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Risk Sharing, SMEs' Financial Strategy, and Lending Guarantee Technology

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Abstract: Several governments use the Credit Guarantee Schemes to ease SMEs' access to funding and support their growth and survival. This paper suggests a lending guarantee technology based on risk sharing through a *de facto* shareholding agreement to cover potential losses and reduce the premature default risk. The simulation of a typical entrepreneurial experiment shows that the key SMEs dynamics (value creation, profitability, risk, leverage, and equity multiplier, among others) and other related financial additionality and sustainability indicators are substantially improved. The ideal financial strategy for the SMEs' entrepreneurs is to keep lower levels of the equity multiplier to transmit positive signals to the market, which improves the business prospects and related creditworthiness. The results indicate that risk sharing alleviates the financiers' reluctance to increase the SMEs funding and improve their risk management systems.

Keywords: risk sharing; entrepreneurship; SMEs; credit-guarantee scheme; dynamics; Saudi Arabia

JEL Classification: G24; G32; G33; G38; I3; M13

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1. Introduction

How can lending restrictions be relaxed for small- and medium-sized enterprises (SMEs)? To what extent can risk-sharing mechanisms be useful for credit-guarantee schemes (CGSs) to favor the unlocking of funding sources? In this article, we attempt to answer these questions and infer the impact on projects' dynamics, SMEs' most suitable financial strategy, and corresponding development opportunities.

The access of SMEs to equity and debt markets is always costly because of the capital-market imperfections. The World Bank (2015) reported that up to 68% of formal SMEs in emerging markets are either unserved or underserved by financial institutions, with a resulting financing gap that is estimated to be close to USD 1 trillion worldwide. This financing gap is principally due to agency-driven problems and a pronounced moral-hazard risk on the part of SMEs. The latter suffer from a lack of collateral, historical financial performance, and documented accounting records. Because of their orthodoxy, financiers are reluctant to raise funds in the absence of perfect market conditions.

The most common form of government interventions to support the SME sector is CGSs, with the aim of unlocking funding sources in more than half the countries around the world (World Bank 2015). Although there is no canonical legal framework and no unique model, CGSs play the role of a third-party risk guarantor for financiers by partly covering their potential losses (in the case of default) on loanable funds to SMEs, in exchange for fixed fees. CGSs contribute to expanding the loanable funds raised for the SME sector. In addition, positive externalities can be brought forth to see that banks, finance companies, non-bank institutions, and venture capital funds have more incentives to increase their engagements with SMEs, which can improve their lending technologies and risk management systems.

The purpose of this article is to suggest an entrepreneurial model for Saudi Arabia, based on risk sharing that simultaneously allows for total or partial loss coverage on raised

funds and the involvement of CGSs as *de jure* (financial contracting stage) and *de facto* (fund raising stage) shareholders, according to a venture capital setup. The entrepreneurial literature is almost silent about the role of risk sharing in unleashing funding for the SME sector and the related contribution to risk management systems for financiers. This article focuses initially on this gap in order to show how risk sharing has interesting merits for both entrepreneurs and financiers and to what extent it can contribute to the development of the SME sector.

The simulation design and the discussion of results show that all projects' dynamics under consideration are improved when the suggested entrepreneurial model is enforced. In addition, the CGSs' sustainability and capital formation are substantially improved. Financiers' reluctance is alleviated and a project's premature default is significantly reduced to its lowest level. Such merits can have a considerable impact on the growth of the SME sector and on contributions to the Saudi economy. The embedding of the risk-sharing mechanism into the entrepreneurial model improves financiers' lending technologies and can contribute to unleashing required funding for the SME sector.[1]

The remainder of this article is organized as follows. Section 2 provides some background. Section 3 discusses the research question and the hypothesis development. Section 4 presents the entrepreneurial model. Section 5 explains the methodology and the simulation design. Section 6 provides the results and the implications. Finally, Section 7 provides conclusions.

2. Background

2.1. Literature Review

The access of the SME sector to external funding sources is closely associated with innovation, job creation, social welfare, and economic development. Indeed, the performance of this sector is usually associated with the largest contribution to the gross domestic product (GDP) and highest share of total employment in most developed economies. The OECD (2017, p. 9) reported that "in all countries, micro-enterprises (up to 9 employees) dominate the business landscape, accounting for 70% to 95% of all firms. Nevertheless, significant cross-country differences are observed in the contribution of micro-enterprises to employment and value added. For instance, in the services sector, their share in employment ranges from more than 60% in Greece to 20% in Denmark and Germany, while their share in value added ranges from about 45% in Luxembourg to 15% in Switzerland".

The inability to access external finance is frequently considered as the major obstacle for the SME sector. As seen from financiers' perspectives, financial market failures, information asymmetry, lack of valuable collaterals, and limited expertise outweigh SMEs' growth potential. The financing constraints become severe when access to external finance is limited and/or accessible only at a hurdle rate.

According to the OECD (2017), other forms of obstacles that hinder the SME sector from growing include the following: (i) inefficient insolvency regimes, (ii) the complexity of regulatory procedures and conditions for regulatory compliance, (iii) disproportionate access to innovative technology, (iv) high costs of tax compliance, and (v) the inability to access strategic sources.

A large body of theoretical and empirical studies has examined the lending restrictions imposed on the SME sector and their related determinants and mitigations. Two principal strands of theoretical literature support the foundation of financing-constraints theory. First, the capital structure theory explores the optimal financing choices for managers who are subject to capital-market imperfections to tailor their choices either through the trade-off theory (Kraus and Litzenberger 1973) or the pecking-order theory (Myers 1984; Myers and Majluf 1984). Second, the financial-intermediation theory (Diamond 1984) explores bank–firm ties and the impact of net worth and collateral in alleviating the severity of financing constraints. Most of the original theoretical and empirical contributions to the financing constraints theory[2] (e.g., Fazzari et al. 1988; Kaplan and Zingales 1997; Hubbard 1998; Carpenter and Petersen 2002) confirm that the capital accumulation of the most constrained

firms is most likely hampered by market failures. Investment–cash-flow sensitivity is debated as the relevant indicator of the degree of financing constraints.

Banerjee (2014) studied the impact of financing constraints on profitability across age distribution of SMEs. He showed that financing constraints reduce the profitability and become more severe when reporting to lenders that access to finance is the greatest obstacle. Moscalu et al. (2020) investigated the impact of financing constraints on the growth of the SME sector and the role that the banking markets' integration might play in this regard. The authors found that the perceived, rather than the actual, financing constraints undermined SMEs' growth and that increasing the integration of banking markets fostered it.

CGSs play a central role in delivering governmental support and ensuring that public resources are used efficiently to enable the ecosystem to function and to improve the support for the SME sector. Indeed, CGSs can enlarge SMEs' potential to access wider financing sources by relaxing the collateral requirements. The Vienna Initiative (2014, p. 9) Report considered that the basic CGSs' business model entails providing "guarantees on loans to borrowers by covering a share of the default risk of the loan. In case of default by the borrower, the lender recovers the value of the guarantee. Guarantees are usually provided against a fee, covered either by the borrower, the lender or both. In case of a default, the lender usually is obliged to proceed with the collection of the loan and share the proceeds with the guarantor. Credit guarantees allow the partial transfer of credit risk stemming from a loan or a portfolio of loans. In this respect, they show similarity to credit insurance products and credit default swaps".

Public CGSs are created by public authorities and are considered as independent legal bodies that can use the business models of various structures, such as development financial institutions and development funds. Independently of the business mode they choose, all public CGSs are run by public authorities that tailor the SME-sector-support strategy. Such a strategy can include, among other things, a bundle of policies that guarantee the SMEs directly, provide counter-guarantees to private CGSs, and/or help them to have access to financiers.

Although most CGSs in emerging economies are held by public authorities, private forms of CGSs exist in some of the developed economies. Indeed, such private CGSs can take the form of mutual guarantee schemes created by beneficiary SMEs. The latter contribute the capital to the mutual CGS and benefit from loan guarantees in the form of mutual shares.

There are large numbers of successful credit guarantee institutions in developed and emerging economies. In Chile, the established CGS is the Partial Credit Guarantee Fund (FOGAPE). According to the OECD (2009), the size of guaranteed loans covered by the guarantee fund reached USD 472 million in 2004 with a 65% coverage ratio. The partial coverage ratio ranged from 50% to 80% for loans above and below USD 90,000, respectively. The success of FOGAPE was mainly attributed to (i) a strong regulatory and supervisory ecosystem, (ii) intensive promotional campaigns by the government, and (iii) transparency and equal access to the services of the program by all.

