Research Article

Distributed Optimization of Social Welfare and Regulation in Industrial Economy

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For the industrial economy, its development is closely related to social welfare, and the two influence each other. Therefore, the role of social welfare on social and economic development strategies and directions cannot be ignored, and the adjustment and innovation of social welfare should be used to win a more favorable institutional environment for the industrial economy. In the context of innovative social governance, it will help to make the country's labor and social welfare security system more complete and provide more effective social welfare and security for social members, but at the same time, social members should also actively participate in social welfare. In the further construction and development of the security system, a better supervisory role will be played. This article studies the social welfare in the industrial economy and uses distributed algorithms to optimize the impact of social welfare and regulation on the industrial economy, so that the new thinking of the social welfare security system will also provide a certain guarantee for the continued development of the national economy, allowing that the industry to the economic development in society has become more stable, the gap between the rich and the poor has narrowed, and the efficiency of social management has been improved.

1. Introduction

The speed of urbanization has an important impact on macroeconomic growth and fluctuations. As the main body of macroeconomic regulation, the government can adjust the speed and rhythm of urbanization by controlling the increase in urban population and the speed of urban land construction and development, so as to control the macro-economy and improve social welfare. The speed of urbanization can neither be too fast nor too slow. Too slow will lead to insufficient domestic demand to meet the requirements of stable economic growth. Although too fast speed can promote rapid economic growth in the short term, in the long run, economic growth will be limited by the rigid constraints of resources and the environment [1]. Overall, the urbanization rate of population and land has been fluctuating along the economic cycle. In a period of relatively fast economic growth, the urbanization rate is relatively fast, and in a period of relatively slow economic growth, the urbanization rate is relatively slow. The counter-cyclical adjustment effect of urbanization on macroeconomic fluctuations has not been brought into full play [2].

Within a specific area, various industries have complex cooperation and competition relationships, concentrated in a specific geographic area. Enterprises, suppliers, and financial organizations are interconnected to form the same cluster, and each industry cluster is more complex and at the same time very different. The industrial cluster contains many contents, including manufacturers, sales channels, and consumers. Industrial clusters are different from ordinary industrial categories and go beyond the general industrial scope. They can integrate different industries in a specific area, integrate various institutions and organizations, and establish a symbiosis, so as to give play to their own

competitive advantages [3–5]. The development of industrial clusters is to continuously expand the production chain and carry out in-depth integration and processing to achieve industrial transformation and upgrading. Examining industrial clusters from a micro perspective means that enterprises develop vertically and internal transactions replace market transactions. Because the cost of internal transactions is relatively low, the development cost of enterprises can be saved. Through integrated development, enterprises can stably implement the links of enterprise manufacturing and enterprise sales, and through integrated development, enterprises can obtain competitive advantages and improve enterprise barriers. The relationship between innovative social governance and labor and social welfare security can be interdependent and coordinated development.

The labor and social welfare security system is a crucial link in the process of building a long-term and stable innovative social governance [6]. Therefore, it is necessary to gradually enhance the scientific, stability, and sustainability of the social welfare security system, and jointly safeguard the relevant legal mechanisms for the construction of a more complete social welfare security system. The welfare security system has laid a solid foundation. Social welfare security is a basic right enjoyed by citizens. The labor social welfare security system is a basic labor welfare security system enacted and enforced by the state. It is a right enjoyed by all citizens. This is one of the most important measures for normal development. However, labor and social welfare security only provides a form of security that meets the most basic living needs of citizens within a certain period of time and will not meet the requirements of citizens' all-round quality of life. Social welfare security is an objective and basic need for people's basic life. In recent years, extensive work has been done in theestablishment of labor social welfare security, and many problems have been solved. The establishment of a social insurance system should be based on social insurance, assistance, and social welfare, with basic endowment insurance, basic medical insurance, and the improvement of the minimum living security system as the key, supplemented by various commercial insurances as supplementary elements and build a more complete labor and social welfare security system [7, 8]. Social welfare security is an inevitable prerequisite for promoting the positive development of culture. The sustainable development of a social economy is directly reflected in the effective improvement of the country's comprehensive national strength, and it is also an inevitable prerequisite for realizing the cultural rights and interests of the Chinese people. To this end, we should explore the profound cultural background, give full play to our unique advantages, and strive to achieve certain achievements in the construction of socialist spiritual culture. It is necessary to let more local industrial economy radiate stronger vitality. The vigorous development of the industrial economy will inevitably lead to the improvement of the public cultural system, and the positive prosperity of culture will have a counteracting effect on the further optimization and innovative development of the social welfare security system.

