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The Role of Sustainable Management for Two-sided Platform Competition

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Abstract

This study develops a theoretical framework to analyze investment for corporate social responsibility (CSR) activities in competing two-sided platforms. Building on previous research, we model two platfors, a platform with CSR and without CSR, where consumers and providers choose platforms based on utilities that network externalities, valuation for CSR, and regulatory costs. Agent personality is captured by assuming CSR valuations and regulation loss sensitivities follow uniform distributions. We derive closed form equilibrium numbers of consumers and providers and equilibrium prices under quadratic CSR costs and probabilistic violation losses. Numerical analysis with calibrated parameters from prior literature shows that higher CSR investment raises expected profits, participant numbers of consumers, and equilibrium prices for both platforms, platform with CSR consistently outperforming its without CSR counterpart. The results demonstrate that CSR investment as a sustainable management functions both as a strategic tool for customer acquisition leveraging enhanced network externalities and as an effective risk management mechanism by reducing expected violation losses. Moderate CSR investment thus yields competitive advantages, suggesting platform managers should integrate CSR considerations into early design and pricing strategies. The model also highlights trade offs between investment costs and network benefits, providing a basis for optimizing CSR levels under varying market conditions. Future work will empirically calibrate key parameters to validate and refine these theoretical insights.

Keywords: Two sided platform, Corporate social responsibility, Sustainable management, Competition

1 Introduction

A two sided platform refers to a market that acts as an intermediary for multiple groups of agents, matching them so they can transact on the same platform [1]. Its defining feature is network externality, which means that any one agent's utility depends on the number of agents on the opposite side. For example, consider consumers and providers: as the number of consumers grows, providers enjoy more opportunities to trade, and the platform becomes

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more valuable to them. Conversely, as the number of providers increases, consumers gain access to a wider range of choices and services, improving their convenience. This mutual reinforcement of value between consumers and providers is what researchers call network externality in this field.

Because of this effect, the size of each side's user base interacts in complex ways. Platform operators themselves do not supply goods or services directly; instead, they enhance convenience for both suppliers and demanders through matching algorithms, payment systems, reputation mechanisms and data analytics, thereby capturing value from those network externalities. In recent years, two sided platforms have grown rapidly and become mainstream business models in many areas, such as Airbnb, Uber, online food delivery and e-commerce.

However, alongside efficiency gains and wider adoption, these platforms have given rise to multiple layers of challenges, including induced environmental burdens, impacts across the entire life cycle and governance issues. For instance, ride hailing services like Uber may worsen urban traffic congestion and increase CO_2 emissions by drawing demand away from walking and public transport. Online food delivery platforms have also triggered massive consumption of one time use plastic containers and cutlery; during the COVID-19 pandemic, CO_2 emissions from food delivery are estimated to have risen by 35 percent due to the surge in demand [2]. In the e-commerce sector, researchers have examined environmental concerns stemming from pandemic-related demand spikes and excessive packaging [3]. Such induced demand impacts on the environment are key factors that platform operators must manage directly through their service design and marketing strategies. In addition, platforms face numerous governance challenges as part of their social responsibility. A notable example occurred in 2018 in China, when a user of the ride-hailing service DiDi was sexually assaulted and murdered by a driver; the Chinese government ordered the suspension of its "Hitch-ride" service, causing DiDi to incur approximately RMB 800 million in lost profits [4]. In response, the company invested RMB 2 billion in 2019 to strengthen cooperation with law enforcement, improve its warning system and triple the size of its safety team. Airbnb has likewise received complaints of sexual assault during stays, some of which have drawn significant public scrutiny.

To address these complex challenges, two sided platforms must undertake CSR activities that consider sustainability—establishing environmentally conscious management systems, introducing safety certifications, bolstering cooperation with police and ensuring rapid complaint resolution. Corporate social responsibility (CSR) denotes the obligations a firm bears toward society and the environment through its business operations. It has attracted broad attention in recent years, and in 2010 ISO issued ISO 26000 as an international standard for integrating social responsibility throughout an organization.

