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# Effective but Illegal: A Health Economics Analysis of the Black Market for GS-441524 in Treating Feline Infectious Peritonitis in China

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## Abstract

# Background

This study evaluates the health economics of the small-molecule antiviral drug GS-441524 in treating Feline Infectious Peritonitis (FIP) within China's informal (black) market. It examines factors influencing pet owners' willingness to pay (WTP), tests the income elasticity of WTP, and estimates social welfare losses resulting from market distortions.

# Methods

We conducted a cross-sectional online survey of Chinese pet owners (N = 201) who used black-market GS-441524 to treat cats with FIP during 2025. Data were collected on treatment costs, clinical outcomes, and WTP (using contingent valuation). Multiple linear regression models were constructed to analyze determinants of WTP and income elasticity. Consumer surplus, deadweight loss, and negative externalities were calculated. Probabilistic sensitivity analysis (PSA) was performed using 5,000 Monte Carlo simulations.

# Results

Mean total treatment cost was 6,478 RMB (approximately 32 times estimated production cost), with a clinical cure rate of 68.2%. Median WTP was 13,543 RMB, yielding a mean consumer surplus of + 7,065 RMB. Critically, WTP exhibited strict "zero income elasticity": the coefficient of ln(income) was near zero and statistically insignificant ($P > 0.9$), indicating that psychological willingness to save a cat's life did not vary with owner income. Cat breed, age, and weight were also insignificant predictors of WTP. Interaction analysis confirmed this pattern across all city tiers, suggesting a "decommodification" of companion animal life in life-or-death decisions. PSA showed that at the median WTP threshold, the probability of black-market treatment being cost-effective was 98.3%. Nationally, estimated annual deadweight loss and negative externalities from this black market were approximately 59.8 million RMB and 48.9 million RMB, respectively.

# Conclusion

While the black market for GS-441524 provides a clinical lifeline for cats with FIP, it imposes substantial social welfare losses through market failure. The finding of zero income elasticity reveals that in critical care decisions for companion animals, emotional bonds can transcend conventional budget constraints, leading to the "decommodification" of animal life. We recommend that authorities accelerate legal drug approval, implement cost-based pricing, and establish formal institutional mechanisms to replace informal compensation channels, thereby optimizing social welfare distribution.

# 1. Background

1. 1 Research Background: From "Incurable Disease" to Technological Breakthrough

Feline Infectious Peritonitis (FIP) is a fatal, immune-mediated systemic disease caused by mutations in feline coronavirus (FCoV). Historically, FIP was considered an "incurable disease" in veterinary medicine due to its high mortality rate and complex pathogenesis[1]. Clinically, FIP manifests in effusive (wet), non-effusive (dry), or mixed forms, with symptoms including persistent fever, serous cavity effusion, neurological impairment, and ocular lesions[2].

The development of small-molecule antiviral drugs after 2018 revolutionized FIP treatment. Murphy et al. first demonstrated that the nucleoside analog GS-441524 potently inhibits FIP virus replication in vitro[3]. Subsequent clinical trials by Pedersen et al. reported survival rates exceeding 80% in treated cats [4]. This breakthrough fundamentally altered prognostic expectations and treatment decision-making for pet owners worldwide.

# 1.2 Formation of the Black Market in China: "Citizen Medicine" and Institutional Compensation Under Regulatory Vacuum

Despite its demonstrated efficacy, GS-441524 has not obtained formal market authorization in China due to complex patent ownership and lengthy veterinary drug approval processes. This institutional supply gap, combined with strong treatment demand from pet owners, created a substantial supply-demand mismatch and catalyzed a large underground informal market.

In this regulatory vacuum, a unique phenomenon of "citizen veterinary medicine" has emerged in China[5]. Unable to obtain the drug through legal channels, pet owners have turned to informal social networks (WeChat groups, Xiaohongshu, online forums) to seek treatment options. A decentralized, nationwide underground supply chain has developed, sourcing drugs through overseas proxy purchasing, domestic community group-buying, active pharmaceutical ingredients marketed as "research-grade chemicals," and preparations from private laboratories. This black market represents a form of "self-rescue" — a compensatory mechanism arising when formal institutions fail. However, the associated price volatility, quality uncertainty, and risks of unsupervised administration pose complex challenges for health economics and public governance.

# 1.3 Theoretical Significance: Zero Income Elasticity of WTP and the Decommodification of Companion Animal Life

In classical health economics, willingness to pay (WTP) for mortality risk reduction or health gains typically exhibits positive income elasticity[10]. Under the rational actor model, health is considered a

normal or even luxury good; as budget constraints loosen, higher-income groups are generally willing to pay more for life and health.

This study examines and reveals a significant theoretical deviation in the context of critical medical decisions for companion animals: WTP exhibits strict zero income elasticity. Our empirical analysis shows that when facing life-or-death decisions for a companion animal, traditional economic rationality and budget constraints are largely superseded by deep emotional bonds. This homogeneous high WTP across income groups and geographical strata reflects a form of "cross-stratum altruism." In this decision context, the life of a companion animal acquires a "sacred value" that transcends conventional medical services, and its pricing logic becomes thoroughly "decommodified"[9].