South Korea created its credit guarantee scheme (KOTEC) in 1989 as a non-profit guarantee institution under the new "Korea Technology Finance Cooperation Act". KOTEC is oriented toward supporting SMEs' investments in technology. Kang and Heshmati (2008) showed that KOTEC played a positive role in improving the sales growth and productivity of companies that benefited from KOTEC services.

CGSs' ability to ensure a better risk mitigation of projects and to alleviate information-driven frictions attracted the attention of supranational institutions to support their role and to contribute to their regulation. According to the World Bank's (2015, p. 2) report, "the CGSs may add limited value and nay prove costly when they are not designed and implemented well". Viewed from governments' perspectives, CGSs may be inefficient if their capital is eroding; i.e., they may not be sustainable and their financial additions to economies may not be significant.

In conjunction with stakeholders from global financial systems, the World Bank Group and the FIRST (Financial Sector Reform and Strengthening) Initiative developed CGS principles via consensus and extensive consultation. The objective of these principles is to serve as a generally accepted set of good rules of conduct for the design, execution, and evaluation of public CGSs in relation to four areas that are covered by these principles: (i) the legal and regulatory framework; (ii) corporate governance and risk management (iii) the operational framework; and (iv) monitoring and evaluation.

2.2. Institutional Context in Saudi Arabia

The Saudi economy is undergoing a structural transformation after the implementation of Vision 2030. Due to its leading position in global energy markets and their high dependency on oil, Saudi authorities developed this strategic plan to diversify income sources and to re-tailor the economy structure to ensure its sustainability and resilience.

Mansour et al. (2020) reported that, despite a 90% share in the number of registered businesses and a 60% share in total employment, the overall contribution of SMEs in the economic and social atmosphere has been below expectations. For example, only 2% of Saudi Arabia's total lending in 2011 was allocated to the SME sector. The Saudi authorities instituted the Small and Medium Enterprises General Authority (*Monsha'at*) in 2016 in order to establish the SME market, support its growth, and increase its contribution to GDP to 35% by 2030.

Monsha'at's mission is in line with Vision 2030's aspirations. Indeed, it has generated a number of initiatives to support SMEs in accessing external finance. A government venture capital with SAR 2.8 billion in capital investments deployed around SAR 1 billion through indirect lending.

In the midst of the Saudi SME ecosystem, the *Kafalah* program has been a vital player since it was instituted by the Saudi government to offer partial guarantees to SMEs. Like the Cooperation Council for the Arab States of the Gulf (GCC), the *Kafalah* program is open to SMEs that are more exposed to moral-hazard risks. *Kafalah* is supported by *Monsha'at* in conducting its mission. Indeed, *Monsha'at*'s boards of directors are in charge of issuing and enforcing the guarantees, in line with the Saudi Ministry of Finance. Table 1 provides a summary comparison of the most notable credit guarantee institutions in the GCC. According to the Kafalah Program (2020), Kafalah financings increased by 156% during 2020, reaching a total of SAR 12.3 billion. The Kafalah program approved 5720 financing requests during 2020, compared with 1777 requests during 2019.

Table 1. State-sponsored credit guarantee programs for the SME sector in the GCC.

	Saudi Arabia	Bahrain	United Arab Emirates	Qatar
Program	Kafalah	Tamkeen	Khalifa fund, Dubai SME	Qatar Development Bank
Direct financing	Not applicable	5000–250,000 dinars	Yes	Not applicable
Coverage ratio	Up to 80 percent of principal *	Up to 50 percent of principal	Yes	Case by case, up to 80 percent of principal
Requirement	Open to all active banks	Open mostly to partners of Bahrain Development Bank	Selected banks	Open to all active banks

Source: Mansour et al. (2020), adapted from the World Bank (2016). * The Kafalah program has updated the coverage ratio policy to more than 80% for some sectors to foster their growth.

The Saudi SME institutional context is complemented by the issuance of the Financial Sector Development Program (FSDP) as a national strategy implemented jointly by many governmental institutions, such as the Saudi Central Bank, the Ministry of Finance, the Capital Market Authority, and the Fund of Funds. The most recent FSDP (2021) report updates the expected impact of the governmental initiatives in relation to the SME sector,

the most important of which is to increase loans to SMEs, as a percentage of bank loans, to 11% by 2025.

3. Research Question and Hypothesis Development

This article aims to answer the following question: Will the entrepreneurial risk-sharing mechanism improve SMEs' dynamics and contribute to higher value creation?

Although they can carry a high potential value, the SMEs projects face tightened financial constraints in the early years. Using the risk-sharing mechanism, we expect to see the lending restrictions relaxed by financiers on account of improved project dynamics and other indicators of value creation and sustainability. Premature defaults are expected to be lowered to their minimum level during the early years of the project, which is the main advantage of improvements in financiers' lending technology.

We use a simulation design to test for the hypothesis that project dynamics and related value creation indicators are improved with the use of the entrepreneurial risk-sharing mechanism, against the hypothesis that they are not improved.

4. Risk-Sharing Entrepreneurial Model

We start with a basic entrepreneurial model based on a risk-sharing financing mechanism in an economy in which entrepreneurs are risk neutrals. A typical entrepreneur in this economy is endowed with an initial wealth, W_0, and is willing to invest at time $t = 1$ in a project that costs $I_1 > W_0$. In order to finance the project, the entrepreneur needs to raise long-term external funds ($B = I_1 - W_0$) from a financier at a determined mark-up rate amounting to r. With the agreement of the credit-guarantee scheme, it is assumed—for simplicity purposes—that the financier offers a standard contract, according to which the entrepreneur has to hand over constant linear repayments $\left(\frac{B}{T}\right)$ and the funding mark-up (cost), rB, where T is the project's duration.

The project's investment evolves according to capital accumulation, as reflected by the following accounting identity:

$$I_t = K_t - (1 - \delta)K_{t-1} \tag{1}$$

where K_t and K_{t-1} represent the capital at times t and $t - 1$ and $0 < \delta < 1$ is thedepreciation rate. The entrepreneur's project generates a revenue, R_t, and experiences a fixed cost, C. The project's profit is defined as:

$$\pi_t = R_t - \left(r + \frac{1}{T}\right)B - C. \tag{2}$$

The timing of events is described in Figure 1. The main aspects of stages 1 and 2 can be expressed as follows:

Stage 1

- The entrepreneur approaches the financier, revealing the project's business prospects. The financier agrees to raise the required funding in accordance with the credit-guarantee agreement that is already effective with the CGS.
- The CGS agrees to cover the project's risk, according to the risk-sharing principle.
- The entrepreneur allocates the investment funds and effectively starts the operating activities.

Stage 2

- By the end of each fiscal year, the entrepreneur reveals the information related to profit and hands over $\left(\frac{1}{T} + r\right)B$ to the financier.
- In case the entrepreneur reports a default for a given fiscal year t ($\pi_t < 0$), the CGS injects $\left[\left(\frac{1}{T} + r\right)B + C\right] - R_t$ into the project's capital to eliminate any risk of premature default and to ensure its business continuity. In this case, the financier

will surely receive from the entrepreneur the agreed-upon repayment in due time. In exchange for the injected loss, the entrepreneur becomes committed to considering the CGS as a stockholder and pays, starting from $t+1$, the share of profit on a pro rata basis of the injected funds.

– In case the entrepreneur reports a profit, the financier receives the agreed-upon repayment in due time. The CGS does not cover any loss, because the project is successful.

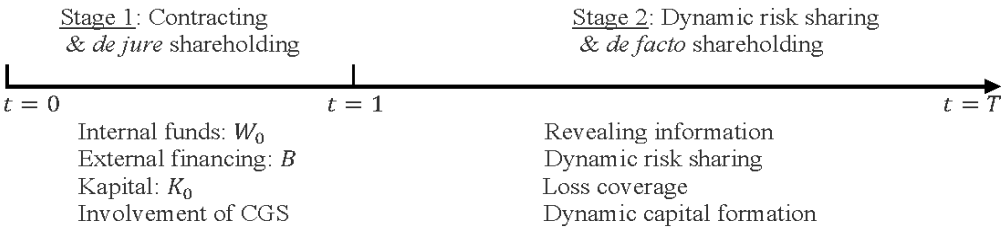

Figure 1. Timing of events.

Figure 2 shows the risk-sharing mechanism; it shows the CGS's commitment to be engaged as a *de jure* shareholder in stage 1. Any loss will accordingly be covered, which entitles the CGS to earn a share in the project's capital in proportion to the sum of injected funds. The purposes of the CGS are to ensure the raising of external funds by the financier and to guarantee the business continuity of the project, especially during the early years of the project. If the economic conditions improve and the entrepreneur considers that the CGS's involvement as a *de facto* shareholder is no longer needed, an exit option and repurchase agreement can be discussed and implemented any time during stage 2. The exit option is easier when the CGS's involvement[3] in the project is limited.