2 Related Works

Empirical and theoretical work suggest that CSR practice yields multiple benefits: gaining societal trust; averting business disruptions due to conduct that contravenes public expectations; enhancing corporate reputation and brand value; improving employee morale, recruitment and retention; and strengthening stakeholder relations. These outcomes indicate that CSR can influence a firm's profitability and market competitiveness, making it a vital consideration in managerial decision making. Moreover, Oga et al. (2024) show that, during social downturns, appropriately calibrated CSR investments can lower a firm's social risk and increase corporate value, underscoring CSR's role in risk management [5]. In the context of two sided platforms, CSR can prevent profit losses arising from governance or environmental violations, bolster user trust and enhance safety, reputation and social value.

However, CSR activities entail costs, and overly stringent regulations or measures may unduly burden providers. For instance, if high environmental standards force providers to incur additional expenses, some may exit the platform, leading via network externalities to a decrease in consumers. Thus, CSR initiatives can compress short-term profitability and risk reducing user numbers. For platforms to sustain growth, they must therefore adopt optimal CSR strategies that effectively attract and retain users. Concretely, platforms should determine investment levels that account for both provider and consumer needs, striking a balance between trust enhancement through CSR and the rigor of regulatory measures.

Prior research on two sided markets is extensive. Armstrong (2006) provided a foundational model of competition structure and pricing in two sided platforms, explaining why platforms adopt different pricing strategies for providers and consumers through concepts such as network externality and single homing versus multi homing, and clarifying differences in pricing and profit structures under monopoly versus competitive coexistence [1]. Wei et al. (2023) used a game theoretic model to analyze how network externalities and risk aversion affect CSR investment decisions, identifying a dilution effect—where strong consumer network externalities can cause CSR investment to reduce platform usage—and an incentive effect whereby risk aversion consistently promotes CSR spending [6]. Sui et al. (2024) conducted a theoretical analysis of dynamic pricing and value added service (VAS) investment strategies for competing platforms, constructing a two stage game model that shows how an early low-price strategy combined with VAS offerings in the growth stage can expand market size [7]. Although these studies shed light on competition and CSR in two sided markets, there remains no comprehensive analysis of how CSR-driven competition for customer acquisition affects platform dynamics.

Accordingly, this study aims to develop a theoretical framework that analyzes how CSR activities reduce social risk and influence user dynamics through inter-platform competition for user acquisition—thereby elucidating the significance of CSR in managing competition and risk in two sided markets and guiding the efficient and effective adoption and diffusion of CSR initiatives.

3 Model

This study builds on the framework of Wei et al.(2023). We consider a market in which two two sided platforms compete for users. There are consumers and providers in the market, and each must choose either the platform with CSR A or the platform without CSR B. Based on prior research, we define the utilities of consumers and providers, determine the number of participants on each platform, and then let each platform $i \in \{A,B\}$ set its price p_i to maximize its profit.

3.1 Consumer Utility

A representative consumer on platform with CSR A obtains utility

$$U_{cA} = v - p_A + a_c n_{dA} + \beta e, \tag{1}$$

where v is the intrinsic value of the good, p_A is the price on platform with CSR A, a_c is the consumer network externality coefficient, n_{dA} is the number of providers on A, β is the consumer's valuation of CSR activities and e is the CSR investment level of platform with CSR A.

If the consumer joins platform without CSR B, utility is

$$U_{cB} = v - p_B + a_c n_{dB}, \tag{2}$$

since platform without CSR B does not engage in CSR activities.

Consumers choose platform with CSR A if $U_{cA} \geq U_{cB}$ and platform without CSR B otherwise. We assume each consumer's CSR valuation β is uniformly distributed on $[0,1]$. Let β^* satisfy $U_{cA}(\beta^*) = U_{cB}(\beta^*)$. Then the number of consumers on each platform is

$$\begin{aligned} n_{cA} &= \int_{\beta^*}^{1} d\beta = 1 - \beta^* \\ &= \frac{e - (p_A - p_B) + a_c\,(n_{dA} - n_{dB})}{e}, \end{aligned} \tag{3}$$

$$\begin{aligned} n_{cB} &= \int_{0}^{\beta^*} d\beta = \beta^* \\ &= \frac{p_A - p_B - a_c\,(n_{dA} - n_{dB})}{e}. \end{aligned} \tag{4}$$

For simplicity, we assume every consumer who joins a platform makes a transaction.