2. Impact of Industrial Economy on Social Welfare

The existence of the total equilibrium interval will lead to a certain "deadweight loss" of social welfare. At the same time, due to the change in the social welfare pattern, there will be macro-control resistance from different aspects, and different policy measures must be taken to deal with this. On the premise of a closed market, the welfare effect of the subsidy policy is analyzed with and without considering the institutional cost. Since the industry develops to a certain stage, it needs to be matched with the corresponding price control policy in order to comply with Kaldor–Sigg's improvement guidelines. After analyzing the welfare effects of the target price subsidy policy and the price stabilization policy, it is believed that the target price subsidy policy can save grain reserves and policy costs, but the subsidy efficiency has a greater impact on the welfare effect; the grain price stabilization policy is restricted by the institutional cost and only effective reduction [9–11]. Only the system cost can improve the total social welfare and, on this basis, relevant suggestions can be put forward. For industrial economy, it is mainly divided into a broad sense and a narrow sense. In a broad sense, the industrial economy involves various industries, from production to circulation, which can be called industries. Based on the narrow scope, in the industrial economy, industry occupies an important position and is closely related to economic development. Therefore, in many cases, the industrial economy is more inclined to the industrial sector. In industrial economics, the research angle is a broad industry, involving various industries and sectors of the national economy. In the current industrial economy, it can be divided into three levels, the first is the industry that is divided by the same commodity market, the second is the industry that is divided according to the similarity of technology and process, and the third is roughly based on economic based on the economy roughly. At this stage, the national economy is divided into industries composed of several main parts, that is, the industrial structure. The industrial economy shows its applicability, and the purpose of the industry is generated to meet the needs of industrial analysis [12]. Export-related industries are facing industry consolidation, and short-term fluctuations may be large. Textiles, home appliances, communications, and electronic products are the main export products, and the proportion of exports of consignment products is gradually increasing. In the context of RMB appreciation, it will also have an impact on the electronics industry, but due to the current situation of the electronics industry's perfect industrial chain, its pattern as a world processing factory will continue. The spiraling investment demand of investment-related industries drives the development of related industries. As a representative industry of fixed asset investment demand, steel reflects the rise and fall of fixed asset investment in the whole society. The steel industry is currently

undergoing effective structural adjustment. The manufacturing industry is likely to have a release period of profit growth in the future. Therefore, the steel industry, including downstream special steel product manufacturers, will have good development opportunities if their products meet the new round of steel demand, but backward production capacity will face elimination. Rising grain prices in consumer-related industries have brought cost pressures. Among consumer-related industries, our analysis also focuses on the food processing industry due to its importance. As shown in Figure 1, the four-quadrant evaluation method is adopted. It is highly likely that prices will maintain an upward trend this year. The food processing industry, which is a downstream industry of agricultural products, will inevitably be affected. It also determines its future earnings.

