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Corporate Tax Burden Minimization Strategies under Tax Incentive Policies - Based on Mathematical Planning and Simulation Analysis

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ABSTRACT
The implementation of tax incentives is a powerful measure to reduce the burden of enterprises, build a new development pattern, and expand reform and opening-up. Some enterprises in nine provinces from 2010 to 2023 are sampled to verify the role of tax incentives in reducing the tax burden by using the double difference model. The weight coefficients are introduced as learning factors for the population center of mass, and the SWC-PSO algorithm is proposed to improve the shortcomings of PSO, which has low convergence accuracy and is prone to fall into local extremes, and to realize the mathematical planning for minimizing the tax burden of enterprises. After controlling the variables of tax policy and enterprise nature, the regression coefficient reflecting the enterprise tax burden is significantly negative at 1% level, and the tax burden of enterprises receiving tax incentives is significantly reduced, which proves the role of tax incentives in reducing the enterprise tax burden. After using SWC-PSO for planning, the sample units have a total of 1,779,919,000 yuan of tax relief, and the business tax rate of a construction project decreases from 3.35% to 0.42%, which indicates that the improved algorithm in this paper can plan the strategy of minimizing the tax burden of enterprises more efficiently.

Keywords: SWC-PSO, double difference model, tax incentives, corporate tax burden minimization

1. Introduction

There are many visible costs and expenses in the process of company operation, procurement costs, labor costs, publicity and promotion costs, equipment rental fees, venue fees, travel and catering costs, etc. In recent years, the economic situation has declined and costs have risen, and companies are trying to find ways to save money on costs in order to maintain their operations or to increase profits [1-4].

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In addition to the visible costs, there is a very large hidden cost is the enterprise must not be ignored, is the cost of taxes. Why do enterprises need tax planning, because tax reduction is to reduce costs. Headquarters economic investment, some local tax incentives are enterprises can enjoy, simple planning but can reduce a lot of tax burden [5-8].

There are various ways to reduce the tax burden of enterprises, one of which is reasonable planning tax planning. Enterprises should make reasonable tax planning programs according to their own business conditions and tax policies. This includes optimizing the enterprise's organizational structure, capital structure and business model in order to reduce the amount of tax payment. For example, through the establishment of subsidiaries or affiliated companies, the use of branch income tax incentives to reduce the tax burden of enterprises [9-12]. The second is to comply with the operation. Enterprises should actively comply with tax laws and regulations to ensure compliant operations. This includes timely and accurate declaration and payment of taxes to avoid penalties and interest due to tax violations [13-15]. Thirdly, make full use of tax incentives. The government has formulated a series of tax incentives to encourage the development of enterprises. Enterprises should fully understand and utilize these policies in order to reduce tax burden [16-18]. In addition, there are active foreign investment, on-time declaration of tax exemption programs, and rational use of tax planning tools can reduce the tax burden of enterprises [19-20].

This paper investigates the impact of the implementation of tax incentives on the decline of corporate tax burden, and accordingly discusses the realization strategy of minimizing corporate tax burden. Enterprises in a total of nine provinces in the northeastern and central regions are selected as samples from 2010 to 2023, and corporate tax burden, fixed asset investment ratio, and return on total assets are chosen as the explanatory variables, with tax preferential policies as the dependent variables, and a double-difference model is constructed and regression analysis is carried out to preliminarily validate the effect of the support of tax preferential policies on the reduction of corporate tax burden. Subsequently, for the shortcomings of particle swarm optimization algorithm, which has low convergence accuracy and is easy to fall into local extremes, the learning of population center of mass is introduced, and the weight coefficient is used as the learning factor of population center of mass to realize the improvement of PSO. The improved SWC-PSO algorithm is used to simulate the planning of the tax minimization strategy, and the algorithm is effective in minimizing the tax burden.

2. Impact of tax incentives on the tax burden of enterprises

2.1. Problem formulation and research design

Using data from the Enterprise Tax Burden Survey, this paper adopts the test of Double Difference DID and takes the full transition of tax incentives in some regions as the entry point to study the key questions: as the implementation of tax incentives goes on, will the downward trend of tax burden continue in the longer term?

2.1.1. Sample Selection. This paper takes 2010-2023 as the main research period, and uses double difference (DID) analysis to study the impact of the implementation of tax incentives on enterprise tax burden, fixed assets investment and enterprise operating efficiency. To ensure the robustness of the research conclusions, this paper excludes the annual data of enterprises with the following characteristics:

1) Enterprises not belonging to the tax reform industry are excluded, and enterprises in the following industries are selected as the research sample: 1. agriculture, forestry, animal husbandry, and fishery. 2. Mining. 3. Manufacturing. 4. Electricity, heat, gas, and water production and supply. 5. Wholesale and retail trade.

