Platform financing and CSR performance in an E-commerce marketplace

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Abstract

Purpose – This paper investigates whether and how the financial services offered by an e-commerce platform can help budget-constrained small- and medium-sized suppliers improve their corporate social responsibility (CSR) performance.

Design/methodology/approach – The authors examine a supply chain in which a budget-constrained supplier engages in CSR, produces a finished product and sells it on the marketplace of an e-commerce platform. This platform offers financial services to the supplier, choosing among three types of financing models: target rate of return, credit limit and CSR-linked financing. Using a Stackelberg game approach, the authors can drive the equilibrium decisions under each financing model.

Findings – The results reveal that all three financing models help improve the supplier's CSR investment as long as consumer sensitivity toward CSR exists. Moreover, the last one leads to the highest profitability of the overall supply chain and each member.

Originality/value – The findings shed light on the role of platform financing and how to design the most appropriate financing model to improve CSR for supply chain managers.

Keywords CSR, E-commerce platform, Budget constraint, Platform financing

Paper type Research paper

1. Introduction

In today's global business environment, the growth of online marketplaces, such as Amazon, eBay, Alibaba or JD.com, is leading to a significant transformation in commerce operations. These platforms have transitioned into a marketplace mode, allowing third-party suppliers to directly transact with the end consumers. Even traditional online retailers like Walmart and Carrefour are embracing this marketplace approach, recognizing the potential to reach a larger pool of potential buyers. The success of these marketplaces hinges heavily on small and medium-sized suppliers, who utilize these platforms to expand their customer base. However, as suppliers actively participate in these marketplaces, they are facing increasing pressure in their business operations. Consumers, governments and other stakeholders are pressuring companies to exhibit more Corporate Social Responsibility (CSR) behaviors due to the severe impacts of industrial activities on our environment and society (Ashby *et al.*, 2012). The concept of CSR was first introduced by Bowen (1953) who states that firms should not

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only pursue economic benefits, but also should pay attention to the needs of society, the economy, the environment and stakeholders. The definition of CSR has evolved over time in the literature, but in broad terms, CSR has been defined as "the voluntary integration by firms of social and environmental concerns in their business operations and their relationships with interested parties" (Commission of the European Communities-COM, 2001).

Over the last few decades, the literature in strategy, marketing and business ethics has confirmed the generally positive influence of CSR on consumers' evaluations of companies/brands, customer satisfaction, customer loyalty and customer-firm identification (Cruz and Wakolbinger, 2008; Dang *et al.*, 2020; Fatima and Elbanna, 2023; Lin *et al.*, 2023). Some studies even suggest that CSR positively associate with consumer purchase intention (Dang *et al.*, 2020), and increases the demand for the firm's product (Hosseini-Motlagh *et al.*, 2019). In practice, consumers are now willing to pay higher prices for firms' products and services with CSR attributes. According to the results of a 2016 survey by Nielsen [1],66% of survey respondents (up from 55% in 2015 and 50% in 2014) are willing to pay more for sustainable products that are committed to positive social efforts. However, Chen *et al.* (2023) show that the phenomenon of e-commerce platforms utilizing their digital power to practice algorithmic price discrimination strategies can also negatively affect consumers' perceptions of the platforms' CSR and ethics, and thus, their loyalty to these platforms. At the same time, Zeng *et al.* (2022) find that higher consumer perceptions of CSR in e-commerce can reduce their negative reactions to platform service failures. Therefore, e-commerce platforms, while increasingly powerful forces in supply chains, are particularly concerned about the aforementioned phenomenon. On one hand, these platforms are highly exposed to consumers' awareness, necessitating a response to their explicit or more diffuse social demands and expectations regarding environmental and social issues. On the other hand, these platforms can both directly and indirectly benefit from the investments decided by suppliers in CSR activities.

