

Application of the Chinese digital economy to supply-side reform and its effects on the imbalance in income distribution

Yan Huang

Chinese Academy of Management Science, Beijing, China

Abstract. The operation of digital economy is to integrate artificial intelligence technologies such as big data, Internet, cloud computing, machine learning, Internet of Things, and blockchain into various links such as production, exchange, distribution and consumption. The emergence of this phenomenon will inevitably lead to a large "reshuffle" in the industry pattern centered on the elimination of excess production capacity. How does this affect the structural restructuring of the supply side? How supply-side structural issues should respond to the development of the digital economy. Therefore, this project intends to conduct an in-depth discussion on income distribution and equity in the big data environment from the game perspective, using "game" and "principal-agent" theories as tools. The results of the game show that if both parties have fair motives in the monopolistic income distribution game, they can get reciprocal distribution results and reduce the income difference. On the contrary, the two parties will not be able to obtain reciprocal distribution results, so the income difference may become larger. In the context of big data, the gap between the rich and the poor can be reduced from the aspects of system construction and justice concept.

Keywords: Digital Economy; The Supply Side; Game Theory; Income Distribution; Unbalance

1. Introduction

Digital economy is a new type of economy in which enterprises are invested and operated by new technologies and macro-managed by the state. The development of this form has caused economists to ponder and discuss a series of issues such as economic selection behavior, resource allocation mode, industrial organization and industrial structure change. However, explaining whether socioeconomic activity will adopt the way the digital economy operates requires defining not only the nature and scale of the digital economy, but also the depth and breadth of big data, the Internet, and artificial intelligence. Analyze and demonstrate the process and mechanism of enterprises using cloud platform, cloud computing and artificial intelligence for investment and operation. In this process, the operation mode of the digital economy will have an impact on people's economic choice behavior and the allocation of resources, and these changes will finally be reflected in the changes of industrial organization and industrial structure. It will be reflected in the supply and demand decisions of products and services as well as their structure. From this perspective to examine the operation of the digital economy, then the structure and change of the supply side of goods and services should be the object of our analysis of the operation of the digital economy. In the context of "big data" and "Internet", the structural changes in the supply side of goods and services are closely related to the development level and penetration rate of "digital economy". From the current supply mode, the market-oriented supply mode and the new technology-oriented supply mode exist simultaneously. Although our government's contact rate with new technology providers is still higher than that of new technology providers, this situation will change in the near future [1]. The supply side under the guidance of new technology refers to the output of goods and services generated by enterprises using big data, Internet, artificial intelligence and other technologies through investment and operation of enterprises, as well as their types and structures. Because enterprises use cloud platforms, cloud computing and artificial intelligence and other means to collect, integrate and classify the behavioral data of other enterprises and users, and through the processing and processing of these big data, they plan and decide on their own supply and structure [2]. From the perspective of the whole society, if only a small number of enterprises' investment and operation are guided by new technologies, the digital economy phenomenon is only generated in the operation of the social economy, and cannot be regarded as the operation mode of the digital economy. Therefore, an in-depth understanding of

this will become a breakthrough point for us to conduct in-depth discussions on the operation of "digital economy" and "supply-side reform". Income distribution is a problem of income distribution involving all classes, and the formation of income distribution pattern is a competitive relationship among various interest groups in income distribution. Since the reform and opening up, China has always regarded solving the problem of income distribution as the fundamental to achieve sustainable and coordinated development. In the transitional stage, China has taken adjusting the interest relationship and reforming the distribution system as the central task of reform [3]. Therefore, the income distribution system has been continuously adjusted, and finally formed the current distribution system of "distribution according to work as the main distribution, multiple distribution methods coexist", and more recently, it has focused on the distribution model of distribution according to factors [4]. Although China has always been working hard to promote the reform of the income distribution system and ensure fairness and justice in the distribution process, the gap in national income is still increasing, and the speed of increase is very rapid, mainly reflected in four aspects: the income gap between different groups, urban and rural income gap, regional income gap and industrial income gap. At present, the income difference of China is undergoing new changes. First, the government's intervention effect is not good in the process of transition. In addition, some vested interests use their power and status to hinder fair distribution, resulting in the overall income disparity can not be reversed in the short term. In addition, the effects of the aforementioned institutional reforms have been gradually reflected. Chinese experience over the past few years has made allocation policy more scientific [5]. At the same time, with the deepening of state-owned enterprises, it will also change the power of monopoly and produce profound changes in the labor market. All sorts of favourable factors will lead to national income inequality beginning to narrow. The outcome of the power game will affect the gap between rich and poor in China. This problem has aroused great attention in the academic circle, and caused a great debate. Many scholars are optimistic about the current social and economic situation, and proposed that there will be two "Lewis turning points" in China, that is, the labor force from "infinite" to "limited small", that is, the labor force can reach equilibrium, labor relations will change, and the salary level of unskilled workers will also increase. The second is the "turning point" under Kuznets' "U" -shaped hypothesis [6]. That is, when Chinese economic development reaches a certain level, the "turning point" will promote the emergence of this turning point, but this hypothesis itself is not enough empirical evidence to support. In any case, only by reducing the income disparity and establishing a fair and reasonable distribution system can we ensure the harmony and stability of a society and provide a steady stream of power for the sustainable development of a country. Income is generated by a defined distribution system, not a single solution, but an equilibrium formed by a game involving multiple individuals. In the context of the era of big data, various interest groups can have more information. However, due to the differences in resources, skills and subjective judgment, there are certain differences in the quantity and quality of information they have [7]. In the multi-agent game, the choice of information quantity, quality and game mode among different agents will have different effects on income distribution. This project takes "game", "principal-agent" and other theories as tools to conduct an in-depth discussion on income distribution and equity in the big data environment.