After completing the reform of the government and the coordination of enterprises, we must improve the ability of regional social welfare regulation, improve the regional economic development situation, and improve the level of regional economic development from the perspective of ability. Through industrial economy and capital investment, we make the quality and quality of products in the region reach a higher level, drive the economic development of the region, obtain higher income and reputation, narrow the economic gap with developed regions, and coordinate the development of various regions. The development trend between the two is to achieve a common development goal. And through the active promotion of social welfare control measures, the allocation of financial resources, material resources, human resources, and resources will be more perfect, to achieve a better development trend, strengthen the construction of infrastructure facilities, actively introduce foreign capital, and cooperate with other regions for common development. In economic development, the market has played a fundamental role in the effective allocation of resources, but the government's regulation cannot be ignored [13]. The first is to pay attention to the refinement of the social division of labor. This is mainly because many high-tech industries need to increase technological investment, and it is difficult for private enterprises to fully meet the needs. At the same time, intellectual factors have become an important factor affecting economic development. Therefore, the increase in investment in intangible assets has increased the prediction of enterprises' economic development prospects, and the entire society is facing adjustments to the structure and distribution of benefits [14–16]. With the help of the government's macro-control, it can realize the rational allocation and guidance of industrial economy and welfare, promote the market process, give full play to its flexibility, and focus on the determination of the model. With the help of macro-policy control, it can play a more effective role.

3. Distributed Optimization Algorithm

The idea of "decentralization" in distributed systems is a breakthrough idea that came into being in the context of this large-scale data. As long as multiple servers work together, information exchange between adjacent nodes can be used to process tasks to reduce the task allocation time in a centralized
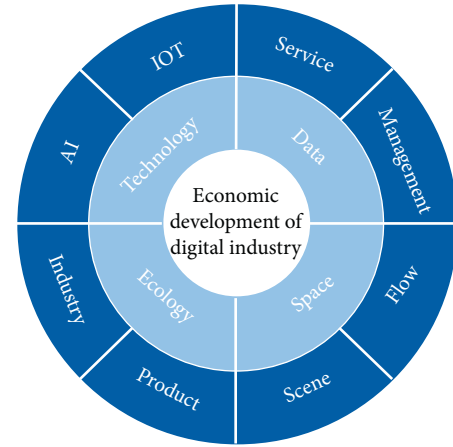

FIGURE 1: Schematic diagram of economic development mode of digital industry.

system, and the overall processing capability of the system can be enhanced by increasing the number of servers. Its good scalability and fault tolerance can effectively solve complex problems that cannot be solved by other methods. Among them, distributed optimization theory, as one of the important development directions of contemporary systems and control science, has received extensive attention in fields such as wireless sensor networks, machine learning, and cooperative control [17–20]. Distributed optimization of multi-agent systems is mainly based on the actual problem of distributed optimization modeling as the minimization of a global objective function, that is, the problem is solved on a connected network and distributed by multiple agents as shown in Figure 2. The database and multiple agents are interrelated.

In recent years, with more and more attention paid to distributed optimization in wireless sensor networks, machine learning, collaborative control and other fields, a large number of scholars began to pay attention to the field of distributed optimization and gradually applied to scientific research, engineering applications and society [21]. Practical problems based on distributed optimization can be modeled as the minimization of a global objective function, i.e., solving the problem on a connected network. The distributed optimization problem of social welfare and regulation in an industrial economy is modeled, mainly considering the constraints of industrial economy.

$$\min f(x) := \frac{1}{m}\sum_{i=1}^{m} f_i(x^i),$$
$$f_i(x^i) := \frac{1}{p_i}\sum_{n=1}^{p_i} f_i^n(x^i). \tag{1}$$

Among them, m represents the number of nodes, the local cost function f_i is the composition function averaged by p_i, and x is the independent variable.