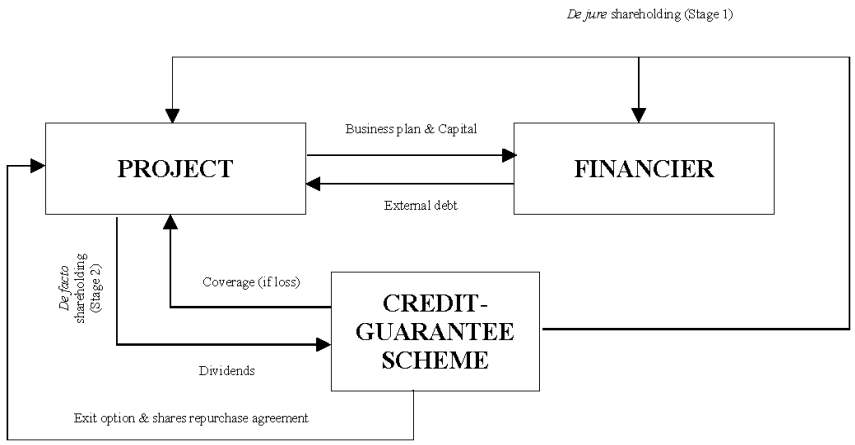

Figure 2. Risk-sharing mechanism. Source: adapted from Mansour et al. (2015).

The entrepreneur's profit, π_t^e, can be defined through the following discontinuous function (for any $1 \leq t \leq T$):

$$\pi_t^e = \begin{cases} 0, If\ R_t < \left[\left(\frac{1}{T}+r\right)B + C\right] \\ R_t - \left[\left(\frac{1}{T}+r\right)B + C\right], Otherwise \end{cases} \quad (3)$$

Equation (3) indicates that the entrepreneur's profit can either be equal to zero, when the project is unsuccessful, or to the excess of the revenue over the sum of all operating and financial expenses, $\left(R_t - \left[\left(\frac{1}{T}+r\right)B + C\right]\right) > 0$, when the project is successful. As stage 2 indicates, the CGS will intervene each time the project turns out to be unsuccessful

by injecting $\left|R_t - \left[\left(\frac{1}{T} + r\right)B + C\right]\right|$ into the project to cover the loss. Accordingly, once the CGS has covered the loss at least once, say during fiscal year $t-1$, the entrepreneur's profit-discontinuous function, starting from the next fiscal year t, becomes equal to:

$$\pi_t^e = \left(R_t - \left[\left(\frac{1}{T} + r\right)B + C\right]\right)\left[1 - \left(\frac{\sum_{t=1}^{t=n} d_t\left[n\left[\left(\frac{1}{T} + r\right)B + C\right] - \sum_{t=1}^{t=n} d_t R_t\right]}{K_0 + \sum_{t=1}^{t=n} d_t\left[n\left[\left(\frac{1}{T} + r\right)B + C\right] - \sum_{t=1}^{t=n} d_t R_t\right]}\right)\right], \quad (4)$$

$$d_t = \begin{cases} 1, & If\ R_t < \left[\left(\frac{1}{T} + r\right)B + C\right] \\ 0, & Otherwise \end{cases}, \quad (5)$$

where d_t is a dummy variable that takes the value of the unity in case of loss, and zero otherwise, and $1 \leq n \leq T$ is the number of times the CGS has injected the loss (i.e., $\left[\left(\frac{1}{T} + r\right)B + C\right] - R_t$) into the project's capital to ensure business continuity and to eliminate the risk of premature default. It can be seen from Equation (5) that, in case a profit is reported by the entrepreneur, π_t^e reduces to $\left(R_t - \left[\left(\frac{1}{T} + r\right)B + C\right]\right)$, as determined in Equation (3). In case of loss, π_t^e will be deduced by the CGS's share in the reported profit, which is equal to $0 \leq \sum_{t=1}^{t=n} d_t\left[n\left[\left(\frac{1}{T} + r\right)B + C\right] - \sum_{t=1}^{t=n} d_t R_t\right] \leq 1$. This amount indicates the sum of all CGS's injected cash to cover the loss that has, so far, occurred n times. The denominator, $K_0 + \sum_{t=1}^{t=n} d_t\left[n\left[\left(\frac{1}{T} + r\right)B + C\right] - \sum_{t=1}^{t=n} d_t R_t\right]$, amounts to total capital after covering the loss n times.

The CGS's profit can be calculated based on the success/failure outcome of the project. The traditional CGS's business model does not allow any sharing of the project's profit, because the purpose is only to cover loss when it occurs. This can expose the CGS to the eroding of its capital and, therefore, to its inability to fulfill its mission over the long term. However, the use of the dynamic risk-sharing principle can sustain the CGS's capital. The CGS's profit function is defined as follows:

$$\pi_t^{cgs} = \left(R_t - \left[B\left(\frac{1}{T} + r\right) + C\right]\right)\left(\frac{\sum_{t=1}^{t=n} d_t\left[n\left[\left(\frac{1}{T} + r\right)B + C\right] - \sum_{t=1}^{t=n} d_t R_t\right]}{K_0 + \sum_{t=1}^{t=n} d_t\left[n\left[\left(\frac{1}{T} + r\right)B + C\right] - \sum_{t=1}^{t=n} d_t R_t\right]}\right). \quad (6)$$

Equation (6) indicates that the CGS's profit will remain equal to zero if the project is successful for all fiscal years until T. In addition, the CGS will be entitled to a share in the announced profit during the fiscal year following the year when the failure happened, i.e., $\pi_1^{cgs} = 0$. The CGS will be involved in stage 1 with the condition that, at any time $0 < t < T$, all losses injected into the project should remain, throughout the project's life, lower than the capital. If this condition is not met, the project becomes a shell company and the CGS will have the right to foreclose for the purpose of restructuring assets and/or financial arrangements. This inequality is termed the CGS's involvement condition and can be expressed as follows:

$$\frac{\sum_{t=1}^{t=n} d_t\left[n\left[\left(\frac{1}{T} + r\right)B + C\right] - \sum_{t=1}^{t=n} d_t R_t\right]}{K_0 + \sum_{t=1}^{t=n} d_t\left[n\left[\left(\frac{1}{T} + r\right)B + C\right] - \sum_{t=1}^{t=n} d_t R_t\right]} < 1.$$

The above inequality indicates that, for all $0 < t < n < T$, the CGS's sum of all injected funds (paid-in capital), i.e., $\sum_{t=1}^{t=n} d_t\left[n\left[\left(\frac{1}{T} + r\right)B + C\right] - \sum_{t=1}^{t=n} d_t R_t\right]$, should not exceed the capital, i.e., $K_0 + \sum_{t=1}^{t=n} d_t\left[n\left[\left(\frac{1}{T} + r\right)B + C\right] - \sum_{t=1}^{t=n} d_t R_t\right]$, to guarantee that the CGS is not the sole owner of the project. It is noteworthy that the extreme case of full ownership by the CGS is not supposed to happen, at least in theory, because the CGS's role consists of covering losses in exchange for an increasing share in the capital. The CGS does not have the managerial ability and knowledge to manage the project on behalf of the entrepreneur.

5. Methodology and Simulation Design

In order to validate the relevance of the suggested entrepreneurial mode, a set of quantitative assessment indicators (Table 2) must first be identified. The indicators are classified into two categories:

- Project dynamics' indicators: they include the most important indicators for the project's stakeholders in terms of profitability, risk, equity multiplier, leverage, financial constraints, and attractiveness to potential financiers, and other factors.
- Value creation and sustainability indicators: the value creation is crucial for the owners because it shows to what extent the project can be valuable to them and to society. Value creation complements sustainability. Indeed, the involvement of the CGS in the project should not be associated only with the incentive to the financier to raise funds for the project. The CGS should also have a societal contribution (as reflected by the financial additionality) by ensuring the business continuity of the project and, simultaneously, providing an additional source of income to contribute to its sustainability (as reflected by the cumulated share of profits earned throughout the project's life).

All these indicators will be numerically determined based on the simulation of the project's revenue, and two scenarios will be compared:

- The first scenario corresponds to the entrepreneurial model based on the risk-sharing mechanism (RSM) suggested in this article. This scenario will be termed the *RSM* scenario.
- The second scenario corresponds to the alternative scenario, with respect to which the CGS does not interfere according to the RSM. This means that the second scenario does not entail loss coverage and the CGS is considered neither as a de jure shareholder in stage 1 nor as a de facto shareholder in stage 2. This alternative scenario will be termed the standard scenario.