2) Firms with negative or zero owner's equity in any year during the sample period, or with missing relevant financial indicators, are excluded. The finalized sample size of the same households in this

paper is 2089 households, of which 1025 households are in the control group sample. The experimental group sample of 1064 households is truncated at the upper and lower 1% for all continuous variables included in the test.

2.1.2. Double difference model construction. If only the enterprises in the rest of the country are taken as the object of study, comparing the differences in tax burden, behavior and performance between enterprises before and after the implementation of tax incentives are implemented, the impact of some special events or macro factors during the policy change will be neglected. If we take enterprises in the Northeast region and enterprises in other regions of the country as the research object and compare the differences between these two types of enterprises after the implementation of tax incentives implementation, we will ignore the impact of these two types of enterprises' own factors.

Therefore, we should not only compare the enterprises in the Northeast region, part of the central region and the rest of the country, but also compare all enterprises before and after the implementation of the tax policy transition, and synthesize the method of considering these two differences, i.e., the double-difference model. The double difference method can better solve the endogeneity problem by controlling the mutual influence effect between the dependent variable and the independent variable, so the method is widely used in the research on the policy effect [21].

1) Dependent and explanatory variables. This paper takes the enterprises in the corresponding industries in the regions where the tax policy does not change during the implementation of the tax incentives as the sample of the control group, and the enterprises in the regions where the tax incentives are implemented as the sample of the treatment group, and compares the differences between the treatment group and the control group after the occurrence of the policy by controlling for other factors.

We use corporate tax burden, fixed asset investment ratio, and return on total assets as explanatory variables. The variable “policy” reflects whether the sample is a treatment group or not. In this case, a value of 1 represents the companies in the area where the tax incentives have just been implemented, and a value of 0 represents the companies in the pilot area where no change occurs after the implementation of the tax incentives. The variable “period” reflects the process of reform, taking the value of 1 in the year when the tax incentives are implemented and thereafter, and 0 otherwise.In order to test the effect of the reform, we set up the cross-multiplier term (DID), which is the cross-multiplier of policy and period. The cross-multiplier term takes the value of 1 when both POLICY and PERIOD are 1, and 0 otherwise.In this form, we divide the sample into four groups: pre-reform treatment group $(policy=1, period=0)$, post-reform treatment group $(policy=1, period=1)$, pre-reform control group $(policy=0, period=0)$, and post-reform control group $(policy=0, period=1)$. The double-difference model is then:

$$Y_{i,t}=\alpha_{0+}\alpha_1 Policy_{i,t}+\alpha_2 Period_{i,t}+\alpha_3 DID_{i,t}+\varepsilon_{i,t} \tag{1}$$

where, Y is the explanatory variables, which are the corporate tax burden, the proportion of investment in fixed assets (and the return on total assets. α_1 controls for the difference between the treatment and control groups, α_2 controls for the common shock that time brings to the treatment and control groups, α_3 is the variable we really care about, the coefficient that can reflect the effect of the reform, i stands for the individual firms, and t stands for time. The specific explanations are as follows:

For the control group, i.e., $policy=0$, from equation (1), the Y before and after the reform in the control group are denoted respectively:

$$Y_{i,t}=\begin{cases}\alpha_0 & When\ Period=0,\ i.e.,\ before\ reforms\\ \alpha_{0+}\alpha_2 & When\ Period=1,\ i.e.,\ after\ the\ reform\end{cases} \tag{2}$$

Therefore, the change in control group Y during the pre- and post-reform period is α_2. α_2 reflects the impact of macroeconomic and technological innovations on Y. As for the treatment group, i.e., $policy = 1$, from equation (1), the Y of the treatment group before and after the reform is denoted as respectively:

$$Y_{i,t} = \begin{cases} \alpha_{0+}\alpha_1 & When\ Period = 0,\ i.e.,\ before\ reforms \\ \alpha_{0+}\alpha_{1+}\alpha_{2+}\alpha_3 & When\ Period = 1,\ i.e.,\ after\ the\ reform \end{cases} \tag{3}$$

As can be seen, the change in treatment group Y between the pre- and post-reform periods is $\alpha_2 + \alpha_3$. Therefore, the "net effect" of the tax incentives is $\alpha_2 + \alpha_3 - \alpha_2 = \alpha_3$. If the tax incentives have a negative effect on the tax burden of firms, then the sign of α_3 should be significantly negative. If the tax incentives have a negative effect on the corporate tax burden, then the sign of α_3 should be significantly positive. The sign of α_3 should be significantly positive if the implementation of tax incentives can promote the improvement of corporate efficiency. After this treatment, the effects of general factors affecting national enterprises, such as macroeconomics and technological innovation, on Y will be eliminated, so that the policy effects of the implementation of tax incentives can be estimated more accurately.