2. Supply-side reform and digital economy

The ability of vendors to mine, collect, integrate, classify, process and process big data, and thus potentially obtain complete and accurate information, will depend on the coverage of artificial intelligence tools such as the Internet, Internet of Things, sensors, social media, positioning systems, machine learning, and blockchain [8]. The amount of coverage will also have a great impact on the intelligence of major manufacturers. In the application of intelligent data, enterprises can carry out relevant analysis according to the multidimensional characteristics of big data, so as to screen and select the data that can correctly reflect the relationship between supply and demand. Because big data has great scale and integrity, enterprises can collect and process this data to reflect the link

between supply and demand. From the perspective of changes in the supply side structure of products and services, data intelligence is promoting enterprises to adjust the supply structure based on demand big data [9]. It also allows companies to tap and adjust their supply potential. Figure 1 shows the supply-side behavioral interactive network system under artificial intelligence in the era of digital economy (the picture is quoted in Journal of Manufacturing Technology Management. 19.92-124).

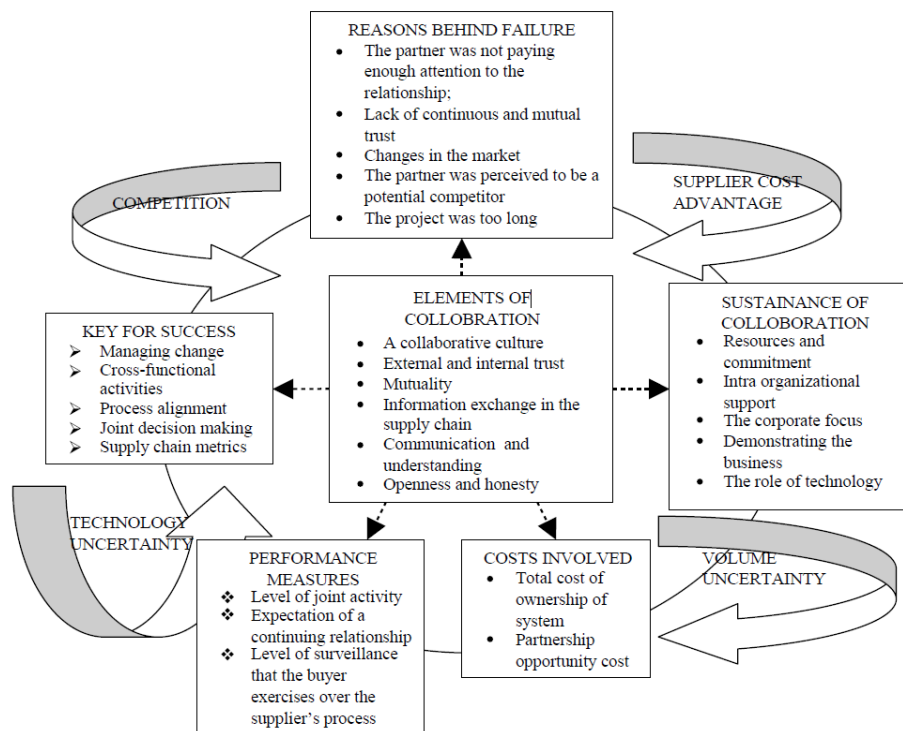


Fig. 1 Interactive network system of both suppliers

If all manufacturers have sufficient data intelligence coverage, and the degree of data intelligence has reached a relatively high degree, that is, the entire society has completed the operation of the digital economy [10]. Because of the intelligence of data, it will bring about structural changes in the supply side of products and services. Through the use of big data intelligence technology, it is possible to enhance business-to-business and business-to-customer interactions. The network collaboration composed of such interactions will also affect the supply-side structure, thus forming the supply-side structure corresponding to the operation of the digital economy. In terms of supply-side structural changes, the most important role of the network cooperation architecture of industrial organization is to realize the production and price decisions of products by using the behavior interaction between firms and consumers. It can also realize the functions of data intelligence, transaction de-intermediation, and flat operation and management. Network