



Research on the Game Decision of Enterprise Investment and Government Tax Revenue Based on Equilibrium Model Analysis

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Abstract. Government intervention is prevalent in developing countries, with fiscal expenditures continuously increasing and the burden of government debt constantly growing. "Taxation" intervention focuses on production scale and short-term profits, especially as the traditional extensive growth model still plays a role in investment areas. Extensive investments characterized by repetitive construction and low-level investment continue to exert inertia on macroeconomic growth, making it difficult for the economy to stabilize in the short term without relying on extensive investment. Taxation on both operating income and profits, with a higher proportion on operating income, and accompany by incentivizes local governments to encourage enterprises to expand production scale investments. When the government has strong intervention capabilities over enterprises, it may lead to excessive investment. Although such investments may not significantly impact long-term corporate profits, the governments reduced focus on enterprise profits and increased tax expenditures might be a natural outcome of excessive investment .nearly years, it is rather than a result of active government interference. This paper analyzes the decision-making models of enterprise investment and government taxation through game theory, focusing on equilibrium analysis and extended equilibrium analysis. Both government intervention and managerial self-interest are constrained by legal conditions and corporate governance, maintaining reasonable levels without compromising the goal of maximizing shareholder interests. The equilibrium analysis is divided into two parts,part one is the ideal state, and part two is the imperfect state, but it is closer to the real state. In the ideal state, corporate investment aims for long-term growth in shareholder returns. In the imperfect state, corporate investment seeks long-term expansion (maximizing government VAT revenue) and current profit growth (maximizing management interests). The overall conclusion is that both the government and corporate management should encourage companies to reduce inefficient investments rather than cut investments altogether.

Keywords: enterprise investment, government tax, game decision-making model, equilibrium analysis of model

1 Introduction

Government intervention is widespread in developing countries, some interventions aim to achieve economic catch-up strategies, while others serve the private interests of government leaders. In cases where local government governance fails, government decisions are often swayed by top leaders, potentially deviating from the goal of maximizing social welfare and instead serving leadership promotions (Zhou Lianan, 2007). This manifests in investment as government-induced overinvestment and short-term behavior, leading to excess capacity and increased pollution (Xu Yekun and Ma Guangyuan, 2019; Xi Penghui et al., 2017). When economic growth slows or faces significant sudden shocks (such as the COVID-19 pandemic), government leaders bear the arduous task of "ensuring basic living standards, securing wages, and maintaining operations," while also considering their own career advancement. Therefore, they may expect companies to increase investment to boost GDP growth and tax revenues. On the other hand, if the local business environment is favorable and corporate governance structures are sound, capable of effectively protecting shareholder interests, companies can resist improper government intervention. However, if corporate governance structures are inadequate and there is a situation where actual controllers align with government wishes, companies will find it difficult to withstand government pressure and may have no choice but to comply (Xin Qingquan et al., 2007). From a micro perspective of corporate behavior regarding tax administration The effect of tax administration on corporate R&D investment was tested. The results show that tax administration has an incentive effect on corporate R&D investment, although this positive impact is not significant. Further consideration of the combined influence of internal corporate characteristics and external institutional environment reveals that compared to state-owned enterprises, the positive impact of tax administration on corporate innovation activities is more pronounced in non-state-owned enterprises. In regions with lower levels of local government intervention, the inhibitory effect of tax administration on corporate R&D investment also weakens accordingly. Fiscal vertical imbalance not only directly affects capital misallocation but also indirectly influences it through local government tax efforts. That is, as the degree of fiscal vertical imbalance increases, local government tax efforts decrease, which in turn distorts the efficiency of capital allocation.

In fact, as fiscal expenditures continue to rise and the governments debt burden grows heavier, "taxation" intervention is aimed at pursuing production scale and short-term profits. Especially when the traditional extensive growth model still plays a role in investment, extensive investments characterized by repetitive construction and low-level investment continue to exert inertia on macroeconomic growth. This makes it difficult for stable economic growth to break free from reliance on extensive investments in the short term.

