Ownership and Objectives of the Firm, and Derivatives

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August 2004

http://ssrn.com/abstract=725341

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ABSTRACT

This paper has shown that, first, "the owner of the firm" is a misleading word. Just as Robin Hood cannot be termed as the owner of the gang, shareholders of the firm cannot be termed as the owners of the firm. Each resource provider of the firm has property rights only on the resource he provides, i.e., he has an ex-ante choice to join or not to join the firm, and after he invests his resource in the firm, he obtains a right (an option) to ex-post share the big pie generated by the firm. Since unlike public goods, firms always have clear definitions for the resource providers' property rights, and the ex-post wealth of the firm will be distributed to the resource providers according to ex-ante contracts, the so-called first claim of debtholders (or material providers or labor providers) does not have any advantage. Second, as argued by Coase, the size of the firm is determined by the transaction cost of using the price mechanism and the transaction cost of using authority or power, and an activity will be counted as a part of the firm only when it is under the direction of the firm. But power or authority cannot come from the firm's long-term contracts (as Coase suggested), the monitor's revising or adding contracts (as Alchian et al. suggested), or owning nonhuman assets (as Alchian et al. and Hart suggested). Power comes from choices (more choices mean more power), and choices come from innovations which can create excess profits to "buy or bribe" people. Third, in the absence of transaction costs, maximizing excess profits of the firm is equivalent to maximizing any resource provider's wealth (i.e., the Coase theorem: who (or no one) owns the property rights of production (excess profits) is irrelevant to the value of production); the Modigliani-Miller first proposition (i.e., the market value of the firm is independent of the firm's capital structure) is the Coase theorem when the equityholder owns the property rights of production; and if the labor provider owns the property rights of production, the Modigliani-Miller first proposition can be restated as: the market value of the firm is independent of the firm's ratio of hired labor's input to labor-owner's input, and the Modigliani-Miller second proposition can be restated as: the rate of return on the labor-owner's input increases with the ratio of hired labor's input to labor-owner's input. Fourth, each resource of the firm is both a European call option and a European put option, and there is no owner

of the firm (and no one owns all the assets of the firm). When the firm moves from a more certain project to a more uncertain project, the current market value of equity increases but the current market values of debt, material input and labor input decrease, i.e., there is a wealth redistribution among the resource providers. This result has nothing to do with the resource providers' attitudes toward risk. Each resource of the firm is also a stock plus a forward contract, and Knight's (1933) claim, that the residual claimant has the power to direct the resource providers who receive fixed payments, does not hold.

Key words: transaction costs, the Coase theorem, ownership, property rights, authority (power), choices, innovation, the market value of the firm, the Modigliani-Miller propositions, derivatives.

JEL Classifications: D20, D21, D23, G32, L21, L23.

1. Introduction

The theory of the firm is important to both economists and management scientists to understand how firms are organized, why firms exist, and who owns what and controls what in firms. Coase (1937, 1960, and 1988) argue that in the absence of transaction costs, the institutions which make up the economic system have neither substance nor purpose. Alchian and Demsetz (1972) suggest that in the firm, a monitor is needed to reduce shirking, and hence, he has the power to direct resources. Hart (1995) argues that the person who owns nonhuman assets has the power because he can fire the employees who only have human assets. The finance literature (e.g., Brealey, Myers and Allen, 2006; Ross, Westerfield and Jaffe, 2005; etc.) asserts that shareholders are the owners of the firm (and they own the power), and the firm should maximize shareholders' wealth.

This paper first uses the Robin Hood case to show that there is no such a thing as the owner of the gang (firm). Each resource provider of the firm has property rights only on the resource he provides, and only those entrepreneurs who can innovate to create excess profits can have the power to control the firm. The paper also shows that in the absence of transaction costs, maximizing excess profits of the firm is equivalent to maximizing any resource provider's wealth (i.e., the Coase theorem: who (or no one) owns the property rights of production (excess profits) is irrelevant to the value of production). If the labor provider owns the property rights, the Modigliani-Miller first proposition can be restated as: the market value of the firm is independent of the firm's ratio of hired labor's input to labor-owner's input, and the Modigliani-Miller second proposition can be restated as: the rate of return on the labor-owner's input increases with the ratio of hired labor's input to labor-owner's input. Each resource of the firm is both a European call option and a European put option. When the firm moves from a more certain project to a more uncertain project, the current market value of equity increases but the current market values of debt, material input and labor input decrease. This result has nothing to do with the resource providers' attitudes toward risk. Each resource of the firm is also a stock plus a forward contract, and Knight's (1933) claim, that the residual claimant has the power to direct the resource providers who receive fixed payments, does not hold.

The remainder of this paper is organized as follows. Section 2 examines the meaning of the owner of the firm. Section 3 shows that in the absence of transaction costs, maximizing excess profits of the firm is equivalent to maximizing any resource provider's wealth. Section 4 shows that all the resources of the firm are both European call and put options, and each resource is a stock plus a forward contract.