1. 1.4 Research Objectives This study aims to:
2. 1. Systematically quantify price distribution, cost composition, and financial burden of black-market GS-441524 for Chinese pet owners.
3. 2. Analyze pet owners' WTP and its determinants, with particular focus on testing the income elasticity hypothesis.
4. 3. Estimate consumer surplus, deadweight loss, and negative externalities associated with this black market.
5. 4. Provide evidence-based policy recommendations for drug approval, pricing mechanism design, and market regulation.

# 2. Data and Methods

2. 1 Study Design and Sample Source

This cross-sectional study assessed the economic impact of using black-market GS-441524 for FIP treatment based on micro-survey data. Chinese pet owners who used black-market drugs to treat cats with FIP during 2025 were purposively recruited via an online survey platform. The study protocol received ethics approval, and all respondents provided online informed consent.

# 2.2 Inclusion and Exclusion Criteria

Respondents met all following criteria: ( 1) cat resided in Mainland China; (2) diagnosed with FIP by a veterinarian in the past 12 months (based on clinical signs, laboratory findings, or imaging); (3) drug obtained through informal (black market) channels; (4) treatment course lasted at least 4 weeks (or until endpoint events including death or euthanasia); (5) owner could provide detailed medical expenditure records and volunteered to participate. Technical measures excluded responses with missing key variables and duplicates (identified by IP address and cat characteristics). The final sample comprised 201 valid questionnaires, meeting medium-precision research requirements and comparing favorably with similar international studies.

2.3 Data Collection and Variable Definition The survey covered four dimensions:

1. Cat characteristics: breed, age, weight, clinical form (effusive/non-effusive).

2. Treatment and costs: drug source, formulation, administration route, comprehensive expenditures (diagnosis, medication, shipping).

3. Treatment outcomes: cure, death, euthanasia, or relapse.

4. Owner socioeconomic characteristics: monthly household income, education, administrative region.

For the core research objective, we used the Contingent Valuation Method (CVM) to measure pet owners' maximum WTP to save their cat's life under a hypothetical scenario assuming > 80% cure rate.

## 2.4 Health Economics Evaluation Framework

We constructed multi-dimensional economic evaluation indicators:

Consumer surplus: difference between maximum WTP and actual cost.

Deadweight loss: estimated using triangle approximation method, with benchmark equilibrium price based on production costs plus reasonable profit margin.

Negative externalities: secondary expenditures from treatment failure and forgone tax revenue.

To handle parameter uncertainty, we performed 5,000 Monte Carlo simulations (PSA). Cost variables and effectiveness (cure rate) were modeled with Gamma and Beta distributions, respectively. Cost-effectiveness acceptability curves (CEAC) and tornado diagrams were generated using Stata 17.0.

## 2.5 Statistical Analysis

Statistical analysis was performed using Stata 17.0. Continuous variables were described using mean ± standard deviation or median (interquartile range) based on distribution. For empirical analysis, we constructed log-log multiple linear regression models with ln(WTP) as the dependent variable, focusing on the coefficient of ln(Income) to test the income elasticity hypothesis. Control variables included breed, age, weight, and owner's education. Province and city-tier fixed effects, as well as interaction terms between income and city tier, were introduced to examine heterogeneity. All statistical tests were two-sided with significance level set at $P < 0.05$.

# 3. Results

3. 1 Sample Characteristics

3.1.1 Basic Clinical Characteristics of Affected Cats
The study included 201 cats with FIP treated with GS-441524 (Table 1). Mean age was 3.7 ± 2.2 years, and mean weight was 4.6 ± 1.3 kg. British/American Shorthairs (28.9%) and Chinese Domestic Cats (20.9%) were most common. Wet FIP accounted for 37.8% of cases, dry FIP for 32.3%, and uncertain/mixed forms for 29.9%. Only 28.9% of cases were confirmed by PCR testing, reflecting diagnostic challenges in the black-market context.

Table 1
Basic Characteristics of Affected Cats (N = 201)

| Characteristic Dimension | Statistics / Category | Case (%) or Mean ± SD |
|---|---|---|
| Biological Indicators | Age (years) | 3.7 ± 2.2 |
| | Weight (kg) | 4.6 ± 1.3 |
| Breed Distribution | Dragon Li (Domestic Shorthair) | 42 (20.9) |
| | British/American Shorthair | 58 (28.9) |
| | Ragdoll | 31 (15.4) |
| | Other Purebreds | 38 (18.9) |
| | Mixed/Uncertain Breed | 32 (15.9) |
| Clinical Classification | Effusive (Wet) FIP | 76 (37.8) |
| | Non-effusive (Dry) FIP | 65 (32.3) |
| | Uncertain/Mixed Form | 60 (29.9) |
| Diagnostic Method | RT-PCR Testing | 58 (28.9) |
| | Clinical Diagnosis by Veterinarian | 75 (37.3) |
| | Uncertain/Presumptive | 68 (33.8) |

3.1.2 Socioeconomic Characteristics of Respondent Owners

Respondents represented 26 Chinese provinces, concentrated in eastern coastal areas (Guangdong, Shandong, Jiangsu). The sample was highly educated, with 88. 1% holding a bachelor's degree or higher. Monthly household income distribution was relatively balanced (Table 2), with 16.9% of households reporting monthly income exceeding 30,000 RMB.