3.2 Provider Utility

Similarly, a provider joining a platform i obtains utility

$$U_{dA} = (1-\lambda)p_A - c + a_d n_{cA} - \gamma n_{dA} - me, \tag{5}$$

$$U_{dB} = (1-\lambda)p_B - c + a_d n_{cB} - \gamma n_{dB}. \tag{6}$$

where λ is the commission rate, c is the cost of production and distribution, a_d is the provider network externality coefficient, γ captures competition intensity among providers (internal network effect), and me is the loss to providers from CSR - related regulation at level e.

Providers choose platform with CSR A if $U_{dA} \geq U_{dB}$ and platform without CSR B otherwise. We assume each provider's loss parameter m is uniformly distributed on $[0,1]$. Let m^* satisfy$U_{dA}(m^*) = U_{dB}(m^*)$. Then providers with $m \leq m^*$ join platform with CSR A, and those with $m > m^*$ join platform without CSR B. Since $g(m) = 1$ on $[0,1]$, the number of providers on each platform is

$$\begin{aligned} n_{dA} &= \int_{0}^{m^*} dm = m^* \\ &= \frac{(1-\lambda)(p_A - p_B) + a_d\,(n_{cA} - n_{cB}) + \gamma}{e + 2\gamma}, \end{aligned} \tag{7}$$

$$\begin{aligned} n_{dB} &= \int_{m^*}^{1} dm = 1 - m^* \\ &= \frac{e - (1-\lambda)(p_A - p_B) - a_d\,(n_{cA} - n_{cB}) + \gamma}{e + 2\gamma}. \end{aligned} \tag{8}$$

3.3 Platform Profit

The profit functions of the platform with CSR A and the platform without CSR B are given by:

$$\pi_A = \lambda n_{cA} p_A - \eta L - \frac{1}{2}ke^2, \tag{9}$$

$$\pi_B = \lambda n_{cB} p_B - \eta L. \tag{10}$$

Here, $\lambda n_{ci} p_i$ is revenue from user transactions, η is a random variable with mean μ and variance σ^2 representing the probability of compliance violations or other social losses, and L denotes the associated loss or penalties. The coefficient $k > 0$ measures the cost of CSR investment, assumed quadratic in e. By investing in CSR, platform A reduces the expected violation probability from μ to $(1-e)\mu$, mitigating potential losses. Taking expectations yields:

$$E[\pi_A] = \lambda n_{cA} p_A - (1-e)\mu L - \frac{1}{2}ke^2, \tag{11}$$

$$E[\pi_B] = \lambda n_{cB} p_B - \mu L. \tag{12}$$

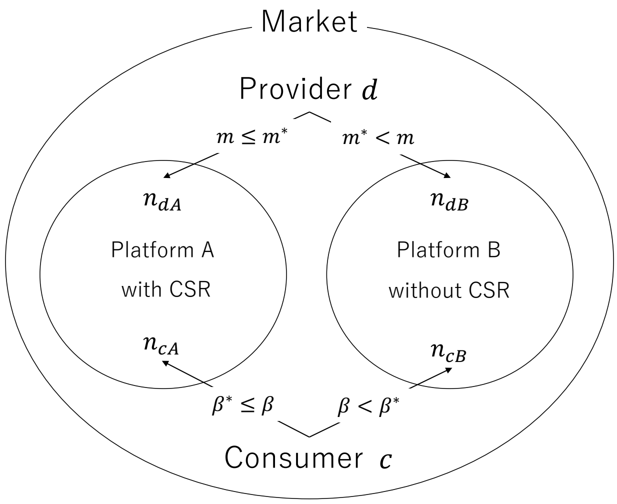

Figure 1: The relationship between users and platforms

4 Equilibrium

4.1 Equilibrium Numbers of Platform Participants

From equations (3) to (8), solving the simultaneous equations yields the equilibrium numbers of consumers and providers on each platform:

$$n_{cA} = \frac{e(e+2\gamma) - \{(e+2\gamma) - 2a_c(1-\lambda)\}(p_A - p_B)}{e(e+2\gamma) - 4a_c a_d} - \frac{a_c(e+2a_d)}{e(e+2\gamma) - 4a_c a_d} \tag{13}$$