Concluding remarks appear in Section 5.

2. Who is the Owner of the Firm?

Imagine Robin Hood wants to organize a group of gangsters to rob a bank. Here the resources providers are: a planner (the boss: Robin Hood), an archer, a lookout, and an old lady who cooks for the gang. According to the *ex-ante* contracts among these resources providers, after each robbery, the cook will be the first to get $2000, and the rest of the money will be split among the archer (50%), lookout (30%), and boss (20%).[1] After each robbery, the gangsters will hide out for two to three months, and redo it again. Now, we can see that this gang acts just like a firm (corporation). The cook is like the debtor of the gang (firm): she has first claim on the gang's cash flow, and the archer, lookout and boss are like equityholders: they obtain residuals. The only difference between a gang and a firm is that the latter does not need to liquidate and hide out for a period of time.[2]

The above example shows two simple facts. First, there is no such a thing as "the owner of the gang (firm)". If it is ridiculous to say that Robin Hood is the owner of the gang, then it is also ridiculous to say that shareholders are the owners of the firm. Each resource provider of the firm has property rights only on the resource he provides, i.e., he has an ex-ante choice to join or not to join the firm (gang), and after he invests his resource in the firm (gang), he obtains a right to ex-post share the big pie generated by the firm (gang). Second, although the cook has first claim on the firm's assets and operating income, her first claim does not affect the ex-post distributions among the resource providers. No matter who has first claim (or everyone has the same first claim), the big pie generated ex-post will be split exactly according to the resource providers' ex-ante contracts (i.e., first claim is meaningless). Also, only in the cases where there are no clear definitions for property rights (such as public goods: fish in a lake owned by no one) can we say that first claim has an advantage. But firms (or gangs) always have clear definitions for the resource providers' property rights, and there is no such a thing as: "stockholders do receive more earnings per dollar invested, but they also bear more risk, because they have given lenders first claim on the firm's assets and operating income" (Myers, 1984, p.94).[3]

Jensen and Meckling (1976) argue that "the private corporation or firm is simply one form of legal fiction which serves as a nexus for a set of contracting relationships among individuals" (p. 310). But

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[1] If the cooker obtains only $1,600 this time, she may get compensations ($400 plus some interests) next time. In any case, it is an ex-ante contract between her and other members of the gang.

[2] Assume little or no Coase's transaction cost (i.e., no costs of discovering, informing, bargaining, contracting, and monitoring the people with whom you want to make transactions, see Coase, 1960). No transaction costs also means no bankruptcy costs and no agency costs (i.e., no conflict of interests between debtholders and equityholders).

[3] See also Chang (2004).

this legal fiction (or contractual relations) view of the firm can hold only when there are no transaction costs. Coase (1937, 1960) have pointed out that in the absence of transaction costs, the maximum value of production by the firm or by markets are the same (i.e., the Coase theorem).[4] Coase argues that the size of the firm is determined by two kinds of transaction costs in directing resource allocation: (1) the cost of using the price mechanism, and (2) the cost of using authority or power. An activity will be included within the firm if its costs of using markets are greater than its costs of using direct authority. For example, if producing a piece of equipment within the firm costs $6,000 and buying it from outside suppliers costs $7,000 (where the opportunity cost of the resource, i.e., the maximum amount other purchasers are willing to pay to the resource provider, is $5,000, and hence, the costs of using markets are $2,000 (= 7,000 – 5,000), and the costs of using authority are $1,000 (= 6,000 – 5,000)), the firm will expand to include this production activity. However, an activity will not be counted as a part of the firm just because it has a contract with the firm (e.g., outsourcing). It is only when a resource is under the direction of the firm can we say it is a part of the firm. Coase emphasizes the entrepreneur of the firm has the power and authority to direct resources. But Coase has never clearly pointed out where this power or authority comes from. He argues that since the purchaser will not know which of several courses he will want the supplier to take, "the details of what the supplier is expected to do are not stated in the contract but are decided later by the purchaser … A firm is likely, therefore, to emerge in those cases where a very short-term contract will be unsatisfactory" (Coase, 1937, p. 40). That is, long-term contract gives purchaser the power to direct resources. However, since each resource provider has a free choice to join or leave the firm (he always can obtain $5,000 from other purchasers), Coase's long-term contract is, in fact, a short-term contract, and it cannot give the firm (the purchaser) any power.[5]

I will argue that power or authority comes from choices: If you have more choices (i.e., have a larger choice set), you will have more power than the persons you cooperate with. For example, assume that Michael Jordan is the only person having special talent in playing basketball, and his five-member basketball team can earn $70 a year. Other basketball teams, because of having no special talent, can only earn $50 a year, i.e., each player obtains $10 opportunity cost. It is clear that the $20 excess profit (70 – 50 = 20) generated in Michael Jordan's team belongs to Michael Jordan only (because Michael Jordan can cooperate with other players, and other players can earn only $10 a year). Suppose Michael Jordan takes $4 from the $20 excess profit and split it equally among his four other team members (i.e., now each of them can have $11 a year). Then we can imagine that because Michael Jordan owns the excess profit and can use it to "bribe or buy" people, he will have some power (authority) in his team.