In order to determine the impact of embedding the risk-sharing mechanism in the project's dynamics, we first need to simulate the revenue over a period of 15 years using the Monte Carlo Simulation (MCS) method. It is assumed that the revenue evolves according to the following geometric Brownian motion (GBM):

$$dR_t = \mu R_t dt + \sigma R_t dz_t, \tag{7}$$

where μ and σ represent the drift and volatility of the revenue generation process, respectively. The term dz corresponds to the Brownian motion. Using the calibration of variables[4] in Table 3, the simulation of Equation (7) generates revenue over 15 years (Figure 3). It turns out that, during the first five years, the probability of default is excessively high. Indeed, the project's revenue is lower than the fixed operating costs and the debt servicing for years 1, 2, and 4. The cumulative profits and losses for these years amount to USD 8 K and USD 78.8 K, respectively. From the perspective of the financier's orthodoxy, this excessive risk during the early years of the project represents the main cause of the reluctance to be engaged as a residual or non-residual claimant.

Table 2. Assessment indicators *.

Indicator	Measurement	Explanation
	Project's dynamics indicators	
Capital structure	The shares of the shareholders in the capital	The capital structure reveals the dynamics of the shareholders' shares. The capital structure is subject to a change each time the CGS injects funds in proportion of the loss to ensure business continuity.
Profitability	$ROE = \frac{Net\ profit}{Equity}$	It reflects the ability to attract potential shareholders and can be used to reflect the business's prospects.
Average profitability	Average ROE to time $1 < t \leq T$	This indicator can indicate the attractiveness of the project until time t without waiting for the termination date, T.
Risk	The standard deviation of profits	The risk is a principal indicator the financiers and shareholders use to decide whether or not to get involved in the project.
Average risk	Average standard deviation of profits to time $1 < t \leq T$	To further analyze the project's risk, the use of average risk is informative because it can assess the extent to which there is an improvement on an annual basis.
Relative standard deviation (RSD)	$\frac{\text{The standard deviation of } ROE}{ROE}$	The RSD is helpful because it mixes both the average return and risk of the project. A typical, risk averse financier prefers a lower RSD for the project's life and decreasing RSD when calculated on an annual basis.
Cumulative profits	$\sum_{j=1}^{j=n}\sum_{t=1}^{t=T} d_j\left[R_t - \left(\frac{1}{T}+r\right)B + C\right]$, where $d_j = \begin{cases} 1, & If\ R_t < \left[\left(\frac{1}{T}+r\right)B + C\right] \\ 0, & Otherwise, \end{cases} \forall 1 \leq t, j, n \leq T$	This indicator is helpful for comparative purposes because it reveals which scenario is more able to generate cumulative profits faster.
Cumulative profits to cumulative losses	$\left\lvert \frac{\sum_{j=1}^{j=n}\sum_{t=1}^{t=T} d_j\left[R_t - \left(\frac{1}{T}+r\right)B + C\right]}{\sum_{j=1}^{j=n}\sum_{t=1}^{t=T} d_j\left[\left(\frac{1}{T}+r\right)B + C - R_t\right]} \right\rvert$ where $d_j = \begin{cases} 1, & If\ R_t < \left[\left(\frac{1}{T}+r\right)B + C\right] \\ 0, & Otherwise, \end{cases} \forall 1 \leq t, j, n \leq T$	This indicator shows the cumulative profits to cumulative losses in absolute value after the CGS has covered the loss n times. The higher this indicator, the lower the financier's reluctance to become engaged in the financial contract and the lower the lending restrictions. This indicator is a good signal for business continuity.
Equity multiplier	$\frac{Assets}{Equity}$	It is expected that this indicator tends to be lower in the early stage of the business cycle and during periods of distress. A higher equity multiplier indicates that the risk-sharing mechanism helps to finance the business activity using equity capital. The assets are defined as the sum of equity and debt.
Leverage	$\frac{Borrowing}{Equity}$	The use of the risk-sharing mechanism should improve the leverage, because the losses are absorbed and the equity's market value does not deteriorate.
Financial constraints and information asymmetry	Investment–cash-flow sensitivity	$\sum_{t=1}^{t=m} I_t \times \frac{CF_t}{\sum_{t=1}^{t=m} CF_t} - \frac{1}{m}\sum_{t=1}^{t=m} I_t$, where m is the number of observations, I is investment (measured according to Equation (1)), and CF is cash flow (measured by net profit + depreciation and amortization).
	Value creation and sustainability's indicators	
Incremental equity value	Absolute variation of equity value	A higher incremental equity value is always a positive indicator for shareholders. The creation of a sustainable market value for shareholders supports the relevance of the risk-sharing mechanism for the CGS business model.
Economic value	Net Present Value of the project	This indicator shows the contribution to economic growth and welfare in society.
Financial additionality	$\left[n\left[\left(\frac{1}{T}+r\right)B + C\right] - \sum_{t=1}^{t=T}\sum_{j=1}^{j=n} d_j R_t\right]$ where $d_j = \begin{cases} 1, & If\ R_t < \left[\left(\frac{1}{T}+r\right)B + C\right] \\ 0, & Otherwise,, \end{cases} \forall 1 \leq t, j, n \leq T$	Defined as the extra volume of loans/injected funds that would not have been raised without the CGS. This indicator reflects the volume of credit granted due to the existence of the CGS. Under the risk-sharing entrepreneurial mechanism, this indicator corresponds to the sum of all injected funds to cover the loss to ensure business continuity. The coverage ratio amounts to 100% each time a loss is reported by the entrepreneur.
Sustainability	CGS's cumulative share of profits	The CGS's cumulative revenue shows the ability to generate a sustainable revenue from the CGS. This indicator indicates the extent to which the project is sustainable.

* The use of double summation in some of the assessment indicators shows that the CGS is supposed to intervene $0 < n < T$ separate times so that the CGS's involvement condition holds true.

Table 3. Calibration of variables *.

Variable	Symbol	Input
Initial revenue	R_1	USD 100 K
Fixed operating costs	C	USD 140 K
Initial internal funds	W_0	USD 200 K
External financing	B	USD 300 K
Drift	μ	5%
Profit's volatility	σ	25%
Depreciation of capital	δ	1%
Maturity	T	15 years
After-tax borrowing cost	r	3%

* For simplicity, we adopted the notation of all figures in USD. One Saudi Riyal is pegged at USD 3.75.

Although the engagement of the CGS in the project may reduce the financier's reluctance, its societal contribution is limited because, under the project, no more jobs or value will be created in the economy. In order to ensure the business continuity of the project, the suggested entrepreneurial model proposes to embed the CGS as a potential, *de jure* stakeholder in stage 1 and a *de facto* stakeholder in stage 2, once the first reported loss is covered.

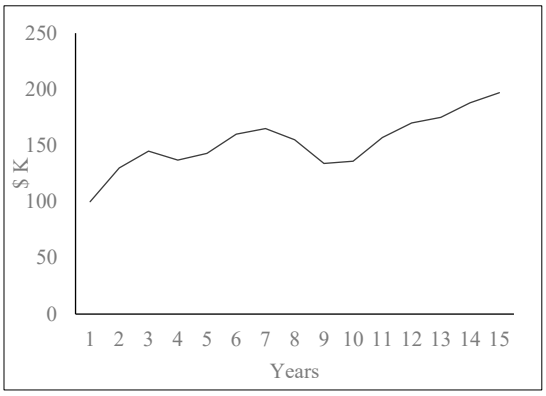

Figure 3. Simulated revenue.

Figure 4 shows that the project remains unappealing to financiers until year 10 because the entrepreneur is unable to show that they can obtain a low-risk benefit. This constitutes an excessively long period for a project to be profitable and cannot be tolerated by financiers. In addition, the agency-related problems constitute an additional source of reluctance, which justifies the involvement of the CGS to play its fundamental role. As seen in Figure 1 (stage 1) and Figure 2, the CGS has an obligation to inject the amount of the losses that occur in years 1, 2, 4, 9, and 10. The involvement of the CGS as a *de jure* stakeholder relaxes the financier's lending conditions. Indeed, Arping et al. (2010, p. 26) argued that "the state support can raise welfare by relaxing financial constraints, but it can also reduce lending standards if entrepreneurs substitute public sources of collateral for their own assets, if it encourages excessive entrepreneurial entry, or if it undermines bank monitoring incentives".

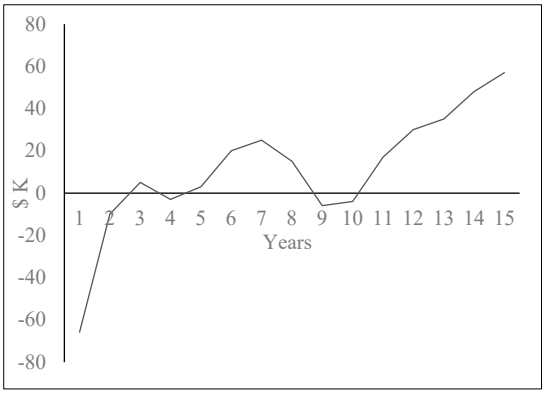

Figure 4. Simulated profit.

