A Property Right Theory of Capital Structure

Roland Bel
Euromed-Marseille
roland.bel@euromed-marseille.com

Abstract

Access and veto rights are alternative instruments to foster incentives in an incomplete contracts setting. When both are required ownership is optimal. Considering the governance features of debt and equity, we view (secured) debt as the allocation of veto rights by an entrepreneur to an investor, while equity corresponds to the allocation of access rights.

The model rationalizes the respective roles of debt-holders and equity-holders. Debt-holders should have veto on the entrepreneur's asset to prevent him from investing on substitutable projects. While equity-holders should have access to increase their incentives to invest. Overall our framework highlights the complementary and independent roles of debt and equity for the concerned parties: equity is an incentive device for investors while debt is a disciplining device for entrepreneurs.

We find out that debt is optimal when the entrepreneur has low marginal productivity and the asset is highly substitutable at the margin, whereas equity financing is optimal when the agent has high productivity and the asset is always complementary at the margin to the financial asset. Independent assets should be financed by retained earnings, differentiated assets by equity and idle assets by debt. Owners of intangible assets should finance their projects with retained earnings or minority equity, while owners of human assets should finance them with retained earnings or debt.

Using the same framework, we analyze the determinants of capital structure and study the link between R&D intensity and financing choices, and the role of venture capital in financing an entrepreneur's business.

1. Introduction

Since Modigliani-Miller (1959) and their irrelevance theorem, many scholars have tried to find explanations to the capital structure of the firm and in particular the choice between debt and equity. Several theories have emerged, in particular the trade-off theory, based on cost-benefit analysis of debt and dividends, the free cash-flow theory (Jensen & Meckling, 1976) based on agency costs, and the pecking order theory (Myers, 1984) based on asymmetric information[1]. This paper proposes a theory based on the allocation of rights.

Property rights have long been an important topic for economists (Coase, 1960, Alchian, 1961, Demsetz, 1967) but their formalization is more recent. In particular, the incomplete contracts literature emphasizes the role of control rights in providing incentives. *Ownership* (Grossman and Hart, 1986, Hart and Moore, 1990) provides ex ante incentives to invest, *access* (Rajan and Zingales, 1998) provides power, and *exclusive contracts* (Segal and Whinston, 2000, de Meza and Selvaggi, 2007) foster investment. Consolidating those approaches, and building on Segal (2003), Bel (2008) defines control as 'access with no outside veto' and shows that access and veto (exclusion) are alternative instruments to foster ex ante incentives in an incomplete contracts environment. When both are required, integration (ownership) is optimal.

In this context, – direct – control is exercised by access (provided no one else has veto), and – indirect – control is provided by veto.

Corporate finance theory still does not properly explain the coexistence of multiple securities with differentiated control rights (Tirole, 2001). Here we consider the governance features of debt and equity, and their respective incentive effects on all the agents involved: the managers and the lenders. (Secured) debt is characterized by contractual constraints and a pre-emptive role but no intrusion (Williamson, 1988) and thus corresponds to the allocation of veto power on the assets of the firm to the debt-holder[2]. The entrepreneur cannot "steal" the assets underlying the project to be financed (Hart and Moore, 1994) and cannot benefit from their revenue stream without the debt-

[1] See Harris and Raviv (1991) for a survey of capital structure theories and Myers (2001) for an overview.
[2] Hansmann and Kraakman (2002) define a security interest as 'a contingent claim on an asset that permits the holder of the interest to take physical possession of the asset and sell it to a third party upon the non-payment of the debt'. They explain that a security interest is a property right because it is enforceable against subsequent transferees of rights in the asset.

holder. On the other hand, equity is characterized by a residual claimant role and extensive intrusion (Williamson, 1988) and thus corresponds to the allocation of access to the equity-holder (who gets income rights). We define the concept of focus effect (focusing on fewer investment opportunities may increase the marginal product of investment) and find that equity is more efficient than debt (in terms of total welfare) when the marginal productivity of the productive agent with her own asset is higher than the focus effect.

