

A Comparative Study on Welfare Losses of Specific Duties and Ad Valorem Duties in Monopolistic Markets

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Abstract. Based on the establishment of a monopoly market model, this paper conducts a comparative analysis of the welfare effects of specific tax and AD valorem tax policies. The findings show that in a monopoly market, specific taxes and AD valorem taxes have different effects on market equilibrium, consumer surplus, producer surplus, and total social welfare. By studying monopolistic markets described by linear demand functions and cost functions, we explore the pricing, output and welfare loss of monopolistic enterprises under two tax systems. The results show that the specific tax, which is a fixed unit tax rate, directly increases marginal costs, thus resulting in a small increase in monopoly prices but a significant decrease in output. AD valorem taxes, which are levied proportionally, indirectly affect pricing, and the extent of their welfare loss depends on the rate of tax and the elasticity of demand. In general, AD valorem taxes cause less unnecessary loss than specific taxes because AD valorem taxes have a certain self-regulating function, which to some extent can mitigate the adverse effects of monopoly pricing on social welfare. But when the elasticity of market demand is low or the degree of monopoly is high, the gap in welfare loss between the two will be smaller. In addition, this paper also analyzes issues such as tax revenue, administrative costs, and the possibility of policy implementation, and argues that AD valorem tax has certain advantages in terms of the stability of tax revenue and the effectiveness of anti-monopoly, but there are also problems in terms of collection costs and regulatory difficulty. Therefore, the findings of this study provide some reference value for the government in formulating tax policies in monopolistic industries. It is recommended to choose appropriate tax methods based on the characteristics of different industries, market conditions and policy goals to achieve the greatest social benefits.

Keywords: Specific taxation; AD valorem tax; Monopoly market; Loss of benefits; Unnecessary loss.

1. Introduction

In today's market economy, monopolies are more common in industries such as telecommunications, energy, and public utilities, and the characteristics of these industries determine that government tax policies have a greater impact on social welfare. According to the National Bureau of Statistics, the CR4 index of market concentration in China's telecommunications industry has remained above 85% from 2019 to 2023, and in the energy industry, the market concentration in the oil and gas extraction industry is also relatively high. These monopolistic or oligopolistic industries pay a large portion of the national fiscal revenue. Taxation is one of the important means by which the government regulates the market, and the choice of its tax collection method directly affects market efficiency and social welfare. Specific taxes and AD valorem taxes are two major forms of taxation that have significant differences in their mechanisms of action and welfare effects in monopolistic markets. Therefore, a comparative study of the welfare losses of these two tax systems in monopolistic markets is of great theoretical and practical significance. At present, academic research on monopoly market tax policies mainly focuses on the effects of one tax type, lacking comparative studies of welfare losses in monopolistic markets by specific taxes and AD valorem taxes. This paper attempts to establish a reasonable theoretical model to explore the transmission paths, equilibrium conditions and welfare effects of the two tax systems in monopolistic markets, thereby providing a reference for the government's choice of tax policies in monopolistic industries [1].

2. The Theoretical Basis and Tax Mechanism Analysis of Monopoly Markets

2.1. Basic Characteristics and Equilibrium Conditions of Monopoly Markets

A monopoly market is an extreme form of market with only one seller, high barriers to entry, no substitutes for the product, and the monopolist has pricing power. In a monopoly market, businesses are faced with a demand curve that slopes down to the right and can make excess profits by changing prices by altering supply. The monopolist maximizes profits under the condition that marginal revenue equals marginal cost, $MR=MC$, which is fundamentally different from the equilibrium condition in a perfectly competitive market where price equals marginal cost. The market failure caused by monopolistic equilibrium is mainly reflected in the production being lower than the socially optimal level and the price being higher than the marginal cost, resulting in unnecessary losses. From the perspective of China's telecommunications industry, the average profit margin of mobile communication services remained at 15%-20% between 2020 and 2023, far exceeding the average level of most competitive industries, indicating the adverse effects of monopolistic pricing on consumers. These characteristics of monopolistic markets determine that the way tax policies are transmitted in this market structure is very different from that in competitive markets, and the extent of tax transfer, price changes, and the impact on social welfare all need to be reconsidered [2].