2 Internal and external constraints on enterprise investment decisions and effect on income statement

Taxing both operating income and profits, with a higher proportion of operating income, motivates local governments to encourage companies to expand production scale investments. When the government has strong intervention capabilities over businesses, it may lead to excessive investment. Although such investments might not significantly impact long-term corporate profits, the reduced focus on corporate profits and increased tax expenditures could be a natural consequence of excessive investment in the current year, rather than a result of active government intervention. However, in recent years, influenced by various factors, China's fixed asset investment growth rate has noticeably slowed down, with the decline in productive investment being even more pronounced. While international experience suggests that an excessively large investment volume naturally requires adjustment, the rapid decline in productive investment clearly does not align with China's strategic requirements for industrial upgrading and transformation of economic growth patterns. Excessive investment often leads to overinvestment. However, in financial economics, the mathematical description of the relationship between government taxation and corporate investment is as follows:

1. In the perfect ideal state, the government representing the public and the enterprise representing the shareholders will negotiate to determine the equilibrium tax burden for the consideration of long-term economic growth, social welfare increase and corporate value. This tax burden can realize the balance between public interest and shareholder interest.

2. In the case of agency problem of government, in order to satisfy private interests and obtain more current tax revenue, government representatives will urge enterprises to increase investment, but they should not give too much pressure, otherwise enterprises will flee the local area.

3. When the government is less constrained by external constraints and the enterprise has a high migration cost, the government will force the enterprise to increase investment.

4. When the government is less constrained, but the enterprise has a perfect corporate governance and the law provides good protection for the enterprise. The enterprise can resist the pressure of the government and do not invest too much.

5. When government actions are subject to certain constraints and corporate governance is inadequate, the actual controllers of both the government and enterprises will engage in dynamic negotiations until they reach an agreement, leading to an equilibrium solution. At this point, the short-term interests of both the government and the actual controllers are maximized, but the public interest and the interests of corporate shareholders cannot be guaranteed.

This study focuses on corporate investment issues under the dual failures of government and corporate governance. Without considering bank loans, this is a multi-party game involving four main parties: the public, the government, shareholders, and management. The primary points of contention are short-term and long-term interests. In reality, shareholder interests and those of management are not entirely separate, nor

are government interests and public interests. The actual game dynamics are not so clearly defined. Considering the relationships among these four roles in an imperfect state. Along with two additional variables, we then discuss the strategies of each party. At its core, it is about the companys investment decisions. To enhance the game dynamics of the model, we introduce the assumption that "the government does not levy income tax on the portion of corporate profits used for fixed asset investments," revising and rederiving the model. We also add analysis for less ideal scenarios, introducing constraints from social laws and corporate governance to examine the decision-making strategies of the government and management under fewer constraints.

The balanced analysis is divided into two parts. The first part discusses equilibrium under perfect conditions, which is a long-term equilibrium. In the long run, it benefits both corporate development and social welfare. The second part addresses equilibrium under imperfect conditions, meaning equilibrium in real-world scenarios. This type of equilibrium is short-term and aims to maximize the interests of enterprises and the government. Government leaders seek promotions, while management teams demand bonuses, so they all push for maximum current tax revenue and profits. At the same time, once production capacity is established, it generates a long-term growth effect. This growth primarily manifests as an increase in sales revenue, but this long-term growth also aligns with government interests. However, it does not bring more profit to shareholders, making this state an imperfect one. In reality, investment has become a function of maximizing government tax revenue and managerial gains, while shareholder interests have become less important. The primary safeguard for shareholder interests is ensuring that the companys profits remain positive and prevent delisting, as small shareholders would not tolerate such outcomes. Now, regarding shareholder interests, the requirement that the net profit of an enterprise must be positive in the current year has also been broken. So some loss-making companies do not even need to delist, so we can not discuss the factors of delisting here. That is, the cost of enterprise migration still needs to be considered.

3 A mathematical description of the relationship between government taxation and business investment

1. Game decision model of enterprise investment and government tax revenue

. Generally, the government taxes both the operating income and profits of enterprises. To simplify the model, it is assumed that the government only levies value-added tax and income tax on enterprises, with rates denoted as τ_a and τ_b , respectively. The government does not impose income tax on the portion of enterprise profits used for fixed asset investment. Considering the three-period investment decision model of an enterprise, the specific variables are defined as:

(1) At time T_0 , it is assumed that the enterprise only uses the current profit for re-investment, the current operating income is Y_0 , the pre-tax profit is R_0 , the cost of the enterprises relocation is Q_0 , the investment strategy is fixed asset investment I_0 , and the current earnings attributable to the shareholders of the enterprise are D_0 ;

(2) At time T1, the current operating income is Y1, the pre-tax profit is R1, the cost of enterprise relocation rises to Q1, the government and management of the enterprise promote the enterprise to continue to increase investment with the current profit, the enterprises fixed asset investment is I1, and the current earnings attributable to shareholders of the enterprise are D1;

