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Does Venture Capital Substitute Islamic Profit and Loss Sharing Contracts? Theoretical Analysis on Musharakah and Venture Capital

HECHEM AJMI[a*], HASSANUDDEEN ABD AZIZ[b]
AND SALINA KASSIM[a]

[a]*IIUM Institute of Islamic Banking and Finance, International Islamic University Malaysia*
[b]*Kulliyyah of Economics and Management Sciences, International Islamic University Malaysia*

ABSTRACT

This paper emphasizes on the conflicts of interest between agents in order to assess whether venture capital can be a potential model of musharakah in imperfect markets. To achieve this purpose, this study opts for the financial contracting enforceability approach and Monte-Carlo simulation to identify the contract that maximizes the value of the firm subject to the enforcement constraint for the agent and the participation constraint for the principal, taking into account market frictions, and the two levels of the industrial shocks. Findings reveal that musharakah is the optimal contract for agents, subject to their constraints when the shock is low and high. In addition, the simulation results indicate that the increase in market frictions engenders higher profit-sharing ratio for the financier when venture capital and musharakah financings are used. The increase in the value of the firm in case of high shock is attributed to the increase in the profit-sharing ratios for both contracts to mitigate the selfish behavior of the agent. Therefore, the financier tends to require a higher profit-sharing ratio as a compensation for the severer information asymmetry.

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Keywords: Profit-and loss sharing; Conflicts of interest; Market frictions; Optimal Contract; Monte-Carlo simulation

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* Corresponding author: Email: hechemajmi@gmail.com

INTRODUCTION

This paper examines the conflicts of interest among agents when *musharakah* and venture capital financings are used. Al-suwailem (1998) proposed venture capital as a potential model of *musharakah* for two reasons. Firstly, the author indicated that venture capital is very close to the spirit of Islamic finance because it is based on profit and loss sharing mechanism. Secondly, there has been many success stories of venture capital.[1] For instance, several firms including Apple, Facebook, Google, Starbucks, Airbnb, among others, raised venture capital funds in their early years to boost their growth, (Devigne and Manigart, 2018). Nevertheless, (Al-suwailem, 1998) did not provide significant evidence to support his proposition in favour of the imperfect market.

In this regard, further evidence is needed in order to choose the optimal contract for the principal (the financier) and the agent (the entrepreneur) when moral hazard and information asymmetry occur. Dealing with the principal-agent problem, the existing studies showed that conflicts of interest are mostly attributed to the gap between the declared and non-declared profits[2]. Consequently, many attempts have been made in order to mitigate conflicts of interest among agents[3]. Subsequently, an agreement must be established in order to protect the interests of the principal and the agent.

Ideally, an optimal contract should maximize the profit and minimize agency costs. In this regard, the incomplete contract theory pioneered by (Hart and Moore, 1992) and (Aghion et al., 1992) asserted that careful allocation of decision rights and control can be an effective solution to conflicts of interest. Therefore, it becomes the basis for performance remunerations to align with agents' interests. Nevertheless, this approach assumes that the principal is risk neutral and there is symmetric information ex-ante, which is difficult to be satisfied in the context of banker-entrepreneur relationship for two reasons. Firstly, bankers cannot be risk neutral. Secondly, asymmetric information and moral hazard constitute the key factors in the financing decision for agents.

To do so, this paper opts for the financial contracting enforceability approach based on the study of (Cooley et al., 2004) and Monte-Carlo simulation to identify the optimal contract for the principal and the agent among *musharakah* and venture capital. This approach aims to determine the optimal contract that maximizes the value of the firm subject to the agents' interests, namely, the enforcement constraint of the agent (the entrepreneur) and the participation constraints of the principal (the principal) when the industrial shock is low and high, and regarding the variation of market frictions. Following the studies of (Tauchen, 1986) and (Adda and Cooper, 2002), these shocks follow a first-order Markov process, which means the value of the high shock depends on the low shock value. Similarly, it allows us to assess the level of market frictions that both agents can support in case of low shock and high shock for *musharakah* and venture capital financings.

In sum, the financial contracting enforceability approach enables us to determine the optimal contract that aligns agents' interests. In addition, it allows us to identify the variation of market frictions regarding the two levels of shocks and the type of the contract.

The remainder of this paper is structured as follows. Section two discusses the most relevant studies in the conventional and Islamic literature. Section three highlights the methodology adopted, the different equation and models linked to each contract and the assumptions. Section four considers the calibration of parameters. Section five presents the simulation results. Section six discusses the simulation findings. Finally, section seven provides the conclusion.

LITERATURE REVIEW

Theoretical foundation of financial contracting theory

Contractual arrangements have been widely treated in the conventional literature. Starting from (Smith, 1776) some incentive issues linked to sharecropping contracts, which are profit-and-loss sharing, monitoring process and adverse selection in human cooperation, have been determine,. To mitigate these issues, (Coase, 1973) highlighted a new theory to assess the performance of a firm by putting stress on the role of technology and

[1] See Drover et al. (2017); Manigart and Wright (2013); Vanacker and Manigart (2013) for the examination of risk-sharing arrangement and the understanding of venture capital financing

[2] See Hart (2017) for the examination of conflicts of interest among agents in contractual arrangement

[3] See Hart (1995) for the theoretical understanding of the incomplete contract theory

return to scale, as important determinants of the size of the firm and the optimal production. Nevertheless, he considered the firm as a black box and completely ignored incentive problems within it (Hart, 1995). This theory was later extended by (Williamson, 1979) and (Jensen and Meckling, 1976) and became known as the economics of organization. The authors established the agency theory that considers the effect of the manager and the selfish behaviour of agents to assess the contractual relationship when moral hazard and asymmetric information occur. However, the agency approach falls foul of the same criticism because it does not say much about the internal organization of the firm (Hart, 1995).

An alternative approach to address the issues in incomplete contracts proposed that the cornerstone of the incomplete contract theory is the allocation of decision rights[4], which later was extended to include the roles of bargaining power in order to align the interests of agents. (Hart and Moore, 1994) showed that careful allocation of decision rights can substitute the contractually specified rewards. Accordingly, this approach has been developed based on important conditions: (i) the principal is risk-neutral; (ii) there is only one principal and one agent; and (iii) the agents have symmetric information ex-ante. The assumption that agents do not face asymmetric information[5] problem *ex-ante* is a rather strong assumption to make. Consequently, it is difficult to admit the first and third conditions in our study as in real practice bankers cannot be risk-neutral. In addition, information asymmetry[6] represents the main determinant of any investment decision. In sum, we shall argue that financial contracting theory and incomplete contract approach have brought relevant solutions for decisions and rights control, and further insights and procedures must be implemented regarding conflicts of interest between agents.