Table 2
Owner Socioeconomic Characteristics (N = 201)

| Characteristic Indicator | Category | Case (%) |
|---|---|---|
| Monthly Household Income | < 5,000 CNY | 36 (17.9) |
| | 5,000–10,000 CNY | 47 (23.4) |
| | 10,001–20,000 CNY | 49 (24.4) |
| | 20,001–30,000 CNY | 35 (17.4) |
| | > 30,000 CNY | 34 (16.9) |
| Educational Attainment | High School and Below | 24 (11.9) |
| | Junior College / Bachelor's | 94 (46.8) |
| | Master's and Above | 83 (41.3) |

# 3.2 Black Market Price Distribution and Treatment Cost Composition

Mean total treatment cost was 6,478 RMB (median: 6,420 RMB; interquartile range: 4, 194–8,810 RMB). Cost composition (Table 4) showed diagnostic fees (32.7%) and drug costs (31.9%) as primary expenditure items, with shipping costs accounting for the smallest proportion (5.5%). Total costs did not differ significantly across drug sourcing channels (Table 3), suggesting the black market has developed relatively stable informal pricing mechanisms.

Table 3
Total Treatment Costs by Drug Source Channel

| Sourcing Channel | Case (%) | Average Cost (CNY) | Price Range (CNY) |
|---|---|---|---|
| Overseas Purchasing Agent | 54 (26.9) | 6,520 | 4,703–8,810 |
| Domestic Community Group Buying | 64 (31.8) | 6,400 | 4,588–8,579 |
| Self-made Preparation | 59 (29.4) | 6,430 | 4,194–8,447 |
| Other Channels | 24 (11.9) | 6,590 | 5,238–8,250 |

Table 4
Composition of Treatment Costs

| Cost Item | Average Amount (CNY) | Proportion (%) |
|---|---|---|
| Medication Expenses | 2,068 | 31.9 |
| Diagnostic Expenses | 2,115 | 32.7 |
| Transportation Expenses | 355 | 5.5 |
| Other Related Expenses | 1,940 | 30 |
| Total | 6,478 | 100 |

# 3.3 Treatment Outcomes and Economic Welfare Measures

The sample cure rate was 68.2%, with death or euthanasia accounting for 17.9%. Mean maximum WTP (contingent valuation) was 13,543 RMB, significantly exceeding actual expenditure. This generated substantial consumer surplus (mean: +7,065 RMB; total sample surplus: 1.42 million RMB). However, 12.4% of respondents reported WTP lower than actual cost, indicating that some experienced extreme financial pressure or negative psychological surplus from black-market transactions.

3.4 Factors Influencing Willingness to Pay: Evidence for Zero Income Elasticity

3.4. 1 Core Finding: Zero Income Elasticity and Decommodification

Table 5 presents baseline regression results after controlling for province fixed effects (Model M3). The coefficient for ln(Income) was 0.001 and statistically highly insignificant (P = 0.969). This finding strongly supports the zero-income-elasticity hypothesis: when facing life-or-death decisions for a companion animal, WTP does not vary with owner income. Whether monthly

income was 3,000 RMB or 40,000 RMB, psychological willingness to save the cat's life remained unchanged.

Furthermore, traditional "market attribute" variables—cat breed, age, weight—were not statistically significant. Compared to Chinese Domestic Cats, expensive breeds like Ragdolls or British Shorthairs did not command higher WTP premiums. This reinforces the decommodification thesis: in life-or-death situations, companion animals are valued as "family members" with non-commodity attributes, and life value achieves equality across breed characteristics in owners' valuation systems.

Table 5
Determinants of ln(WTP): Province Fixed Effects Model (M3_Baseline)

| Variable | Coefficient | Robust Std. Err. | P-value |
|---|---|---|---|
| ln(Income) | 0.001 | 0.033 | 0.969 |
| Breed (Ref: Dragon Li / Domestic Shorthair) | | | |
| - British/American Shorthair | -0.043 | 0.063 | 0.495 |
| - Ragdoll | 0.001 | 0.069 | 0.988 |
| - Other Purebreds | 0.027 | 0.071 | 0.704 |
| - Mixed/Uncertain Breed | -0.012 | 0.063 | 0.849 |
| Age | -0.007 | 0.012 | 0.56 |
| Weight | -0.019 | 0.019 | 0.317 |
| Province Fixed Effects | Controlled | | |
| Constant | 9.292 | 0.331 | < 0.001 |
| R-squared | 0.208 | | |
| Observations | 201 | | |
| Note: Full province fixed effects coefficients are shown in Table S1. | | | |

# 3.4.2 Regional Heterogeneity: Geographic Variation in Emotional Valuation

Although income and breed were insignificant, province fixed effects showed high significance, revealing geographic variation in WTP. Holding other variables constant, respondents in several provinces had significantly higher WTP than the baseline control group ($P < 0.01$): Tianjin (+ 0.639), Chongqing (+ 0.638), Shaanxi (+ 0.454), Fujian (+ 0.449), Shanxi (+ 0.391), Hebei (+ 0.385), and Shandong (+ 0.343). This suggests that valuation of companion animal emotions may be influenced by local pet community culture, mutual aid networks, and informal institutional environments.