cooperation architecture is a new market transaction architecture supported by new technology. It has the characteristics of "staggered time and space, synchronous parallel". We can guide enterprises in what to invest and what to produce, and reduce the degree of blindness [11]. The network collaboration system based on big data intelligence can maximize the "inventory reduction" of enterprises, and can also realize the effective matching of "supply side" and "market". Figure 2 shows the network collaboration architecture based on data Intelligence (image from Artificial Intelligence-Enabled Intelligent 6G Networks). Practice has proved that the regulation of the single market mechanism on the supply side will lead to market failure, the regulation on the supply side will lead to the failure of the government, and the regulation on the supply side will lead to the contradiction and restriction between the two. In the period of industrial transformation, enterprises can not realize the intelligence and collaboration of data, resulting in enterprises can not realize the optimal configuration of the supply side, and can not realize the operation of the digital economy of the whole society [12]. The development and application of new technology is directly related to the development and application of digital economy.

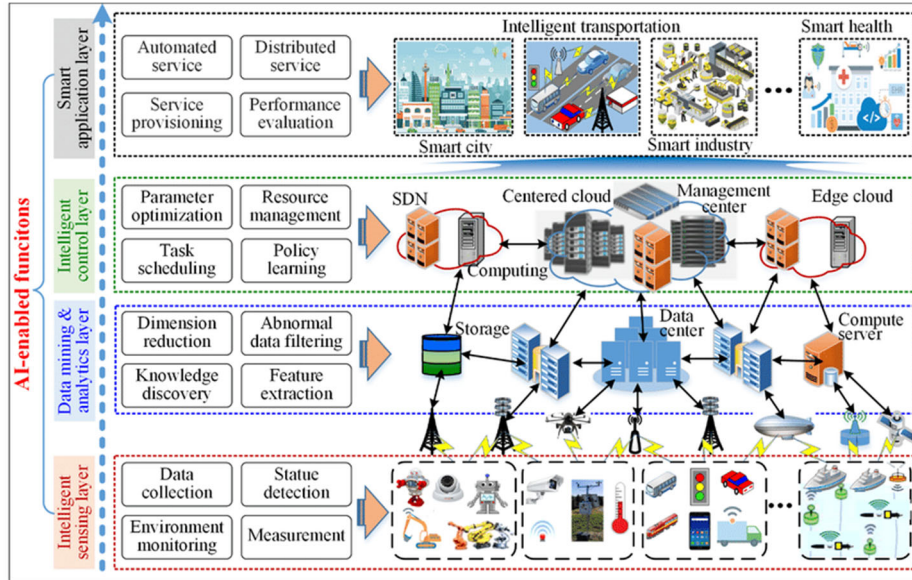


Fig. 2 Network collaboration architecture based on data intelligence

3. Design of game model of income distribution

In order to explain the payoff distribution strategy under the information monopoly condition, we will construct a model based on the principal-agent theory [13]. The principal is regarded as the information disadvantage and the agent as the information monopolist. This paper studies how asymmetric information and asymmetric income affect the income distribution strategy and fairness. Assumptions:

- 1) The principal is risk neutral, while the agent is risk averse.
- 2) The linear output function is expressed as $\delta = \lambda + \beta$. λ is a one-dimensional effort variable. β is an exogenous uncertainty (a normally distributed random variable with a mean of 0 and a variance of σ^2), so $W\delta = W(\lambda + \beta) = \lambda, Var(\delta) = \sigma^2$.
- 3) The agent utility function is $s = -e^{-\eta\omega}$. η is the absolute risk avoidance coefficient. ω is the real monetary coefficient.
- 4) Agent's effort cost $f(\lambda) = \mu\lambda^2 / 2, \mu > 0$ is the cost coefficient.