In response to this, most suppliers are increasingly interested in CSR activities, such as mitigating pollutant emissions, improving working conditions and making philanthropic donations to ensure their business practices are socially responsible (Lee and Kim, 2009). However, incorporating CSR into business operations often comes with significant costs, posing a considerable challenge for suppliers. This is especially true for small and medium-sized suppliers, who typically have little cash (Yi *et al.*, 2021) and limited access to commercial bank loans due to their weak credit ratings and lack of sufficient assets for collateral (Vandenberg, 2003). To tackle this challenge, some e-commerce platforms (e.g. Amazon and Alibaba) have started to offer financial aid to qualified suppliers, known as platform financing, specifically designed to relieve the financial pressure of suppliers. For instance, Amazon, the world's largest e-commerce platform in terms of revenue, launched in 2011 its lending program [2] to help suppliers invest in operations (equipment, inventory, etc.). Through the lending program, Amazon offers short-term loans of up to $750,000 exclusively for its suppliers. In another example, Alibaba Group Holdings has adopted the "Ant Micro Loan" to provide credit to small and micro-enterprise suppliers in its ecosystem. Since 2011, this program has issued $64.42 billion to millions of small and medium-sized suppliers who mostly need money. Other large retailers, including eBay Inc's PayPal, JD.com and Best Buy, which run third-party marketplaces, are also turning to financial service to boost their vendor base.

In addition to offering financial assistance, the platform possesses extrinsic motivations to incentivize its suppliers to make CSR investments. Concerns have recently grown louder regarding the insufficient CSR practices observed within various platforms. For instance, Amazon was sued by Mercedes for selling "strikingly similar" counterfeit autoparts [3]. These incidents emphasize the urgent necessity for e-commerce platforms to extend financial support towards CSR initiatives within their supply chains.

Several advantages of platform financing have already been highlighted in the literature at the interface of e-commerce and supply chain finance. For example, Tunca and Zhu (2018)

show that platform financing can simultaneously benefit supply chain participants. Wang *et al.* (2019) find that platform financing achieves the coordination of supply chain finance. Gong *et al.* (2020) investigate the value of platform financing, showing that this innovative financing plan is beneficial for both sellers and platforms. Nevertheless, all of the above research fails to consider the impact of this financing scheme on the CSR efforts of the supply chain participants. Fundamentally, the interaction between CSR and financing can exhibit a twofold influence on the platform's performance. On one hand, by alleviating financial constraints, this financing scheme can enable suppliers to have more financial resources for their CSR activities. In turn, these actions may positively influence customers' attitudes towards their products, improve competitiveness and allow firms to increase their sales and expand their business into new markets (Flammer, 2015), consequently affecting the revenue structure of the platform (through referral fees). On the other hand, the platform can bear the credit risk (the risk that the supplier fails to pay back the financing amount at the end of the financing period) when extending the financing amount to suppliers. Thus, the adoption of platform financing can have different impacts on platform operations, which is worth the effort to conduct a detailed analysis.

Motivated by these observations, we aim to study the operating mechanism behind platform financing, explore whether and how this financing scheme can drive the CSR efforts of the supply chain. Therefore, we focus on the following critical questions: (1) What is the impact of platform financing on the operational and CSR decisions of suppliers? (2) Can a well-designed financing program achieve both increased profits and improved CSR performance?

By exploring these research questions, we make two major contributions to the literature on the management of CSR within e-commerce platforms. First, our research reaffirms the important role of CSR and CSR investments within e-commerce markets for enhancing consumer satisfaction and loyalty. It emphasizes that CSR investment can only be effective when there is collaboration between e-commerce platforms and their suppliers. This collaboration serves to boost the motivation and engagement of suppliers in CSR initiatives, ultimately benefiting the entire supply chain by increasing profitability. Second, to the best of our knowledge, this study is the first to investigate the intersection of finance, operations and CSR within the context of an e-commerce supply chain. We seek to provide insights into how these aspects can interplay. These insights provide theoretical support on how platforms can adopt their financial services as a financing mechanism to encourage the CSR performance of their budget-constrained suppliers. In particular, our results reveal that all three of our proposed financing models help improve the supplier's CSR investment as long as consumer sensitivity towards CSR exists. Consequently, the platforms can adopt financial services to enhance both their profit and the social sustainability of their supply chain. Notably, the CSR-linked financing model leads to the highest profitability of the overall supply chain and each member. Therefore, the platform can prioritize funding suppliers that demonstrate a commitment to CSR practices.

The rest of this paper is organized as follows. Section 2 presents the problem formulations. In Section 3, we develop the modeling and analysis. Numerical analysis is conducted in Section 4 for further insights. Finally, we conclude this paper in Section 5.