Regarding the importance of moral hazards and information asymmetry in the principal-agent relationship, the financial contracting theory has also been explored from the Islamic perspective. A particular focus has been given to the notion of profit-and-loss sharing (PLS) and risk sharing, alongside with the moral hazard and asymmetric information problems. Therefore, the remainder of this section discusses the most important studies dealing with PLS arrangement in Islamic finance.

Theoretical underpinning of financial contracting from the Islamic perspective

The Islamic literature was divided into two mainstreams where the first justifies the marginalization of PLS-based contracts, whereas the second encourages their adoption. Among those who justified the marginalization of PLS contracts, (Dar and Presley, 2000), (Farooq, 2007) and (Ebrahim and Sheikh, 2016) assumed that an imbalance between management and control rights is attributed as a major cause of lack of PLS in the practice of Islamic finance. Given this imbalance, the agency problem becomes more severe, which renders the PLS principle less attractive vis-à-vis other modes of financing, and this is in line with the studies of (Muhammad, 2014) and (Lone and Quadir, 2017). In this regard, (Al-Suwailem, 1998) proposed venture capital as a potential model of *musharakah*. However, the author did not provide relevant evidences about the relationship between the venture capital mode and the Islamic model of partnership regarding moral hazard and asymmetric information problem. The recent study by (Mehri et al., 2017) proposed a theory of profit-sharing ratio with information asymmetry and considered the negotiated profit-sharing ratio (PSR) as a screening device in their framework. Although this theoretical framework constitutes a new tool for the type of screening managers, the authors found that adverse selection can be captured when the (PSR) accepted by the manager exceeds a given threshold value, which represents the maximum payoff to the venture capitalist.

Among those who encouraged the adoption of PLS agreement, (Muda and Ismail, 2010) and (Sapuan, 2016) proposed optimal conditions to minimize the problem of asymmetric information, such as providing incentives for entrepreneurs when the profit generates a positive value, and the establishment of monitoring device for *musharakah*. In the same context, (Ernawati, 2016) analysed the risk of PLS financing in Indonesian Islamic banking. The author showed that it is more secure for Islamic banks to allocate funds in *musharakah* contracts instead of *mudarabah*.

In line with the aforementioned studies, (Nabi, 2012) examined the effect of PLS contract on the evolution of the income inequality with capital accumulation process based on the study by (Aghion and Bolton, 1997). The author examined the problem of wealth inequality between two investors with different wealth

[4] See Hart (1989), Hart (2003), Hart (2017) for the examination of allocation of decision rights in the incomplete contract theory
[5] See Ross (1973); Arrow (1971); Jensen and Meckling (1976); Akerlof (1970) and Tirole, (1999) for a theoretical understanding of moral hazard and information asymmetry in contractual arrangements.
[6] See Chichti and Mansour (2010-a, 2010-b, 2012) and Mansour (2014) for a theoretical background on information asymmetry.

classes. (Nabi, 2012) found that the wealth inequality between the two classes of investors decreases over time, which proves that the profit-sharing contract changes the dynamics of wealth. This evidence implies that the entrepreneurship allows the latter to catch-up with the initial wealth class which is in line with the study by (Maghrebi and Mirakhor, 2015). In a nutshell, (Nabi, 2012) showed that substituting the debt contract by a profit sharing contract modifies the relationship between capital accumulation and income inequality, implying that income inequality disappears at the second stage of the development.

Based on the agency issues related to equity-based contracts,[7] (Mansour et al., 2015) proposed a new equity-based instrument through a three-tier partnership by including a new contracting party defined as the risk moderator in order to absorb the underlying risk of default and adjust the annual revenue to a predetermined annual cost. Interestingly, the simulation results show that immunization against premature default through the involvement of the risk moderator to absorb any potential loss is indicative of an incentive factor for the project's survival and business continuity. (Al-Suwailem, 2003) examined the optimal sharing contracts by comparing the PLS contract to the standard debt contract (involving *riba*), under the cases of symmetric and asymmetric information. It has been found that the aggregate expected profits from the sharing contract exceed those of the debt contract, under both symmetric and asymmetric information. Moreover, for a certain range of the opportunity cost, both the financier and the agent are better off when they get involved in a sharing contract instead of debt contract, which is in line with the study by (El Fakir and Tkiouat, 2015).

The study by El Fakir and Tkiouat (2016) employed a game theory approach when *mudarabah* financing is used in order to test how Islamic banks may identify non-efficient agents from the efficient ones in the case of an imperfect market. The authors identified two types of banks and two types of clients. They also considered two types of contracts, namely, low type and high type. Another agreement was added, namely, menu contract, where the agent has the right to choose between the aforementioned contracts. Furthermore, (EL Fakir and Tkiouat, 2016) assumed that bankers are more likely to offer a higher type of contract to an efficient agent with the aim to get higher profit. Findings revealed that menu contracting might not be the best solution to achieve a higher social value. More precisely, it has been found that, even under a higher probability of an agent's efficiency, the bank is not better off offering a higher type contract due to the severity of market frictions.

(Ahmed, 2002) came up with a theoretical framework for PLS financing contracts based on the study by (Gale and Hellwing, 1985), with the aim of determining the incentive-compatible contracts. While banks do not mostly have the incentive to enforce PLS contracts, (Ahmed, 2002) provided several incentives to bankers and entrepreneurs to proceed with this financing contract. The author asserted that the specification of the profit share, the adverse selection analysis[8], the auditing rule and the reward/punishment rules are fundamental to build a strong partnership in imperfect markets.

Theoretical perspectives

The existing literature[9] provided relevant insights regarding the adoption of PLS contracts instead of debt financings. However, some critics have been addressed to PLS mechanism due to the existence of market frictions. In this regard, the study by (Al-suwailem, 1998) highlighted the need to adopt venture capital instead of *Musharakah* and *mudarabah* because it has been found to be very successful in Western countries. From the Islamic perspective, the venture capital contract is very close to the spirit of Islamic finance because it is based on profit-and-loss sharing. Thus, it can be an incentive to Islamic financial institutions to invest their funds and promote a PLS arrangement (Al-suwailem, 1998).