(3) At time T2, the current operating income Y2 of the enterprise is R2, the pre-tax profit is R2, the cost of relocation rises to Q2, and the current earnings of shareholders belong to the enterprise D2;

The investment of the enterprise in T0 and T1 periods will generate actual operating income and profit in T2 period. Let the corresponding operating income function be F1 (x) and F2 (x), and the corresponding profit income function be f1 (x) and f2 (x), and satisfy:

$$F1(x) > 0, F1(x) < 0, F1(x) > 0$$

$$F2(x) > 0, F2(x) < 0, F2(x) > 0$$

$$f1(x) > 0, f1(x) < 0, f1(x) > 0$$

$$f2(x) > 0, f2(x) < 0, f2(x) > 0$$

Investment constraints for enterprises

$$D0 = (R0 - I0)(1 - \tau_b) \geq 0$$

$$D1 = (R1 - I1)(1 - \tau_b) \geq 0$$

$$D2 = (f1(I0) + f2(I1) + R2)(1 - \tau_b) \geq 0$$

$$\text{Tax constraints: } Y0\tau_a + (R0 - I0)\tau_b \leq Q0, \quad Y1\tau_a + (R1 - I1)\tau_b \leq Q1, \\ (F1(I0) + F2(I1) + Y2)\tau_a + (f1(I0) + f2(I1) + R2)\tau_b \leq Q2$$

remember

$$Y = \sum_{i=0}^2 Y_i$$

$$R = \sum_{i=0}^2 R_i$$

The total tax revenue of the third phase of the government is:

$$\varphi = (Y + F_1(I_0) + F_2(I_1))\tau_a + (R + f_1(I_0) + f_2(I_1) - I_0 - I_1)\tau_b$$

The total profit attributable to shareholders of the enterprise is:

$$\rho = \sum_{i=0}^2 D_i = (f_1(I_0) + f_2(I_1) + R - I_0 - I_1)(1 - \tau_b)$$

From the perspective of enterprises, when the corporate governance system is sound, enterprises invest to maximize the interests of shareholders, and its objective function is

$$\max_{\{I_0, I_1\}} \rho$$

From the governments point of view, the government pursues the maximization of total tax revenue, and its objective function is

$$\max_{\{\tau_a, \tau_b\}} \varphi$$

2. Model equilibrium analysis

(1) Ideal state equilibrium analysis

(a) Corporate investment decisions

For enterprises with a relatively perfect corporate governance system, their operating income and operating profit can be assumed to grow steadily

$$R = (1 + r)^2 R_0$$

0. To time corporate investment decisions are influenced by the government, shareholders, and management. Shareholders demand continuous profit growth, the government requires long-term tax revenue growth, and management aims to maximize individual returns. T0 and T1 times when expanding investments. At this point:

$$D_0 = D_1 = 0$$

get

$$R_0 = I_0$$

$$I_1 = R_1 = R_0(1 + r) = I_0(1 + r)$$

The total profit attributable to shareholders of the enterprise is:

$$\rho = (f_1(I_0) + f_2(I_0(1 + r)) + R - I_0 - I_0(1 + r))(1 - \tau_b)$$

$$= (f_1(I_0) + f_2(I_0(1 + r)) + I_0(1 + r)^2)(1 - \tau_b)$$

For the above formula

I₀ About the partial derivative, the investment decision conditions of the enterprise are as follows:

$$f_1(I_0) + (1 + r)f_2(I_0(1 + r)) + (1 + r)^2 = 0$$

Therefore, when companies make decisions to expand investment, they need to weigh the expected marginal returns of investments at time T0 and T1, as well as the expected government tax policies. Given that the investment revenue functions F1(x) and F2(x) are determined, companies can reduce operating costs by improving corporate governance systems, thereby enhancing investment profits f1(x) and f2(x). When government tax policies are reasonable, companies will consider long-term value growth and formulate appropriate expansion strategies to achieve a balance between shareholder interests and government taxation.

(b) Government tax decisions

As you can see, ρ is about government tax policy

τ_b A and τ_b The linear function of b, whose optimal decision is on the boundary.