2. Problem formulation

Supply chain structure: Consider a supply chain consisting of a budget-constrained supplier ("she") and an e-commerce platform (hereafter, platform) ("he"). The platform offers online marketplace services that enable a direct connection between the supplier and the consumer (Tian *et al.*, 2018). The supplier produces a finished product and sells it on the marketplace of the platform over a single selling period at a price p which is assumed exogenous. The platform charges the supplier a referral fee for each unit sold on the platform. The referral fee is an exogenously given percentage γ of the revenue. For each unit of any sold good on the

platform, the platform keeps a fraction $\gamma \in (0,1)$ of the revenue for herself and returns the rest $1-\gamma$ to the supplier. The supplier may make a CSR investment y (on each unit of product). The costs associated with this CSR investment are solely borne by the supplier.

Demand function: It is assumed that the CSR activities can potentially impacts the market demand, so the supplier faces a CSR-sensitive demand denoted by X which follows a normal distribution Normal$(\mu_0 + ag(y), \sigma_0)$, where μ_0 denotes the demand mean and σ_0 shows the standard deviation of primary demand when no CSR investment is made. The parameter a indicates the maximum increase in the expected demand due to the CSR investments. The function $g(y)$ is used to establish the relationship between the CSR investment and the CSR effort level, and consistent with Hsueh (2014), we model the CSR effort function as $g(y) = 1–1/(1 + 0.5y)$. For the sake of convenience, we denote the cumulative distribution function of the primary market demand ξ as $F[\xi]$, the complementary cumulative distribution function as $\overline{F}[\xi] = 1 - F[\xi]$, and the probability density function as $f[\xi]$. In addition, we utilize the symbol μ to represent $ag(y)$, and μ' to denote the first-order derivative of μ with respect to y.

Sequence of Events: The sequence of the events is shown in Figure 1.

Before each season, the supplier is endowed with some initial budget B which is insufficient to support her desired operations, e.g. pay for the costs of production and CSR investment. The platform offers a general financing model to the supplier. It is constructed as $\{L, r\}$ where L is the credit limit and r is the interest rate charged by the platform. If $L = 0$, it indicates that the platform does not offer any loan to the supplier. Conversely, if $L = +\infty$, the platform is willing to lend the supplier any requested amount. In addition, the interest rate r may be constant or depends on the supplier's production quantity and/or CSR effort level. Given a financing model $\{L, r\}$, the supplier simultaneously decides the loan size l, the production quantity q and the CSR investment per product y. These decisions must satisfy two conditions: (*1*) The supplier's available cash after borrowing does not fall below the expenses associated with production and CSR investment, i.e. $(c + y)q \leq l + B$, and (*2*) The loan amount not exceed the credit limit, i.e. $l \leq L$.

At the end of selling period, the demand is realized. The total sales revenue is realized as $p\min\{q, X\}$. The platform then takes a proportion γ cut of the total revenue. The supplier is allocated the remainder of the revenue and then repays the principal amount plus interest

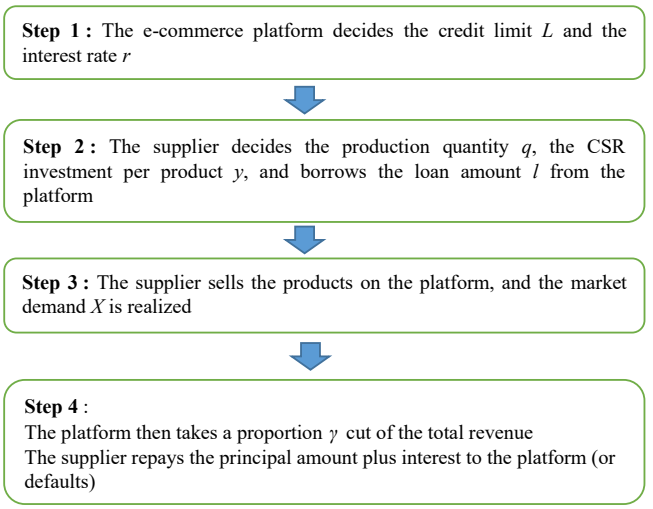

Figure 1.
Sequence of the events

Source(s): Figure by authors

$l(1+r)$ to the platform. However, if the supplier's revenue is not sufficient to fully repay the loan, such that $(1-\gamma)p \min\{q, X\} < l(1+r)$, the supplier defaults on her loan obligation. In such cases, the platform acquires the total revenue realized to recover the loan.