In the first part, the countermeasures of two participants in the asymmetric situation are discussed. In the context of big data, some people can obtain more important information and resources, which leads to the monopoly of these important information [14]. We can assume that in the context of big data, the principal can realize the value of the information contained in it, and in order to obtain more possible benefits, he will choose to entrust the agent to manufacture the product. The effort of the agent in this process is also unobserved. Therefore, in the contract setting, it is necessary to include the basic fixed income paid by the principal to the agent, the performance salary to motivate the agent to work harder, and the information cost generated by the principal to obtain more resources and the right to use information [15]. Assuming that the principal pays the information cost once, and the agent does not care about the initial price of the exclusive knowledge he holds, we can set up a linear contract:

$$d(\delta) = \kappa + f^* + \varphi\chi \tag{1}$$

κ is the agent's fixed income. f^* is the information cost paid, and φ is the output share of the risk shared by the agent [16]. Because the principal is risk neutral, his expected utility is equal to his expected income;

$$\begin{aligned}
 Wv &= W(\chi - d(\delta)) = W(\delta - \kappa - f^* - \varphi\chi) \\
 &= -(\kappa + f^*) + (1 - \varphi)W\delta \\
 &= -(\kappa + f^*) + (1 - \varphi)\lambda
 \end{aligned} \tag{2}$$

The actual income of the agent is the contract income less the effort cost:

$$v = d(\delta) - f(\lambda) = \kappa + f^* + \varphi(\lambda + \beta) - \frac{\mu}{2}\lambda^2 \tag{3}$$

If Wv is the agent expecting to receive, then:

$$Wv = \kappa + f^* + \varphi\lambda - \frac{\mu}{2}\lambda^2 \tag{4}$$

From $s(x) = Ws(v)$, its deterministic equivalent income x is:

$$x = \kappa + f^* + \varphi\lambda - \frac{\mu}{2}\lambda^2 - \frac{1}{2}\eta\varphi^2\sigma^2 = Wv - \frac{1}{2}\eta\varphi^2\sigma^2 \tag{5}$$

$\frac{1}{2}\eta\varphi^2\sigma^2$ can be regarded as agent risk cost. Let \bar{v} reserve the income level for the agent [17].

If the deterministic equivalent income is less than the retained income level, the agent will not accept the contract, and the participation constraint IR of the agent can be obtained as follows:

$$\kappa + f^* + \varphi\lambda - \frac{1}{2}\eta\varphi^2\sigma^2 - \frac{\mu}{2}\lambda^2 \geq \bar{v} \tag{6}$$

Because of the information monopoly, the agent's effort level λ is unobservable, and the incentive compatibility constraint IC of the agent given (κ, φ) needs to maximize its deterministic equivalent income x :

$$\frac{\partial x}{\partial \lambda} = \varphi - \mu\lambda = 0 \Rightarrow \lambda = \varphi / \mu \tag{7}$$

Therefore, the solution of the principal optimization problem is to select (κ, φ) to satisfy the expected income of the principal under the agent's participation in constraint IR and incentive compatible constraint IC :

$$\begin{cases}
 \max_{\kappa, \varphi} Wv = -(\kappa + f^*) + (1 - \varphi)\lambda \\
 s.t. (IR) \kappa + f^* + \varphi\lambda - \frac{1}{2}\eta\varphi^2\sigma^2 - \frac{\mu}{2}\lambda^2 \geq \bar{v} \\
 (IC) \lambda = \frac{\varphi}{\mu}
 \end{cases} \tag{8}$$

The principal will pay no more than the agent's retained earnings and will receive:

$$\kappa + f^* + \varphi\lambda - \frac{1}{2}\eta\varphi^2\sigma^2 - \frac{\mu}{2}\lambda^2 = \bar{v} \Rightarrow \kappa = \bar{v} - \varphi\lambda - \frac{1}{2}\eta\varphi^2\sigma^2 - \frac{\mu}{2}\lambda^2 - f^* \tag{9}$$

By participating in the surrogate objective function of constraint IR and incentive compatible constraint IC , the optimization problem is simplified as follows:

$$\max_{\varphi} \frac{\varphi}{\mu} - \frac{1}{2}\eta\varphi^2\sigma^2 - \frac{\mu}{2}\left(\frac{\varphi}{\mu}\right)^2 - \bar{v} \tag{10}$$

The first order condition is:

$$\frac{1}{\mu} - \eta\varphi\sigma^2 - \frac{\varphi}{\mu} = 0 \tag{11}$$

Namely

$$\varphi = \frac{1}{1 + \mu\eta\sigma^2} > 0 \tag{12}$$

At this time, the client's expected income is:

$$Wv = -(\kappa + f^*) + (1 - \varphi)\lambda = -(\kappa + f^*) + \eta\sigma^2 / (1 + \mu\eta\sigma^2)^2 \quad (13)$$

In the case that an agency has exclusivity, the agency must not only provide incentives for the agency that cannot be observed, but also pay a certain fee for its own revenue. When the principal sets the best remuneration contract, the agent will deduct the information cost from the retention payment that the client can afford when providing the fixed remuneration to the principal, which has nothing to do with the information cost paid by the principal [18]. The expected benefits that the principal can get also need to be deducted from the last information cost that the agent can get.