When the government is less constrained, the government representatives will try their best to increase the tax burden in order to satisfy their private interests and obtain more tax revenue, and at the same time, they will try their best to encourage enterprises to expand investment through administrative means. At this time, the governments tax revenue is too high, which greatly squeezes the profits of enterprises, and the profits of shareholders belong to enterprises are zero

$$D_0 = D_1 = D_2 = 0$$

get

$$\tau_b = 1$$

It can be seen that the government will set tax strategies according to the business operation and investment expectations of enterprises, which greatly squeezes the profits of enterprises. At this time, the government can get more tax revenue, but

when the tax paid by enterprises exceeds the cost of enterprise migration, it may encourage enterprises to flee from the local area.

For the indirect tax rate strategy, consider the migration cost constraints

$$\tau_a = \min \left\{ \frac{Q_0 + I_0 - R_0}{Y_0 + I_0}, \frac{Q_1 + I_1 - R_1}{Y_1 + I_1}, \frac{Q_2 - f_1(I_0) - f_2(I_1) - R_2}{F_1(I_0) + F_2(I_1) + Y_2} \right\}$$

The total government revenue at this time is:

$$\varphi = (Y(r) + F_1(I_0) + F_2(I_1) + I_0 + I_1)\tau_a + R(r) + f_1(I_0) + f_2(I_0) - I_0 - I_1$$

It can be seen that the total government revenue is positively correlated with corporate investment and operating income, as well as the cost of business relocation. For companies, the cost of relocating mainly consists of direct costs such as duplicate investments in different locations and opportunity costs like destination tax policies, expected revenue, and operating costs. When government actions are subject to certain constraints, policymakers focus more on long-term taxation. The government can adjust competitive tax policies and improve the business environment to reduce the opportunity costs for companies to relocate, thereby increasing long-term tax revenues.

In order to ensure tax revenue, the government will improve the business environment through administrative means to improve the expected return on investment

of enterprises $F_1(I_0), F_2(I_1)$ $\left(\begin{matrix} 1. \text{For enterprises, they will also pay more attention} \\ \text{to the expected income brought by current investment.} \end{matrix} \right)$

(2) Extended equilibrium analysis

In reality, government actions are subject to public scrutiny, and corporate managements investment decisions can be influenced by shareholders. To consider the constraints between the government and the public, corporate management, and shareholders, we introduce social legal constraints l_1 and corporate governance constraints l_2 , ensuring that $l_1, l_2 \in [0,1]$. For corporate management, the pursuit of maximizing short-term benefits is paramount; however, for shareholders, long-term growth benefits align more closely with their interests. Therefore, under the premise of corporate governance constraints, the goal profit function of corporate management can be defined as follows

$$\rho = l_1 D_0 + (1 - l_1) \sum_{i=1}^2 D_i$$

Under corporate governance constraints, management cannot solely pursue maximizing short-term benefits. It must balance current performance with long-term growth. Similarly, government officials, under pressure from term evaluations, tend to focus more on current tax revenues, while the public hopes for sustained social income growth. The objective function of government decision-making can be defined as

$$\varphi = l_2((Y_0 + I_0)\tau_a + (R_0 - I_0)\tau_b) + (1 - l_2)((F_1(I_0) + F_2(I_1) + Y_1 + Y_2 + I_1)\tau_a + (f_1(I_0) + f_2(I_1) + R_1 + R_2 - I_1)\tau_b)$$

When the social legal system is sound and corporate governance is sound,

$l_1 = l_2 = 0.5$, at this time, the short – term benefit and long – term benefit of the enterprises target profit function are balanced, and the short – term benefit and long – term benefit of the governments decision – making target function are balanced, which is the ideal situation discussed in the ;

When the social legal conditions are not perfect and the government is less constrained, that is l_1 About 1 o'clock, there is

$$\begin{aligned} \varphi &= (Y_0 + I_0)\tau_a + (R_0 - I_0)\tau_b \\ &= Y_0\tau_a + R_0\tau_b + (\tau_a - \tau_b)I_0 \end{aligned}$$

Under the constraint of enterprise migration cost, the optimal government tax policy is satisfied

$$\tau_b = \frac{Q_0 - (Y_0 + I_0)\tau_a}{R_0 - I_0} \quad \begin{array}{l} \text{When the enterprise governance system is} \\ \text{not stable, the management of enterprises is less constrained, that is} \end{array} l_2$$

About 1 o'clock, there is

$$\rho = l_1 D_0 = (R_0 - I_0)(1 - \tau_b)$$

Current fixed asset investment of the enterprise

l_1 The relationship between 0 and enterprise income is negative.

$$I_0 = 0$$

From the above analysis, it can be seen that when government representatives and management have fewer constraints. They will only pursue current profit performance and maximize immediate gains, without actively expanding fixed asset investment. However, when the government gains tax benefits from corporate investment activities, government representatives will actively support increased fixed asset investment by enterprises. This game between the two parties achieves a decision equilibrium for both government representatives and management. In the long term, this equilibrium will harm the long-term interests of the public and shareholders. The public and shareholders need to promote social legal systems and corporate governance to continuously constrain government agents and management, ensuring stable growth in corporate value and social welfare.