$$n_{cB} = \frac{\{(e+2\gamma) - 2a_c(1-\lambda)\}(p_A - p_B) + a_c(e - 2a_d)}{e(e+2\gamma) - 4a_c a_d} \tag{14}$$

$$n_{dA} = \frac{(e(1-\lambda) - 2a_d)(p_A - p_B) + e(\gamma - a_d) - 2a_c a_d}{e(e+2\gamma) - 4a_c a_d} \tag{15}$$

$$n_{dB} = \frac{e(e+\gamma+a_d) - (e(1-\lambda) - 2a_d)(p_A - p_B) - 2a_c a_d}{e(e+2\gamma) - 4a_c a_d} \tag{16}$$

4.2 Optimal Platform Pricing

Each platform sets its price to maximize expected profit. For the platform with CSR A, the optimization problem is

$$\max_{p_A} E[\pi_A] = \lambda n_{cA} p_A - (1-e)\mu L - \frac{1}{2}ke^2. \tag{17}$$

The first-order condition $\frac{dE[\pi_A]}{dp_A} = 0$ yields

$$p_A = \frac{e(e+2\gamma) - a_c(e+2a_d)}{2\{e+2\gamma - 2a_c(1-\lambda)\}} - \frac{1}{2}p_B. \tag{18}$$

Similarly, the non-CSR platform B solves

$$\max_{p_B} E[\pi_B] = \lambda n_{cB} p_B - \mu L, \tag{19}$$

and its first-order condition gives

$$p_B = \frac{a_c(e-2a_d)}{2\{e+2\gamma - 2a_c(1-\lambda)\}} + \frac{1}{2}p_A. \tag{20}$$

Solving these simultaneously yields the equilibrium prices:

$$p_A^* = \frac{2e(e+2\gamma) - a_c(e+6a_d)}{3\{e+2\gamma - 2a_c(1-\lambda)\}}, \tag{21}$$

$$p_B^* = \frac{e(e+2\gamma) + a_c(e-6a_d)}{3\{e+2\gamma - 2a_c(1-\lambda)\}}. \tag{22}$$

The second-order condition for optimality requires $\frac{(e+2\gamma)-2a_c(1-\lambda)}{e(e+2\gamma)-4a_c a_d} > 0$.

5 Numerical Analysis

Based on the equilibrium solutions derived above, we conduct a numerical analysis. To examine the significance of CSR investment, we analyze how the expected profit, number of consumers, number of providers, and equilibrium price vary with the CSR investment level e. The baseline parameters which were determined by previous researches, are set as follows.

First, regarding expected profit (Fig. 4), we observe that as the CSR investment level increases, profits of both platform with CSR A and platform without CSR B rise. Under the baseline parameter setting, platform with CSR A outperforms the non-CSR platform in terms of expected profit. This can be attributed to the larger consumer base attracted by CSR investment (Fig. 2), which allows platform A to set a higher price than platform B (Fig. 5). These results suggest that competition for customers and investment for CSR as a form of risk management may be beneficial for the platform.

Table 1: Baseline parameter settings

Symbol	Description	Value
λ	Commission rate	0.15
a_c	Consumer network externality coefficient	0.9
a_d	Provider network externality coefficient	0.9
γ	Internal network effect among providers	0.4
μ	Mean probability of CSR violation	0.1
L	Loss from CSR violation	0.3
k	CSR investment cost coefficient	0.2

6 Conclusion

This paper provides a theoretical analysis of two sided platforms' CSR activities, focusing on how investment for CSR activities as sustainable management and influences user acquisition competition. Based on our parameterized model, we confirm the usefulness of CSR activities through changes in platform profit functions. Practically, our findings support greater investment in CSR by platforms as it enhances profitability and competitive standing. This model has some limitations. First, we have a high parameter dimensionality. Conducting empirical surveys to measure and estimate key parameters in real-world settings would enable more accurate and context-specific insights. Second, our analysis is based on the strong hypothesis that the probability distribution of users' utility for CSR is uniform. This is based on previous research, but further analysis and model expansion are needed. In future studies, it will be necessary to address these challenges with the aim of enhancing social applicability.

