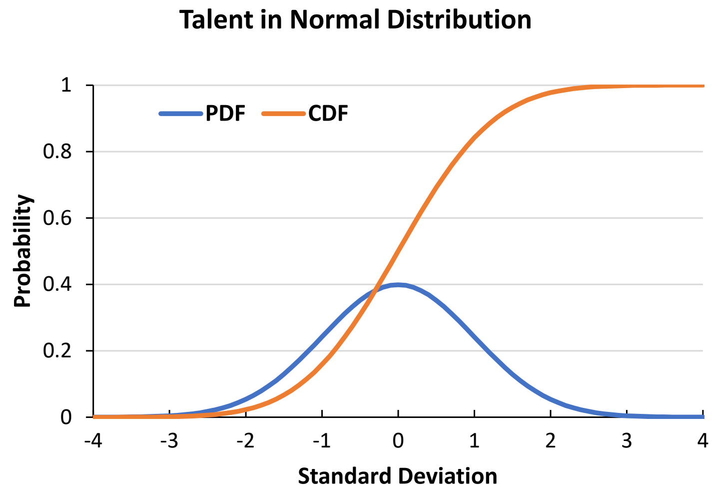

Fig.1 Talent distribution described in terms of how many standard deviations (SDs) to be away from the mean. Assuming each SD represents an intelligence level, when education and enabling technologies raise people's ability from one intelligence level to the next higher one, there is a sharp increase in talent supply before level E (i.e. +1 SD), as represented by the increasing CDF curve.

To illustrate how education and enabling technologies impact talent supply, we assume that natural level A corresponds to intelligence more than three standard deviations (SDs) above the average (approximately 0.15% of the population), represented as <-3 SDs in Fig,1; level B corresponds to between -2 and -3 SDs (approximately 2.35%); level C between -1 and -2 SDs (approximately 13.5%); level D between 0 and -1 SD (approximately 34%); level E between 0 and 1 SD (approximately 34%); level F between 1 and 2 SDs (approximately 13.5%); level G between 2 and 3 SDs (approximately 2.35%); and level H more than 3 SDs (approximately 0.15%). CDF represents the cumulative distribution of talent for higher than a certain level. When enabling technologies allow level D people perform level B tasks, people qualified for level B jobs will increase from 2.5%

to 50% of the population. If level B jobs are 2.5% of all positions, without enabling technologies, level B people would be invited by employers to take these jobs. With enabling technologies, they have to compete with other people for the 1:20 opportunity.

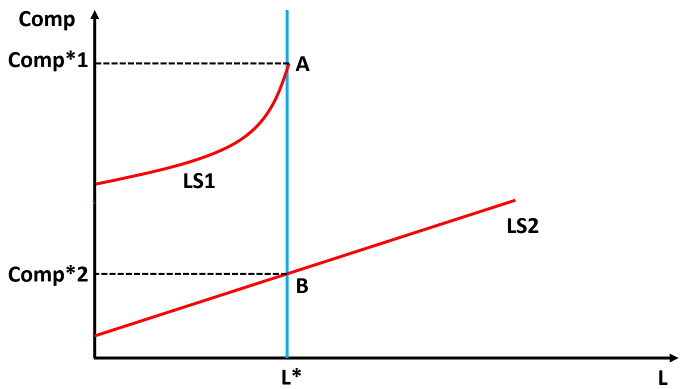

Fig.2 Education and enabling technologies increase talent supply and decrease compensation received by the employed talents. L, labor; L*, labor demanded for talent at level X; Comp, compensation; LS1, level X labor supply curve before education and enabling technologies increase its supply; LS2, level X labor supply curve after education and enabling technologies have increased its supply; Comp*1, equilibrium compensation determined by the intersection between L* and LS1 at point A; Comp*2, equilibrium compensation determined by the intersection between L* and LS2 at point B.