Assuming that the objective function $f(x)$ is strongly convex and has a strongly convex parameter μ, the following formula can be obtained:
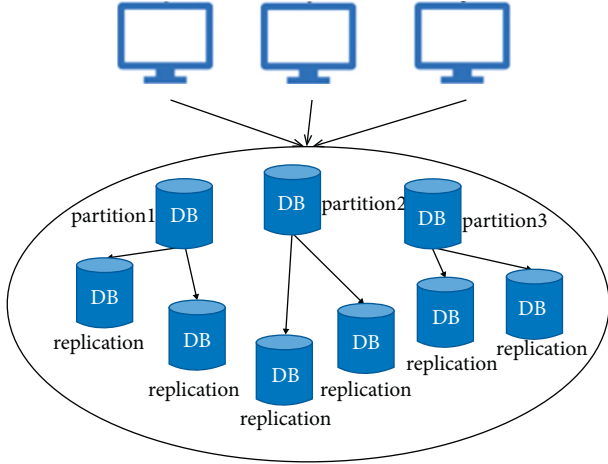
FIGURE 2: Distributed computing connection mode.

$$(\nabla f(x) - \nabla f(y))^T (x - y) \geq \mu \|x - y\|^2. \tag{2}$$

The Lipschitz constant is L_f, which has the following formula:

$$\nabla f_i^n(x) - \nabla f_i^n(y) \leq L_f x - y. \tag{3}$$

In the above formula, $L_f > \mu > 0$.

The decentralized gradient descent method is as follows:

$$x_{k+1}^i = \sum_{j=1}^{m} w_{i,j} x_k^j - \alpha_k \nabla f_i(x_k^i), \tag{4}$$

where $\alpha_k > 0$ is a constant step size and w is a double random weight matrix.

Using the instantaneous function gradient randomly calculated at time k to approximate the gradient $\nabla f_i(x_k^i)$, the update rule of $v_{k+2}^{i,j}$ is as follows:

$$\begin{aligned} v_{k+2}^{i,j} &= x_{k+1}^i, j = t_{k+1}^i, \\ v_{k+2}^{i,j} &= v_{k+1}^i, j \neq t_{k+1}^i. \end{aligned} \tag{5}$$

From the above formula, k iterations can be obtained, the remaining gradients remain unchanged, and the following update formula is obtained:

$$\sum_{j=1}^{p_i} \nabla f_i^j \left(v_{k+1}^{i,j} \right) = \sum_{j=1}^{p_i} \nabla f_i^j \left(v_{k+1}^{i,j} \right) + \nabla f_i^{t_{k+1}^i} \left(x_k^i \right) - \nabla f_i^{t_{k+1}^i} \left(v_k^{i,t_k^i} \right). \tag{6}$$

The above formula can obtain the full gradient that only needs to be calculated in the first iteration so that large-scale optimization problems can save a lot of resources and costs.

The local objective function containing i agents is given as follows:

$$f_i(x) = \frac{1}{q_i} \sum_{n=1}^{q_i} \left\| C_i^n x - d_i^n \right\|^2. \tag{7}$$

Among them, C_i^n is the sensing matrix in the problem model and d_i^n is the measured value.

EVS is the explained variance, which refers to the variance score of the model, and R^2 is the coefficient of determination or goodness of fit. The two calculation formulas are as follows:

$$\begin{aligned} \text{EVS} &= 1 - \frac{\text{Var}\left(X_i - \overline{X}_i\right)}{\text{Var}\left(X_i\right)}, \\ R^2 &= 1 - \frac{\sum \left(X - \widehat{X}\right)}{\sum \left(X - \overline{X}\right)}, \end{aligned} \tag{8}$$

where Var is the variance, X_i is the actual value, and $\overline{X}_i$ is the mean.

MSE is the mean square error, which represents the expectation of the error variance:

$$\text{MSE} = \frac{1}{n} \sum_{i=1}^{n} \left(X - \widehat{X}\right)^2, \tag{9}$$

where X is the actual value and $\widehat{X}$ is the predicted value.