In summary:

(1) In the case of a complete monopoly, in the optimal reward contract, for the fixed income of the agent, not only the risk cost and the salary that the agent can bear in the traditional theory should be taken into account, but also the information cost that the principal is willing to pay in order to obtain the exclusive resources and information held by the agent.

(2) In the case of monopoly, the risk sharing coefficient φ in the contract has nothing to do with the one-time information cost paid by the principal to the agent. For $\varphi = \frac{1}{1 + \mu\eta\sigma^2}$, respectively, $\partial\varphi/\partial\mu < 0, \partial\varphi/\partial\eta < 0, \partial\varphi/\partial\sigma^2 < 0$, φ is a decreasing function of μ, η, σ^2 . According to $\lambda = \varphi/\mu$, when μ is larger, the principal artificially encourages the agent to achieve the same level of effort λ , and the agent needs to obtain more share φ of output, but the risk cost $\frac{1}{2}\eta\varphi^2\sigma^2$ is also larger.

Therefore, the principal can choose to save risk cost with lower level of effort. When η, φ^2 is larger, the agent is more risk-averse, the variance of output χ is larger, and the uncertainty increases [19]. Considering the agent's risk preference and the balance between incentive and insurance, the optimal incentive contract designed by the principal should reduce the agent's uncertain income and require a smaller φ to share the risk [20]. In the case of information asymmetry, even if the agent has monopoly information, since the agent has no cost to obtain the information, the principal does not need to consider the one-time information cost when setting the risk sharing coefficient of the contract, and only needs to consider how to motivate the agent to pay more effort according to the balance between the principal's risk cost and effort level and the agent's risk preference. As shown in Figure 3

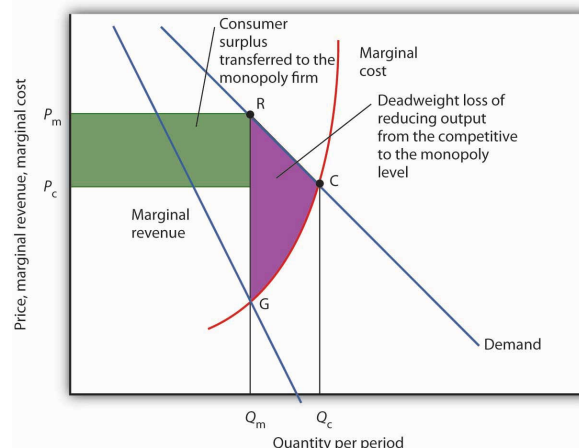


Fig.3 Game model of income distribution under monopoly

(3) When $z < \mu\eta^2\sigma^2 / 2(1 + \mu\eta\sigma^2)^2$, $Wv^* > Wv$. In the case of fairness and reciprocity, even if the two parties have different levels of resources and information, there is still a win-win situation: on the one hand, the principal sacrifices his own interests in exchange for more goodwill of the agent, and the agent will make a certain amount of extra efforts to obtain more profits than the general principal-agent model; On the other hand, with the increase in the total amount available for

distribution, the principal has the opportunity to obtain greater expected utility, the higher the degree of fairness and reciprocity he can give to the agent, and the higher the degree of effort the agent will exert.

4. Conclusion

The principal-agent model is used to discuss the game problem of monopoly income distribution. It can be concluded that in the case of resource and information monopoly, the principal can avoid moral hazard and motivate the agent to achieve more returns by establishing risk sharing. Therefore, the principal can obtain the monopoly resources and the right to use the information owned by the agent by paying a certain information cost. If other factors are given, it is assumed that both individuals have the concept of equality and the tendency of mutual benefit, then both individuals will get greater benefits, thus reducing the income difference between the two individuals. On the contrary, if both individuals are not fairly distributed, then the difference in income between them will become larger. The experiment of less game has proved that in the process of interaction, human beings have not only self-preference, but also innate fairness preference, which also reflects the duality of human having both natural and social attributes. This is an innovative point of this paper. However, the article has many flaws. The choice of strategy is relatively simple, and it is not analyzed from the specific details of income distribution justice. In addition, due to the limited space, the model could not be supported in terms of data. The next stage will be to dig deep into the data to demonstrate the model proposed in this paper.

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