Nevertheless, the difference between *musharakah* and venture capital may come to the picture in the case of profit distribution. Assuming that the principal and the agent have the same contribution (internal fund = external fund), the venture capitalist is more likely to receive the highest profit sharing ratio in case of profit because she plays the role of financier, advisor and monitor. When *musharakah* financing is used, the principal cannot receive the highest profit-sharing ratio while the agent provides the internal fund and her managerial skills (Hasan, 1985). Thereby, the profit-sharing mechanism in this case may represent an issue for the principal and the agents because economic agents have different preferences and expectations.

[7]See Majdoub et al. (2014, 2016, 2018), Bedoui and Mansour (2015), for an examination of the theoretical foundation of equity-based contracts.

[8] See Ahmed (2002), ELFakir Tkiouat (2016) and Ajmi et al. (2019b) for the theoretical understanding of the adverse selection issue in contractual arrangements

[9] See Ajmi et al (2019c) for the examination of the financial contracting theory from the Islamic and the conventional perspectives.

In view of the lack of insights regarding venture capital and *musharakah* financings, this paper highlights the financial contracting enforceability approach in order to determine the optimal contract that maximizes the value of the firm and aligns agents' interests[10]. In addition, this approach enables us to identify the level of market frictions that agents may bear if they want to maximize their profit when the industrial shock is low and high. In a nutshell, the financial contracting enforceability approach and Monte-Carlo simulation may yield additional proof regarding the selection of the most attractive contract for the principal and the agents when venture capital and *musharakah* financings are used.

METHODOLOGY

The notion of enforceability is one important process in financial contracting. It is defined according to the literature as the ability of each part to repudiate the contract for a given reason. Several studies[11] dealt with this issue to examine the risk of repudiation in the case of limited liability or to find out the optimal lending contract through the financial contracting enforceability theory. Following the study of (Cooley et al. 2004), the optimal contract must maximize the value of the firm subject to the enforcement constraint for the agent and the participation constraint for the principal, regarding market frictions. The first constraint indicates that the agent (the entrepreneur) may accept to enforce the contract when the profit received exceeds the default value. This default value is an endogenous function depending on the capital invested, and the industrial shocks affecting the production function of the firm.

According to (Tauchen, 1986) and (Adda and Cooper, 2002) , these shocks follow a first-order Markov process, which means the value of the high shock depends on the low shock value. The second constraint implies that the profit given to the principal (the financier) must be greater or equal to the set-up investment. Otherwise, the contract will not be executed. This approach enables us to identify the contract that maximizes the value of the firm and aligns agents' interests when market frictions occur. In addition, it allows us to assess the level of market frictions that the principal and the agent may bear when the chock is low and high.

Model Design

Consider X_t the payments received by the entrepreneur at time t. The maximization program based on (Cooley et al., 2004) is the following:

$$\max V_t(F_t, Z) = E_t \sum_{t=1}^{T} \beta^t X_t \quad (1)$$

Subject to

$$E_t \sum_{t=1}^{T} \beta^t X_t \geq D_t \quad (2)$$

$$D_t = \overline{V_t} - \kappa \quad (3)$$

$$\overline{V_t} = (1-p)\, V_t(F_t, z_L) + p V_t(F_t, z_H) \quad (4)$$

$$E_t \sum_{t=1}^{T} \beta^t Y_t \geq I_0 \quad (5)$$

Equation (1) defines the value of the firm, which depends on the profit generated by the firm "X_t" , the maturity of the contract *T*, which is equal to 5 years, the total fund invested"F_t", the labor parameter l_t and the discount rate factor. Furthermore, the variable Z= [z_L,z_H] presents the industrial shocks which could be low or high. According to Tauchen (1986), these shocks follow a first order Markov process because the value of the shock in the future depends on the previous or actual value. As mentioned by (Adda and Cooper, 2002), the probability of fulfilling z_H depends on the current value of the shock which is z_L.

Equation (2) is the enforcement constraint, where the first component defines the profit received by the agent (the entrepreneur) and the second component refers to the default value or the repudiation value.

[10] See Ajmi et al (2019a) for the determination of the optimal contract when debt financings are used.

[11] See Atkeson, (1991); Kehoe and Levine (1993); Quintin (2003); Marcet and Marimon (1993); Cooley et al., 2004) for a theoretical background on the financial contracting enforceability approach

According to (Cooley et al., 2004), the value of continuing the contract for the firm after realization of the shock cannot be smaller than the value of repudiation. More precisely, the authors indicated that the firm shall continue the project only if the enforcement value is greater than the default value. As pointed out by the same authors, the default value has been defined in equation (3), where $\bar{V}_t$ and κ are respectively, the value of searching a new project and the cost of repudiation. Similarly, (Cooley et al., 2004) claimed that the value of searching a new project is endogenous and depends on all the equilibrium conditions. Also, they imply that the variable p in the equation (4) refers to the probability of finding the high productivity project, which depends on the availability of the projects and on the number of searching entrepreneurs. Therefore, they assume that $p = \min\left\{\frac{\mathrm{M}}{\mathrm{S}}, 1\right\}$ where M refers to the available projects and S defines the number of searching entrepreneurs. (Cooley et al., 2004) measured this probability according to how the economy responds to the arrival of a new technology that increases the number of high-productivity projects *M*.