In an incomplete contract setting, we show the following results. If the financial asset is always complementary (at the margin) to the entrepreneur's asset and the productivity of the entrepreneur with his asset is higher than the focus effect, he should raise equity (i.e. give access to the financial investor). But when his productivity becomes lower than the focus effect, the financial investor should take full ownership. If the entrepreneur's asset is always substitute at the margin (even in presence of the financial asset) to other assets and the productivity of the firm is lower than the focus effect, it should raise debt (i.e. give veto to the financial investor). But if its productivity is higher than the focus effect, the firm should finance its investments by itself (i.e. retained earnings).

The intuition is the following. When the financial asset is complementary (at the margin) to the entrepreneur's asset in presence of other assets, giving access to the financial investor will increase its incentives and its marginal productivity without decreasing the marginal productivity of the productive agent (they both are residual claimants). Moreover it will increase the incentives of potential additional investors. Thus it is efficient from a welfare point-of-view. On the other hand, when the entrepreneur's asset is substitute (at the margin) with other assets even in presence of the financial asset, his incentives may be reduced. Giving veto to the financial investor will prevent the entrepreneur from making investment in substitute assets. In other words, the debt, by creating a strain on the firm's cash flow, prevents the entrepreneur agent from engaging in hazardous investments.

The model rationalizes the respective roles of debt-holders and equity-holders. Debt-holders should have veto on the physical asset to prevent managers from merging substitute assets (or from investing on too many projects). While equity-holders should

have access to increase their and additional investors' incentives to invest. Overall our framework highlights the complementary and independent roles of debt and equity for the concerned parties: equity is an incentive device for investors while debt is a disciplining device for managers. This interpretation of our model provides a rationalization of the free cash-flow theory, which states that debt is the solution to force managers to pay out cash rather than investing in hazardous or unprofitable projects[3]. Our interpretation is also similar to a 'debt is hard, equity is soft' formulation *a la* Dewatripont and Tirole (1994), Hart and Moore (1990b), or Berkovitch and Israel (1996).

Using the same framework, we also study the link between R&D intensity and financing choices, and the role of venture capital in financing an entrepreneur's business.

The framework points out how a proper allocation of control rights determines the capital structure and achieves the optimal outcome. The technical foundation for the model is provided by Hart and Moore (1990) and Bel (2008). Hart and Moore provide the original framework for modeling the role of ownership allocation in an incomplete contract environment, while Bel de-bundles ownership into access and veto rights.

This paper brings about two new perspectives to the study of capital structure in an incomplete contract setting. First, in the study of an entrepreneur's financing, we account for a second entrepreneur which imposes negative externalities on the first one. Where Hart and Moore (1990) considers several agents but avoid negative externalities by assuming complementarity at the margin between agents and assets, most models, e.g. Aghion and Bolton (1992) or Dewatripont and Tirole (1994), are focused on a single agent. Second, the notion of control structure used here is new and inspired by Bel (2008). The GHM literature focuses on control rights rather than income rights, Aghion and Bolton show that control rights are 'just as important' as revenue streams in providing incentives, and Dewatripont and Tirole determine a correlation between control rights and revenue streams. Here, we consider that both veto and access provide control (and hence incentives), and accessorily generate income streams. Directly with access: the agent who accesses an asset can generate revenue with it; and indirectly with veto: veto confers bargaining power and hence a claim on the revenue generated by the other agents.

[3] "The problem is how to motivate managers to disgorge the cash rather than investing it below the cost of capital or wasting it on organizational inefficiencies" (Jensen, 1986).