6. Results and Implications

The simulation experiment corresponds to a typical entrepreneurial case in which a project is poorly performing in the early years. However, the project becomes profitable over time, which may be attributed to better macro conditions, improved business experience of the entrepreneur, and more favorable industry dynamics. This section will examine the impact of the RSM on the various indicators under consideration, in comparison with the standard scenario that does not involve the CGS.

6.1. Project Dynamics

The capital structure remains unchanged when the RSM is not used. Indeed, the capital[5] amounts to the initial financing by the entrepreneur and the raised funds by the financier, i.e., USD 500 K. Assuming that the financier will not require the liquidation of the assets in order to receive payment, the nominal value of the capital remains unchanged throughout the project's life. However, the financier does not seem to be content with the series of losses that occurred in the early years. Figure 5 shows the injected funds by the CGS to cover the losses for years 1, 2, 4, 9, and 10, amounting to USD 88.8 K. The gradual injection of funds to cover the losses increases the gap between the capital in the case of the standard scenario and the capital in the case of the RSM scenario (Figure 6). Although the shares in the capital of the entrepreneur and financier remain constant, the CGS's paid-in capital keeps increasing gradually to reach USD 88.8 K.

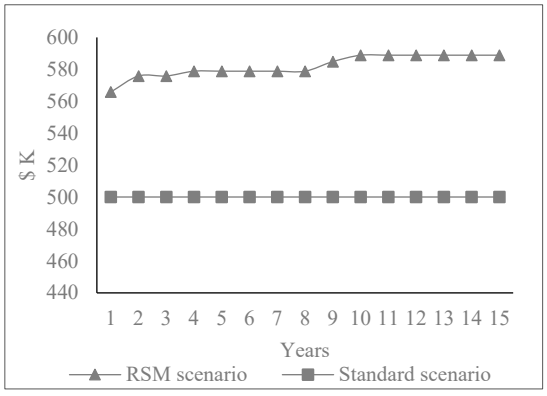

Figure 5. Capital.

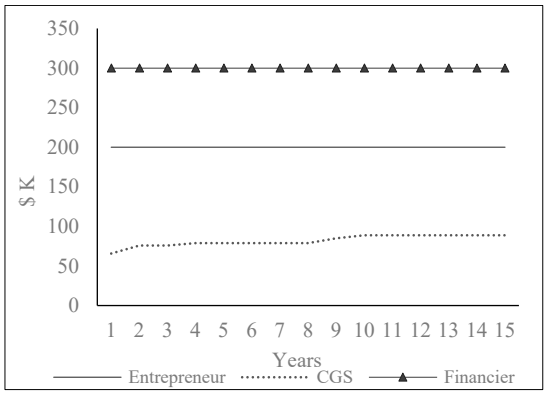

Figure 6. Capital shares (RSM scenario).

It is crucial to stress the CGS's involvement condition, under which the ratio of cumulative paid-in capital should always be lower than the project's capital at all times. Figure 7 shows that this condition is always met, since the aforementioned ratio starts with 11.63% at time $t = 1$ and ends at 15.08% at time $t = 15$. This means that the CGS's entitlement to profit will range from 11.63% to 15.08%. The fact that the CGS's involvement condition holds true can be interpreted by the financier as a positive signal for the long-term profitability of the project. Indeed, the involvement of the CGS as a de facto shareholder starting from $t = 1$ has the following merits: (i) it can save the project from a premature default; (ii) it can provide an incentive for the financier to increase the funds to the entrepreneur, and (iii) it does not represent a threat to the shareholding structure. Accordingly, the daily and strategic decision-making will remain exclusive to the entrepreneur.

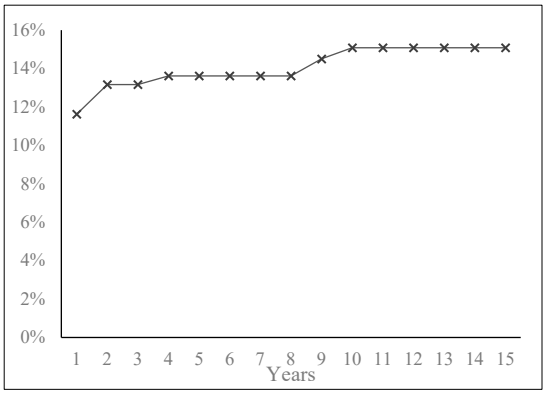

Figure 7. CGS's involvement condition (RSM scenario).

The entitlements of the three contracting parties to profit are presented in Figure 8. Although the CGS's entitlement jumps from 11.63% ($t = 1$) to 15.08% ($t = 15$), the entitlements of the entrepreneur and financiers slightly decrease by 1.38% (from 35.35% at $t = 1$ to 33.97% at $t = 15$) and 2.07% (from 53.02% at $t = 1$ to 50.95% at $t = 15$), respectively. These slight decreases show that the entrepreneur's and the financier's positions will not be impaired after the CGS's involvement for 15 years as a *de facto* shareholder. In other words, the dividends distributed to the entrepreneur and the financier will decline by a very small percentage over a period of 15 years.

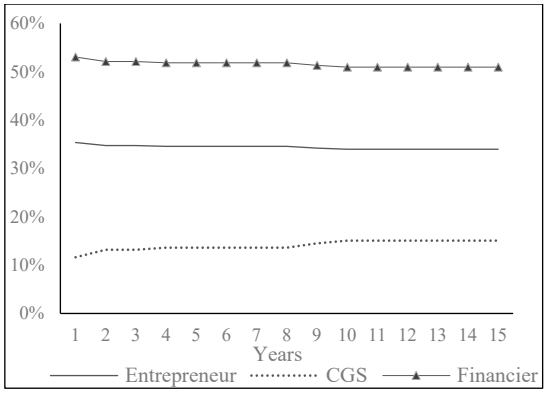

Figure 8. Entitlements to profit (RSM scenario).

A central element of the project's dynamics is the linkage between profitability and risk. Because the financier is risk averse by default, a low, unstable profitability coupled with an excessive risk during the early years of the project is considered a principal reason for the financier to express reluctance regarding the increase of external funds for the entrepreneur. Figure 9 shows the project's annual ROE for both scenarios.

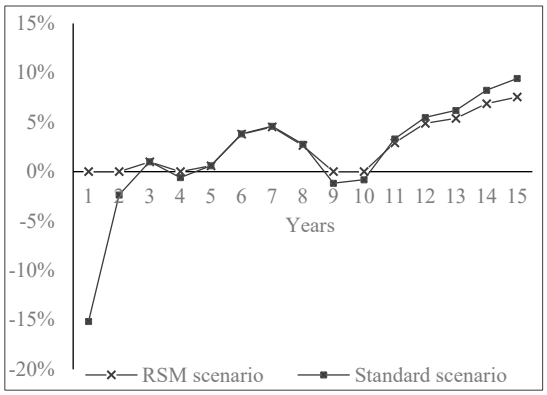

Figure 9. Profitability.

It is clear that the CGS's involvement allows the project not to bear losses and to ensure that the profitability is equal to zero in the worst cases. In addition, during the 15-year period, the average ROE amounts to 2.35% and 1.74% for the RSM and standard scenarios, respectively. Similarly, ROE risk for the 15-year period amounts to 2.38% and 5.79% for the RSM and standard scenarios, respectively. In other words, the risk-sharing mechanism allows for a 1.35% increase in profitability and a 2.43% decrease in risk.

The annual ROEs for the RSM scenario constantly dominate those of the standard scenario, except for the last two years. This fact can be further corroborated using average profitability (Figure 9) and average risk (Figure 10). It is clear that the average profitability and the average risk for the RSM scenario dominate those of the standard scenario. This fact helps relaxing the lending restrictions imposed by the financier because the CGS's involvement contributes to improving the project's profitability and reducing the related risk (Figure 11). To further confirm this important result, the fluctuation of the relative standard deviation[6] is stabilized when the CGS is involved (Figure 12). The standard scenario induces a high fluctuation in the first five years of the project and tends to generate more stable values. Nonetheless, the RSM scenario minimizes the values of relative standard deviation because the risk of failure is shared by the CGS in exchange for an increasing share in the profit.

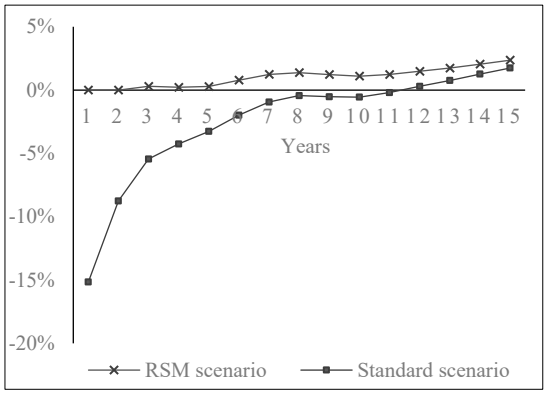

Figure 10. Average profitability.