(Cooley et al., 2004) considered two assumptions about the persistence of the shock, which are temporary and permanent. However, we should mention that in our study the persistence of the industrial shock cannot be permanent because the economy has always been changing. Concerning the situation of temporary shocks, they consider the case in which M_t is independently and identically distributed as uniform in the interval $[0, n]$ where n is the mass of new-born entrepreneurs. Thus, the expected value of M_t is defined by $\bar{M} = {}^{n}/_{2}$. Although in equilibrium only new-born entrepreneurs search for a high-productivity project, (Cooley et al., 2004) claim that $S_t = n$, and the probability of success $p = {}^{M_t}/_{n}$ is uniformaly distributed in the interval $[0,1]$. In the same way, (Cooley et al., 2004) showed that after a long sequence of $M_t = \bar{M}$, the arrival of a new technology increases M_t to $2\,\bar{M} = n$. Hence, this implies that after a long sequence of $p_t = 0.5$, this probability increases to one, then it reverts to its mean value after the next period. Although $p = \min\left\{\frac{\mathrm{M}}{\mathrm{S}}, 1\right\}$, $\bar{M} = {}^{v}/_{2}$ and $S_t = n$ are in equilibrium, the expression of the probability of finding the high productivity project will be defined as given: $p = \min\left\{\frac{\frac{n}{2}}{\mathrm{n}}, 1\right\}$. More precisely it will be equal to $p = \min\left\{\frac{1}{2}, 1\right\}$. Equation (5) is the participation constraint for the principal (the financier), where Y_t is the profit given to the financier and I_0 is the setup investment. This constraint imposes that the discounted value of payments received by the principal should be equal or greater than the setup investment. Otherwise, the contract may be repudiated by the financier.

Profit and Cost Equations

This sub-section aims at determining the profit and cost equations for the agent when *murabahah* and *ijarah* financing are used. For what follows, (Cooley et al., 2004) assumed that it is convenient to define the discounted expected profit generated by the firm before determining the profit equations related to both contracts. Accordingly, the profit equation form is given below:

$$\pi_t(F_t, l_t, \omega_t, Z) = -F_t + \left(\frac{1}{1+r_f}\right)[bF_t + (1-b)[(1-\delta)F_t + f_t(Z, F_t, \alpha) - \omega_t l_t]\,] \tag{6}$$

The production function can take two different values:

$$f_t(z_L, F_t, \alpha) = z_L F_t(1-\alpha) \quad \text{in case of low shock} \tag{7}$$
$$f_t(z_H, F_t, \alpha) = z_H F_t(1-\alpha) \quad \text{in case of high shock} \tag{8}$$

where the parameter $0 < b < 1$ is the probability of liquidation that stems from the event of losing the project due to the agent's death or any other unexpected events, (Cooley et al., 2004). The function f_t depends on the industrial shock $Z = (z_L, z_H)$ and the invested funds. The parameter $0 < \alpha < 1$ measures market frictions. The parameter $0 < \delta < 1$ is a random variable defining the depreciation rate. Finally, the parameters ω_t and l_t represent the wage and the labor, respectively.

The profit function of (Cooley et al., 2004) takes account of several variables that may affect the production function and the survival of the firm in imperfect markets. They considered that the industrial shocks, the probability of liquidation, the wage and labour are fundamental to assess the profit generated by the firm. If the firm is liquidated, which happens when b reaches the unity, the firm's value is equal to $\frac{-r_f F_t}{(1+r_f)} < 0$.

Nevertheless, if the firm does not face any risk of liquidation, i.e., $b = 0$, the production takes place and the firm's value is $-F_t + \left(\frac{1}{1+r_f}\right)[(1-\delta)F_t + f_t(Z, F_t, b) - \omega_t l_t]$. The disutility from working is defined by Cooley et al. (2004) as: $\varrho(l_t) = Bl^{(1+\epsilon)/\epsilon}$, where *B* is a factor that captures the amount of time spent on working and ϵ corresponds to the elasticity of labor. The properties of the disutility function can be given by the following partial derivatives with respect to labour: $\varrho(0) > 0$; $\varrho'(l_t) > 0$; and $\varrho''(l_t) > 0$. Cooley et al. (2004) claim that the wage factor is the first derivative of the disutility from working $\omega_t = \varrho'(l_t)$, implying that $\varrho'(l_t) = \omega_t = B\ \frac{1+\epsilon}{\epsilon}\ l^{(1+\epsilon/\epsilon)-1}$.

Profit and Cost equations for Musharakah

While *musharakah* is based on profit-and-loss sharing, agents must bear losses according to their contribution. However, the profit shared between them is based on a pre-determined rate λ_t, which is a random variable. Let $F_t = F_t^i + F_t^e$ be the total fund invested by the firm, where the first component defines the internal fund invested by the firm and the second element presents the external fund. The profit equation of the firm in case of *musharakah* contract is the following:

$$X_t^{Mush} = \lambda_t\ \pi_t(F_t, l_t, \omega_t, Z) \tag{9}$$

In case of gain, the firm receives $\lambda\ \pi_t(F_t, l_t, \omega_t, Z)$, where λ varies between zero and one. However, if the firm fails, losses are divided between the principal and the agent according to their contribution. In the same context, *musharakah* contract has an explicit cost, which is related to the investor participation. In other words, if the firm obtains $\lambda_t$when the project is profitable, the principal receives $(1-\lambda_t)$. Thus, the cost function of the firm is defined below:

$$Y_t^{Mush} = (1-\lambda)\ \pi_t(F_t, l_t, \omega_t, Z) \tag{10}$$

Profit and Cost Equations for Venture Capital

Venture capital is an amount of money provided by the principal to finance such a project.

From the Islamic perspective, the venture capital contract is very close to the spirit of Islamic finance because it is based on profit-and loss sharing. Thus, it can be an incentive to Islamic financial institutions to invest their funds and promote PLS arrangement (Al-suwailem, 1998).

Nevertheless, the difference between *musharakah* and venture capital may come to the picture in the case of profit distribution[12]. The venture capitalist provides the asset and her managerial expertise for the firm in exchange for an important equity stake until the end of the contract. In other words, the profit share of the venture capitalist will be greater than the share of the firm. Thus, the agent receives a lower remuneration until the end of the contract. Consider η the profit share of the firm, which is a random variable and $F_t = F_t^e + F_t^i$ which is the total funds invested, the profit of the firm is defined below:

$$X_t^{VC} = \eta_t\ \pi_t(F_t, l_t, \omega_t, Z) \tag{11}$$

Although the higher profit share is received by the venture capitalist, the cost equation can be illustrated as follows:

$$Y_t^{VC} = (1-\eta_t)\ \pi_t(F_t, l_t, \omega_t, Z) \tag{12}$$

where $(1-\eta)$ is greater than η because the principal provides the asset and his managerial skills. In case of profit, the benefit is divided according to this parameter. However, if the project fails the firm loses control of the asset.

[12] Refer to section four for the theoretical understanding of venture capital and *musharakah*, and the calibration of the states and control variables.