# 3.4.3 Testing the Universality of Zero Income Elasticity: City-Tier Interaction Analysis

To verify robustness across urban development levels, we introduced "monthly income × city tier" interaction terms (Table 6). All interaction terms were insignificant ($P > 0.19$), and the main effect of ln(Income) remained negligible across city tiers. This indicates that zero income elasticity exhibits significant cross-stratum universality—whether in resource-rich first-tier cities or fifth-tier cities with tighter budget constraints, pet owners' decision-making logic to save their cat's life showed high

consistency. This pattern of "cross-stratum altruism" paints a collective picture of companion animals as "family members" among China's new generation of pet owners.

Table 6
Heterogeneity Analysis: Income and City-Tier Interactions (M3_Interaction)

| Variable | Coefficient | Robust Std. Err. | P-value |
|---|---|---|---|
| ln(Income) | 0.1 | 0.147 | 0.496 |
| City Tier (Ref: Tier 1 Cities) | | | |
| - New Tier 1 | 2.594 | 2.572 | 0.314 |
| - Tier 2 | 1.89 | 1.509 | 0.211 |
| - Tier 3 | 0.763 | 1.807 | 0.673 |
| - Tier 4 | -0.028 | 1.449 | 0.985 |
| - Tier 5 | 0.842 | 1.407 | 0.55 |
| Interaction: Income×City Tier | | | |
| - New Tier 1 × ln(Income) | -0.294 | 0.273 | 0.283 |
| - Tier 2 × ln(Income) | -0.214 | 0.165 | 0.195 |
| - Tier 3 × ln(Income) | -0.096 | 0.195 | 0.622 |
| - Tier 4 × ln(Income) | -0.018 | 0.161 | 0.909 |
| - Tier 5 × ln(Income) | -0.105 | 0.157 | 0.505 |
| Breed, Age, Weight | Controlled | - | - |
| Province Fixed Effects | Controlled | - | - |
| Constant | 8.752 | 1.32 | < 0.001 |
| R-squared | 0.059 | | |
| Observations | 201 | | |

# 3.5Mechanism Analysis: From Willingness to Behavior and the First-Tier City "Price Paradox"

To explore how psychological preferences translate into actual economic behavior, we regressed ln(Actual Cost) on owner and cat characteristics (Table 7). Several notable patterns emerged.

First, there was a significant disconnect between WTP and actual cost. In both province fixed effects (M2_Province) and city-tier (M2_City) models, ln(WTP) had no significant effect on actual cost. Once treatment decisions were initiated, owners' subjective expectations did not predict final economic outlay.

In the black-market context, pet owners were classic "price takers," with actual financial burden depending more on disease progression and local informal market conditions than on personal WTP.

Second, breed variables showed an inverse association in the expenditure model. Compared to Chinese Domestic Cats, purebreds (British Shorthairs, American Shorthairs, Ragdolls) had significantly lower actual treatment costs ($P < 0.05$). This may reflect "preventive care" effects: purebred owners typically have higher health awareness and more mature pet-keeping experience, enabling earlier recognition of clinical signs and intervention. This "early detection, early intervention" pattern creates positive behavioral externalities, avoiding high-cost rescue treatments and complex complication management.

Third, we observed a counter-intuitive first-tier city "price paradox." Despite having more transparent information networks and concentrated supply chains, first-tier cities exhibited significantly higher actual treatment costs. Costs in new first-tier through fifth-tier cities were 21.4% to 37. 1% lower than in first-tier cities ($P < 0.01$). This paradox suggests that resource agglomeration advantages in megacities are offset by higher diagnostic and treatment premiums, expensive ancillary testing, and more complex combination drug regimens. In critical care for companion animals, resource concentration may increase household financial burden through "overtreatment" or high support-service costs rather than producing economies of scale.

Table 7
Determinants of ln(Actual Cost)

| Variable | Model M2_State (State FE) | Model M2_City (City Tier FE) |
|---|---|---|
| ln(WTP) | 0.070 | 0.023 |
| | (0.043) | (0.039) |
| ln(Income) | -0.012 | -0.003 |
| | (0.019) | (0.019) |
| Breed (Ref: Dragon Li / Domestic Shorthair) | | |
| - British/American Shorthair | -0.092** | -0.027 |
| | (0.036) | (0.038) |
| - Ragdoll | -0.072* | -0.059 |
| | (0.041) | (0.041) |
| - Other Purebreds | -0.081** | -0.051 |
| | (0.037) | (0.039) |
| - Mixed/Uncertain Breed | -0.074** | -0.028 |
| | (0.036) | (0.040) |
| Age | -0.007 | -0.015 |
| | (0.012) | (0.012) |
| Weight | -0.020 | -0.010 |
| | (0.019) | (0.019) |
| City Tier (Ref: Tier 1 Cities) | | |
| - New Tier 1 | - | -0.371*** (0.077) |
| - Tier 2 | - | -0.225*** (0.036) |
| - Tier 3 | - | -0.272*** (0.046) |
| - Tier 4 | - | -0.252*** (0.038) |
| - Tier 5 | - | -0.214*** (0.032) |
| - Other Tiers | - | -0.226*** (0.062) |
| Province Fixed Effects | Controlled | Not Controlled |
| R-squared | 0.197 | 0.069 |
| Observations | 201 | 201 |