2) Control variables. To ensure the robustness of the results, we add the following variables to the above model to control for the potential impact of firm characteristics on the dependent variable: (1) Firm size, measured using the natural logarithm of the firm's total assets at the beginning of the year. (2) Financial leverage, measured using the ratio of the firm's total liabilities at the beginning of the year to its total assets at the beginning of the year. (3) Growth, measured using the growth rate of a firm's total assets at the end of the year relative to total assets at the beginning of the year. (4) Age of the firm, measured using the number of years between the fiscal year and the year of the firm's inception. (5) Policy year, measured using the year in which the tax optimization policy was implemented. (6) Firm type, using the five types of firms categorized in the previous section. Thereby, the aggregate regression model constructed in this paper is set up as follows:

$$\begin{aligned} Y_{i,t} = \alpha_0 + \alpha_1 Policy_{i,t} + \alpha_2 Period_{i,t} + \alpha_3 DID_{i,t} + \alpha_4 Size_{i,t} \\ + \alpha_5 Lev_{i,t} + \alpha_6 Growth_{i,t} + \alpha_7 Age_{i,t} + \alpha_8 Year + \alpha_9 Co + \varepsilon_{i,t} \end{aligned} \tag{4}$$

2.2. *Analysis of baseline regression results*

The hypothesis established in this paper is as follows: firms supported by tax incentives have a lower effective tax burden than other firms. A regression analysis of the baseline regression model is conducted to verify the hypothesis. In order to avoid the effect of firm heterogeneity on firms' effective tax rates, all regression models in this paper are based on firm-level fixed effects models. Table 1 gives the benchmark regression results.

The first column reflects the results of controlling only for the provincial tax incentives dummy variable, which has a significantly negative regression coefficient. This suggests that firms supported by local government tax incentives experience a significant 1.7% reduction in their effective tax rate compared to firms discouraged by local government tax incentives.

In the second regression, a series of firm-level control variables such as Growth, Age, Financial leverage, and Size are included to prevent the omitted variable problem. It can be seen that the coefficient of primary interest α_3 does not change significantly to -1.6% and remains significantly negative at the 1% level. In addition, during different years, tax incentives are implemented differently and focused on different industries, all of which can affect firms' effective tax rates in the current year, so year fixed effects are also added to the third regression in order to remove the effect of time.

Controlling for year fixed effects, tax incentives introduced by the local government cause the local government to reduce the effective tax rate of the industry by 1.9% and remain significant at the 1%

level. Since local tax incentives are formulated by the province based on actual local development, there are large differences between different enterprises in different provinces.

In order to remove the effect of the existence of differences across firms, the fourth regression controls for firm fixed effects, while the coefficient on local tax incentives remains unchanged. After controlling for both year and enterprise fixed effects, the main concern coefficients also remain unchanged and are significantly negative at the 1% level. Based on the above statistical results, the hypothesis of this paper is basically verified, i.e., the tax incentives of local governments can make enterprises enjoy greater tax incentives, thus significantly reducing the actual tax burden of the industry.

Table 1. The effect of tax preferential policies on corporate tax

Variable	(1)	(2)	(3)	(4)	(5)
DID	-0.017***	-0.016***	-0.019***	-0.019***	-0.018***
	(-3.38)	(-3.48)	(-6.66)	(-6.66)	(-6.25)
Period		-0.003	-0.008***	-0.008***	-0.006*
		(-0.89)	(-2.87)	(-2.87)	(-1.98)
Policy		0.055***	0.045***	0.045***	0.034***
		(15.91)	(15.33)	(15.33)	(14.14)
Growth		-0.031***	-0.032***	-0.032***	-0.033***
		(-20.14)	(-16.99)	(-16.99)	(-15.84)
Age		0.002	0.004***	0.004***	0.003
		(1.38)	(6.64)	(6.64)	(1.65)
Financial leverage		-0.000	-0.000	-0.000	-0.000
		(-0.22)	(-0.32)	(-0.32)	(-0.33)
Size		0.000	0.000	0.000	0.000
		(1.44)	(1.45)	(1.32)	(1.42)
$Within-R^2$	0.000	0.035	0.036	0.036	0.028
observation	30188	24538	24538	24538	24538
Count	2089	2089	2089	2089	2089
Year fixed effect	NO	NO	YES	NO	YES
Enterprise fixation effect	NO	NO	NO	YES	YES