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[4] The Coase theorem emphasizes that "in the absence of transaction costs, there is no economic basis for the existence of the firm … it does not matter what the law is, since people can always negotiate without cost to acquire, subdivide, and combine rights whenever this would increase the value of production. In such a world the institutions which make up the economic system have neither substance nor purpose" (Coase, 1988, p. 14).

[5] Alchian and Demsetz (1972) correctly point out that "it is not true that employees are generally employed on the basis of long-term contractual arrangements any more than on a series of short-term or indefinite length contracts" (p. 784).

In the firm, according to Schumpeter's idea, it is only those entrepreneurs who can innovate and create excess profits (and hence, have more choices and can bribe or buy people) can have power or authority. Other resource providers of the firm can only obtain the opportunity costs of their resources.[6] Once Robin Hood loses his ability to innovate and create excess profits,[7] but his subordinate Little John can, then Little John will replace Robin Hood as the leader of the gang and have the power. An employee currently might be willing to accept a lower salary (in comparison with the opportunity cost he can earn from other employers) if he thinks his firm has a great chance in successfully innovating, and in the future he can have a part of the possible excess profits.

Alchian and Demsetz (1972) use three factors to explain the existence of the firm. First, because of shirking in the team production of the firm, a monitor is needed to detect and determine each individual's contribution to the output of the cooperating inputs. The monitor, as a residual claimant, earns the net earnings of the team (i.e., net of payments to other inputs) through the reduction of shirking. Second, "to discipline team members and reduce shirking, the residual claimant must have power to revise the contract terms and incentives of *individual* members without having to terminate or alter every other input's contract" (p. 782).[8] Third, "how can residual-claimant, central-employer-owner, demonstrate ability to pay the other hired inputs the promised amount in the event of loss? He can pay in advance or he can commit wealth sufficient to cover negative residuals. The latter can take the form of machines, land, buildings, or raw materials committed to the firm" (p. 791). I will argue that, first, just like other input providers, Alchian et al.'s monitor is also an input provider of the firm. Unlike Marxist's capitalist, Alchian et al.'s monitor does not have any power to pressure labors (and other resource providers) to work harder and exploit them to receive the residual since each resource provider (including the monitor) has a free choice to leave or stay in the firm. Second, whether the firm will make contracts with new or additional suppliers is not the resource providers' concern because they have a free choice to leave or stay, and care only whether they can earn the opportunity costs of the resources they provide. The monitor will not have any power just because he can make new contracts or revise or terminate old contracts.[9] Third, the monitor will not have the power just because "he can pay in advance or he can

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[6] Schumpeter (1934) argues that entrepreneurs are those who can innovate to devise new product, new producing method and new organization structure, and find new markets and new resources. He terms capitalists as the persons who do not innovate but only provide capitals and take risks, and entrepreneurs as the persons who innovate and do not take any risk. Coase, on the other hand, follows Adam Smith and Alfred Marshall's idea that capitalists and entrepreneurs are the same, and entrepreneurs do not have the feature to innovate, i.e., "… I shall use the same term 'entrepreneur' to refer to the person or persons who, in a competitive system, take the place of the price mechanism in the direction of resources" (Coase, 1937, footnote 10, p. 36).

[7] Some may call it: losing "charisma" or losing "leadership".

[8] This view point is similar to Coase's (1937) argument: "It is true that contracts are not eliminated when there is a firm, but they are greatly reduced. A factor of production (or the owner thereof) does not have to make a series of contracts with the factors with whom he is co-operating within the firm, as would be necessary, of course, if this co-operation were a direct result of the working of the price mechanism" (p. 39).

[9] Contrary to Coase's argument, producing by markets also might not need to make a series of contracts. For example, a merchant makes contracts with different firms (labors) to manufacture different parts of a machine, and then organizes these

commit wealth sufficient to cover negative residuals". The monitor will have the power (or authority) only when he is Schumpeter's entrepreneur who can innovate and create excess profits (to buy or bribe people).

Hart (1995) argues that "the concept of nonhuman assets is also helpful in clarifying the notion of authority … Coase … argued that the distinguishing feature of the employer-employee relationship is that an employer can tell an employee what to do … When nonhuman assets are present, it is not difficult to understand the difference between the employer-employee situation and the independent contractor situation. In the former case, if the relationship breaks down, the employer walks away with all the nonhuman assets, whereas in the latter case each independent contractor walks away with some nonhuman assets. This difference gives the employer leverage" (pp. 57-58). I will argue that as long as the so-called 'employee' can innovate to create excess profits, he will have the power and can "fire the employer" and cooperate with others. Nonhuman assets (such as machines, land or money) do not provide authority or leverage.