When education and enabling technologies have increased talent supply at a certain level, compensation, and social status received by the employed at that level will decrease accordingly. As illustrated in Fig.2, when there are only a limit positions L* requiring level X ability, the level X people represented by labor supply curve LS1 will be employed at the equilibrium compensation level Comp*1. When education and enabling technologies have sharply increased supply at level X and shifted the labor supply curve to LS2, people employed for L* will receive a much lower equilibrium compensation Comp*2.

Since rulers, business owners, and superiors also want subordinates to satisfy their emotional need for conceitedness and self-grandeur, employees' emotional intelligence and communication skills play a key role career success. As emotional intelligence is roughly linearly distributed, talent oversupply not only make it more difficult for naturally talented people to shine but also give emotionally skilled people more opportunities to outsmart the naturally talented people by currying favors from their superiors.

The human capital theory attributes the economic growth in the twentieth century to the investment in human capital to a large part. Partly due to its influence, investment in education especially university education has sharply increased in all developed countries and emerging economies. Without breakthrough technological progress, the demand for talent increases linearly with the size of the economy, and the non-linearity of normal distribution means that the growth of supply due to investment in human capital will far outpace demand growth. Therefore, people with university education have to perform tasks previously performed by people with much lower levels of education. For example, because of the expansion of university education since the 1980s especially the 1990s, many university graduates in China have to work at jobs done previously by people with primary school education or the illiterate.

While human-enabling technologies enable people to perform tasks they could not perform before and increase talent supply, the ultimate enabling technology will be human-replacing technologies that reduce the demand for human talent. Technological progress in automation and robotics decreased the demand for blue-collar workers in manufacturing. AI and robots will on the one hand enable people of lower levels of talent to perform jobs done previously by people of higher levels of talent, making it more difficult for high-level talent to stand out and intensifying competition among people similarly qualified; on the other hand, people of all levels of talent may eventually be replaced by AI and robots altogether in the production processes and service.

4. Discussion

In the present study, we have investigated how education and enabling technologies have increased talent supply and its consequences. The invention of printing especially the steam engine-powered printing (Dittmar 2011; Eisenstein 1980) enabled universal education. Education is usually considered to increase human capital, which is often proxied by years of schooling. More education can usually allow job candidates to have a high ability to master the operational skills of a sophisticated machine. However, secondary school graduates need only a few weeks or months of training to use and operate most machines. People with bachelor's, master's, or doctorate degrees might not have many advantages. This indicates more complex relationships between human capital, talent, and technology. Hiring postgraduates to perform jobs competently done by secondary or even primary school leavers appears to be a great waste of social and private resources (Caplan 2018). Furthermore, progress in information and communications technology (ICT) made good memory and analytical ability much less important for scholarly or engineering jobs. These enabling technologies help churn out thousands and thousands of postgraduates with Ph.D. degrees or other doctorate degrees each year globally, leading to an oversupply of high-end talent.

Rulers' or leaders' preference and behaviors direct the behaviors of most subordinates, as Confucius commented: "The superiors' virtue is the wind. The inferiors' virtue is grass. Wherever the wind blows, grass bends" (Waley 2012). In the present study, we propose that superiors have an emotional need to feel important and respected by their subordinates. Leaders and managers tend to prefer subordinates who can do their jobs satisfactorily and behave obediently and obsequiously (Beu and Buckley 2004; Einarsen, Aasland, and Skogstad 2007) but have to tolerate disobedient ones when talent is in short supply. We also assume that emotional intelligence is linearly distributed among people, such that a large number of emotionally-talented people will compete for jobs once technologies have enabled them. When enabling technologies and higher education produce talent oversupply, leaders and managers have the luxury of neglecting disobedient competent subordinates and promoting obedient ones. Networking and communicating skills become more important than intelligence/intellect in career success (Nabi 2003). Therefore, truly talented people face two obstacles to standing out from people with average intelligence: one is because enabling technologies have blurred their differences; the other is that truly talented people have to compete with others on keeping superiors happy. To obtain or keep a good job, competent employees have to show extra respect to their superiors and lose their strength of character. That is why people in China think contemporary scholars lack fenggu which traditional Chinese intellectuals are thought to have.