The decision-making process of the two supply chain members is modeled as a two-stage Stackelberg game in which the platform acts as the leader and the supplier as the follower. In the first stage, the platform moves first to make his decisions on the parameters of the financing models (i.e. the credit limit L and the interest rate, r). In the second stage, given the platform's offer $\{L, r\}$, the supplier simultaneously determines the loan value l, the production quantity, q and CSR investment y.

3. Modeling and analysis

3.1 No platform-based financing model

We begin by examining a benchmark scenario, where the platform financing is unavailable, and the supplier does not access to capital market. In this setting, the supplier uses her entire initial budget. Hence, the supplier's expected profit can be calculated as

$$\Pi_s = E[(1-\gamma)p\ min\{q, X\} - (c+y)q] = (1-\gamma)p\left(\mu + \int_0^{q-\mu} \overline{F}(\xi)d\xi\right) - (c+y)q \quad (1)$$

and, the platform's expected profit is

$$\Pi_P = E[\gamma p\ min\{q, X\}] = \gamma p\left(\mu + \int_0^{q-\mu} \overline{F}(\xi)d\xi\right) \quad (2)$$

Given $\gamma \in (0,1)$, the supplier solves the following constrained optimization problem:

$$\max_{q,y} \Pi_s \quad (3)$$

$$\text{subject to} (c+y)q \leq B \quad (4)$$

where the inequality (4) represents the supplier's budget constraint.

Proposition 1 presents the optimal decisions in the benchmark case with no budget constraints. Moving forward, Proposition 2 shows the optimal decisions with the presence of budget constraint.

Proposition 1. When the supplier has sufficient budget, the optimal operational decisions (q^N, y^N) that maximizes the supplier's expected profit are given by the following simultaneous equations.

$$\begin{cases} y = p(1-\gamma)\overline{F}[q-\mu] - c \\ q = p(1-\gamma)\mu'\left(1-\overline{F}[q-\mu]\right) \end{cases}$$

Proposition 2. When the supplier is budget-constrained, the optimal operational decisions (q_0^*, y_0^*) that maximizes the supplier's expected profit are given by the following simultaneous equations.

$$\begin{cases} \dfrac{q}{c+y} = \mu'\left(\dfrac{1}{\overline{F}[q-\mu]} - 1\right) \\ (c+y)q - B = 0 \end{cases}$$

Plugging either (q^N, y^N) or (q_0^*, y_0^*) back in equations (1) and (2), we obtain the first-best profit of the supplier and the platform respectively.

3.2 Platform financing

3.2.1 Optimal decisions under a general financing model {L, r}. When the selling season ends, the supplier obtains revenue $(1-\gamma)p\ min\{q, X\}$ from selling products. She then repays $min[(1-\gamma)p\ min\{q, X\}, l(1+r)]$ to the platform. Thus, the expected profit of the supplier is formulated as below:

$$\Pi_s = E[(1-\gamma)p\ min\{q, X\} - \min\{(1-\gamma)p\ min\{q, X\}, l(1+r)\}] - B \tag{5}$$

The expected profit of the platform is modeled as follows:

$$\Pi_P = E[\gamma p\ min\{q, X\}] + E[\min\{(1-\gamma)p\ min\{q, X\}, l(1+r)\}] - l \tag{6}$$

In Eq. (6), the first term represents the sales revenue cut, the second term is the loan repayment, and the third term is the loan size.

Let $\widehat{X} = \frac{l(1+r)}{p(1-\gamma)}$ be the supplier's default threshold (i.e. the minimal demand level that the supplier can fully repay her loan obligation (loan amount plus interest). Then, the expected profits the supplier and the platform can be calculated as:

$$\Pi_s = (1-\gamma)p\left(\int_{\widehat{X}-\mu}^{q-\mu} \overline{F}(\xi)d\xi + \widehat{X}\overline{F}[\widehat{X}-\mu]\right) - l(1+r)\overline{F}[\widehat{X}-\mu] - B \tag{7}$$

$$\Pi_P = \gamma p\left(\mu + \int_0^{q-\mu} \overline{F}(\xi)d\xi\right) + (1-\gamma)p\left(\mu + \int_0^{\widehat{X}-\mu} \overline{F}(\xi)d\xi - \widehat{X}\overline{F}[\widehat{X}-\mu]\right) + l(1+r)\overline{F}[\widehat{X}-\mu] - l \tag{8}$$