3. Equivalency between Maximizing Profits of the Firm and Maximizing Resource Providers' Wealth

Assume a one-period model: in the beginning of the period, the firm employs labor (L) and capital (K) to produce output ($q = q(L, K)$). At the end of the period, the capital has no scrap value, and the firm sells its outputs and liquidates. The firm's profit-maximizing problem is:

$$\underset{L,K}{Max} \quad \pi = p(q(L,K)) \cdot q(L,K) - w\,L - (1+r)\,K\,, \tag{1}$$

where w is the wage rate, $1 + r$ is the rental price of capital.

The first-order conditions for eq. (1) are:

$$\frac{\partial \pi}{\partial K} = \frac{\partial}{\partial K}[\,p(q(L,K)) \cdot q(L,K)] - (1+r) \equiv 0 \tag{2}$$

$$\frac{\partial \pi}{\partial L} = \frac{\partial}{\partial L}[\,p(q(L,K)) \cdot q(L,K)] - w \equiv 0\,. \tag{3}$$

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parts to make the machine (i.e., it is a kind of outsourcing). These firms (labors) will only care the opportunity costs they can earn, and do not need to make contracts with each other. In this case, the merchant (the 'organizer') will not have any power (since everything will be done according to well-specified ex-ante contracts).

The optimal inputs: L^* and K^* can be obtained by solving eq.'s (2) and (3) simultaneously.

We can also solve eq. (3) first for $L = L(K)$, and then substitute it into eq. (1):

$$\underset{K}{Max} \quad \pi(K) = p(q(L(K),K)) \cdot q((L(K),K) \; - \; w \cdot L(K) \; - \; (1+r) \cdot K \,, \tag{4}$$

where " $p(q(L(K),K)) \cdot q(L(K),K) - w \cdot L(K)$ " is the quasi-rent when K is fixed asset. Eq. (4) is the capital provider's wealth-maximizing problem, i.e., it assumes that the capital provider owns the property rights of the production (i.e., in addition to the opportunity costs of the capital input, the capital provider also owns the excess profits of the firm).

If we solve eq. (2) first for $K = K(L)$, and then substitute it into eq. (1):

$$\underset{L}{Max} \quad \pi(L) = p(q(L,K(L)) \cdot q((L,K(L)) \; - \; (1+r) \cdot K(L) \; - \; w \cdot L \,, \tag{5}$$

where " $p(q(L,\ K(L))) \cdot q(L,K(L)) - (1+r) \cdot K(L)$ " is the quasi-rent when L is fixed asset. Eq. (5) is the labor provider's wealth-maximizing problem, i.e., it assumes that the labor provider owns the property rights of the production (i.e., in addition to the opportunity costs of the labor input, the labor provider also owns the excess profits of the firm).

Notice that the maximum excess profits (π^*) and the optimum inputs (L^* and K^*) derived from eq. (1), eq. (4), or eq. (5) will be the same. That is, in the absence of transaction costs, maximizing excess profits of the firm and maximizing any resource provider's wealth are equivalent. For example, assuming that $q(L,K) = L^{1/2}K^{1/2}$, $w = 1$, $r = 0.5625$, and $p(q) = 10 - q$. Solve eq. (1), eq. (4) or eq. (5), $\pi^* = 14.0625$, $L^* = 4.6875$, and $K^* = 3$. These are the results of the Coase theorem: in the absence of transaction costs, who (or no one) owns the property rights of production (excess profits) is irrelevant to the value of production, and "Professor Steven N. S. Cheung has even argued that, if transaction costs are zero, 'the assumption of property rights can be dropped without in the least negating the Coase Theorem' and he is no doubt right" (Coase, 1988, pp. 14-15).

In the above example, suppose that the capital provider owns the property rights of the production (i.e., eq. (4)) and invests three units of K of his own money in the production. Then the rate of return on equity is: $(14.0625 + 3 \times 1.5625) / 3 = 625\%$, and the market value of the firm, i.e., the share which belongs to fund providers, is: $(14.0625 + 3 \times 1.5625) = 18.75$. If the capital provider invests one unit of K of his own money and borrows two units of K from the capital market, then the rate of return on equity increases to: $(14.0625 + 3 \times 1.5625 - 2 \times 1.5625) / (3 - 2) = 1{,}562.5\%$, but the market value of the firm is still the same: $(14.0625 + 3 \times 1.5625) = 18.75$. These results show that in the absence of transaction costs, Modigliani-Miller's first proposition (i.e., the market value of the firm is independent

of the firm's capital structure) is just the Coase theorem. Also, Modigliani-Miller's second proposition (i.e., the rate of return on equity increases with the firm's debt-equity ratio) holds, but it has nothing to do with risk.