Note: Standard errors in parentheses; * P < 0.10, ** P < 0.05, *** P < 0.01

## 3.6 Probabilistic Sensitivity Analysis

Probabilistic sensitivity analysis (PSA) with 5,000 Monte Carlo simulations accounted for parameter uncertainty. Figure 1 shows the cost-effectiveness acceptability curve (CEAC) for black-market treatment compared to "no treatment" (zero health outcome, zero cost). At a societal WTP threshold of 5,000 RMB, the probability of cost-effectiveness was 0%. However, at the median respondent WTP ( 13,543 RMB), cost-effectiveness probability rose to 98.3%. Using China's per capita GDP (approximately 85,000 RMB) as reference threshold, probability reached 100%. This indicates that under current black-market pricing, GS-441524 treatment remains highly economically valuable for most pet owners.

One-way sensitivity analysis (tornado diagram, Fig. 2) revealed impact weights of parameter fluctuations on net monetary benefit (NMB). Cure rate fluctuations had slightly larger impact (range approximately ± 3,200 RMB) than treatment cost fluctuations (range approximately ± 3,000 RMB). At median WTP of 13,543 RMB, baseline NMB was 2,684 RMB, and NMB remained positive across all parameter variations. This indicates that while economic evaluation is somewhat sensitive to cure rate, overall conclusions remain robust under reasonable parameter uncertainty.

Figure 3 presents the 5,000 Monte Carlo simulations on the cost-effectiveness plane. Scatter points clustered tightly around observed means (total cost 6,478 RMB, cure rate 68.2%), with baseline point (red 'X') in the central cluster. This tight clustering indicates that cost and effect estimates are highly robust despite random parameter variability.

## 3.7 Social Welfare Loss Estimation: Deadweight Loss and Negative Externalities

To assess broader welfare impacts, we constructed a welfare economics model. Assuming our sample represents approximately 1% of total annual national cases (approximately 20, 100 cats treated nationally per year), we estimated:

Deadweight loss (DWL): Using triangle approximation method, with black-market equilibrium price (P_BM) = 6,478 RMB, equilibrium quantity (Q_BM) = 20, 100. Assuming competitive market price (P_C) could drop to 500 RMB (based on production costs plus reasonable profit), and price elasticity would double demand (Q_C = 40,200), estimated annual DWL = 59.8 million RMB.

Negative externalities: Total estimated at 48.89 million RMB, comprising:

Treatment failure costs: 31.8% failure rate × assumed additional medical expenses of 5,000 RMB per failed case = 31.96 million RMB annually.

Forgone tax revenue: National black-market transaction value estimated at 130.2 million RMB × 13% Value Added Tax = 16.93 million RMB annually.

These estimates reveal that the black market for GS-441524 not only increases individual financial burden but also undermines overall social welfare through substantial deadweight loss and multi-dimensional negative externalities. While the informal market provides a "self-rescue" channel under regulatory vacuum, its underlying social costs are extremely high, necessitating formalization through market authorization and price intervention to optimize welfare distribution.

# 4. Discussion

4. 1 Theoretical Contribution: Zero Income Elasticity and the Decommodification Thesis

This study reveals a unique economic behavior paradigm in companion animal medical decision-making. The finding of zero income elasticity challenges the classical health economics assumption that willingness to pay for health increases with income. When facing life-or-death decisions for their pets, individuals' economic budget constraints are largely superseded by deep emotional bonds. Companion animal life undergoes a process of "decommodification": market attributes such as breed, age, and weight become irrelevant, with Chinese Domestic Cats and expensive purebreds receiving equal emotional valuation in life-or-death situations.

This homogeneous high WTP across regions and strata reflects "cross-stratum altruism" and aligns with psychological theories of "sacred values" [9]. When decision objects acquire inviolable moral significance, individuals resist rational cost-benefit trade-offs and follow behavioral rules of "absolute necessity." This study provides the first empirical validation of this phenomenon in health economics using micro-survey data and quantifies its welfare consequences.

# 4.2 Price Mechanisms and International Comparison

Compared to international studies, GS-441524 in the Chinese black market exhibits a unique "price-efficacy" profile. Mean treatment cost (6,478 RMB, ~ 890 USD) is substantially lower than reported in US and UK studies (approximately 3, 100–4,920 USD). This price advantage may stem from low production costs due to China's mature chemical industry and channel premium compression through decentralized community group-buying models.

However, the observed cure rate (68.2%) is slightly lower than foreign clinical trials and cohort studies. This may reflect unstable active ingredient concentrations in illegal drugs and the absence of professional veterinary guidance. The first-tier city "price paradox"—highest treatment costs in most resource-rich areas — further reveals erosion of household economic welfare by medical service premiums and "overtreatment" tendencies in large cities. According to the 2024 China Pet Medical Industry White Paper, average daily inpatient costs in first-tier cities are 1.8– 2.3 times those in second- and third-tier cities, consistent with our findings.