The supply-demand relationship determines the compensation and status of talent. Our present model of normally distributed intelligence and discrete ability levels can explain how education or enabling technologies sharply increase talent supply and tip the balance between supply and demand toward the employers. In many countries, including China, it is difficult for many Ph.D. holders to find a job commensurate with their training and expertise due to oversupply (Patton 2012; Mervis 2016). When this is the case, it is understandable that contemporary Chinese intellectuals lack fenggu. Even if they have it, they might have hidden it. Graduates with Bachelor or Master's degree also find it hard to have a job similar to those held by earlier generations of university graduates. This is a far cry from the situation in China 40 years ago, when emphasis on raising government officials' education level led to promotion of the few available university graduates (usually from ordinary families) to senior government jobs. Although government and business leaders have constantly preached the importance of human talents to economic growth, talented employees tend to be less well treated than before. Those in higher education and scientific research jobs are often managed with short-term KPI (key performance indicators) like industrial workers (Braun et al. 2010; Lane 2010), which increases academic publication output but slows scientific progress (Chu and Evans 2021), and makes papers and patents less disruptive over time (Park, Leahey, and Funk 2023).

Enabling technologies have so far strengthened individual ability to perform tasks and caused more competition among human workers. If we look into future, it seems to be a different scenario. Technological progress will eventually lead to human-replacing technologies that compete with human talent rather than enhance it. Then, competition among humans becomes irrelevant in production processes and even in public administration. Networking ability, vital in current research career success, especially in the social science research community, will no longer matter. The separation between superiors and subordinates will disappear and people can show their character of strength as they like because robots and AI systems will take charge of most productive, service, and administrative jobs (Ma 2023d).

People are still debating whether AI and robots can take nearly all human jobs and cause mass unemployment. Many people think that robots and AI are unlikely to outperform humans in creativity, artistic taste, and insight into complex situations, hence human workers will always hold the commanding positions in the economy. These beliefs are generally misconceived (Ma 2023b). Isaac Newton watching apples falling from a tree (Keesing 1998) or the German chemist Friedrich August Kekulé daydreaming about a snake seizing its tail (Rothenberg 1995) are no more evidence of mystery in human thinking than of its insufficiency in memory accessing and information processing ability. This insufficiency prevents people from combining relevant premises to reach a conclusion or result they seek. AI systems such as AlphaGo (Silver et al. 2016), AlphaGo Zero (Silver et al. 2017), and AlphaZero (Silver et al. 2018; Kissinger 2018) have demonstrated their capacity to find optimal strategies. Future AI and robots will become the ultimate enabling technologies that make human talent irrelevant in production processes.

5. Conclusion

The present study investigates how technological progress including development in AI influences the demand for human capital especially talents by establishing a theoretical framework of differential talent distribution, demand for talents, and enabling technologies. In this framework, without formal education or training, "professional skills" (human capital) were obtained spontaneously by a few individuals with higher levels of intelligence because of their innate talent and the majority could only perform simple labor. The few talents who could perform complex or innovative labor would be highly sought after, so the demand for such talents far outstrips the supply.

Technological progress led to the invention of advanced tools and machines. Education and professional training enable less talented people to use them. The advanced tools and machines enable less talented people to match the performance of talented people without such tools and machines. The more technological progress and advanced tools, the higher the demand for human capital acquired through education and training. However, procedure standardization of normal operations made talented people more dispensable. The emphasis on investing in human capital and the expansion of higher education have dramatically increased the supply of talent through education. Because of the oversupply, talented employees including those in higher education and scientific research jobs, tend to be less well-treated in terms of academic freedom and career opportunities than before. Many universities have introduced corporate-type performance evaluation systems to conduct annual performance appraisals of academics.