Suppose that the labor provider owns the property rights of the production (i.e., eq. (5)) and invests 4.6875 units of L in the production. Then the rate of return on the labor-owner's input is: (14.0625 + 4.6875 $\times$ 1) / 4.6875 = 400%, and the market value of the firm, i.e., the share which belongs to labor providers, is: (14.0625 + 4.6875 $\times$ 1) = 18.75. If the labor-owner invests one unit of L and hires 3.6875 units of L from the labor market, then the rate of return on the labor-owner's input increases to: (14.0625 + 4.6875 $\times$ 1 – 3.6875 $\times$ 1) / (4.6875 – 3.6875) = 1,575%, but the market value of the firm is still the same: (14.0625 + 4.6875 $\times$ 1) = 18.75. Thus, if the labor provider owns the property rights of production, we can rewrite the Modigliani-Miller first proposition as: in the absence of transaction costs, the market value of the firm is independent of the firm's ratio of hired labor's input to labor-owner's input, and rewrite the Modigliani-Miller second proposition as: the rate of return on the labor-owner's input increases with the ratio of hired labor's input to labor-owner's input, but it has nothing to do with risk.

4. Derivatives and Theory of the Firm

In this section, I will show that in the firm, each resource is both a European call option and a European put option, and each resource is a stock plus a forward contract.

4.1 Each Resource Is Both a European Call Option and a European Put Option

Assume that in the beginning of the year, the firm is organized by four resource providers: the equityholder provides \$140, the debtholder provides \$200, the material provider provides material which has market value of \$141, and the labor provider provides labor which has market value of \$50. At the end of the year, the firm liquidates and distributes all it has, $\tilde{TR}$ (where $\tilde{TR}$ lies between \$600 and \$1,000), to the resource providers: the labor provider obtains \$90, the material provider obtains \$170, the debtholder obtains \$240, and the equityholder obtains the residual: Max[0, $\tilde{TR} - 500$]. That is, in the beginning of the year, the four resource providers exchange their resources for the following rights (options):

Equity

	European Call		European Put	
	(1)	(2)	(1)	(2)
Maturity	one year	one year	one year	one year
Market value of the underlying asset at maturity	$\text{Max}[0, \tilde{TR} - 500]$	$\tilde{TR}$	\$0	\$500
Current price of the option	\$140	\$140	\$140	\$140
Exercise price	\$0	\$500	$\text{Max}[0, \tilde{TR} - 500]$	$\tilde{TR}$
Payoff of the option at maturity	$\text{Max}[0, \tilde{TR} - 500]$	$\text{Max}[0, \tilde{TR} - 500]$	$\text{Max}[0, \tilde{TR} - 500]$	$\text{Max}[0, \tilde{TR} - 500]$

Debt

	European Call		European Put	
	(1)	(2)	(1)	(2)
Maturity	one year	one year	one year	one year
Market value of the underlying asset at maturity	\$240	$\tilde{TR}$	\$0	$\tilde{TR} - 240$
Current price of the option	\$200	\$200	\$200	\$200
Exercise price	\$0	$\tilde{TR} - 240$	\$240	$\tilde{TR}$
Payoff of the option at maturity	\$240	\$240	\$240	\$240

Material

	European Call		European Put	
	(1)	(2)	(1)	(2)
Maturity	one year	one year	one year	one year

Market value of the underlying asset at maturity	\$170	$\tilde{TR}$	\$0	$\tilde{TR}$ -170
Current price of the option	\$141	\$141	\$141	\$141
Exercise price	\$0	$\tilde{TR}$ -170	\$170	$\tilde{TR}$
Payoff of the option at maturity	\$170	\$170	\$170	\$170

Labor

	European Call		European Put	
	(1)	(2)	(1)	(2)
Maturity	one year	one year	one year	one year
Market value of the underlying asset at maturity	\$90	$\tilde{TR}$	\$0	$\tilde{TR}$ -90
Current price of the option	\$50	\$50	\$50	\$50
Exercise price	\$0	$\tilde{TR}$ -90	\$90	$\tilde{TR}$
Payoff of the option at maturity	\$90	\$90	\$90	\$90

Suppose that the firm changes to a more uncertain production activity, and $\tilde{TR}$ now lies between \$10 and \$1,600, where the labor provider is the first to get payment, the material provider is the second to get payment, the debtholder is the third to get payment, and the equityholder obtains the residual. Then the four resources of the firm are the following European options:

Equity

	European Call		European Put	
	(1)	(2)	(1)	(2)
Maturity	one year	one year	one year	one year
Market value of the underlying asset at maturity	$\text{Max}[0, \tilde{TR} - 500]$	$\tilde{TR}$	\$0	\$500
Current price of the option	\$140	\$140	\$140	\$140
Exercise price	\$0	\$500	$\text{Max}[0, \tilde{TR} - 500]$	$\tilde{TR}$
Payoff of the option at maturity	$\text{Max}[0, \tilde{TR} - 500]$	$\text{Max}[0, \tilde{TR} - 500]$	$\text{Max}[0, \tilde{TR} - 500]$	$\text{Max}[0, \tilde{TR} - 500]$