MAE is the mean absolute error as follows:

$$\text{MAE} = \frac{1}{n} \sum_{i=1}^{n} |\widehat{Y} - Y|. \tag{10}$$

With the development of distributed artificial intelligence research, multi-agent systems have been widely used and concerned. Multi-intelligence technology breaks the thinking limitation of traditional centralized algorithms on single-computer computing, and utilizes communication, cooperation, coordination, and scheduling between agents [22]. It can effectively solve the control and management of various problems, with autonomy, distribution and coordination, and strong robustness and reliability. It has a far-reaching impact on promoting human production and life, social military, industrial economy, and other aspects [23–25]. Compared with the traditional centralized optimization algorithm, the distributed optimization algorithm of a multi-agent system is also a corresponding optimization method. The traditional centralized optimization method requires the central agent as a "leader" to control and assign tasks to the agent, and other agents cannot communicate with each other, and can only exchange information through the central agent. Once the "leader" failure will cause the entire system to collapse, which is a single point of failure that often occurs in centralized systems. The "decentralization" idea of the distributed optimization method removes the overall coordination of the central agent. Each agent has its own unique information and data and only needs to communicate with adjacent nodes to exchange information to achieve the overall situation. Target optimization greatly protects the privacy of agents and can also increase the number of agents to optimize the computing performance of the entire system [26]. It has strong flexibility and scalability, and avoids the single point of failure of traditional centralized algorithms. It can adapt to a more complex and larger-scale network environment.
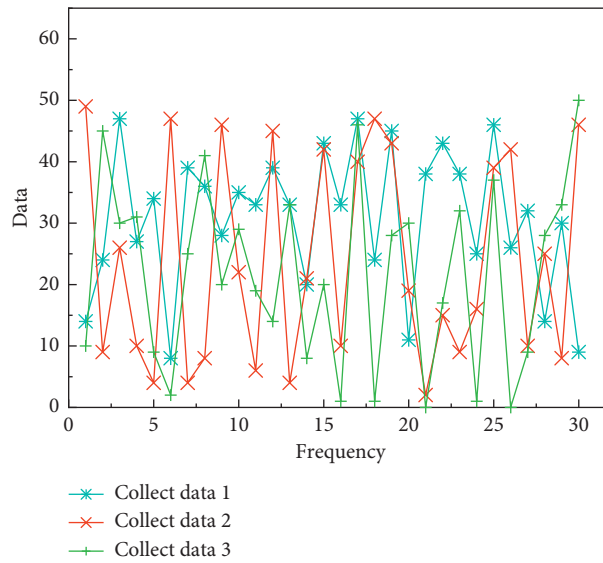
FIGURE 3: Comparison of different collected data.

4. Distributed Optimization of Social Welfare and Regulation

With the rapid development of computer information technology and the era of big data, the huge data scale and people's higher and higher efficiency requirements for production and life have long exceeded the range that the single-computer computing power of centralized algorithms can bear [27]. Various technologies for multi-agent systems have emerged. A large number of problems based on machine learning, wireless sensor networks, and cooperative control can be modeled as mathematical optimization problems [28–30]. Based on the existing first-order distributed methods, the large-scale unconstrained optimization problems of different social welfare and regulation are introduced in detail, proposed a distributed stochastic algorithm that can solve large-scale optimization problems on undirected networks, and through the unbiased gradient estimation technique, a single agent only needs to calculate the gradient of a certain instantaneous function by storing the gradient of the previous iteration of the ladder, which greatly reduces the cost of the agent to calculate the local objective function. This method was much easier to calculate than the method with definite grads. Compared with the method with the definite grads, the method only needed one training data set to update the model's data. The amount of calculation of the algorithm is much less in the face of large-scale data set optimization problems [31, 32]. At the same time, the algorithm selects the step size and momentum parameters within the appropriate range, the algorithm can linearly converge to the global optimal solution, and the acceleration effect is obvious.