The Determination of the Industrial Shocks

Based on (Adda and Cooper, 2002) and (Tauchen, 1986), the two levels of shocks are determined by the following first-order autoregressive process, AR (1):

$$z_{t+1} = \rho z_t + \varepsilon_{t+1}, \text{ var } (\varepsilon_{t+1})=\sigma_\varepsilon{}^2, \text{ where } |\rho| < 1 \quad (13)$$

where ε_{t+1} is defined as the white noise and is distributed with mean zero and unit variance $\sigma_\varepsilon{}^2$. The parameter ρ is the slope coefficient of the AR (1) process, which represents the persistence of the shock. According to (Adda and Cooper, 2002) and (Stockey and Lucas, 1989), the quality of the approximation remains good except when the parameter ρ is very close to the unity. Thus, (Tauchen, 1986) indicated that the parameter ρ must be less than 0.9 for highly persistence of the shock. Experimentations showed that when it is close to 0.9, the gap between consecutive shocks becomes very low. To discretize the AR(1) process, (Tauchen, 1986) assumed that the process stays within a bounded interval to be able to solve the problem. Specifically, he considered that the shock can be approximated by a two-state Markov chain such that Z can take on two values, namely, z_L, z_H ($z_L < z_H$). (Adda and Cooper, 2002) assumed that the probability of the realization of the shocks can be determined by the following symmetric transition matrix:

$$\Pi = \begin{pmatrix} q & 1-q \\ 1-q & q \end{pmatrix}$$

The variables z_L, z_H and q are selected by (Adda and Cooper, 2002) such that the process reproduces the conditional first and second order moments of the AR (1) process as follows:

First-order moment:

$$qz_L + (1-q)z_H = \rho z_L$$
$$(1-q)z_L + qz_H = \rho z_H$$

Second-order moment:

$$qz_L^2 + (1-q)z_H^2 - (\rho z_L)^2 = \sigma_\varepsilon^2$$
$$(1-q)z_L^2 + qz_H^2 - (\rho z_H)^2 = \sigma_\varepsilon^2$$

From the two equations of the first-order moment, we get $z_L = -z_H$, and $q = \frac{1+\rho}{2}$. Inserting these two results into the two equations of the second-order moment generates the following:

$$z_L = \sqrt{\frac{\sigma_\varepsilon^2}{1-\rho^2}} \quad (14)$$

$$z_H = -z_L = -\sqrt{\frac{\sigma_\varepsilon^2}{1-\rho^2}} \quad (15)$$

However, one practice concern for the above approach is how to deal with negative values of the shock. More precisely, this means that the firm's technology produces negative output, which does not hold from an economic perspective. To prevent this situation, it is required to transform the shock by taking its exponential form in order to ensure that all values of the shock are positive.

Assumptions

Assumption 1: the contract is optimal when it maximizes the value of the firm subject to the enforcement constraint for the agent and the participation constraint for the principal (Cooley et al., 2004)

Assumption 2: The principal can observe the information related to the firm only in case of bankruptcy. While it has always been a difference between declared and non-declared profit, the moral hazard problem occurs. Thus, problems of information asymmetry and moral hazards still exist and cannot be ignored, (Cooley et al., 2004).

Assumption 3: There is only one principal and one entrepreneur. (Hart, 1995) considered only one principal and one agent for contract arrangement because, in case of multiple agents and principles, it will be difficult to satisfy the incentives of compatible contracts and the optimality of the transaction.

Assumption 4: The principal and the agent are rational. The literature implies that economic agents are rational because they continuously aim to maximize their profit and minimize agency costs.

Model determination based on contracts

Musharakah contract

Consider a new contract signed at time *t* by the principal and the agent. We denote by X_τ the payments received by the agent. Following the study of (Cooley et al., 2004), the maximization program of the principal and the agent in case of *musharakah* is the following:

$$\max V_t^{Mush}(F_t, Z) = E_t \sum_{t=1}^{T} \beta^t X_t^{Mush} \tag{16}$$

Subject to

$$E_t \sum_{t=1}^{T} \beta^t X_t^{Mush} \geq D_t^{Mush} \tag{17}$$

$$D_t^{Mush} = \overline{V_t^{Mush}} - \kappa \tag{18}$$

$$\overline{V_t^{Mush}} = (1-p)V_t^{Mush}(F_t, z_L) + pV_t^{Mush}(F_t, z_H) \tag{19}$$

$$E_t \sum_{t=1}^{T} \beta^t Y_t^{Mush} \geq I_0 \tag{20}$$

where equations (16), (17) and (20) define the value function of the firm, the enforcement constraint for the agent and the participation constraint for the principal respectively, when *murabahah* financing is used. In addition, equation (18) represents the default value for the agent whereas equation (19) refers to the value of searching a new project in case of *musharakah* contract.

Venture capital contract

When venture capital financing is used, the maximization program for the principal and the agent is defined below:

$$\max V_t^{VC}(F_t, Z) = E_t \sum_{t=1}^{T} \beta^t X_t^{VC} \tag{21}$$

Subject to

$$E_t \sum_{t=1}^{T} \beta^t X_t^{VC} \geq D_t^{VC} \tag{22}$$

$$D_t^{VC} = \overline{V_t^{VC}} - \kappa \tag{23}$$

$$\overline{V_t^{VC}} = (1-p)V_t^{VC}(F_t, z_L) + pV_t^{VC}(F_t, z_H) \tag{24}$$

$$E_t \sum_{t=1}^{T} \beta^t Y_t^{VC} \geq I_0 \tag{25}$$

Equation (21) defines the value of the firm, whereas equations (22) and (25) refer to the enforcement constraint for the agent and the participation constraint for the principal. Furthermore, equations (23) and (24) represent the default value for the entrepreneur and the value of searching a new project in case of venture capital.

PARAMETERS CALIBRATION

Tables 1 and 2 show the calibration of the state and control variables. Whilst a control variable corresponds to a variable that can be parameterized, a state variable is random and cannot be controlled.