Debt

	European Call		European Put	
	(1)	(2)	(1)	(2)
Maturity	one year	one year	one year	one year
Market value of the underlying asset at maturity	\$240 if $TR \geq 500$ TR-260 if $260 < TR < 500$ \$0 if $TR \leq 260$	$\tilde{TR}$	\$0	TR-240 if $TR \geq 500$ \$260 if $260 < TR < 500$ TR if $TR \leq 260$
Current price of the option	\$200	\$200	\$200	\$200
Exercise Price	\$0	TR-240 if $TR \geq 500$ \$260 if $260 < TR < 500$ TR if $TR \leq 260$	\$240 if $TR \geq 500$ TR-260 if $260 < TR < 500$ \$0 if $TR \leq 260$	$\tilde{TR}$
Payoff of the option at maturity	\$240 if $TR \geq 500$ TR-260 if $260 < TR < 500$ \$0 if $TR \leq 260$	\$240 if $TR \geq 500$ TR-260 if $260 < TR < 500$ \$0 if $TR \leq 260$	\$240 if $TR \geq 500$ TR-260 if $260 < TR < 500$ \$0 if $TR \leq 260$	\$240 if $TR \geq 500$ TR-260 if $260 < TR < 500$ \$0 if $TR \leq 260$

Material

	European Call		European Put	
	(1)	(2)	(1)	(2)
Maturity	one year	one year	one year	one year
Market value of the underlying asset at maturity	\$170 if $TR \geq 260$ TR-90 if 90<TR<260 \$0 if $TR \leq 90$	$\tilde{TR}$	\$0	TR-170 if $TR \geq 260$ \$90 if 90<TR<260 TR if $TR \leq 90$
Current price of the option	\$141	\$141	\$141	\$141
Exercise Price	\$0	TR-170 if $TR \geq 260$ \$90 if 90<TR<260 TR if $TR \leq 90$	\$170 if $TR \geq 26$ TR-90 if 90<TR<260 \$0 if $TR \leq 90$	$\tilde{TR}$
Payoff of the option at maturity	\$170 if $TR \geq 260$ TR-90 if 90<TR<260 \$0 if $TR \leq 260$	\$170 if $TR \geq 260$ TR-90 if 90<TR<260 \$0 if $TR \leq 260$	\$170 if $TR \geq 260$ TR-90 if 90<TR<260 \$0 if $TR \leq 260$	\$170 if $TR \geq 260$ TR-90 if 90<TR<260 \$0 if $TR \leq 260$

Labor

	European Call		European Put	
	(1)	(2)	(1)	(2)
Maturity	one year	one year	one year	one year
Market value of the underlying asset at maturity	\$90 if TR>90 TR if $TR \leq 90$	$\tilde{TR}$	\$0	TR-90 if TR>90 \$0 if $TR \leq 90$
Current price of the option	\$50	\$50	\$50	\$50

Exercise Price	\$0	TR-90 if TR>90 \$0 if $TR \leq 90$	\$90 if TR>90 TR if $TR \leq 90$	$\tilde{TR}$
Payoff of the option at maturity	\$90 if TR>90 TR if $TR \leq 90$	\$90 if TR>90 TR if $TR \leq 90$	\$90 if TR>90 TR if $TR \leq 90$	\$90 if TR>90 TR if $TR \leq 90$

The above example shows that, first, each resource is a call or put option. In the beginning of the year, each resource provider provides his resource to obtain an option (a right) from other resource providers so that, at the end of the year, he can share what the firm has. The firm is fictitious. There is no such a thing as "the owner of the firm" since each resource provider has the property rights only on the resource he provides. This result refutes Black and Scholes' (1973) claim that "the bond holders own the company's assets, but they have given options to the stockholders to buy the assets back" (pp. 649-650). Second, when the firm moves from a more certain project (i.e., $\tilde{TR}$ lies between \$600, and \$1000) to a more uncertain project (i.e., $\tilde{TR}$ lies between \$10 and \$1,600), the variance of TR increases, and the current market value of equity will increase but the current market values of debt, material input and labor input will decrease, i.e., there is a wealth redistribution among the resource providers. This is because the debtholder's, material provider's and labor provider's payoffs have upper bounds, and they will not benefit if the more uncertain project succeeds, but they will suffer if the more uncertain project fails. For example, no matter whether the more uncertain project produces TR = \$800 or TR = \$1,600, the debtholder, material provider and labor provider will still obtain the same fixed payoffs: \$240, \$170, and 90, respectively. But for the equityholder (the residual claimant), he will obtain \$300 if TR = \$800, and \$1,100 if TR = \$1,600, i.e., his payoff has no upper bound.[10]

4.2 Each Resource Is a Stock Plus a Forward Contract

In the above example, in the beginning of the year, the total market value of the four resources is \$531, and the resource providers' shares are: the equityholder: 140/531, the debtholder: 200/531, the material provider: 141/531, and the labor provider: 50/531. At the end of the year, if $\tilde{TR}$ is distributed

[10] Note that the four resources are call or put options, and these options' current market prices have nothing to do with the resource providers' attitudes toward risk. See the Appendix for a binomial option example of the redistribution of wealth between debtholder and equityholder.