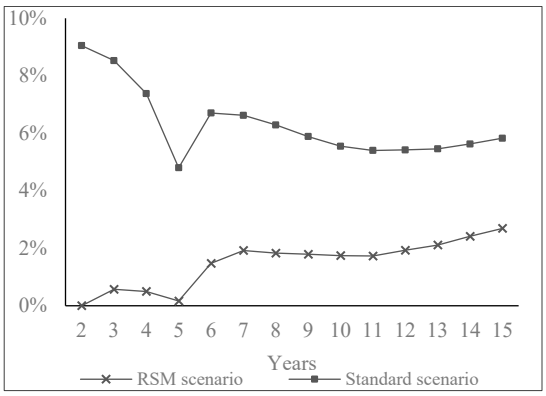

Figure 11. Average risk.

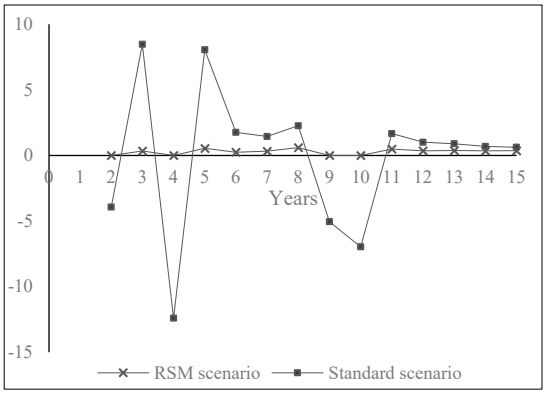

Figure 12. Relative standard deviation.

A closer look at the project's cumulative profits (Figure 13) reveals that the RSM scenario allows the accumulation of profits that remain very limited until year 5. Starting from this date, the profits maintain an upward trend until year 15. Nonetheless, the standard scenario seems to be severely outperforming the RSM scenario until year 12, when the cumulative profits become positive. The financier is likely to be unwilling to raise funds for the entrepreneur because the project, as viewed from her perspective, carries a highly pronounced risk of default.

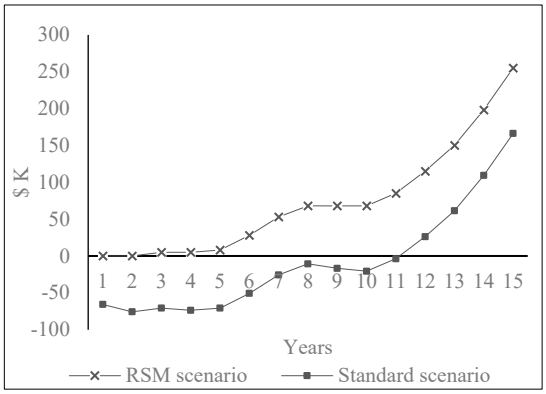

Figure 13. Project's cumulative profits.

In the standard scenario, the entrepreneur and the financier are not better off when compared with their positions under the RSM scenario (Figures 14 and 15). Indeed, what they earn as cumulative profits over years 6–10 cannot cover the losses they accumulated over years 1–5. They must wait until year 10 to start accumulating profits, which is a very long period that the financier does not tolerate. Figure 14 shows that the alternative RSM scenario allows increasing profits for the three shareholders.

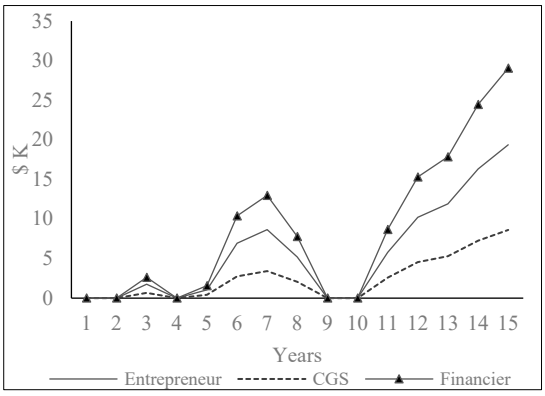

Figure 14. Shareholders' profits: RSM scenario.

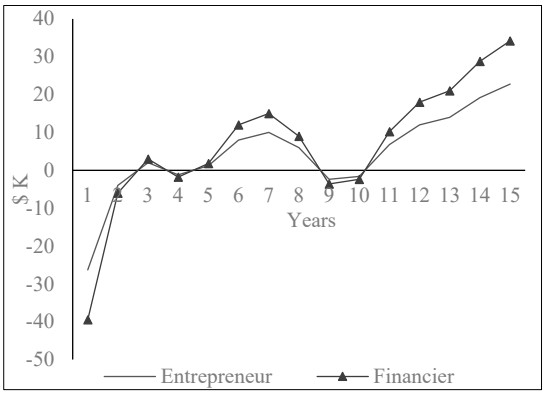

Figure 15. Shareholders' cumulative profits: standard scenario.

Further evidence reveals that the absolute value of the cumulative losses is higher than the absolute value of the cumulative profits from year 1 to year 13 (Figure 16)[7]. This evidence transmits a negative signal about the ability of the project to sustainably generate higher profits for the shareholders. Having this information, the financier cannot

relax the lending restrictions and might increase the hurdle rate upon seeing the highly pronounced risk of the project. However, the RSM scenario can generate cumulative profits that dominate the standard scenario throughout the project's life[8].

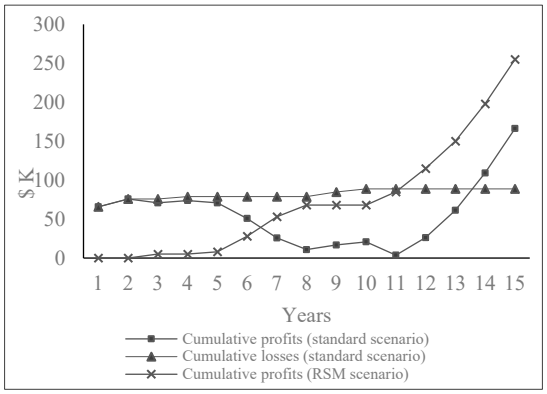

Figure 16. Absolute cumulative profits and cumulative losses.

The equity multiplier and the leverage are crucial indicators about the equity–debt mix and the financial risk it carries. When the RSM is used, the equity multiplier is lowered in comparison with the standard scenario (Figure 17). A lower equity multiplier indicates that the project is using more equity to finance the assets. The debt burden is lower in the RSM scenario and the financial risk is lowered. The debt burden can be serious in the standard scenario because the entrepreneur faces severe difficulty in generating sufficient cash flows from operating activities in the early years of the project. Although a high equity multiplier is recommended for companies that target financing assets with less costly debt sources, this is not applicable in the case of the entrepreneur. The main reason for this is the inability of the entrepreneur to provide sufficient collateral to engage in a financial strategy that targets higher levels of debt. The ideal financial strategy for the entrepreneur is to maintain lower levels of the equity multiplier to transmit positive signals to the market and to potential claimants.

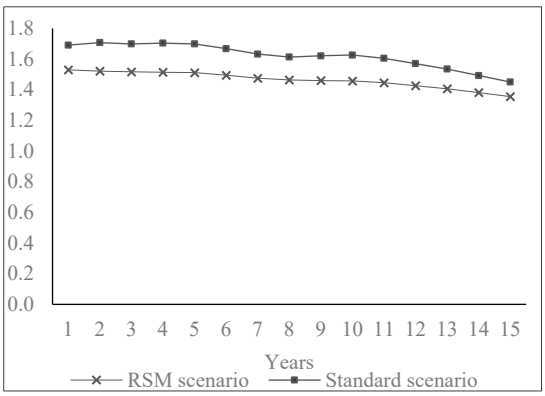

Figure 17. Equity multiplier.

A high leverage is acceptable for a stable firm that is able to generate significant cash flow. Since this is not the case for the entrepreneur's project, the ideal approach is to lower the leverage because the project is risky. The reason for this is that the project's earnings are outweighed by the operating costs and debt repayments, which has an impairing impact on the shareholders' equity market value. The involvement of the CGS allows a reduction of the leverage, which means less debt to equity is used to finance the growth of the project. The RSM's merit is the contribution of the incremental equity value to reducing leverage (Figure 18).