Table 1 Calibration of control variables

Parameter	Label	Value	References
δ	Depreciation rate	0.0579	(Cooley et al., 2004)
r_f	Risk-free rate	0.0400	(Cooley et al., 2004; Ahmed, 2002)
b	Probability of liquidation	0.0500	(Cooley et al., 2004)
l	Labor factor	0.3300	(Cooley et al., 2004; Evans, 1987; Atkeson and Kehoe, 2007)
B	Disutility from working	0.001	(Cooley et al., 2004)
ϵ	The elasticity of labor	1.000	(Cooley et al., 2004)
F	Invested funds	100	Adda and Copper (2002)
F^e	External funds	50	Hasan (1985)
F^i	Internal funds	50	Hasan (1985)

Table 1 shows all control variables used in our study. The same risk-free interest rate, r_f, was considered since the Islamic Inter-bank Rate (IIBR) and London Inter-bank Offered Rate (LIBOR) are significantly dependent on each other (Ben Amar, 2018). Although "Islamic banks pricing practices are likely to converge towards conventional ones" (Ben Amar, 2018, p. 7), the risk-free interest value calibrated by (Cooley et al. 2004) is considered in this study for *murabahah* and *ijarah*. The probability of liquidation is set to $b = 0.05$. Following the study by (Cooley et al. 2004) this is consistent with the numbers reported in industry dynamics studies such as Evans (1987). The elasticity of labor is set to $\epsilon = 1$, which is the value often used in business cycle studies, (Cooley et al., 2004). The parameter *B* is chosen by the authors, so that one third of available time is spent on working. The repudiation factor κ is set to 0.35 (Cooley et al., 2004), implying that the repudiation cost is 35 percent of the value of variable capital used by the firm.

Table 2 Calibration of state variables

Variable	Label	Value	References
λ	Profit share of the firm for *musharakah*	[0.5;0.65]	Hasan (1985) *Shari'ah* Advisory Council (SAC Bank Negara Malaysia)
η	Profit share of the firm for venture capital	[0.35;0.5]	Hasan (1985) *Shari'ah* Advisory Council (SAC Bank Negara Malaysia)
α	Market frictions' parameter	[0;1]	Ahmed (2002)

Although this study examines equity-based contracts, it is recommended to provide theoretical evidences regarding the calibration of the state variables (Table 2)**.** The literature asserts that there are two types of opinion about equity-like instruments among the jurists. (Hasan, 1985) claimed that the *Hanafis* and *Hanbalis* with other few *Shafiis* scholars assume that suppliers of capital have to bear losses in proportion to their contribution. However, they are free to negotiate the profit-sharing ratios. In the same way, the *Malikis* and most of the *Shafiis* considered that in *musharakah*, the profits and losses must be shared according to the same ratio, which is $\frac{F_t^e}{F_t}$ for the principal and $\frac{F_t^i}{F_t}$ for the agent

If the principal and the agent provide the same contribution, they are supposed to have the same profit share. However, in practice, this profit share is not identical because the principal brings only funds whereas the agent provides her managerial skills, expertise, and a share of the capital, which is equal to the principal's contribution in our study. According to (Hasan, 1985), Islamic economists argue that profit is the result of the combined effort of capital and expertise. Hence, keeping the profit-and loss sharing ratios equal for the financier would be unfair to the firm. It will discriminate in favour of the dormant supplier of funds.

Based on the aforementioned proposition, the firm may receive a profit share equal or greater than 50% when the invested funds are identical in case of *musharakah*. Admitting that the lower bound of the profit share is equal to 50%, the question is related to the determination of the upper bound, which defines the maximum profit share. Although the gap between the profit shares received by the principal and the agent should be significant, the upper bound of the agent is set to 65%, according to the *Shari'ah* Advisory Council of Bank Negara Malaysia.Consequently, we set respectively the profit share of the agent and the financier to $\lambda_t = [0.5; 0.65]$ and $(1 - \lambda_t)$=[0.35; 0.5], respectively.

Considering venture capital as the conventional form of partnership, the profit distribution is not identical to *musharakah*, while the venture capitalist provides external funds besides his managerial expertise and the agent (the firm) brings only the initial funds. Compared to *musharakah*, the agent cannot receive more that (50%) when venture capital financing is used, which is considered as the upper bound. Based on the contribution of the venture capitalist, the agent finds herself in the opposite situation of *musharakah* financing. As a

consequence, the firm is hypothetically supposed to receive $\eta_t = [0.35; 0.5]$ and the principal receives $(1 - \eta_t) = [0.5; 0.65]$.

SIMULATION AND RESULTS

This section aims to determine the optimal financing contract that maximizes the value of the firm subject to agents' interests in imperfect markets. The simulation process of the maximazation program is defined as follows.

- First, it is required to calculate the two levels of shocks using the equations (13), (14), and (15), based on the study of (Adda and Cooper, 2002), (Tauchen, 1986) and (Stokey and Lucas, 1989).
- Second, we write the script of the objective function (equation (1)) after calculating the profit generated by the firm using the equations (6), (7) and (8).
- Third, we build the code of both constraints using the equations (2), (3), (4) and (5) in a separate file.
- Fourth, we employ the optimization toolbox in Matlab to generate our results, by identifying the objective function, the constraints and the lower and upper bounds of the state variables.

The simulation generates three plots, namely, the current point (indicating the simulated state variables), the current function (indicating the optimal value of the firm), and the first-order optimality (indicating the value of firm's constraints violation) for each contract. We have to mention that Matlab's output generates negative values for the second and third plots. However, we interpret such simulated values as positive numbers (Table 3).

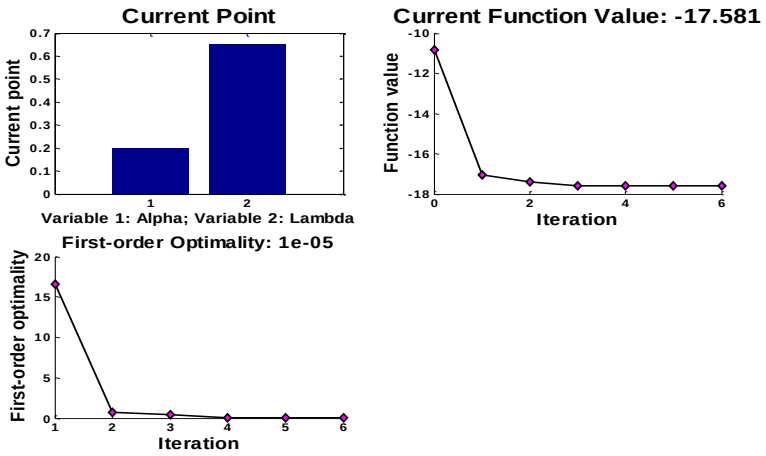

Figure 1 *Musharakah* (low shock)