according to the resource providers' shares, then all the resource providers are like stockholders: the equityholder obtains $\tilde{TR}\times 140/531$, the debtholder obtains $\tilde{TR}\times 200/531$, the material provider obtains $\tilde{TR}\times 141/531$, and the labor provider obtains $\tilde{TR}\times 50/531$. Suppose $\tilde{TR}$ lies between \$10 and \$1,600, and the labor provider (because he has no savings) wants to have some sure gains instead of $\tilde{TR}\times 50/531$. Then, in the beginning of the year, the labor provider can negotiate with the other three resource providers to obtain, say, \$60 plus $(\tilde{TR}-60)\times 20/531$. That is, the labor provider's right is like a stock which will give $\tilde{TR}\times 50/531$, plus a forward contract which will sell $\tilde{TR}\times 50/531$ for \$60 plus $(\tilde{TR}-60)\times 20/531$. If this labor provider only wants fixed payoff: \$90, then his right is equivalent to a stock which will give $\tilde{TR}\times 50/531$ plus a forward contract which will sell $\tilde{TR}\times 50/531$ for \$90. The debtholder's and material provider's rights can also be shown as the combinations of stocks and forward contracts. If all the resource providers (including the equityholder) want to have some fixed payoffs, and the sum of these fixed payoffs is larger than \$10 (the minimum value of $\tilde{TR}$), then it will mean that the transaction costs of their cooperation are too high, and the firm cannot exist. Note that although the equityholder receives uncertain residual, and the labor provider, debtholder and material provider receive fixed payments, it doesn't mean that the equityholder can have any power or authority in directing the labor provider, debtholder and material provider. This result refutes Knight's (1933) claim that with uncertainty, "the system under which the confident and venturesome 'assume the risk' or 'insure' the doubtful and timid by guaranteeing to the latter a specified income in return for an assignment of actual results … With human nature as we know it it would be impracticable or very unusual for one man to guarantee to another a definite result of the latter's actions without being given power to direct his work. And on the other hand the second party would not place himself under the direction of the first without such a guaranty" (pp. 269-270).[11]

5. Concluding Remarks

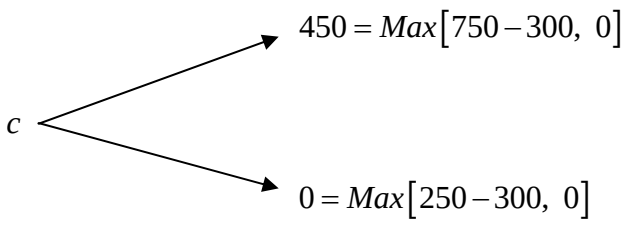
This paper has shown that, first, "the owner of the firm" is a misleading word. Just as Robin Hood cannot be termed as the owner of the gang, shareholders of the firm cannot be termed as the owners of the firm. Each resource provider of the firm has property rights only on the resource he provides, i.e., he has an ex-ante choice to join or not to join the firm, and after he invests his resource in the firm, he

[11] Since each resource is a stock plus a forward contract, it will be meaningless to say that only the equityholder (shareholder) is the owner of the firm, and other resource providers are not. Also, when the firm's product causes harm to its customers, it will be unfair to ask only the equityholder needs to compensate the damages.

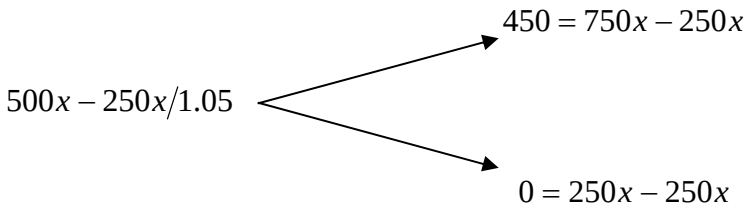
obtains a right (an option) to ex-post share the big pie generated by the firm. Since unlike public goods, firms have clear definitions for the resource providers' property rights, and the ex-post wealth of the firm will be distributed to the resource providers according to ex-ante contracts, the so-called first claim of debtholders (or material providers or labor providers) does not have any advantage. Second, as argued by Coase, the size of the firm is determined by the transaction cost of using the price mechanism and the transaction cost of using authority or power, and an activity will be counted as a part of the firm only when it is under the direction of the firm. But power or authority to direct resources cannot come from the firm's long-term contracts (as Coase suggested), the monitor's revising or adding contracts (as Alchian et al. suggested), or owning nonhuman assets (as Alchian et al. and Hart suggested). Power comes from choices (more choices mean more power), and choices come from innovations which can create excess profits to "buy or bribe" people. Third, in the absence of transaction costs, maximizing excess profits of the firm is equivalent to maximizing any resource provider's wealth (i.e., the Coase theorem: who (or no one) owns the property rights of production (excess profits) is irrelevant to the value of production); the Modigliani-Miller first proposition (i.e., the market value of the firm is independent of the firm's capital structure) is the Coase theorem when the equityholder owns the property rights of production; and if the labor provider owns the property rights of production, the Modigliani-Miller first proposition can be restated as: the market value of the firm is independent of the firm's ratio of hired labor's input to labor-owner's input, and the Modigliani-Miller second proposition can be restated as: the rate of return on the labor-owner's input increases with the ratio of hired labor's input to labor-owner's input. Fourth, each resource of the firm is both a European call option and a European put option, and there is no owner of the firm (no one owns all the assets of the firm). When the firm moves from a more certain project to a more uncertain project, the current market value of equity increases but the current market values of debt, material input and labor input decrease, i.e., there is a wealth redistribution among the resource providers. This result has nothing to do with the resource providers' attitudes toward risk. Each resource of the firm is also a stock plus a forward contract, and Knight's (1933) claim, that the residual claimant has the power to direct the resource providers who receive fixed payments, does not hold.