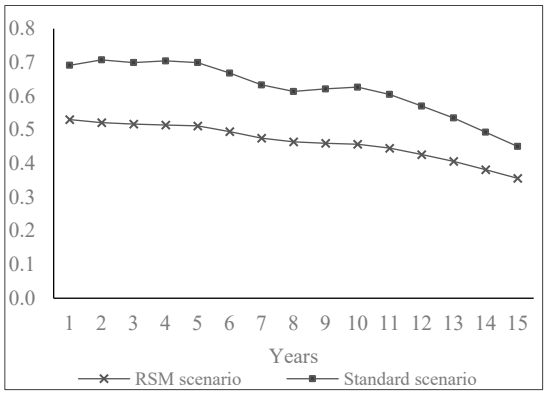

Figure 18. Leverage.

The severity of financial constraints reflects the difficulty the entrepreneur faces in raising external funds at a fair cost. Because of the moral hazard, financiers tend to restrict access to funding sources and/or increase lending costs. Fazzari et al. (1988) showed that the investment–cash flow sensitivity is a good measure of financing constraints. A rich body of empirical literature has dealt with the relevance of the investment–cash-flow sensitivity as an accurate measure[9]. We use Hovakimian's (2009) measure[10] of the investment–cash flow sensitivity as follows:

$$ICFS_t = \sum_{t=1}^{t=m} I_t \times \frac{CF_t}{\sum_{t=1}^{t=m} CF_t} - \frac{1}{m} \sum_{t=1}^{t=m} I_t.$$

The investment–cash flow sensitivity declines sharply in the RSM scenario (Figure 19). Investment is highly sensitive during the first two years, in which two consecutive losses are announced. This indicates that the moral-hazard risk is highly pronounced during the early years of the project, which means that access to external funds is extremely costly or even impossible. However, this sensitivity is greatly deflated because the losses are absorbed each time they occur. In other words, the use of the RSM allows a relaxation of the lending restrictions and reduces the need to raise external funds (under the form of debt-based instruments) from lenders. The sensitivity in the case of the RSM scenario is around 2.4 times less volatile, since its standard deviation is equal to 16.34, compared with 39.21 in the alternative case of the standard scenario.

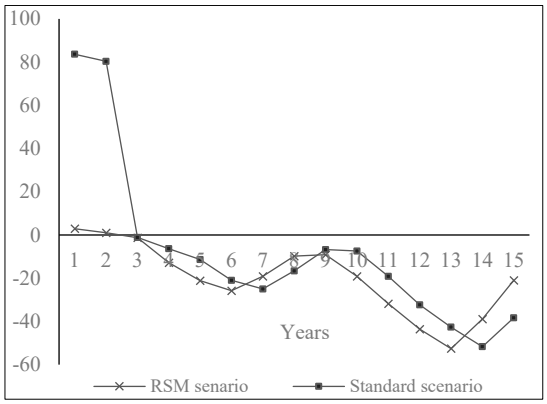

Figure 19. Investment–Cash flow sensitivity.

6.2. Value Creation and Sustainability

The project becomes attractive to shareholders only when it creates for them an incremental equity value (IEV) and contributes to the creation of value to society. The use of RSM induces a higher IEV for the three shareholders. Figure 20 shows that the IEV

is lowest (but still positive) when losses are reported in the RSM scenario. Throughout the simulation period, the IEV in the RSM scenario dominates the IEV in the standard scenario, except for years 8 and 9. This means that the involvement of the CGS as a de facto shareholder does not impair the incremental equity value.

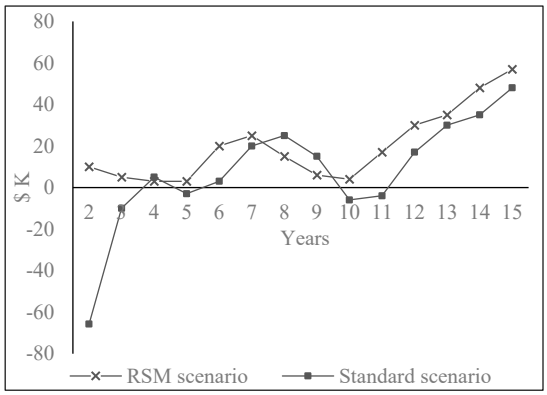

Figure 20. Incremental equity value.

The NPV is clearly higher in the case of the RSM scenario (Figure 21). Although it remains very low during the early years, it increases substantially over time. This is not the case with the standard scenario, since the NPV remains negative (though improving) until year 12, when it records the first positive value.

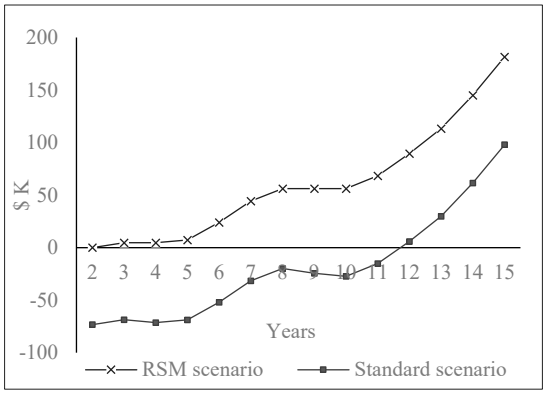

Figure 21. Net present value.

A further examination of value creation focuses on the impact of the cumulative CGS's injected funds on the value creation's proxies, namely NPV, IEV, and the difference between NVPs in both scenarios (i.e., ΔNPV). Figure 22 is a heatmap that corresponds to the response of NPV to the cumulative injected funds of the CGS. The NPV increases throughout the simulation period. Most NPVs lie in the range of USD 0 K to USD 50 K (years 1 to 7) and in the range of USD 50 K to USD 100 K (years 8 to 12). Although the cumulative injected funds of the CGS remain constant at USD 88.8 K over years 10 to 15, the NPVs keep growing until year 15, at increasing annual growth rates.

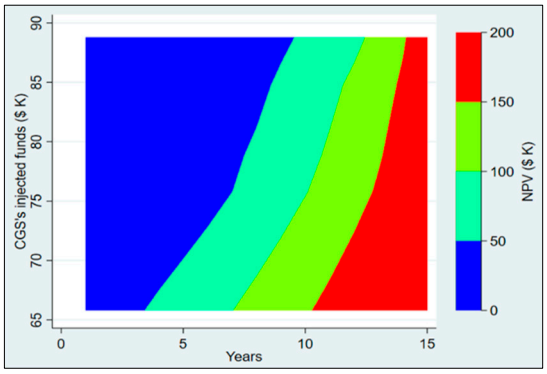

Figure 22. Impact of CGS's injected funds on NPV (RSM scenario).

The IEV responds less monotonically to the cumulative injected funds of the CGS (Figure 23). Indeed, it has two noticeable periods of decline, i.e., in years 2 to 5 and in years 7 to 10), during which the cumulative injected funds of the CGS keep increasing. This can be explained by the reported losses during these two periods. The green zone in the bigger blue zone corresponds to year 7, for which the IEV amounts to USD 25 K. However, the shareholders can continue to gain a higher IEV in the RSM scenario, in comparison with the standard scenario, as shown in Figure 20. Similar results can be found in the last heatmap (Figure 24), which shows a monotonic-upward trend for ΔNPV. The RSM scenario can allow the project to gain an extra value creation that increases until year 10, after which it remains stable at USD 83.55 K until year 15 (Figure 25).

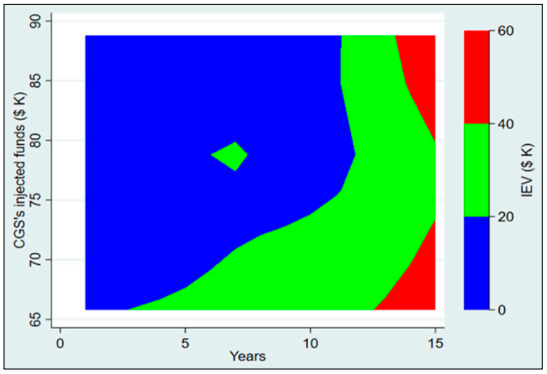

Figure 23. Impact of CGS's injected funds on IEV (RSM scenario).

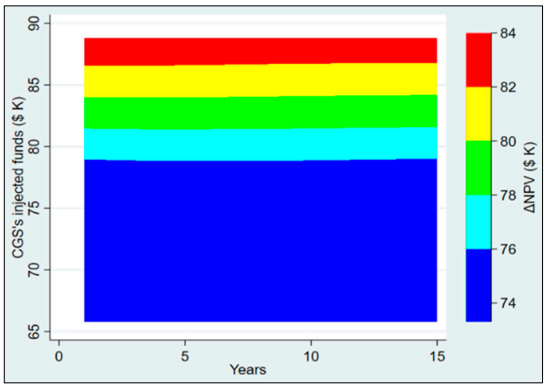

Figure 24. Impact of CGS's injected funds on ΔNPV (RSM scenario).