# 4.3 Welfare Loss and Policy Implications

Welfare estimates show that the black market for GS-441524 causes substantial social resource misallocation. Annual deadweight loss of nearly 60 million RMB and negative externalities of nearly 50 million RMB reveal high social costs behind regulatory vacuum. Based on these findings, we propose the following policy recommendations.

Table 8
Pathways for Formalizing FIP Treatment Market in China

| Core Issue | Policy Intervention Recommendations | Responsible Authorities |
|---|---|---|
| Institutional Supply Shortage | Establish a "green channel" for emergency veterinary drug access to accelerate the legalized registration and approval of GS-441524. During the transition period, grant licensed veterinarians limited clinical prescription rights by referencing human medicine management experience. | Ministry of Agriculture and Rural Affairs (MARA), National Medical Products Administration (NMPA) |
| Price Loss and Profiteering | Implement a cost-oriented pricing mechanism; calculate and release industry-wide maximum retail price guidelines based on the production cost of active pharmaceutical ingredients (API) to squeeze out illegal black-market premiums. | National Development and Reform Commission (NDRC), China Veterinary Medical Association (CVMA) |
| Cost Premium in Major Cities | Strengthen transparency in medical service fee supervision for animal hospitals in Tier 1 cities and crack down on over-treatment. Support commercial pet insurance to include FIP treatment in coverage catalogs to diversify family financial risks. | State Administration for Market Regulation (SAMR), National Financial Regulatory Administration (NFRA), Local Industry Associations |
| Low Supply Chain Transparency | Acknowledge and standardize existing community group-buying models; integrate them into a formal regulatory system via digital platforms and establish drug traceability mechanisms to reduce information asymmetry. | Ministry of Commerce (MOFCOM), Chinese Society of Animal Husbandry and Veterinary Medicine (CSAVM), Social Media Platforms |

## 4.4 Limitations and Future Research

This study has several limitations. First, recruitment through social platforms may introduce selection bias, potentially overrepresenting successful treatment cases. Second, cost and efficacy data relied on retrospective reports with potential recall bias. Third, lacking laboratory-level drug testing, we could not directly establish causal links between drug quality and clinical outcomes.

Future research should focus on "real-world studies" following drug legalization, using large-sample longitudinal cohorts to monitor efficacy, resistance, and cost-effectiveness differences between black-market and formal drugs. Cross-cultural comparative studies exploring income elasticity of companion animal life valuation across different cultural backgrounds would deepen understanding of human-pet relationship economics.

# 5. Conclusion

This health economics analysis of China's black market for GS-441524 reveals that while the informal market clinically saves many cats with FIP, underlying market failures are severe. Mean black-market treatment cost is 6,478 RMB—approximately 32 times production cost—and due to uncontrolled drug quality and lack of professional guidance, 31.8% of affected cats still face death or relapse.

The most striking theoretical finding is strict zero income elasticity of willingness to pay: empirical results demonstrate that regardless of economic status, Chinese pet owners exhibit homogeneous high WTP to save their cats' lives. This transcendence of emotional bonds over economic rationality signifies profound "decommodification" of companion animal life in contemporary Chinese society, forming a collective consensus of "familial perception" across regions and strata.

In actual transactions, owners' WTP does not effectively predict actual expenditure; pet owners are generally "price takers" passively bearing high costs. Significantly higher treatment costs in first-tier cities reveal severe erosion of household welfare by medical premiums in large cities.

Estimates show that this black market generates annual deadweight loss of 59.8 million RMB and negative externalities of 48.89 million RMB—alarming social costs. Therefore, promoting legal market access for GS-441524 and establishing cost-oriented pricing systems are urgent policy priorities. Transforming black-market demand into formal medical demand is not only a rational choice for maximizing economic efficiency but also the most powerful humanistic response to countless instances of "cross-stratum love" in modern society.

# Declarations

As independent researchers conducting a voluntary and anonymized online survey, formal institutional ethics committee approval was waived. However, the study was conducted in accordance with the ethical principles of the Declaration of Helsinki, and all respondents provided online informed consent prior to participating in the survey.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

WS formulated the research question, designed the study, conducted the statistical and health economic analysis, and drafted the original manuscript. LS contributed to the data collection, survey distribution, interpretation of results, and critically revised the manuscript for important intellectual content. Both authors read and approved the final manuscript.