Recall that the platform and supplier play a Stackelberg game, we thus use backward induction to derive the optimal decision parameters. Given the platform's offer $\{L, r\}$, the supplier simultaneously determines the loan size l, the production quantity, q and CSR investment y by solving the following problem:

$$\max_{q,y,l} \Pi_S(q, y, l) \tag{9}$$

$$subject\ to \begin{cases} (c+y)q \le l + B & (9a) \\ l \le L & (9b) \end{cases}$$

where the supplier's objective function Π_S as presented in Eq. (7). Constraint (9a) is supplier's budget constraint, a supplier cannot spend more than what her initial budget and the loan can afford. Constraint (9b) ensures that the supplier borrows within the credit limit offered by the platform.

Anticipating the supplier's reaction, the platform determines the optimal financing parameters by solving the following optimization problem:

$$(\mathbf{P})\ \max_{L,r} \Pi_P(l, r) \tag{10}$$

where the platform's objective function as presented in Eq. (8).

Problem (**P**) represents of a two-level optimization problem, where the first level problem is associated with the platform, while the second level problem, the inner problem, is associated with the supplier. Problem (**P**) must be solved to find the equilibrium decisions. However, the solution for problem (**P**) depends on how the interest rate is determined (i.e. the interest rate is constant or depend on q and/or y), and is hard to solve in general.

3.2.2 Strategic financing. We investigate three kinds of financing models based on how interest rates are determined. The three models are (1) Target rate of return (TRR), (2) Credit limit and (3) CSR-linked financing.

3.2.2.1 The TRR model. In the TRR model, the platform does not impose any limits on the loan size. Instead, the platform charges an interest rate to the supplier, ensuring that the expected loan payment should compensate for the platform's required rate of return, denoted by $\widehat{r}$. Hence, for a given $\widehat{r}$, the interest rate charged by platform r is determined by

$$l(1+\widehat{r}) = E[min\{(1-\gamma)p\ min\{q, X\}, l(1+r)\}] \tag{11}$$

By some expanding the terms, Eq. (11) can be rewritten as

$$l(1+\widehat{r}) = l(1+r)\overline{F}[\widehat{X}-\mu] + (1-\gamma)p\left(\int_0^{\widehat{X}-\mu}\overline{F}(\xi)d\xi - \widehat{X}\overline{F}[\widehat{X}-\mu]\right) \tag{12}$$

Substituting Eq. (12) into the expected profits of the supplier and the platform respectively, we simplify their respective expected profits as

$$\Pi_S = (1-\gamma)p\left(\mu + \int_0^{q-\mu}\overline{F}(\xi)d\xi\right) - ((c+y)q - B)(1+\widehat{r}) - B \tag{13}$$

$$\Pi_P = \gamma p\left(\mu + \int_0^{q-\mu}\overline{F}(\xi)d\xi\right) + ((c+y)q - B)\widehat{r} \tag{14}$$

3.2.2.2 Credit limit model. In the credit limit model, the platform establishes a maximum loan amount (i.e. L) that the supplier can borrow, as well as a fixed interest rate that does not depend on the supplier's decisions. Increasing the credit limit allows the supplier to increase the scale of her operations (production and CSR investment). This leads to higher operation income for the platform. In the opposite effect, the platform could bear more loss in the event that the supplier defaults. Therefore, we intuitively expect the existence and uniqueness of a credit limit L that maximizes the profit of the platform for a given fixed interest rate, and the optimal value of L be characterized by a balance between the platform's operation income and the expected loss on the loan amount. Mathematically, the platform's problem under the credit limit model is the same as problem (**P**) presented in Section 3.2.1 where r does not depend on both q and y. To solve problem (**P**) in this case, we rely on the assumption of the concavity of supplier's expected profit function with respect to q and y. Hence, we replace the inner problem by its corresponding Karush–Kuhn–Tucker (KKT) conditions and thus reduce problem (**P**) into a single objective function of the platform with a set of constraints (KKT conditions). This optimization problem can be solved by continuing to use the KKT approach.