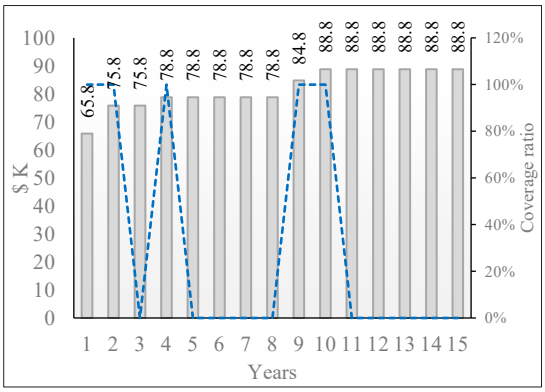

Figure 25. Financial additionality and coverage ratio (RSM scenario).

The RSM entrepreneurial model assumes a scenario of full (100%) coverage for all years for which losses are reported. In exchange for this commitment, the CGS will have the right to a share in the profit. By doing so, the CGS will be endowed with an ownership right that can be purchased back by the entrepreneur when economic conditions improve. In other words, it is possible to embed an exit strategy for the CGS to allow for a repurchase option for the entrepreneur when a safe zone is reached. This safe zone might, in our simulation experiment, starts from year 5, as only two limited losses occur in years 9 and 10, with no significant impact on the project's dynamics. The CGS can improve its sustainability and rate of return of its business activities, as shown from Figure 26.

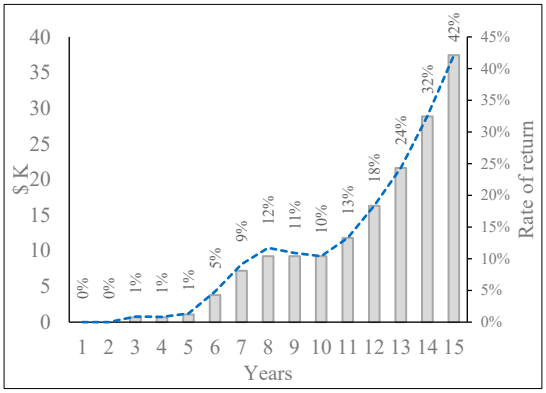

Figure 26. Sustainability and CGS's rate of return (RSM scenario).

6.3. Discussion of Implications

Most models of cash-flow risk assume that investments are exposed to default when a series of revenues is lower than expenses. It turns out that embedding the risk-sharing mechanism into the CGS scheme constitutes an interesting entrepreneurial model for the entrepreneurs of micro firms and small firms. Although these entrepreneurs are endowed with potentially innovative ideas, they lack the sufficient funds to finance their projects. Since access to external funds is always costly because of agency-driven problems, a large number of governments around the world instituted CGSs to relax the lending restrictions and contribute to economic growth.

This article examines an alternative business model of CGSs, within which they can fulfill their mission through a *de facto* shareholding in the project. The simulation of the project's dynamics and other indicators related to value creation and sustainability reveals interesting implications. The capital structure of the project is dynamic, as the losses are simultaneously covered, which can increase the market value and the potential for growth during periods of favorable economic outcomes. The business continuity of the project is ensured once the risk of premature default is reduced to its lowest level. The entrepreneur's

risky position is instantaneously improved by the CGS's injection of cash, which allows for a reduction of the financier's reluctance to become engaged into the project.

Under the RSM scenario, the profitability of the project can increase from 1.74% to 2.35% in the standard scenario. The project risk is reduced from 5.79% to 2.38%. All project dynamics confirm that the lending restrictions are improved under the RSM scenario. In deciding to raise (or not raise) external funds for the entrepreneur, the financier aggregates the indicators related to the project's dynamics and value creation to determine her involvement.

Investment–cash flow sensitivity tends to decrease under the RSM scenario, which means that access to external funding sources becomes easier over time. The financing constraints are less severe throughout the project's life. More importantly, the first two years are marked by two consecutive losses and a high degree of financial constraints. However, the use of RSM allows for a substantial deflation of investment–cash flow sensitivity, indicating that the moral hazard risk is alleviated.

The RSM scenario shows that each time a loss is reported, investment–cash flow sensitivity increases but remains lower than in the case of the standard scenario. The sensitivity is more stable in the case of the RSM scenario. Except for the first two years, during which the sensitivity is positive, it tends to be negative during the remaining years of the project.

In relation to improvement of the degree of financial constraints, the equity multiplier shows a lower reliance on debt to finance assets and maintain the continuity of the business when the RSM is used. The absorption of the reported losses by the injection of the CGS's funds can sustain the project's resilience without resorting to extra borrowing via debt instruments.

The equity multiplier decreases over time in the RSM scenario. A high equity value is accepted for large firms, because they do not incur business difficulties in generating sufficient cash flows to cover the costs of their operating activities. The access of these firms to external debt sources is feasible at low costs, especially when they have strong ties with banks and other financiers. This may not apply to young entrepreneurs with very limited collateral who are exposed to severe financial constraints. However, the ideal financial strategy is to maintain lower levels of the equity multiplier to transmit positive signals to the market and to potential claimants. The RSM scenario shows that this can be achieved, as the equity multiplier is lowered over time.

The significance of embedding risk sharing within the SME sector can be viewed from three key contributions. First, access to external finance is enabled with less restrictive lending requirements. Indeed, SME entrepreneurs can finance their projects with less reluctance by financiers. The equity becomes higher over time, which reduces the reliance on debt instruments. Second, the value creation for society is more pronounced, as the risk of premature default is reduced to the lowest level and business continuity is ensured. Third, governmental engagement is more efficient because the financial resources of the CGSs are more sustainable.

The model suggested in this article is particularly adapted to the Saudi context because Government Vision 2030 aims at empowering the SME sector and increasing its contribution to 35% of GDP by 2030. The risk-sharing mechanism is an important input into the entrepreneurial ecosystem because it helps in mobilizing the financial resources to finance new development opportunities with better risk management systems. The regulatory framework can endorse the risk-sharing mechanism to provide existing CGSs and other financing vehicles in Saudi Arabia with the opportunity to contribute in reaching the Vision 2030 aspirations. The lending-guarantee technology can make interesting strides if the risk-sharing principle is embedded in the CGSs' business model in Saudi Arabia.

7. Conclusions

This article proposed an entrepreneurial model that embeds the risk-sharing mechanism into the CGS's business model to simultaneously relax lending restrictions, alleviate

pre-mature defaults, and ensure business continuity in the SME sector. While the suggested model is most suitable for emerging economies, it fits very well with the Saudi SME ecosystem in seeing promising financial aspirations and enabling governmental initiatives.

The CGS can be involved as a de jure shareholder to instantaneously cover a project's loss each time it is reported. After injecting the absolute value of the loss, the CGS is considered as a de facto shareholder and is entitled to a share in the profits. The CGS's involvement contributes to ensuring business continuity, lowering premature defaults, improving the financing technology of the financiers, and creating economic value for society.

The simulation results showed that all of a project's dynamics and related value-creation and sustainability indicators are substantially improved. The results suggest an interesting financial strategy to be adopted by entrepreneurs to improve a project's business prospects and related creditworthiness indicators, which will render it easier to access external funding.

This article has some limits. First, it did not include a measure of information asymmetry that might arise between the entrepreneur and the financier. The use of the investment–cash-flow sensitivity was used instead as a parsimonious proxy to capture the information asymmetry. Second, the model is deterministic in nature; it did not take into account sectoral/systemic technology and/or demand shocks. This article can be extended in various ways. For example, it can be used for further study of the CGS's performance indicators, with potential applicability in emerging economies.

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Notes

1 See FSDP (2021) for a discussion on the financial aspirations in relation to the SME sector.

2 See Hubbard (1998), Mansour (2014, 2019), and Chichti and Mansour (2010, 2012) for a review.

3 See below the CGS's involvement condition.

4 The simulation design was undertaken following Mansour et al. (2015).

5 For simplicity, the capital is represented without using the rate of depreciation. However, the results remain qualitatively unchanged when the depreciation rate is taken into consideration.

6 The RSD negative values are used to compare the fluctuations between the two scenarios. The RSD is calculated as the moving average of three observations.

7 We used the absolute values of cumulative profits and losses in Figure 16 for the purpose of comparison.

8 It is noteworthy that, in the RSM scenario, the absolute value of cumulative losses amounts to zero because the CGS absorbs all announced losses.

9 See Mansour et al. (2017) and Mansour (2014, 2019) for a literature review.

10 The number of observations, m, is determined by decomposing the project's life into five equal sub-periods, which reduces to three observations based on moving averages. This number of observations is used to determine the 15 simulated values of the investment–cash-flow sensitivity.

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