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# Figures

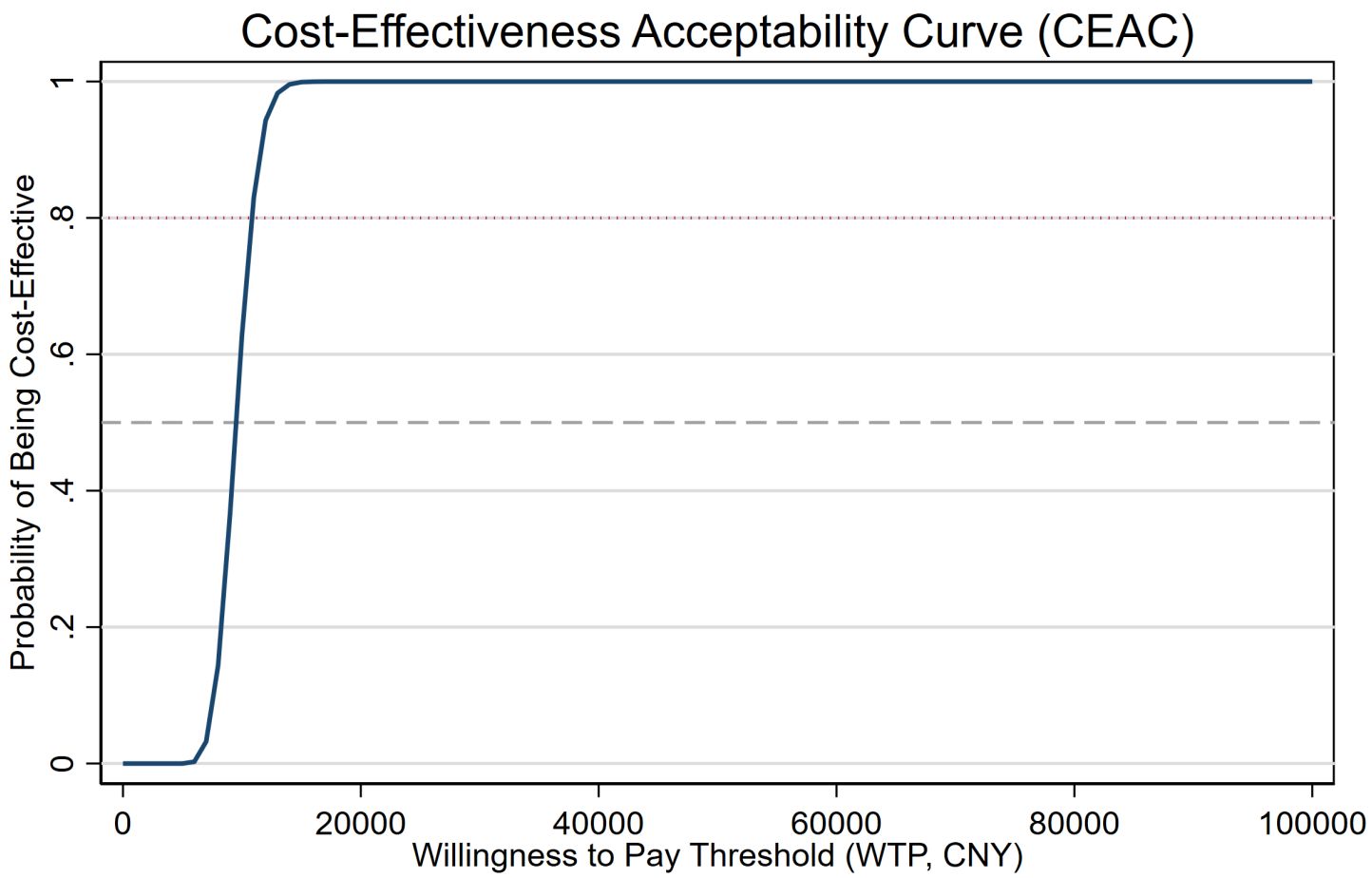



**Figure 1**

Cost-Effectiveness Acceptability Curve

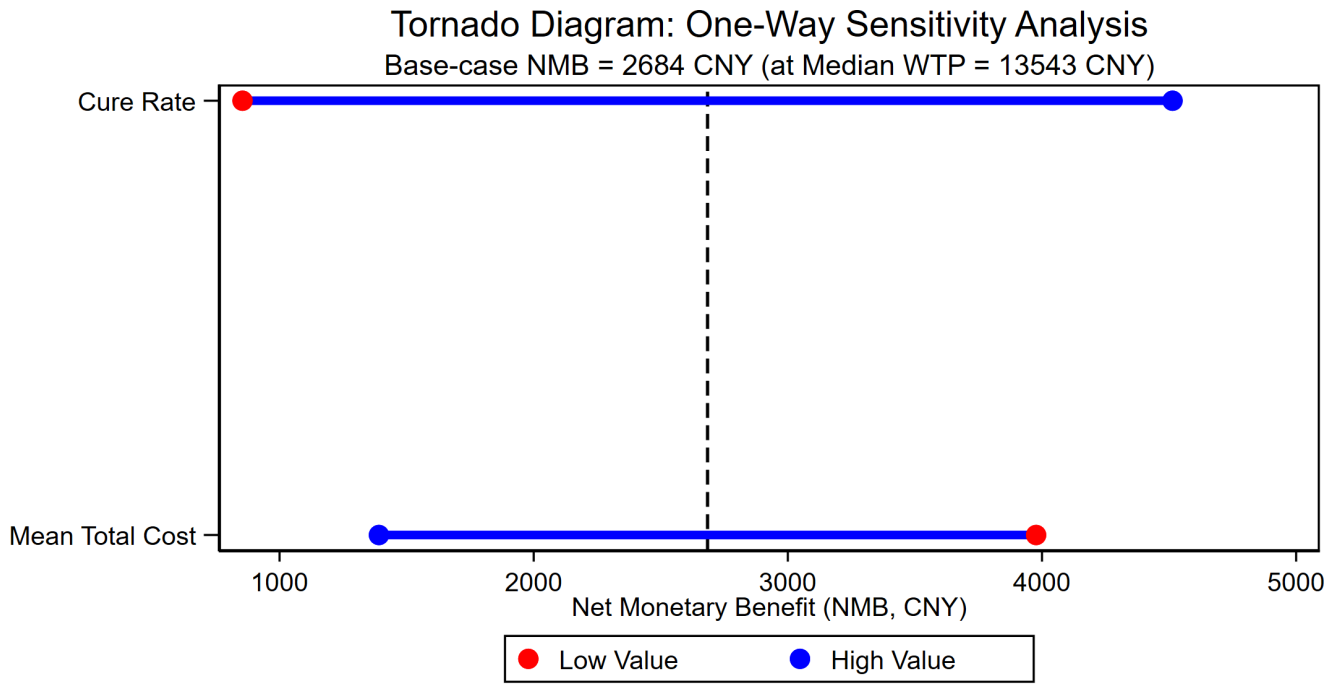



**Figure 2**

Tornado Diagram (One-Way Sensitivity Analysis)