2.3. Double difference model regression analysis

1) Parallel trend hypothesis test. One of the first prerequisites for using the double-difference method is to satisfy the parallel trend assumption, that is, there is no significant difference between the experimental and control groups before the policy shock. Based on this, this paper constructs formulas to conduct the parallel trend test:

$$\begin{aligned} Y_{ipyg} &= \beta+\alpha_1 d\_5+\alpha_2 d\_4+\alpha_3 d\_3+\alpha_4 d\_2 \\ &+\alpha_5 d0+\alpha_6 d1+\alpha_7 d2+\alpha_8 d3+\alpha_9 d4+\alpha_{10} d5 \\ &+\alpha_{11} d6+\alpha_{12} d7+\alpha_{13} d8+\alpha_{14} d9+\delta_i+\gamma_y+\varepsilon_{iy} \end{aligned} \tag{5}$$

Due to the large time span of the samples in this paper, for simplicity, this paper adopts a reduced-tail treatment. Among them, d_5, d_4, d_3, d_2, d0, d1, d2, d3, d4, d5, d6, d7, d8, and d9 are newly constructed dummy variables, which represent the observed values of the enterprise in the five, four, three, two, and one years before it was supported by the local tax incentives. If none of the coefficients of d_ are significant, this indicates that there is no significant difference between the experimental and control groups in terms of tax burden above before being subjected to the policy shock, satisfying the assumption of parallel trends. On the contrary, if the regression coefficients are still significantly negative, it means that the decrease in the effective effective tax rate of firms may be due to the impact of other policies. Table 2 shows the results of the parallel trend assumption test.

Table 2. Parallel trend assumption test

Variable	(1)	Variable	(1)	Variable	(1)
d_5	0.031	d5	-0.082***	Corporate tax	-0.046***
	(0.38)		(-16.42)		(-4.25)
d_4	0.055	d6	-0.083***	Proportion of fixed assets	0.083***
	(0.65)		(-17.88)		(3.92)
d_3	0.053	d7	-0.085***	Age	0.000
	(0.51)		(-18.83)		(0.28)
d_2	0.019	d8	-0.092***	Growth	0.002***
	(1.56)		(-19.81)		(3.87)
d0	0.001	d9	-0.095***	Financial leverage	-0.000
	(0.15)		(-19.32)		(-0.81)
d1	-0.031***	Policy	0.005	Size	-0.000
	(-6.25)		(0.95)		(-0.73)
d2	-0.058***	Period	0.038***	$Within-R^2$	0.043
	(-11.44)		(9.42)	Observation	24538
d3	-0.062***	DID	-0.031***	Corporate Count	2089
	(-13.31)		(-15.24)	Year fixed effect	NO
d4	-0.082***	ROA	0.001***	Enterprise fixation effect	NO
	(-15.55)		(5.78)		

A parallel trend test plot is produced from the regression results in Table 2, and Figure 1 is the parallel trend image. The regression coefficients of d_ are all insignificant and positive in years 1-5 before the policy intervention. This indicates that before being affected by the policy, the trend of the effective effective tax rate of enterprises remains consistent, which meets the requirements of the parallel trend test.

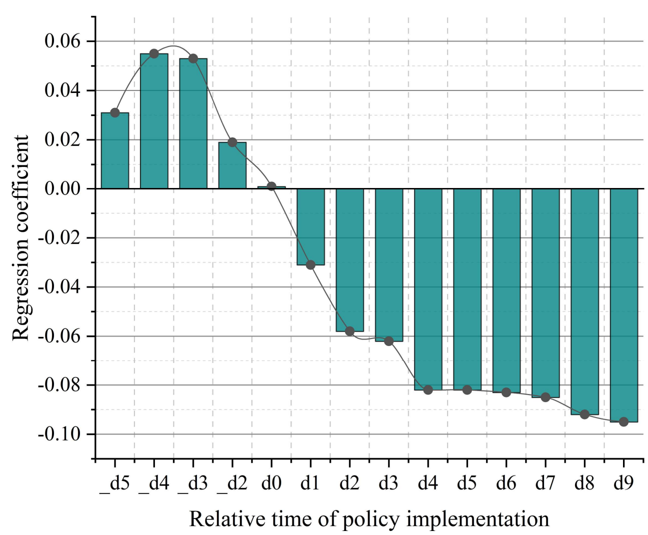

Fig. 1. Parallel trend image

2) Empirical regression results of double difference models. Table 3 presents the empirical regression results of the double difference model. From the results, it can be seen that none of the regression coefficients of Diff(FU) are significant either, indicating that after the implementation of the tax incentives, the control group and the treatment group are increasingly converging in terms of their performance in the three aspects mentioned above.