Appendix

This appendix uses a binomial option example to show the redistribution of wealth between debtholder and equityholder when the firm moves from a more certain project to a more uncertain project. Assume that in the beginning of the year, the sum of the market value of debt and market value of equity is \$500. At the end of the year, the firm liquidates and pays the debtholder fixed amount: \$300. If the firm's project succeeds, TR = \$750. If the firm's project fails, TR = \$250. One-year risk-free interest rate is 5%. The equityholder's payoff is either \$450 ($= Max[750 - 300, 0]$) or \$0 ($= Max[250 - 300, 0]$), i.e., the firm's equity is equivalent to the following European call option:



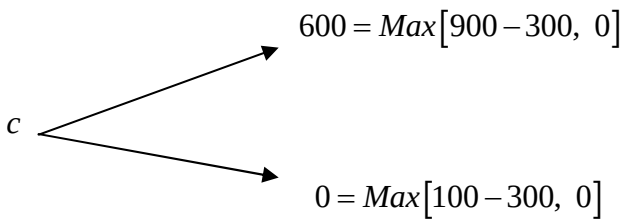
Suppose that in the beginning of the year, we set up a portfolio by borrowing (\$250 × x)/(1 + 5%) and purchasing (\$500 × x) of the sum of the market value of debt and market value of equity (i.e., x ratio of debt and equity) so that at the end of the year, the portfolio can provide the same payoffs as the firm's equity:



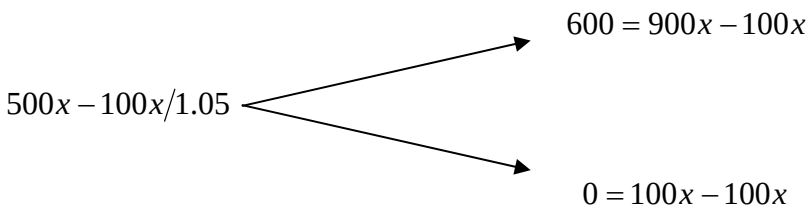
Then x = 0.9. The current market value of the firm's equity is: \$235.71 (= 500 (0.9) – 250(0.9)/1.05),

and the current market value of the firm's debt is: \$264.29 (= 500 – 235.71).

Suppose the firm moves to a more uncertain project which at the end of the year provides: *TR* = \$900 or *TR* = \$100 (where the sum of current market value of debt and market value of equity is still \$500). Then the firm's equity is equivalent to:



In the beginning of the year, we can also set up a portfolio by borrowing (\$100 × *x*)/(1 + 5%) and purchasing (\$500 × *x*) of the sum of the market value of debt and market value of equity so that at the end of the year, the portfolio can provide the same payoffs as the firm's equity:



where $x = 0.75$. Thus, the current market value of the firm's equity increases to: \$303.57 (= 500(0.75) – 100(0.75)/1.05) > \$235.71, and the current market value of the firm's debt decreases to: \$196.43 (= 500 – 303.57) < \$264.29.

The above example shows that when the firm moves from a more certain project (*TR* = \$750 or \$250) to a more uncertain one (*TR* = \$900 or \$100), the variance of *TR* increases, and the current market value of equity will increase but the current market values of debt will decrease. Also, this redistribution effect of wealth between debtholder and equityholder has nothing to do with their attitudes toward risk. All the resources of the firm are European call or put options. These results refute both

the claim that “there is a fundamental distinction between holding an option on an underlying asset and holding the underlying asset. If investors in the marketplace are risk-averse, a rise in the variability of the stock will decrease its market value. However … a rise in the variability in the underlying stock increases the market value of the call” (Ross, Westerfield and Jaffe, 2005, p.629), and the claim that “in most financial settings, risk is a bad thing; you have to be paid to bear it. Investor in risky (high-beta) stocks demand higher expected rates of return. High-risk capital investment projects have correspondingly high costs of capital and have to beat higher hurdle rates to achieve positive NPV. For options it’s the other way around” (Brealey, Myers and Allen, 2006, p.557).

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