2.2. From the Mechanism of Action and Transmission Path of Quantitative Taxation

A specific tax is a type of tax levied based on physical units such as quantity, weight, and volume of goods. Its most significant feature is that the tax amount is fixed and does not change due to changes in the price of the goods. In a monopoly market, a specific tax affects the pricing and production decisions of the monopoly by increasing the marginal cost of the enterprise. When the government imposes a specific tax on a monopoly, the marginal cost curve of the enterprise shifts upward to the right by a distance of unit specific tax. Monopolies need to redetermine their output and price in order to maintain the profit-maximizing principle that marginal revenue equals marginal cost. The transmission process of quantity-tax is relatively simple and straightforward, and its impact on monopolistic behavior can be well explained by standard microeconomic theory. Take China's tobacco industry as an example. This industry implements a combination of specific and AD valorem taxes, with the specific portion being 150 yuan per article in 2019 and adjusted to 170 yuan per article in 2023, which has led to significant changes in both the price and sales volume of tobacco products [3]. The advantage of specific taxation is that it is convenient to collect and the tax revenue is relatively stable and not affected by price fluctuations. However, the disadvantage is that it has no automatic adjustment function and cannot automatically adjust the tax burden according to inflation or changes in market conditions, which may cause the problem of tax policy lag.

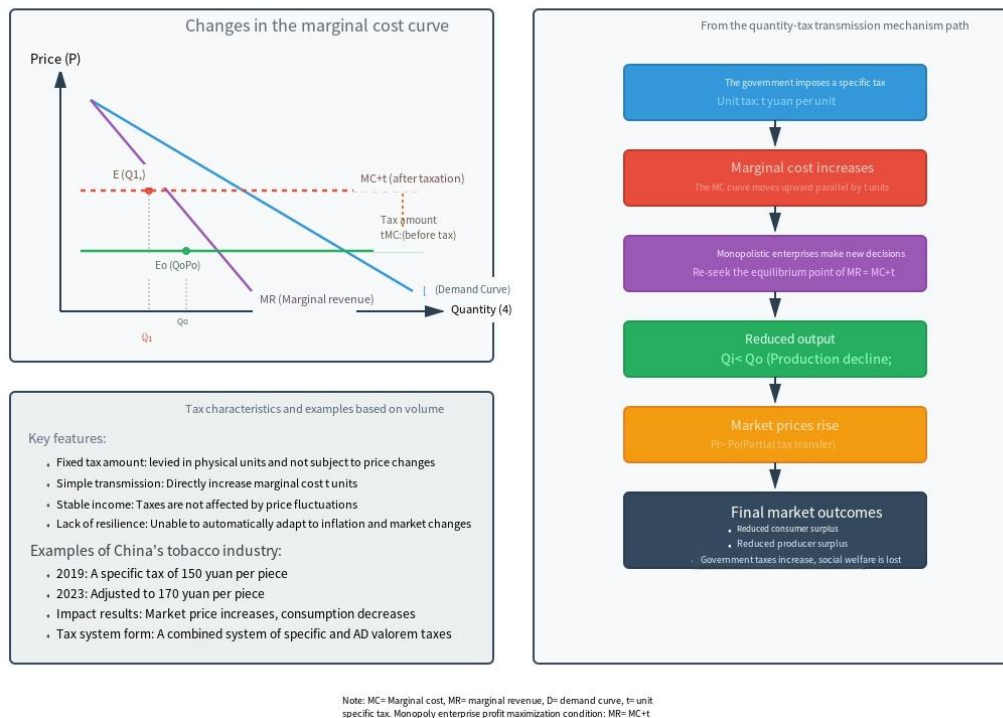


Figure 1. Mechanism and Transmission Path of specific taxes in monopolistic markets