From the perspective of corporate tax burden, the regression coefficient of DID is negative, -0.003, and reaches the significance level of 1%, indicating that after the implementation of tax incentives, the corporate tax burden of enterprises in the areas where the tax incentives are implemented has a very significant downward trend of change in a longer period of time. From the perspective of the proportion of investment in fixed assets, the regression coefficient of DID is positive, 0.016, reaching a significance level of 1%, indicating that after the implementation of tax incentives, the implementation of tax incentives for the implementation of regional enterprises in the fixed asset investment has a more significant growth, the enterprise's investment vitality has been significantly enhanced. From the perspective of return on assets, the regression coefficient of DID is positive, 0.004, reaching the significance level of 5%, indicating that after the implementation of tax incentives, the economic efficiency of the enterprises in the regions where the tax incentives are implemented has grown significantly, indicating that the reform of the tax incentives policy has improved the business performance of enterprises to a certain extent.

Table 3. Empirical regression of the double difference model

		Corporate tax	Proportion of fixed assets	ROA
Base line	Control	0.025***	0.492***	0.026***
		(6.88)	(13.84)	(3.68)
	Treated	0.023***	0.485***	0.035***
		(8.66)	(13.97)	(2.84)
	Diff(BL)	0.002	-0.009	-0.006
		(1.36)	(-0.25)	(-0.58)
Follow up	Control	0.021***	0.494***	0.023***
		(6.15)	(14.38)	(3.46)
	Treated	0.023***	0.499***	0.039***
		(5.52)	(15.38)	(4.28)
	Diff(BL)	0.002	0.006	-0.000
		(0.85)	(0.48)	(0.58)
	DID	-0.003***	0.016***	0.004**
		(-6.13)	(3.69)	(2.18)
Control Variables	Size	-0.002***	-0.003***	0.008***
		(-9.58)	(-4.89)	(23.13)
	Financial leverage	-0.016***	-0.078***	-0.098***
		(-27.76)	(-12.56)	(-70.45)
	Growth	-0.002***	-0.244***	0.038***
		(-17.76)	(-105.68)	(46.59)
	Age	0.000***	0.002***	-0.000***
		(7.58)	(16.35)	(-7.34)
	Year fixed effect	Control	Control	Control
	Enterprise fixation effect	Control	Control	Control

3. Tax planning strategy and simulation analysis based on improved PSOs

3.1. Improved sorted weighted center of mass PSO algorithm

3.1.1. Introduction to the PSO algorithm. Particle swarm optimization algorithms are designed to find the optimal solution of a population by driving the evolution of the algorithm through the interaction and comparison of information among individuals in the population. In the algorithm, each individual is abstracted as a particle without mass and volume in d-dimensional space. If there are n individuals in the population, vector $X_i = (x_{i1}, x_{i2}, \cdots\cdots x_{id})$ is used to represent the position of the $i(i = 1, 2\cdots\cdots n)$ th particle in d-dimensional space, and vector $V_i = (v_{i1}, v_{i2}, \cdots\cdots v_{id})$ is used to describe the state and direction of flight of each particle.

The position of each particle in the algorithm is used to record the possible values of the optimal solution in the search space, and each particle determines the current adaptation value through the objective function. At initialization, the algorithm assigns random values to the position and velocity of each particle of the swarm, after which it brings in the objective function to calculate the adaptation value of the i th particle. At this time, the first evolution has not yet begun, so each particle takes the current adaptation value as the best position (Pbest) found by itself in the history as its own experience, in addition to this, each particle is informed of the best position found among the current swarm of particles through the sharing of information of the swarm (the global extreme value, where Gbest is the optimal value in Pbest). This is used as the particle swarm population experience. After finding these two optimal values, the position and velocity of the particles are updated by the following two equations:

$$X_1(t+1) = X_1(t) + V_1(t+1) \tag{6}$$

$$\begin{aligned} V_1(t+1) = V_1(t) + C_1 * R_1(t)\left(Pbest_i(t) - x_i(t)\right) \\ + C_2 * R_2(t)\left(Gbest(t) - X_i(t)\right) \end{aligned} \tag{7}$$

where: C_1, C_2 are learning factors that are used to adjust the role played by the particle's own experience and the experience of the group in its movement. R_1, R_2 are two independent random numbers. When the particle arrives at a new position, based on the particle's current position, it is substituted into the objective function to arrive at the particle's individual history extreme value Pbest and the particle swarm group extreme value Gbest.