3.2.2.3 CSR-linked financing. In the CSR-linked financing model the platform encourages the suppliers invest in CSR activities by reducing the interest rate when suppliers increase their CSR performance. A higher CSR performance level corresponds to a lower financing interest rate. We propose a CSR-linked financing under which the platform first releases a potential maximal interest rate R and then determines a final interest rate r according to the supplier's CSR performance level. That is $r = R - \beta g[y]$, where $g[y]$ represents supplier's CSR performance level corresponds to her CSR investment y, and $\beta \geq 0$ represents sensitive coefficient (discount coefficient) of the supplier's CSR performance level to the interest rate.

The basic decision variables of the platform in the CSR-linked financing model are the maximal interest rate R and the discount coefficient β. Mathematically, the platform's problem under this financing model as described in problem (**P**) where the constraint (9b) is removed, and the platform's decision on the interest rate is converted into the decisions of the maximal interest rate and the discount coefficient. The analytical solutions of this kind of problems are also difficult. Therefore, we leave it to be resolved by a numerical method to get the equilibrium decisions the next section.

4. Numerical analysis

In this section, we investigate numerically the supply chain performance under the three financing models discussed, and develop more insights. We use the base case parameters which are the same as presented in Table 1.

4.1 Budget constraint

We first consider the budget constraint. By varying $B = 0, 300, 600, \ldots, 2100$, we present the supply chain outcome in Figure 2. This figure clearly shows that the supplier's production quantity, CSR effort and profits all increase as the supplier's initial budget increases. The result demonstrates that a shortage of funds negatively impacts the overall supply chain performance. Therefore, it is necessary to implement platform financing to help these suppliers alleviate liquidity problems, which is also better for the platform.

4.2 Impact of platform's decisions on supply chain performance

Figure 3 presents how the platform's financing decisions effect the various supply chain outcomes, including production quantity, CSR effort (proxied by the CSR performance level $g(y)$) and profits. It can be observed that the CSR effort increases with the credit limit but decreases with the target rate of return. This suggests that the platform has the flexibility to

Notation	Meaning
Objective function	
Π_P	The expected profit of the platform
Π_S	The expected profit of the supplier
Decision variables	
L	The credit limit decided by the platform
r	The interest rate charged by the platform
q	The production quantity decided by the supplier
y	CSR investment level decided by the supplier
l	Loan amount borrowed by the supplier

Exogenous parameters		Typical value (hypothetical)
γ	The referral fee	0.15
p	Product price	30
c	Unit cost of production	16
B	Initial budget of the supplier	0
a	The maximum demand increase due to CSR	100
μ_0	The mean of primary demand	100
σ_0	The standard deviation of primary demand	35

Source(s): Table by authors

Table 1.
Notations

adopt different financing decisions to encourage the CSR performance of their suppliers. Regarding the platform's profit, Figure 3 illustrates that it is concave in both the target rate of return and the discount coefficient, while it is non-decreasing with the credit limit. Therefore, the platform can improve its profits by increasing the credit limit and carefully setting appropriate levels for the rate of return and the discount coefficient. Overall, Figure 3 highlights the platform's ability to strike a balance between encouraging CSR performance and ensuring profitability. By making thoughtful financing decisions, the platform can effectively achieve both goals.

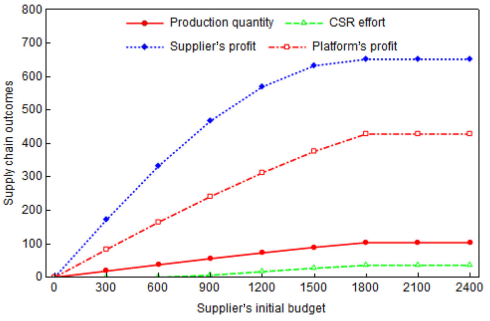

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Figure 2.
Impact of supplier's initial budget on the supply chain performance