2.3. Mechanism and Transmission of AD Valorem Taxes

An AD valorem tax is a tax levied on a certain proportion of the value or price of a commodity. The tax amount varies with the price of the commodity and has the function of automatic adjustment. In monopolistic markets, the mechanism of the AD valorem tax is more complex. On the one hand, it affects the cost structure of enterprises; on the other hand, it has a feedback effect due to the interaction between the tax rate and the price. If an AD valorem tax is imposed on monopolistic enterprises, the actual marginal cost faced by the enterprises is the original marginal cost multiplied by the tax rate adjustment coefficient. This multiplier effect leads to the impact of the AD valorem tax on monopoly pricing being nonlinear. The transmission path of AD valorem tax is dynamic, and there is a mutually reinforcing or mutually restrictive relationship between the tax burden and the product price, which to some extent can play a role in curbing the arbitrary price increase of monopoly enterprises. From 2020 to 2023, China's value-added tax (VAT) revenue accounted for around 35% to 40% of total tax revenue, and as a typical AD valorem tax, VAT has played a positive role in regulating market prices and maintaining fair market competition [4]. The advantage of AD valorem tax is its progressive nature, which can better reflect the principle of tax fairness, and it also has the function of an automatic stabilizer. However, the cost of collection and administration is higher, and the requirements for tax authorities are also higher. In some monopolistic industries, problems such as difficulty in determining the tax base may be encountered.

3. Construction of the Welfare Effect Model of Specific Taxes and AD Valorem Taxes in Monopolistic Markets

3.1. Model of Welfare Loss of AD Valorem Taxes in Monopoly Markets

In a monopolistic market, a specific tax welfare loss model is established. It is assumed that the monopolistic enterprise is confronted with a linear demand function $P=a-bQ$, where P is the price, Q is the output, and a and b are positive numbers. The marginal cost of the enterprise is a constant c , and after the unit specific tax t is imposed, the marginal cost of the enterprise becomes $c+t$. The condition for a monopoly to maximize profits is that the marginal revenue is equal to the adjusted

marginal cost, that is, $MR=MC+t$. Since marginal revenue $MR=a-2bQ$, the equilibrium condition is $a-2bQ=c+t$, the equilibrium output after tax $Q_1=(a-c-t)/(2b)$, and the corresponding equilibrium price $P_1=(a+c+t)/2$. Without taxing zero equilibrium output $Q = (a - c)/(2 b)$, P zero price $= (a + c) / 2$, from the amount of tax to reduce production $t/(2 b)$, prices have risen by $t / 2$ [5]. The unnecessary loss caused by specific taxation can be expressed by the change in consumer surplus and producer surplus before and after taxation. A reduction in consumer surplus was $b (Q \text{ zero squared} - Q_1 \text{ squared}) / 2 + (P_1 - P \text{ zero}) Q_1$, producer surplus is reduced $(P_0 - c) Q_0 - (P_1 - c - t) Q_1$. Tax revenue is tQ_1 , and the total social welfare loss, that is, the unnecessary loss, is the sum of the reduction in consumer surplus and producer surplus minus tax revenue. The unnecessary loss of the specific tax $DWL_1=t^2/(4b)$ indicates that the unnecessary loss is proportional to the square of the tax rate and inversely proportional to the slope parameter b of the demand curve, reflecting the impact of the specific tax on market efficiency.

3.2. A model of Welfare Loss for AD Valorem Tax in A Monopoly Market

For the AD valo welfare loss model, assuming the tax rate is τ , the monopoly firm is required to pay taxes in proportion to τ of sales revenue. In this case, the firm 's actual revenue is $(1-\tau)PQ$, marginal revenue is $(1-\tau)(a-2bQ)$, and the monopoly firm' s profit maximization condition is that the adjusted marginal revenue is equal to the marginal cost, that is, $(1-\tau)(a-2bQ)=c$ Solving for AD valorem tax yields the equilibrium output $Q_2=(1-\tau)(a-c/[1-\tau])/(2b)$, and the equilibrium price $P_2=(a+(c/[1-\tau]))/(2)$. Compared with AD valorem tax, the price transmission mechanism of AD valorem tax is different. The increase in price depends not only on the level of the tax rate, but also on the original cost and demand parameters. The change in output caused by AD valorem tax is Q_0-Q_2 , and the change in price is P_2-P_0 . Similarly, using the welfare analysis method, the unnecessary loss DWL_2 caused by AD valorem tax can be obtained. Because the mechanism of action of AD valorem tax is the interaction between price and tax burden, its unnecessary loss is more complex and takes into account factors such as tax rate, demand elasticity and cost structure. The AD valorem tax loss is different from the specific tax loss. It is related not only to the tax rate but also to the market price level and demand characteristics, which reflects the different regulatory effects of the two tax systems on monopolistic markets. The study found that under the same tax revenue, the AD valorem tax generally generates a smaller loss, but the specific magnitude depends on the market parameters and the tax rate.