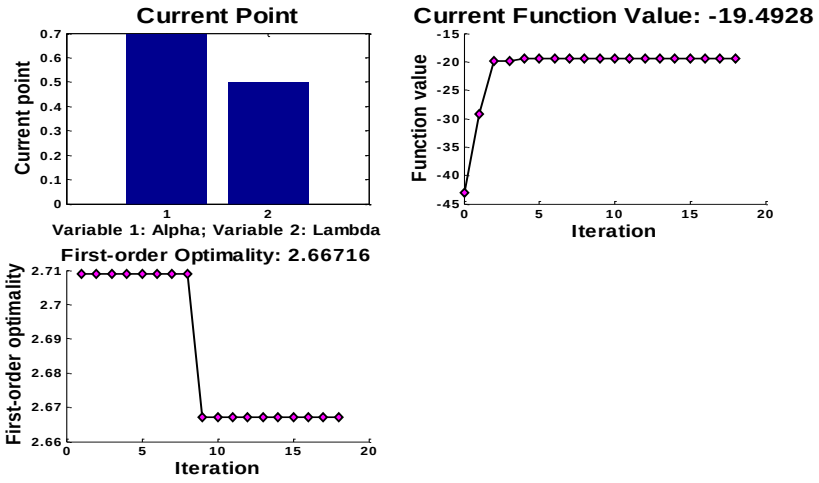

Figure 2 *Musharakah* (high shock)

Figures 1 and 2 show the optimal values of the firm for *musharakah* contract when the shock is low and high, after taking into account the market frictions. The first plots of Figures 1 and 2 show the optimal values of the paramaters related to market frictions and the profit share for the agent. It is noticed that the simulated values of the paramter α has been changed for both contracts when moving from the low shock to the high shock. Indeed, the market frictions is optimally equal to 0.2 in case of low shock and 0.7 in case of high shock. This means that in a riskier environment, when moving from the low shock to the high shock, the seveirty of market frictions becomes higher.

In case of low shock, the profit share λ_t generated is equal to 0.65, which is the optimal share received by the agent. Accordingly, the principal receives 0.35 of the profit generated by the firm. In addition, the optimal values of the firm subject to the safety constraint is equal to 17.5810 and 19.9428 for the low and high shocks, respectively. As for the first-order optimality, the corresponding optimal values are equal to 1e-05 and 2.6671 for the low and high shocks, respectively.

These simulation results indicate that when the shock is low the optimal level of profit shares allow agents to handle the increase in market frictions, and enable the firm to get a value around 17.5810. In case of high shock, the simulated values of the state variables have shown a significant change explained by the increase in market frictions' parameter and the decrease of the profit share of the agent for both contracts. Furthermore, the optimal value of the firm increases to 19.9428, whereas the constraint violation becomes equal to 2.6671.

For a higher level of market frictions at $\alpha = 0.7$, the increase in the optimal value of the firm from 17.5810 (in case of low shock) to 19.9428 (in case of high shock) means that the firm is able to maximize its value and handle conflicts of interest among agents. In case of high shock, the level of market frictions increases to reach 0.7, implying that the agent is more likely to cheat and hide significant information about the project in order to satisfy her interest. However, the increase in the profit share for the principal to 0.5 allows her to handle this higher level of information asymmetry.

Accordingly, the principal and the agent observe their maximized value function increasing as a consequence of a higher value of the shock. It is for this reason that the simulated parameters regarding the market frictions and the profit share have been changed after moving from the low shock to the high shock. Similarly, it is noticed that the increase in the shock alters the behavior of the agent, which can be expressed in terms of more pronounced moral hazard. As a consequence, the principal's profit share increases as a response to the higher risk taken in case of high shock. It is more attractive to enforce *musharakah* in the case of high shock because the maximized value of the firm is higher.

Table 3 Simulation results

	Musharakah		**Venture capital**	
	z_L	z_H	z_L	z_H
Market frictions' parameter:	0.2000	0.7000	0.2000	0.7000
Agent's profit share:	0.6500	0.5000	0.5000	0.3500
Principal's profit share	0.3500	0.5000	0.5000	0.6500
Current optimal function value:	17.5810	19.4928	13.5239	13.6450
Constraints violation	1e-05	2.6671	1e-05	3.6423

Similar findings are found when venture capital is used. Table 3 and Figures 3 and 4 show that the market frictions and the principal profit share's simulated parameters are optimally equal to 0.2 and 0.5, in the case of low shock, and for 0.7 and 0.65, in the case of high shock, respectively. These simulated market frictions' parameters correspond to the same values in the case of *musharakah* contract, which can be attributed to the common PLS-based financial arrangements in both contracts. Compared to *musharakah*, the principal requests a higher profit share in both cases of the shock when venture capital financing is used because she contributes to the project with external funds and managerial expertise. In the same way, we notice that the principal's profit-sharing ratios increase when moving from the case of low shock to the case of high shock. This could be attributed to the fact that the principal observes an increase in the severity of information asymmetry (i.e., higher α) and she judges it relevant to increase her profit share, which is in line with the study by (Mehri et al., 2017). This applies to both contracts.

Regarding the optimized function value, it is clear that it increases in the case of high shock as a response to increased risk. We notice that the optimal function value increased from 13.5239 to 13.6450 for venture capital in the cases of low and high shocks. The comparison between both contracts on the basis of the function value shows that the *musharakah* contract has the highest simulated value in both cases of low and high shocks.

This indicates that the *musharakah* contract dominates venture capital contracts from the principal-agent point of view. For a higher value of market frictions' parameter, the principal and the agent consider that it is more secure to get engaged in a *musharakah* contract because the optimized value of the firm is the highest among both contracts.

The examination of the simulated values that correspond to the first-order optimality indicates that, for both contracts, they tend to increase from a lower value (in case of a low shock) to a higher value (in case of a high shock). This is explained in terms of the agent and the principal constraints that corresponds to the maximization program. Furthermore, it is noticeable that the simulated values of the state variables have been changed for both contracts. A possible explanation is linked to the selfish behavior of the agent who is more likely to hide a significant amount of information about the project to maximize her profit when economic conditions do not improve.