Theoretically, just as the supply from each individual manufacturer can be added to the total social supply, the microadjustment cost from each individual manufacturer can also be added to the total supply-adjustment cost of the entire manufacturer. This total adjustment cost is actually a comprehensive reflection on the macro level of the micro-adjustment costs of countless individual manufacturers in the micro-field. Obviously, the total adjustment cost must also be consistent with the micro-adjustment cost of a single manufacturer in terms of composition, that is, it is also mainly composed of three parts: frictional cost, time delay, and operating cost. The planning and adjustment of industrial structure can be realized by means of public policies. In the current economic development, that is, in the material input of social production and reproduction, the proportion of each element changes, and the proportion of mental input increases, which is also an important factor for changes in the industrial economy. On the one hand, the proportion of knowledge factors has increased.

Therefore, in public policy, it is necessary to pay attention to the adjustment of industrial policy and gradually reduce the demand and dependence of the primary industry on nature and labor to improve the application and development of artificial intelligence. The data collection is shown in Figure 3. The abscissa represents the number of times and the ordinate represents the change value of regulation and control. It can be seen that the changes in the number of labor regulation and control show great irrelevance. Therefore, changes should be made in relevant social welfare and regulation. Pay attention to the development of soft products, avoid using its changes to traditional manufacturing, and promote the upgrading of traditional manufacturing. It is necessary to develop the computer industry, increase computer services, especially the related technical service industries of the information consulting industry, and increase the development speed of the high-tech industry. The use of distributed optimization related to social welfare and regulation of its optimization convergence is shown in Figure 4. The results show that the convergence effect of distributed optimization is better than that of other optimization methods. It shows a relatively fast convergence trend and can achieve better results.
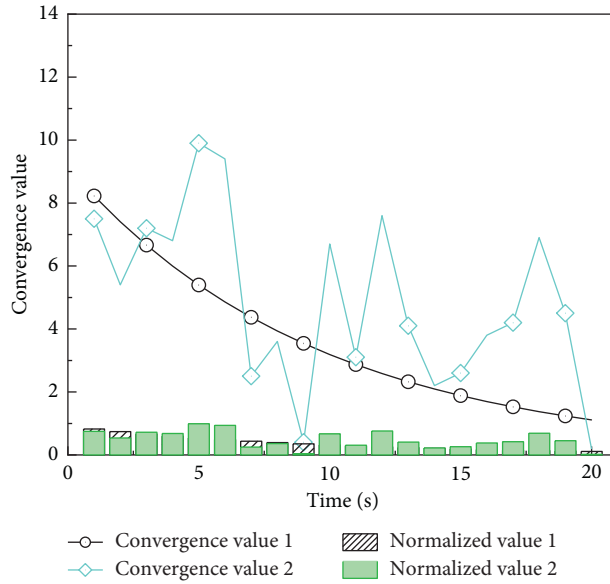
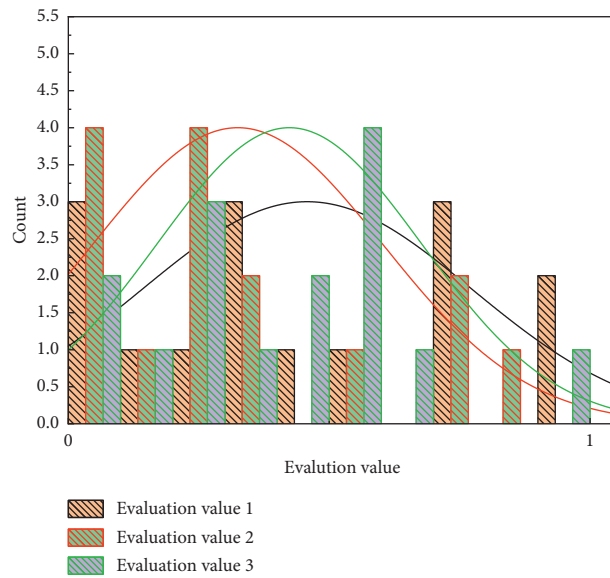FIGURE 4: Distributed optimization convergence diagram.

FIGURE 5: Optimization evaluation value histogram.