Technological progress also makes it more difficult for truly outstanding people to stand out and get appreciated by society. Networking and communicating skills become more important than intelligence and professional skills in career success. Progress in AI will on the one hand erase the impact of different intelligence on performance in most professions except for competitions barring machine assistance. On the other hand, fully automated intelligent machines might no longer need employees, which makes competition among talented people irrelevant.

References

Amabile, Teresa M. 2001. "Beyond talent: John Irving and the passionate craft of creativity." *American Psychologist* 56 (4):333-336.

Ariens, Everhardus Jacobus. 1954. "Affinity and intrinsic activity in the theory of competitive inhibition. 1. Problems and theory." *Archives Internationales de Pharmacodynamie et de Thérapie* 99:32-49.

Becker, Gary S. 2009. *Human capital: A theoretical and empirical analysis, with special reference to education*. Chicago, IL: University of Chicago Press.

Beechler, Schon, and Ian C Woodward. 2009. "The global “war for talent”." *Journal of International Management* 15 (3):273-285.

Berkowitz, Alan J. 1992. "The moral hero: A pattern of reclusion in traditional China." *Monumenta Serica* 40:1-32.

Beu, Danielle S, and M Ronald Buckley. 2004. "This is war: How the politically astute achieve crimes of obedience through the use of moral disengagement." *The Leadership Quarterly* 15 (4):551-568.

Björkman, Ingmar, Mats Ehrnrooth, Kristiina Mäkelä, Adam Smale, and Jennie Sumelius. 2013. "Talent or not? Employee reactions to talent identification." *Human Resource Management* 52 (2):195-214.

Bloom, Irene, and J. Ivanhoe Philip. 2009. Mencius. New York: Columbia University Press.

Boudreau, John W, and Peter M Ramstad. 2007. *Beyond HR: The new science of human capital*. Boston: Harvard Business Press.

Braun, Tibor, Carl T Bergstrom, Bruno S Frey, Margit Osterloh, Jevin D West, David Pendlebury, and Jennifer Rohn. 2010. "How to improve the use of metrics." *Nature* 465 (17):870-872.

Caplan, Bryan. 2018. *The case against education: why the education system is a waste of time and money?* Princeton, New Jersey: Princeton University Press.

Chambers, Elizabeth G, Mark Foulon, Helen Handfield-Jones, Steven M Hankin, and Edward G Michaels III. 1998. "The war for talent." *The McKinsey Quarterly* (3):44-57.

Chu, Johan SG, and James A Evans. 2021. "Slowed canonical progress in large fields of science." *Proceedings of the National Academy of Sciences* 118 (41):e2021636118.

Cleland, WW. 1963. "The kinetics of enzyme-catalyzed reactions with two or more substrates or products: II. Inhibition: Nomenclature and theory." *Biochimica et Biophysica Acta (BBA)-Specialized Section on Enzymological Subjects* 67:173-187.

De Vos, Ans, and Nicky Dries. 2013. "Applying a talent management lens to career management: The role of human capital composition and continuity." *The International Journal of Human Resource Management* 24 (9):1816-1831.

Dittmar, Jeremiah E. 2011. "Information technology and economic change: the impact of the printing press." *The Quarterly Journal of Economics* 126 (3):1133-1172.

Einarsen, Ståle, Merethe Schanke Aasland, and Anders Skogstad. 2007. "Destructive leadership behaviour: A definition and conceptual model." *The Leadership Quarterly* 18 (3):207-216.

Eisenstein, Elizabeth L. 1980. *The printing press as an agent of change*. Vol. 1: Cambridge University Press.

Ericsson, K. A., R. T. Krampe, and C. Tesch-Romer. 1993. "The role of deliberate practice in the acquisition of expert performance." *Psychological Review* 100 (3):363–406.