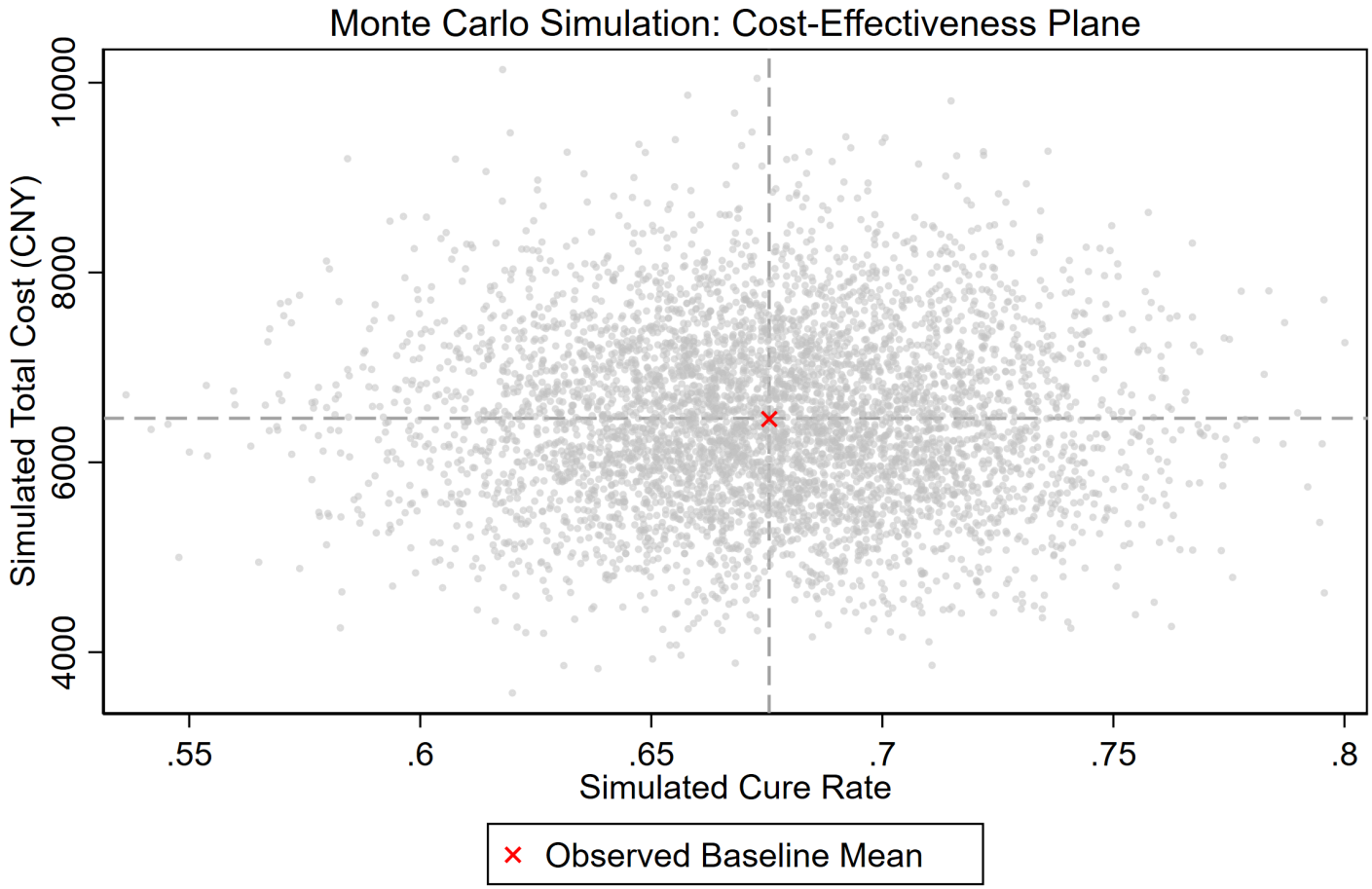



**Figure 3**

Cost-Effectiveness Scatter Plot

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- CHEER2022CheckList.xlsx
- SurveyQuestionnaireEnglishTranslationandChineseOriginal.docx
- SupplementaryInformations.docx