In the development of various industries and economies, fiscal policy plays a vital role, especially the preferential fiscal policies given by the state and regions, and the formulation of the relevant compensation system, which have a decisive role in the development of the industrial economy. The optimization evaluation is shown in Figure 5. In terms of financial policy, it mainly includes some education funds, basic investment, industrial support, etc., and its value curve increases first and then slows down with the growth of different quantities. With the support of this financial policy, different industries will obtain their corresponding financial incentives and strong financial support in the overall environment of economic development, so as to promote the long-term development of the industry and adapt to the overall social and economic development environment. As shown in Figure 6, the leverage of tax policy is used to manage different types of industries, and the state combines macro-control to conduct differentiated management of tax policy. In the current economic development, the state pays more attention to the tax preference for the technology industry of colleges and universities, increases the investment in the high-tech industry, strengthens relevant preferential policies such as taxation, attracts more investment, and expands the investment field.

Playing the role of financial means in public policy is of great significance to the development of the national economy and financial policy. Especially for some emerging industries, financing problems have become a restrictive factor in their development. The evaluation results of different regulation optimization are shown in Figure 7, in

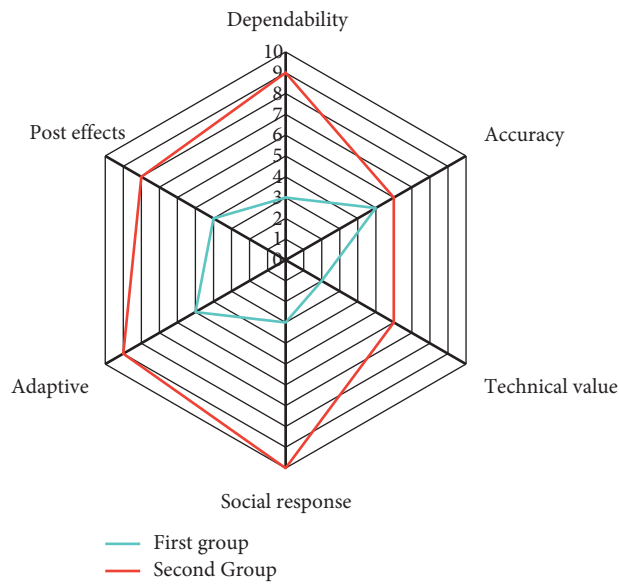FIGURE 6: Stacked area diagram of three optimization regulation.

FIGURE 7: Two groups of optimal control evaluation diagrams.
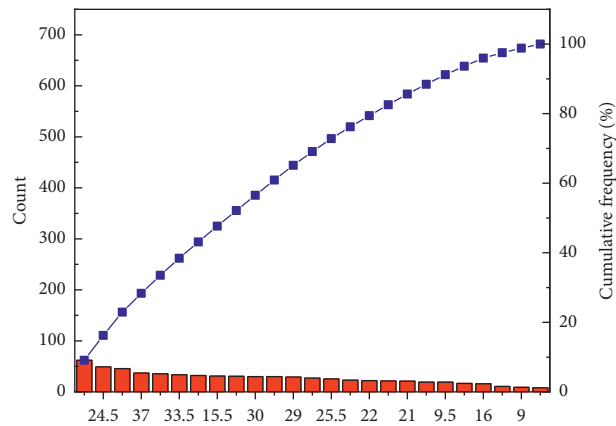

FIGURE 8: Cumulative frequency diagram of distributed optimization of social welfare regulation.

which the first optimization effect is poor. For financing methods, it is necessary to expand the methods, emphasize diversification, broaden financing channels, actively develop internal financing and financial investment, and actively expand external financing methods, especially banks, securities, and foreign capital. The cumulative effect of distributed optimization of social welfare regulation is shown in Figure 8. It can be seen from the figure that with the increase of regulation, the industrial economy will probably develop well, but there will be a certain slow development in the later stage, which is no longer within the acceptable range of social welfare regulation. Therefore, the effect of social welfare regulation is limited.