3.3. Comparison of Equilibrium Price and Output Under The Two Tax Systems

By comparing the equilibrium results of specific taxes and AD valorem taxes in monopolistic markets, it can be seen that there are significant differences between the two tax systems in terms of price transmission and output change [6]. For a specific tax, the increase in price is half the amount of tax, and this fixed proportion of price transmission makes the effect of the specific tax easier to grasp. In the case of AD valorem tax, however, the increase in price depends on factors such as the tax rate, marginal cost, and demand parameters, and is nonlinear. When comparing output under the two tax systems, the comparison should be made on the premise that the tax revenue is the same. Assuming that the two tax systems generate the same tax revenue R , then $tQ_1=\tau P_2Q_2$ can be used to compare the efficiency of the two tax systems under the same fiscal revenue. Generally speaking, under AD valorem tax, the output is higher and the price increase is smaller. This is because AD valorem tax itself has a certain price regulation effect and can prevent monopolistic enterprises from overpricing to a certain extent. However, this is not an absolute case, and the gap between the two tax systems will narrow in situations where demand elasticity is low or monopoly is high[7]. And in the long term, AD valorem tax has the ability to self-regulate and adjust in response to changes in economic conditions and price levels, which AD valorem tax cannot do, which can easily lead to a disconnection between tax policy and the actual situation.