4 Summary and Discussion

The above equilibrium analysis indicates that government intervention and managerial self-interest are constrained by legal conditions. And corporate governance, remaining at a reasonable level without compromising the goal of maximizing shareholder interests. Equilibrium analysis can be divided into two parts: one is the ideal state, and the other is an imperfect state, which is closer to reality. In the ideal state, corporate investment aims for long-term growth in shareholder returns. In the imperfect state, corporate investment seeks long-term expansion (maximizing government VAT revenue) and current profit growth (maximizing managerial benefits). Overall,

the conclusion is that the government and management stimulate companies to reduce inefficient expansion rather than decrease investment altogether.

Reference

1. Sun Ying. Research on the Impact of Tax Administration on Corporate R&D Investment - The Moderating Effect of Property Rights Nature and Government Intervention [J]. Journal of Shanghai Institute of Economic Management, 2021,19(05):41-53.DOI:10.19702/j.cnki.jsemc.2021.05.005.
2. Zhao Na, Li Guangqin, Li Xiangju. Fiscal vertical imbalance, local government tax efforts and capital mismatch [J]. Journal of Hunan University (Social Sciences Edition), 2020,34(06):83-91.DOI:10.16339/j.cnki.hdxbskb.2020.06.011.
3. Xi Penghui. Fiscal Incentives, Environmental Preferences and Vertical Environmental Management —— The Perspective of Bargaining Power of Taxpayers [J]. China Industrial Economics, 2017,(11):100-117.DOI:10.19581/j.cnki.ciejournal.2017.11.009.
4. Xin Qingquan, Lin Bin, Yang Deming. Estimation and Analysis of Factors Affecting the Return on Capital Investment in China —— Experience of Listed Companies from 1999 to 2004 [C]// Journal of Economics (Quarterly), Vol. 6, No.4 (Total Issue No.26). School of Economics and Business Administration, Chongqing University; School of Management, Sun Yat-sen University; School of Business Administration, South China University of Technology, 2007:22.
5. Bai Xuyun, Wang Yanyu, Su Xin. The Impact of R&D Subsidies or Tax Incentives on Government Intervention and Innovation Performance and Quality of Enterprises [J]. Scientific Research Management, 2019,40(06):9-18.DOI:10.19571/j.cnki.1000-2995.2019.06.002.
6. Tang Anbao and Liu Jiao. Environmental Uncertainty, Tax Incentive Policy and Investment Efficiency —— A Study Based on Renewable Energy Enterprises [J]. Industrial Technology Economics, 2019,38(05):79-88.
7. Lou Qinghao. Governance of Local Tax Preferential Policies under the Perspective of Competitive Neutrality [J]. Journal of Anhui Institute of Commerce (Social Sciences Edition), 2019,18(01):45-49.DOI:10.13685/j.cnki.abc.000393.
8. Sun Gang. Research on the Efficiency of Capital Investment of Listed Enterprises in Tax Collection and Administration —— Preliminary Evidence from Local Government Violations of Tax Preferences or Returns [J]. Journal of Central University of Finance and Economics, 2017, (11): 3-17.
9. Bai Chongen, Ma Lin. Government intervention, optimal taxation and structural adjustment [J]. Taxation Research, 2015,(06):46-50.DOI:10.19376/j.cnki.cn11-1011/f.2015.06.011.
10. Zhou Li an. Study on the Promotion Championship Model of Local Officials in China [J]. Economic Research, 2007, (07): 36-50.
11. Xu Yekun and Ma Shuiguang. Local official change and enterprise overcapacity [J]. Economic Research, 2019,54(05):129-145.
12. Jiangyi Lv, Linna Li, Jing Zhao, etc. ,Simulation Machine Learning Algorithm on Efficiency Investment Systems Based on Game Decision Model Function ,2nd Annual International Conference on Computer Science and Automation Technology,[CSAT2024]October 25-27, 2024, Shanghai, China .

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