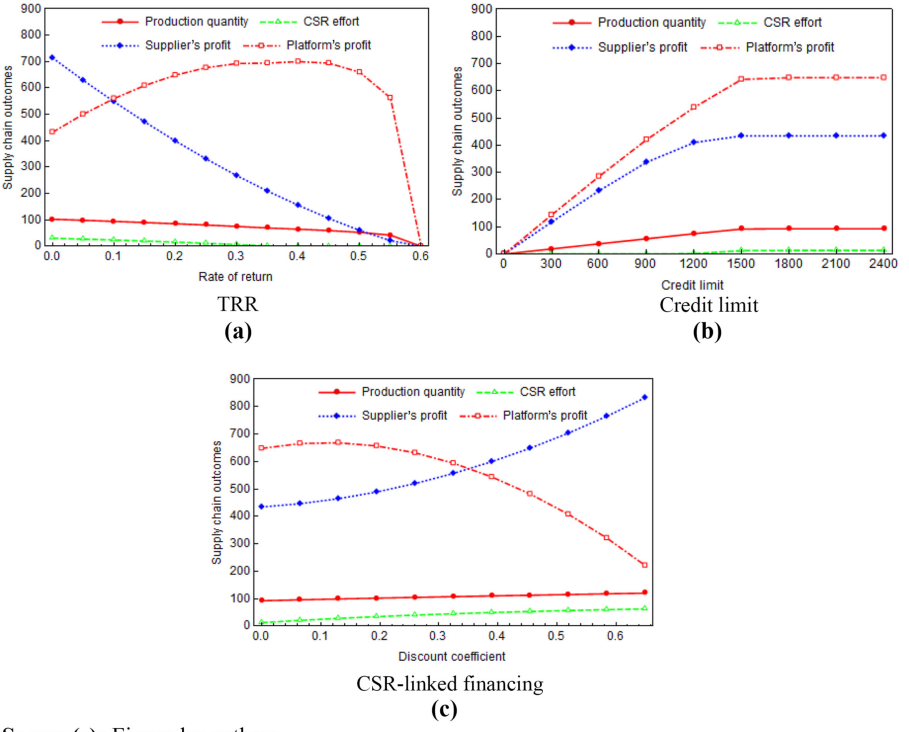

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Figure 3.
Impact of platform's decisions on supply chain performance

4.3 Comparisons of different financing models

In order to compare three financing models from different perspectives of supply chain partners, some scenario-based demands are investigated. Table 2 provides data (hypothetical) for these investigated scenarios.

Table 3 presents the equilibrium results under the three financing models. Comparing the CSR investment decisions across these financing models, we observe that, in all scenarios, the CSR investment is highest in the CSR-linked financing model, followed by the TRR model, while it is the lowest under the credit limit model. Additionally, the profits of the platform and the entire supply chain also reveal that the CSR-linked financing model generates the highest profit for both the platform and the entire supply chain in all scenarios. Therefore, the CSR-linked financing model not only maximizes the profitability of the platform but also motivates the suppliers to invest more in CSR activities. However, the CSR-linked financing model does not lead to an increase in the economic profitability of the supplier. Among the three discussed models, the supplier generates a positive profit in the TRR and credit limit models but receives zero profit under the CSR-linked financing model. Consequently, from the supplier's perspective, this CSR-linked financing model is not preferable when the credit limit and TRR models are available options. We also would like to note that the profits of the platform and the supplier are zero without presence of platform financing since the initial

Table 2.
Data (hypothetical) for investigated scenarios

Scenarios	Description	(μ_0, σ_0)
Scenario 1	Low-demand scenario	(40, 15)
Scenario 2	Medium-demand scenario	(60, 25)
Scenario 3	High-demand scenario	(100, 35)

Source(s): Table by authors

Table 3.
Equilibrium results in three different financing models

	Scenario 1	Scenario 2	Scenario 3
TRR			
Target rate of return	0.28	0.27	0.31
Production quantity	39.35	48.30	70.38
CSR investment	0.82	0.65	0.17
Supplier's profit	126.13	152.47	224.09
Platform's profit	356.33	426.76	655.09
Credit limit			
Credit limit	697.76	905.83	1378.90
Fixed interest rate	0.32	0.34	0.31
Production quantity	42.17	55.70	85.69
CSR investment	0.54	0.24	0.00
Supplier's profit	118.41	147.49	222.35
Platform's profit	369.73	444.44	679.21
CSR-linked financing			
The maximal interest rate	0.82	0.98	0.66
Discount coefficient	0.80	0.80	0.47
Production quantity	106.88	70.19	113.20
CSR investment	2.68	1.56	1.34
Supplier's profit	0.00	0.00	0.00
Platform's profit	1092.64	996.77	1109.76

Source(s): Table by authors

budget of the supplier is zero. Thus, CSR-linked financing model is the best choice for the platform in maximizing her profits while ensuring the supplier's participation when the supplier's initial budget is zero. In other words, facing with a zero-budget supplier the platform prefers the CSR-linked financing model and does not initiate both models of credit limit and TRR.