Feng, Yuan. 1995. "From the imperial examination to the national college entrance examination: The dynamics of political centralism in China's educational enterprise." *The Journal of Contemporary China* 4 (8):28-56.

Fukao, Kyoji, Tatsuji Makino, and Tokihiko Settsu. 2021. "Human capital and economic growth in Japan: 1885–2015." *Journal of Economic Surveys* 35 (3):710-740.

Galor, Oded, and Daniel Tsiddon. 1997. "The distribution of human capital and economic growth." *Journal of Economic Growth* 2 (1):93-124.

Galton, Francis. 1865a. "Hereditary talent and character." *Macmillan's Magazine* 12:157-166.

Galton, Francis. 1865b. "Hereditary talent and character." *Macmillan's Magazine* 12:318-327.

Gan, He. 2008. "Chinese education tradition - the imperial examination system in feudal China." *Journal of Management and Social Sciences* 4 (2):115-133.

Gleason, Shannon C. 2014. "Don't fear the cyborg: Toward embracing posthuman and feminist cyborg discourses in teacher education and educational technology research." *Canadian Journal of Science, Mathematics and Technology Education* 14 (2):120-134.

Gordijn, Bert, and Henk ten Have. 2023. "ChatGPT: evolution or revolution?" *Medicine, Health Care and Philosophy*:1-2.

Gottfredson, Linda S. 1997. "Mainstream science on intelligence: An editorial with 52 signatories, history, and bibliography." *Intelligence* 24 (1):13-23.

Guthridge, Matthew, Asmus B Komm, and Emily Lawson. 2008. "Making talent a strategic priority." *McKinsey Quarterly* 1:48-59.

Keesing, Richard G. 1998. "The history of Newton's apple tree." *Contemporary Physics* 39 (5):377-391.

Kirmani, Ahmad R. 2022. "Artificial Intelligence-Enabled Science Poetry." *ACS Energy Letters* 8:574-576.

Kissinger, Henry. 2018. "How the enlightenment ends." *The Atlantic* (6):

https://www.theatlantic.com/magazine/archive/2018/06/henry-kissinger-ai-could-mean-the-end-of-human-history/559124/.

Lam, Tao-chiu, and Hon S. Chan. 1996. "China's new civil service: what the emperor is wearing and why." *Public Administration Review* 56 (5):479-484.

Lane, Julia. 2010. "Let's make science metrics more scientific." *Nature* 464 (7288):488-489.

Li, Feng. 2004. "Succession and promotion: Elite mobility during the western Zhou." *Monumenta serica* 52 (1):1-35.

Ma, Qing-Ping. 2023a. "Consumption, satisfaction, and life's purpose." In *Economics and Politics in the Robotic Age: The Future of Human Society*, 204-251. Newcastle upon Tyne, UK: Cambridge Scholars.

Ma, Qing-Ping. 2023b. "Human resources, natural resources, and pollution." In *Economics and Politics in the Robotic Age: The Future of Human Society*, 307-345. Newcastle upon Tyne, UK: Cambridge Scholars.

Ma, Qing-Ping. 2023c. "The machine age." In *Economics and Politics in the Robotic Age: The Future of Human Society*, 64-122. Newcastle upon Tyne, UK: Cambridge Scholars.

Ma, Qing-Ping. 2023d. "Social organization." In *Economics and Politics in the Robotic Age: The Future of Human Society*, 395-426. Newcastle upon Tyne, UK: Cambridge Scholars.

MacKinnon, Donald W. 1962. "The nature and nurture of creative talent." *American Psychologist* 17 (7):484-495.

Mervis, Jeffrey. 2016. "'Employment crisis' for new Ph. Ds is an illusion." *Science* 352 (6288):880.

Meyers, M Christina, Marianne Van Woerkom, and Nicky Dries. 2013. "Talent—Innate or acquired? Theoretical considerations and their implications for talent management." *Human Resource Management Review* 23 (4):305-321.