5. Conclusion

On the basis of sorting out social welfare and regulation, rule theory, and optimal control theory in the industrial economy, this study analyzes the impact of social welfare and social regulation on total output and inflation by analyzing the mechanism of industrial economy on macroeconomics, and solves the problem. The optimal population under different welfare loss functions was obtained. The actual value is compared and analyzed, and the corresponding social welfare loss is also calculated. According to the research content of this study, the following conclusions can be drawn: First, there is a positive mutual influence relationship between the macro-economy and the industrial economy, and it is feasible to control the macro-economy by controlling the speed and rhythm of urbanization. On the one hand, the industrial economy will increase potential output by means of the human capital accumulation effect, land use efficiency improvement effect, innovation spillover and diffusion effect, scale economy effect, and industrial structure upgrading effect. Private investment is expected to enhance the strength of the government's fiscal revenue, promote the government to increase infrastructure investment and expenditure on science, education, culture, and health, and increase the quantity and quality of import and export trade to expand effective demand. On the other hand, economic development will drive the adjustment of industrial structure, thus promoting the transfer of rural population and land elements to cities and promoting the development of the industrial economy. On the basis of improving statistical methods, optimizing relevant control technologies, and strengthening policy space reservation, considering the controllable process and pace of urbanization, the relationship between social welfare and macroeconomics has been widely empirically confirmed. With the advantages of both sides regulating the economy at the same time, in a certain stage of economic development, social welfare can be used as a macroeconomic control tool. Second, the setting of optimal industrial economy and speed should focus on its impact on economic fluctuations. From the current three criteria for evaluating whether the industrial economy and speed are optimal, taking the coordination of population urbanization and land urbanization as the goal is a partial equilibrium analysis method; taking the coordination of industrial economy and social welfare as the standard, there is a process of industrialization. Questions cannot be judged by themselves. Policy makers should take the maximization of social welfare as the starting point and destination of all policy formulations. From the perspective of its impact on social welfare, the industrial economy will affect the overall social welfare by affecting economic growth and economic fluctuations. Since, the impact on economic growth is relatively certain. Therefore, policy makers should actively pay attention to the impact of the industrial economy on economic fluctuations, and then reduce economic fluctuations and social welfare losses by controlling the speed of industrial economics. Social welfare is the sum of personal utility. All risk factors that affect personal utility will affect social welfare. Fluctuations in output and inflation in economic fluctuations will affect personal utility. Population urbanization and land urbanization deviating from the equilibrium path will also affect personal utility, so the social welfare function should include both macroeconomic fluctuations and urbanization variable fluctuations. However, since economic fluctuations affect a wider range of people than urbanization fluctuations, the weight of the social welfare function should be larger.

Third, the industrial economy has an important impact on the regulation of social welfare. The industrial economy should respond regularly to the fluctuations of the current social situations. The speed of land urbanization in the current period affects not only the output of the next period, but also the inflation of the next period; but the rate of population urbanization in the current period only affects the total demand in the next period. Due to the mutual influence between output and inflation, social welfare will still affect inflation in the long run. After the stability and controllability test, the economic operation control system described by the total demand and total supply equations of the empirical results is stable and controllable, and the optimal social regulation speed control rules can be calculated using the optimal control theory, which should be based on the current period. Output and inflation are adjusted on an equilibrium path, which can effectively reduce economic volatility. Since urbanization will drive aggregate demand and at the same time increase potential output through the supply side, both optimal population urbanization rules and land urbanization rules have negative feedback on the total output gap and positive feedback on social welfare. Given that population urbanization has a stronger impact on the output gap and the industrial economy has a stronger impact on social welfare, population urbanization has a comparative advantage in managing output fluctuations, and its response to output is more intense. Land urbanization has a relative advantage in managing output fluctuations. It has comparative advantages in managing social welfare fluctuations, and it has a stronger response to an industrial economy.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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