The individual extreme value is updated by the following equation:

$$Pbest_1(t+1) = Best\left(X_1(t+1), Pbest_i(t)\right) \tag{8}$$

For the particle swarm population extremes Gbest is selected according to the following equation:

$$Gbest(t+1) = Best\left(Pbest_i(t+1)\right), i = 1, 2, \cdots\cdots n \tag{9}$$

Define $V\max$ as the maximum speed of particle flight in the PSO algorithm, and all the evolved particle flight speeds are less than or equal to $V\max$. From this, it can be obtained that the global and local search ability of the particle population can be balanced by adjusting the size of $V\max$ [22].

Fig. 2 shows the schematic diagram of the operation flow of the PSO algorithm.

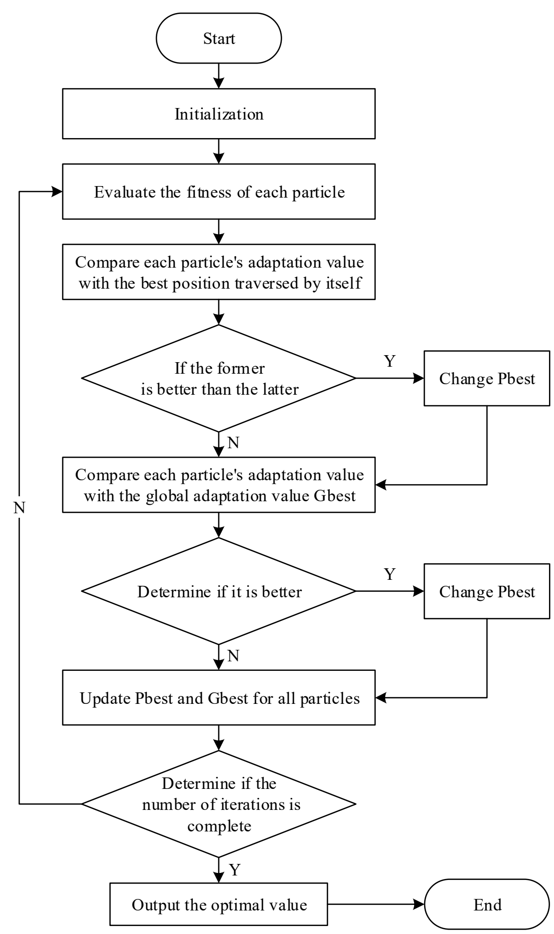

Fig. 2. The operation process of the PSO algorithm

3.1.2. SWC-PSO algorithm. Since the basic PSO algorithm has the disadvantages of low convergence accuracy and easy to fall into local extremes in the solution, the sorted weighted center of mass PSO algorithm (SWC-PSO) is proposed to address the disadvantages. The algorithm proposes the following improvement strategies: 1. Introduce the learning of population center of mass. 2. Use the weight coefficients as the learning factor of population center of mass. 3. The improved SWC-PSO theoretically has higher convergence speed and better stability.

The population center of mass is a virtual position concept, and this position can partially reflect the current evolutionary state of the particle population. It can be just the position of a particle in the particle population, or it can be a hypothetical position through some evaluation index [23].

The following calculation is given:

After the k st iteration, the position of the i nd particle of the population is obtained as $X(k)=\{X_1(k),X_2(k),\ldots,X_i(k),\cdots,X_n(k)\}$, which is brought into the objective function to find the fitness of the i th particle $Fit(X_i(k))$. The merit of the fitness reacts to the degree of merit of the particle in the solution space, but it cannot accurately describe the current evolution of the whole population. After introducing the concept of population center of mass, the current evolution of the particle population can be evaluated by the population center of mass. Meanwhile, after the completion of the k th iteration, the current fitness of each particle is ranked. The particle with the best fitness gets the highest weight, and the particle with the worst fitness gets the lowest weight. This weight is used to derive the sorted weighted center of mass:

$$Weight_i = BubbleSort(X(k)) \tag{10}$$

$$PC(k)=\sum_1^n Weight_i * X_i(K) \Big/ \sum_1^n i \tag{11}$$

$$\begin{aligned} V_i(k+1) &= V_i(k)+C_1*R_1*(pbest_i(k)-X_i(k)) \\ &+C_2*R_2(Gbest(k)-X_i(k))+W*R3*(PC(k)-X_i(k)) \end{aligned} \tag{12}$$

Weight in Eq. (10) denotes the weight obtained after the k st iteration when the adaptation corresponding to the i nd particle in the population is ranked in the set of adaptations of all particles in the population. In Eq. (11) $PC(k)$ calculates the value of the population center of mass based on the sorting results of the adaptive values of the 1st to N th particles in Eq. (10) as the contribution of the i th particle to the location of the population center of mass as a way to provide more information for guiding the evolution in the $k+1$th iteration. Therefore, when the adaptive value $Fit(X_i(k))$ of the i th particle is more optimal, its contribution to the position of the population center of mass will be greater, and its influence will be greater. The fourth term in Eq. (12): $W*R_3*(PC(k)-X_i(k))$ is the "population center of gravity" learning term, reflecting the learning and thinking of individual particles on the "current evolutionary situation of the population". Where: W is the weight coefficient. R_3 is a random number between 0 and 1.