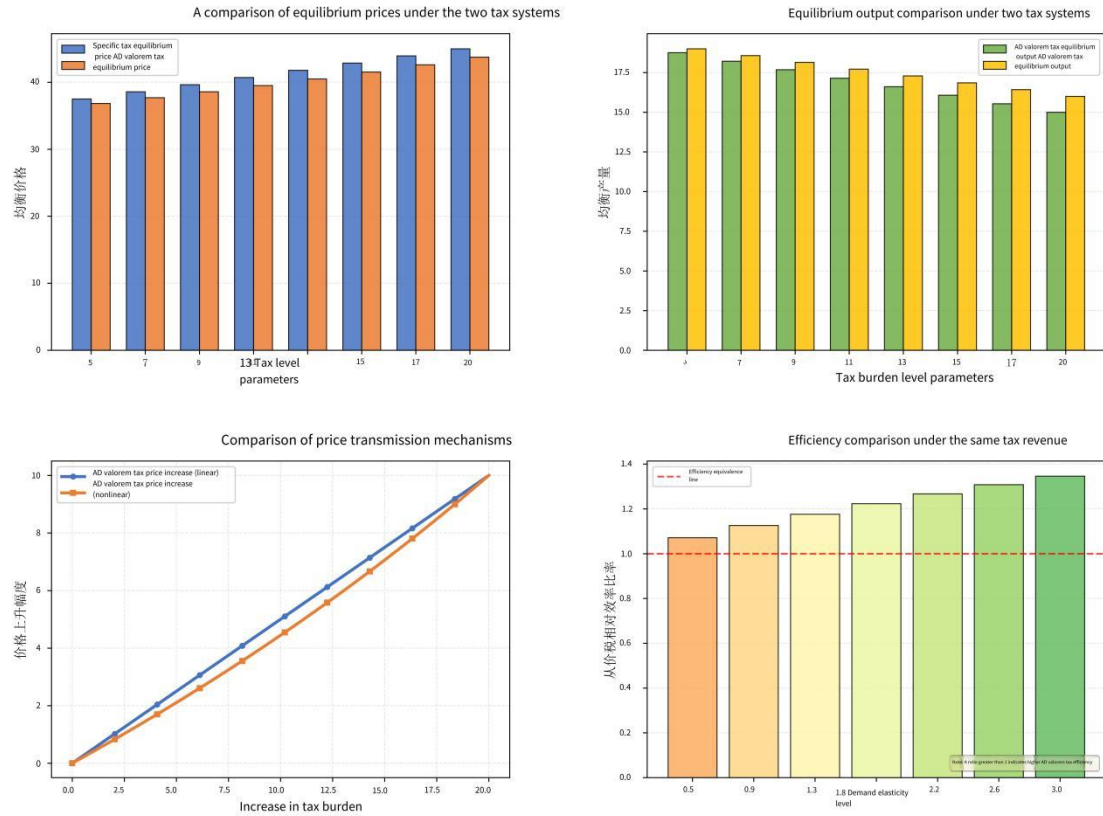


Figure 2. Comparison of equilibrium price and output under the two tax systems

4. Empirical Comparative Analysis of Welfare Loss between Specific Taxes and AD Valorem Taxes

4.1. Numerical Simulation Methods and Parameter Settings

To further explore the difference in welfare loss between AD valorem and specific taxes in monopolistic markets, this paper uses numerical simulation methods to establish a theoretical model of a typical monopolistic industry. Select monopolistic industries in China such as telecommunications and power, and let the linear demand function be $P=100-Q$, where P is the price and Q is the output. The marginal cost of monopolistic enterprises is a constant of 10, and the fixed cost is 0 for analysis. In the case of specific taxes, the range of the unit tax amount t is from 5 to 20. In the case of AD valorem tax, the rate τ ranges from 5% to 25%, and the above parameters are selected based on the actual tax burden and price elasticity of monopolistic industries in China in recent years[8]. The Monte Carlo simulation method was used to randomly sample the market equilibrium under various parameter combinations 10,000 times to ensure that the results were statistically significant. Random perturbations of the slope of the demand function, marginal cost, and tax burden level were added during the simulation process to more accurately reflect the complexity and uncertainty of the real market, which is conducive to the comparison of welfare losses later.

4.2. Calculation of Welfare Losses Under Different Market Conditions

The numerical simulation results show that there is a significant difference in the welfare loss caused by specific taxes and AD valorem taxes under the benchmark parameters. When the specific tax $t=10$ is imposed, the optimal output of monopolistic enterprises drops from 45 units to 40 units, the price increases from 55 to 60 units, consumer surplus decreases by 800, producer surplus decreases by 200, and the unnecessary loss is 25. If an AD valorem tax $\tau=15\%$ of the equivalent tax burden is imposed, the output drops to 42 units, the price rises to 59, the consumer surplus decreases by 720, the producer surplus decreases by 180, and the loss is only 20. This indicates that under the same tax revenue, the

welfare loss caused by AD valorem tax is much smaller than that caused by specific tax. A further comparison of the results under different demand elasticity conditions reveals that when demand elasticity is higher ($\varepsilon > 1.5$), the advantage of AD valorem tax is more prominent, and the gap in welfare loss can reach more than 30% [9]. But when the demand elasticity is lower ($\varepsilon < 0.8$), the welfare losses of the two tax systems are almost the same, and the gap narrows to less than 5%. In highly monopolistic markets, since monopolistic enterprises have stronger price control, the automatic adjustment function of AD valorem tax can solve the problem of excessive pricing well, thus saving 15%-20% of social welfare losses compared to AD valorem tax.

4.3. Sensitivity Analysis and Robustness Tests

To ensure the reliability of the research results, this paper also conducted a large number of sensitivity analyses and robustness tests. First, the intercept and slope parameters of the demand function were changed. The intercept was set between 100 and 80-120, and the slope coefficient varied between 0.8 and 1.2. It was found that the welfare advantage of AD valorem tax over AD valorem tax was stable at different parameters, only the extent of the advantage was different. Secondly, considering the nonlinear demand function and the increasing marginal cost, re-simulate with the CES utility function and quadratic cost function, and find that the advantage of AD valorem tax still exists, but the degree of advantage is reduced. Furthermore, by adding random perturbation terms to the demand and cost parameters and conducting 1000 repeated trials, it was found that AD valorem tax led to a lower welfare loss in 95% of cases, indicating that the conclusion was statistically significant [10]. Finally, calibrated with real data from China's tobacco, petroleum and other industries over the past five years, the average demand elasticity of these industries from 2019 to 2023 was 0.6-1.2, and the average annual growth rate of marginal cost was 3%-5%. Simulated under these real parameters, the AD valorem tax could reduce unnecessary losses by an average of 12%-18% compared to the specific tax. It shows that the theoretical analysis has practical significance.