Mincer, Jacob. 1958. "Investment in human capital and personal income distribution." *Journal of Political Economy* 66 (4):281-302.

Mincer, Jacob. 1984. "Human capital and economic growth." *Economics of Education Review* 3 (3):195-205.

Nabi, Ghulam R. 2003. "Situational characteristics and subjective career success: The mediating role of career‐enhancing strategies." *International Journal of Manpower* 24 (6):653-671.

Papierno, Paul B, Stephen J Ceci, Matthew C Makel, and Wendy M Williams. 2005. "The nature and nurture of talent: A bioecological perspective on the ontogeny of exceptional abilities." *Journal for the Education of the Gifted* 28 (3-4):312-332.

Park, Michael, Erin Leahey, and Russell J Funk. 2023. "Papers and patents are becoming less disruptive over time." *Nature* 613 (7942):138-144.

Patton, Stacey. 2012. "The Ph. D. Now Comes with Food Stamps." *Chronicle of Higher Education*, May 6, 2012.

Pavlik, John V. 2023. "Collaborating With ChatGPT: Considering the Implications of Generative Artificial Intelligence for Journalism and Media Education." *Journalism & Mass Communication Educator*:10776958221149577.

Pelinescu, Elena. 2015. "The impact of human capital on economic growth." *Procedia Economics and Finance* 22:184-190.

Petersen, Charisse, and June L Round. 2014. "Defining dysbiosis and its influence on host immunity and disease." *Cellular Microbiology* 16 (7):1024-1033.

Qiu, Jane. 2009. "China targets top talent from overseas." *Nature* 457 (7229):522.

Roback, Abraham Aaron. 1922. "Intelligence and intellect." *The Journal of Philosophy* 19 (12):325-330.

Roose, Kevin. 2022. "An AI-Generated Picture Won an Art Prize. Artists Aren't Happy." *The New York Times*, September 2, 2022. https://www.nytimes.com/2022/09/02/technology/ai-artificial-intelligence-.

Rothenberg, Albert. 1995. "Creative cognitive processes in Kekule's discovery of the structure of the benzene molecule." *The American Journal of Psychology* 108 (3):419-438.

Silver, David, Aja Huang, Chris J Maddison, Arthur Guez, Laurent Sifre, George Van Den Driessche, Julian Schrittwieser, Ioannis Antonoglou, Veda Panneershelvam, and Marc Lanctot. 2016. "Mastering the game of Go with deep neural networks and tree search." *Nature* 529 (7587):484-489.

Silver, David, Thomas Hubert, Julian Schrittwieser, Ioannis Antonoglou, Matthew Lai, Arthur Guez, Marc Lanctot, Laurent Sifre, Dharshan Kumaran, and Thore Graepel. 2018. "A general reinforcement learning algorithm that masters chess, shogi, and Go through self-play." *Science* 362 (6419):1140-1144.

Silver, David, Julian Schrittwieser, Karen Simonyan, Ioannis Antonoglou, Aja Huang, Arthur Guez, Thomas Hubert, Lucas Baker, Matthew Lai, and Adrian Bolton. 2017.

"Mastering the game of go without human knowledge." *Nature* 550 (7676):354-359.

Simonton, Dean Keith. 2001. "Talent development as a multidimensional, multiplicative, and dynamic process." *Current Directions in Psychological Science* 10 (2):39-43.

Stokel-Walker, Chris. 2022. AI bot ChatGPT writes smart essays-should academics worry? *Nature*. doi:https://doi.org/10.1038/d41586-022-04397-7.

Waley, Arthur. 2012. *The analects of Confucius*. London and New York: Routledge.

Wang, Yan, and Yudong Yao. 2003. "Source of China's Economic Growth, 1952—1999: Incorporating Human Capital Accumulation." *China Economic Review* 14 (1):32–52.