3.1.3. Tax minimization strategy with PSO algorithm. PSO algorithm has its own advantages in solving multi-objective problems.

Firstly. the PSO algorithm can search for non-inferior solutions in parallel using an efficient swarm, and in each iteration, the PSO algorithm can produce multiple non-inferior solutions. Secondly, the memory function of particle swarm optimization algorithm makes the particles track the best solution in the swarm and their own optimal solution to search the search space, which makes the PSO algorithm have high computational efficiency and execution speed. What's more, the PSO algorithm does not rely on the functional characteristics of the problem and the form of the solution, so its application becomes very wide.

Minimizing the tax burden of a firm is a multi-objective optimization problem based on the firm's total income, non-taxable income, and deductions. The design of tax policy planning combined with the PSO algorithm, through which the PSO algorithm regulates the relationship between corporate profitability, tax policy and the amount of monthly tax payments, can keep the enterprise from excessive changes due to the business situation, and is also beneficial to improve the stability of the enterprise's operation and its ability to withstand risks.

In addition, the algorithm can adaptively adjust and optimize the enterprise's tax burden strategy for the current month based on a variety of tax standards, so that it can achieve the lowest total corporate income tax in a year in terms of the current month and the expected income for the whole year. This relies on the application of the PSO algorithm in solving multi-objective optimization problems.

3.2. Simulation Analysis

3.2.1. Comparison of the effect of minimization strategy implementation. Sampling the income data of 10 employees of an enterprise, according to the optimization of the tax burden program and calculation procedures provided in this paper, the optimal amount of tax after optimization of tax payment is calculated in Table 4.Using the WC-PSO algorithm of this paper for the calculation of the tax burden minimization program, the 10 employees can reduce the tax payment of a total of 23,250.5 yuan. According to this method for a unit of more than 200 employees personal income calculation, the results show that a total of 1,779,919,000 can reduce the number of tax payments, the entire enterprise can reduce taxes on millions of dollars. It is easy to see that the use of WC-PSO algorithm can be solved to minimize the tax burden strategy, which is of practical significance for enterprises to save operating costs.

Table 4. The actual tax amount of the employee and the optimization of the tax ratio table

Employee	Pre-tax income	Actual tax payment	Optimal tax payment
1	35828.1	2949.3	2017.9
2	144263.1	22458.8	19312.4
3	56770.3	5556.7	4396.6
4	112520.7	16075.9	13667.7
5	135434.9	20668.7	17540.2
6	129505.5	19505.4	16361.2
7	122353.0	18066.5	15287.7
8	98801.6	13430.9	10906.9
9	76538.6	8901.8	7308.4
10	96503.0	12888.7	10453.1

3.2.2. Case Study of Construction Project Costing under the Preferential Policy of Camp Reform. Taking the construction project as a real case, analyze the process of construction enterprises using the method of this paper to reduce the tax burden. The objective function constructed in this paper is as follows:

$$\begin{aligned} Mint &= 0.12e_1 + 0.031e_2 - 0.049e_{3a} \\ &-0.0183e_{3b} + 0.0768e_{3c} + 0.0482e_4 + 0.12e_5 \end{aligned} \tag{13}$$

This paper selects 10 groups of construction project bidding control price between April 2022 and April 2023, during this period of time in accordance with the 2013 construction project list pricing specification, Sichuan 2015 construction project list pricing quota compilation, the use of the business tax model, so the taxes in it are still business tax and surtaxes, the original data of construction project cost indexes are shown in Table 5.