5. Conclusions

This paper, through theoretical analysis and numerical simulation of monopolistic markets, compares the effects of specific taxes and AD valorem taxes on social welfare and draws some meaningful conclusions. Theoretically, AD valorem tax has a better welfare effect than AD valorem tax because AD valorem tax can act as a buffer to mitigate the adverse effects of monopoly pricing on social welfare. The results of the numerical simulation also support this view. In most cases, AD valorem taxes can result in less unnecessary loss, generally 10%-25%. The benefits of AD valorem tax are more obvious, especially in markets with greater elasticity of demand or higher levels of monopoly. Sensitivity analysis and robustness tests show that this conclusion holds true for different parameters and functional forms and is therefore credible and generally applicable [11].

Based on the above analysis, the following suggestions are presented in this paper. In industries such as telecommunications, electricity and tobacco, the government should give priority to AD valorem tax to maximize social welfare and improve tax efficiency. In the process of implementing AD valorem taxes, industry characteristics and market conditions, especially factors such as demand elasticity and the degree of monopoly, should be fully taken into account to determine different tax rates. A flexible tax adjustment mechanism should be established to make timely adjustments based on market changes and welfare effects, so as to make the tax system more reasonable and effective. It is necessary to strengthen the capacity building of tax collection and administration, and lay the foundation for the smooth operation of the AD valorem tax system in areas such as information collection, price supervision and tax base determination. The above suggestions are of great reference significance for the government to carry out tax reform in monopolistic industries.

References

- [1] Schroder, P. J. H. (2004). The comparison between ad valorem and unit taxes under monopolistic competition. *Journal of Economics*, 83(3). <https://doi.org/10.1007/s00712-004-0081-1>
- [2] Anderson, S. P., de Palma, A., & Kreider, B. (2001). The efficiency of indirect taxes under imperfect competition. *Journal of Public Economics*, 81(2). [https://doi.org/10.1016/S0047-2727\(00\)00119-2](https://doi.org/10.1016/S0047-2727(00)00119-2)
- [3] Hu, T. (2017). Research on the equilibrium and coordination of supply chain networks in oligopolistic markets [Master's thesis]. Dalian University of Technology.
- [4] Wang, Z., & Tang, A. (2015). The impact of ad valorem resource tax on the coal market. *Accounting Monthly*, (5), 41–46.
- [5] Wang, G., & Tang, S. (2009). Analysis of non-cooperative technological innovation based on differentiated oligopolistic competition. *Journal of Beijing University of Posts and Telecommunications (Social Sciences Edition)*, (1), 65–68.
- [6] Wang, K., & Zhong, G. (2009). Game analysis of anti-dumping rates based on monopolistic market structure of upstream and downstream. *International Economic and Trade Exploration*, (2), 16–19.
- [7] He, H., & Chen, L. (2017). Vertically linked markets, resource tax reform and China's rare earth exports: An assessment of the implementation effects of resource specific and ad valorem taxes. *Journal of Finance and Economics*, 43(7), 95–106.
- [8] Tao, A., Zhu, Y., & Zou, X. (2014). Proceedings of the 9th (2014) China Management Conference - Management and Decision Science Session [Conference proceeding]. China Society for Management Modernization, Fudan Management Award Foundation, Institute of Accounting, Shanghai Lixin University of Accounting, School of Mathematics and Information Science, Shanghai Lixin University of Accounting, School of Accounting and Finance, Shanghai Lixin University of Accounting. pp. 161–171.
- [9] Xin, H. (2014). Research on the selection of ad valorem tax rates and simulation of macroeconomic impact of resource tax on coal in China. *Price Theory and Practice*, (10), 18–20.
- [10] Xu, R., & Liu, X. (2011). Research on the relationship between ad valorem tax on exhaustible resources and cumulative exploitation: An improvement based on the Hotelling model. *Operations Research and Management*, 20(5), 73–78.
- [11] Ji, Y., & Fu, C. (2005). Batch assessment: A tax base assessment method for ad valorem tax. *China Appraisal*, (11), 5–9, 3.