When the supplier has some initial budget, she can generate a positive profit by utilizing her entire initial budget. In this case, we investigate whether both supply chain members are still better off with the CSR-linked financing model (compared to other financing models). Based on scenario 3, we change the supplier's initial budget from zero to 1800 (the level of budget where the supplier is not budget-constrained). Our numerical results (as presented in Table 4) show that there always exist specific parameters (R, β) such that the CSR-linked financing model can simultaneously achieve the following objectives: (1) improve CSR performance; (2) improve total channel profits; (3) ensure that each partner in the channel can benefit from the model. Therefore, our numerical results suggest that the CSR-linked financing model is the unique financing equilibrium for the supply chain.

5. Conclusion and implications

Companies around the world are facing critical challenges in CSR investment. In particular, e-commerce platforms governing supply chains may find it challenging to motivate their suppliers, especially budget-constrained small and medium-sized enterprises, to adopt CSR and/or increase their related expenditures. In this study, we investigated a supply chain in which a supplier faces budget constraints but is keen on investing in CSR activities to stimulate market demand. To tackle the supplier's budget constraints, the e-commerce platform offers three distinct financing models: target rate of return (TRR), the credit limit and CSR-linked financing. The credit limit model enables the supplier to access a credit amount without surpassing the established credit threshold. In the target rate of return model, the platform sets a specific target rate of return on its financing amount. The CSR-linked financing model establishes a connection between the supplier's CSR effort and the interest rate applied to the financing.

We have employed a Stackelberg game to analyze the equilibrium decisions under each financing model. Our theoretical and numerical analyses initially show that all three financing models can simultaneously lead to greater engagement in CSR activities by the supplier and higher profits for all supply chain members compared to a similar situation without such financing models. Second, the adoption of a CSR-linked financing model can result in the highest profits for both members as well as an improved CSR performance by the supplier.

Models	Production quantity	CSR investment	Supplier's profit	Platform's profit	Whole channel profit
Benchmark	18	0.30	165.8	80.4	246.2
Credit limit (r* = 0.26, l* = 1185)	89	0.65	223.0	658.9	881.9
TRR (r* = 0.21)	90	1.01	384.2	642.3	1026.5
CSR discount (R, β)					
(R, β) = (0.35, 0.2)	106	1.35	393.2	742.6	1135.2
(R, β) = (0.36, 0.3)	116	1.78	460.8	724.6	1187.6
(R, β) = (0.45, 0.5)	122	2.58	471.6	469.6	944.8

Source(s): Table by authors

Table 4. Computational results in the equilibrium for different models when $B = 300$

Our results provide some practical implications as follows. First, for e-commerce platforms, providing supply chain financial services and integrating CSR criteria into supplier evaluation processes can not only effectively mitigate the financial pressure of suppliers but also improve the CSR performance and profits of their supply chain. By doing so, the platform can prioritize lending suppliers that demonstrate a commitment to CSR practices. Second, our results provide a theoretical explanation for the phenomenon of the increasing inclination of many large e-commerce platforms, such as Amazon.com and JD.com, to use financial services to support their suppliers. Moreover, considering the growing role of financing services offered by these platforms and their demonstrated effectiveness in promoting CSR initiatives, policymakers should expedite the establishment of a regulatory framework to facilitate lending activities by these platforms.

Our work may be viewed as a first attempt to examine the interplay of finance, operations and CSR within the context of an e-commerce supply chain. It emphasizes the critical importance of collaborative efforts between e-commerce platforms and their suppliers for the effectiveness of CSR investments. Therefore, the integration of both supply chain finance and CSR coordination will be a promising avenue for future research.

Notes

1. http://sites.nielsen.com/yearinreview/2016/global-responsibility-and-sustainability.html
2. https://sell.amazon.com/programs/amazon-lending
3. https://ipwatchdog.com/2017/11/15/daimler-trademark-lawsuit-amazon-infringement-counterfeits/id=90101/

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