Table 5. Construction cost index raw data

Cost	Labor	Mechanical	Material fee (tax rate)				Comprehensive	Others	Taxes
			A	B	C	Sum.			
1	22.32	1.87	43.76	0	8.99	52.76	4.18	8.51	3.29
2	12.02	5.12	13.36	0	52.04	65.40	2.43	8.66	3.27
3	21.84	1.57	44.42	0	9.47	53.88	4.06	8.27	3.28
4	12.13	14.46	18.60	0	35.67	54.19	3.05	8.63	3.38
5	13.50	22.75	15.16	0	26.02	41.13	3.95	11.10	3.28
6	21.48	2.42	41.23	0	12.75	53.91	4.02	8.54	3.29
7	19.78	2.28	40.98	0	14.95	55.90	3.70	8.55	3.37
8	12.51	4.74	34.32	0	29.79	64.09	2.77	8.66	3.37
9	18.41	2.20	48.52	0	7.52	56.00	3.76	10.36	3.29
10	25.78	2.11	42.15	0	13.79	55.98	4.51	-	3.35

The construction company has the lowest tax, i.e. the lowest amount of VAT is required. Since the tax in the original data refers to the original business tax and surtax, in the case of VAT, the business tax has been changed to VAT, which is shown in the project cost as output tax minus input tax, and the surtax is incorporated into the comprehensive fee. Combined with the algebraic meaning in the mathematical model, it is necessary to find the range of the proportion of each cost in the (including input tax without sales tax) project cost, so the proportion of each part of the cost divided by the total proportion of the value of the total proportion of the removal of the tax is adjusted to the proportion of each part of the cost.

Although the sales tax rate (3.35% in urban areas) is much lower than the VAT sales tax rate (11%), but in the calculation base of the VAT sales tax in the project cost of input tax is deducted, while the calculation base of the sales tax is not deducted from any cost, so here the impact of the difference between the amount of VAT sales tax and the amount of sales tax on the proportion of each cost is ignored, and the data are approximated. The data adjusted to obtain in 10 groups of actual projects, the proportion of each cost is shown in Table 6.

Table 6. Construction cost index adjusted data

Cost	Labor	Mechanical	Material fee (tax rate)				Comprehensive	Others	Taxes
			A	B	C	Sum.			
1	23.03	1.94	45.26	0	9.28	54.58	4.28	16.16	23.03
2	12.40	5.32	13.82	0	53.82	67.63	2.58	12.07	12.40
3	22.61	1.68	45.93	0	9.81	55.71	4.20	15.89	22.61
4	12.57	14.96	19.21	0	36.89	56.13	3.11	13.22	12.57
5	13.95	23.53	15.63	0	26.95	42.57	4.06	15.87	13.95
6	22.25	2.52	42.60	0	13.16	55.76	4.15	15.27	22.25
7	20.49	2.35	42.40	0	15.44	57.81	3.82	15.47	20.49
8	12.96	4.94	35.49	0	30.79	66.34	2.90	12.91	12.96
9	19.05	2.29	50.19	0	7.75	57.96	3.89	16.83	19.05
10	26.69	2.16	43.65	0	14.27	57.95	4.67	8.55	26.69

According to the WC-PSO algorithm, the coefficients of the respective variables and constraint values in the objective function and constraints are first substituted into the algorithm to obtain the optimal solution that satisfies the conditions. When $X = [11\%, 24\%, 53\%, 1\%, 4\%, 3\%, 4\%]$, the objective function reaches the minimum value of t = 0.42%.

In the optimal solution, the labor and machinery costs account for about 36%, while the material costs account for 55.6%, which is a reasonable proportion according to the empirical judgment of the project cost, at which time the value-added tax (VAT) rate is only 0.42%, which is much smaller than the original sales tax rate of 3.35%.

Through the descriptive statistical analysis of Table 6, the median of each variable is substituted into equation (13) to calculate the VAT rate as $Mint = 0.12e_1 + 0.031e_2 - 0.049e_{3a} - 0.0183e_{3b} + 0.0768e_{3c} + 0.0482e_4 + 0.12e_5$ According to the calculation results, it can be seen that the VAT rate is still smaller than the original business tax rate of 3.18%, and this indirectly shows that the implementation of the VAT policy for the enterprise to reduce the tax and reduce the burden is possible.

4. Conclusion

Using double difference model regression analysis and the improved SWC-PSO algorithm, this paper verifies the role of tax incentives in reducing corporate tax burden and provides a mathematical planning method that can be used to reduce corporate tax burden. The regression coefficients reflecting the corporate tax burden are significantly negative at the 1% level after controlling for tax policy, nature of the enterprise, year fixed effects, and enterprise fixed effects. Before the implementation of tax incentives, there is no significant difference in the level of tax burden among the sample firms. And the tax burden of enterprises receiving tax incentives has a significant downward trend of change, and the proportion of investment in fixed assets and return on assets have also increased significantly.

The simulation case shows that after utilizing SWC-PSO for tax burden planning, a total of 1,779,919,000 yuan of tax relief was granted to a unit, and the business tax rate of a construction project decreased from 3.35% to 0.42%. The above conclusions are sufficient to prove that the improved tax-enabling strategy planning method in this paper can rely on tax optimization policies to further help enterprises save tax expenditure and improve the quality of operation.

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