Acknowledgments

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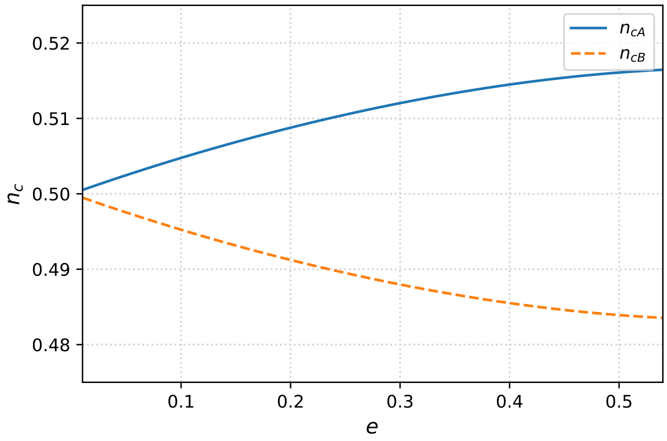

Figure 2: Change in number of consumers n_c as a function of CSR investment level

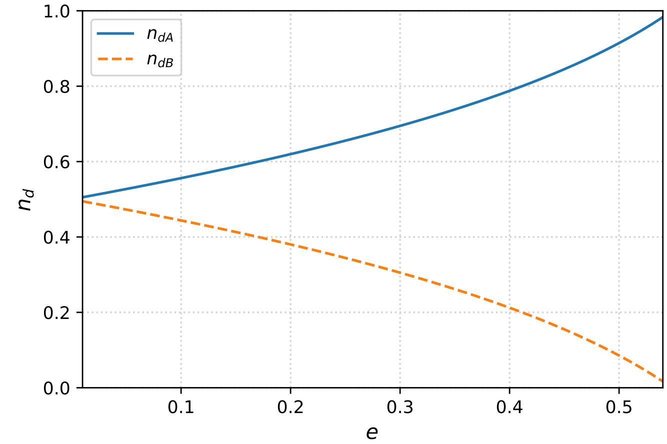

Figure 3: Change in number of providers n_d as a function of CSR investment level

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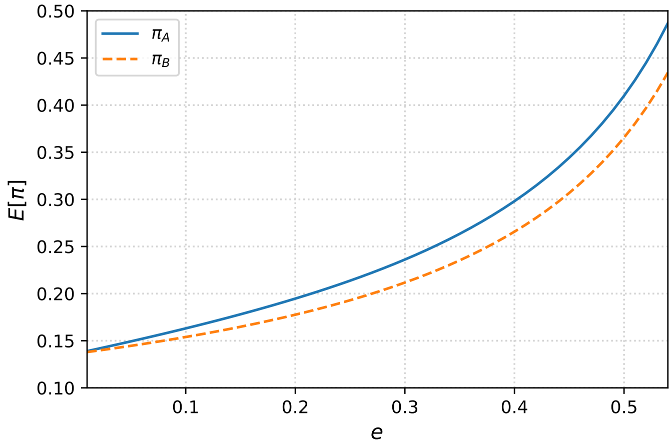

Figure 4: Change in expected profit $E[\pi]$ as a function of CSR investment level

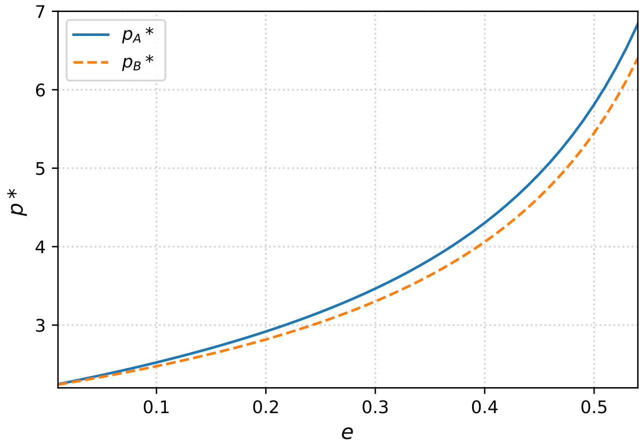

Figure 5: Change in equilibrium price p^* as a function of CSR investment level