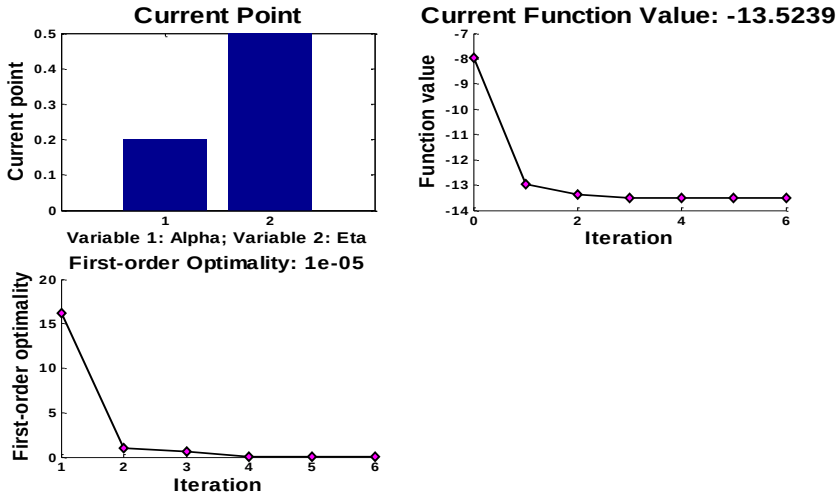

Figure 3 Venture capital (low shock)

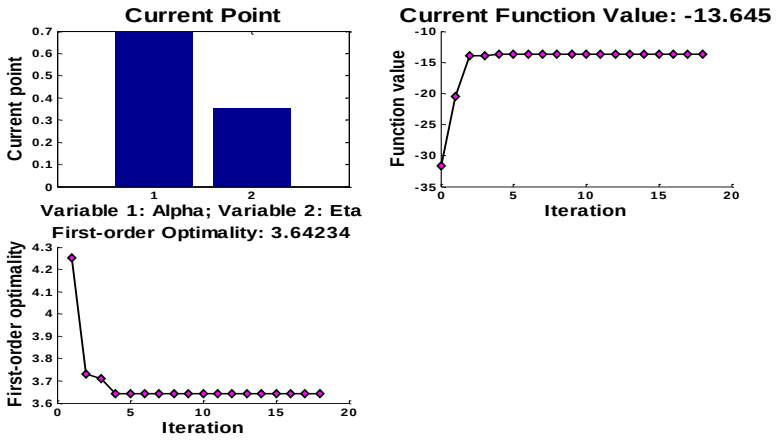

Figure 4 Venture capital (high shock)

DISCUSSION

Although the main purpose of this paper is to determine whether venture capitalist model can substitute *musharakah* financing, findings reveal relevant insights regarding the principal-agent relationship when PLS financing is used. It is shown that both contracts allow agents to handle the lowest level of market frictions when the industrial shock is low. Consequently, the opportunistic behaviour of the agent is less likely to happen when the profit generated is low (Nabi, 2013). Moving from the low shock to the high shock, the simulated market frictions' parameters increase for both contracts. This means that the possibility of cheating is most likely to

occur when the expected profit generated from the project is high (Ross, 1973). As a response to the severity of market frictions, the profit shares of the principal increase for both contracts in the case of high shock. This evidence argues that in a riskier environment, the principal judges that it is relevant to request higher profit share in order to compensate for the severity in market frictions (Jensen and Meckling, 1976; Mehri et al., 2017).

Comparing both contracts based on the optimal simulated values, it is found that *musharakah* dominates venture capital because it enables the principal and the agent to generate a higher optimal value of the firm subject to their interests when the shock is low and high.

Comparing to venture capital, results reveal that the optimal value of the firm in the case of *musharakah* has significantly increased when moving from the low shock to the high shock.

This evidence indicate that venture capital cannot substitute *musharakah* financing from the principal-agent point of view.

CONCLUSION

Financing decision plays a crucial role for small firms and start-ups, due to the difficulties that they may face to raise external funds in imperfect markets. Several financing instruments might be provided for agents whereas the selection of the optimal contract remains hard to achieve. Among equity-based instruments, this study examines *musharakah* and venture capital, with the aim to justify whether venture capital can substitute Islamic profit-and loss sharing contracts from the principal-agent point of view. This paper provides a theoretical evidence by determining the optimal contract that maximizes the value of the firm subject agents' interests when the industrial shock is low and high, and regarding market frictions. Findings reveal that only *musharakah* can maximize the value of the firm subject to the enforcement constraint for the agent and the participation constraint for the principal, implying that venture capital cannot substitute *musharakah*. Furthermore, the simulation shows that agents can bear the lowest level of market frictions when the industrial shock is low, for both contracts. Nevertheless, in case of high shock, the simulated market frictions' parameter significantly increases, implying that agents are more likely to cheat and show off their selfish behavior for both contracts. Therefore, proving that *musharakah* is the optimal contract may encourage bankers and professionals to consider this financing tool and also motivate economic agents to adopt it, while profit-and-loss sharing is the essence of Islamic economics and Islamic finance in particular.

This research has two main limitations. First, our results were not compared to real data because these are not available. Secondly, our study considers a general framework to determine the optimal contract for agents without considering the sectorial characteristics of the firm. However, it can be extended in various ways. The examination of firm dynamics in the case of equity and debt financing can provide further arguments for economic agents regarding the value of the firm, the growth rate and the lifetime of the project in imperfect markets.

Considered as a new venture agreement, the number of crowd-funded projects increased during the last ten years. Therefore, it could be an interesting field of study (Gierczak et al., 2014). Besides its function as money provider, there is a dearth in the existing literature on crowd-funding related areas, inter-alia[13] for the purpose of pre-sale marketing and market research[14]. Similarly, future research may highlight the risk and uncertainties[15] related to this financing tool, as well as explaining what motivates[16] economic agents to adopt crowd funding.

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[14] See Ordanini et al., (2011), Transforming customers into investors through innovative service platforms
[15] See Mollick (2014) for examining the dynamics of crowd-funding
[16] Burtch et al., (2014), for the examination of the Leveraging information systems for enhanced product innovation

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