Finally, the determinants of capital structure, whether internal (profitability, R&D investment,…) or external (industry concentration, product market decisions,…) have received considerable attention both from theoretical and empirical standpoints (for recent contributions, see for example Morellec, 2001, Barclay and Smith, 2005, Gaud *et al.*, 2005, Mahrt-Smith, 2005, Miao, 2005, Lyandres, 2006, Sayilgan *et al.*, 2006, Jiraporn and Gleason, 2007, Kale and Shahrur, 2007). Here, we make a number of testable predictions derived from our model and confront them to some of those studies.

The remainder of the paper is organized as follows. Section 2 analyzes the governance features of debt and equity. Section 3 introduces the basic model and the first results. Section 4 studies the determinants of capital structure. Section 5 generalizes the model to n agents while section 6 analyzes some applications. Section 7 concludes.

2. Governance features of debt and equity

There are two kinds of rights on an asset: the right to *access* the asset and the right to exclude or *veto* others from accessing it. An agent (or a group of agents) 'controls' an asset if she can access it and no one else has veto on it. When no one else can veto her, an agent who accesses an asset can make herself more valuable by specializing on the asset (as in Rajan and Zingales, 1998) and has a claim on the surplus generated that will be divided through ex post bargaining. Hence access with no veto provides power and may foster ex-ante incentives to invest.

In this conception, access provides control while veto removes control. But control may not always provide ex ante incentives to invest. In particular, when assets are substitutes at the margin, controlling another asset may actually *decrease* incentives to invest[4].

So what does it mean to 'access' an asset? An agent who accesses an asset can make human capital investment on it and generate some return. In an incomplete contracts environment, she has ex ante incentives to invest because access will increase her bargaining power in ex-post bargaining. This is because investing on the asset will make her more valuable: access provides power (Rajan and Zingales, 1998); or because

[4] The formal definition will be given later.

the agent who accesses an agent can derive private benefits from it even if she doesn't own it: access provides residual rights of control (Bel, 2008).

In this framework, access is inclusive (if an agent get access on another agent's asset, the former still has access on it), veto is exclusive (if an agent get veto on an asset, no one else can access the asset in her absence), and ownership is collusive (an agent who owns an asset can access it and exclude other agents from accessing it in her absence)[5].

There is a conception that characterizes shareholders as the owners of the firm. But shareholders own securities that embed control rights on the assets of the firm, rather than 'owning' the assets themselves. They own the capital of the firm rather than the physical assets. On the other hand, they have 'access' to the assets of the firm or to proprietary information on the assets. By investing their human capital on those assets, they can generate a return. This investment can take the form of monitoring or speculating, but in both cases shareholders derive a return on their investment. In the first case, they have a residual claim to the firm's earnings and assets, in the second case they receive the proceeds from selling their shares, potentially earning their share of the net increase in the firm's value. Unlike with ownership, which is exclusive, access by shareholders does not prevent the managers themselves to access the assets, and derive return from using them. By their actions, both the shareholders and the managers can maximize the value of the firm's assets. So when do the shareholders 'own' the assets of the firm? They own them when they can access them *and* they can exclude others from accessing them. This happens when a shareholder or a group of shareholders owns the majority of the shares. The majority shareholder then can decide who can access the assets of the firm and take decisions as the real owner. Collectively shareholders own the firm, but individually (provided they don't have the majority) they just have access to it.

Debtholders, on the other hand, do not have access to the firm's assets. But they have exclusive rights on the firm's assets corresponding to their loan. These exclusive rights may include restrictions on the use of the money[6], on the sale of assets[7], on

[5] See Segal (2003) for these concepts.
[6] Hart and Moore (1990b) consider debt as a mechanism to stop managers from getting funds for starting new projects.
[7] Dewatripont and Tirole (1994) consider that debt-holders play the role of controlling outsiders whose role is to discipline managers and to reduce the riskiness of the final value of the firm by taking actions such as canceling some projects, selling some assets or even liquidating the firm.

dividend payment, or on the issuance of new debt, and include the rights of the lender if the firm defaults. They come with a priority claim on the firm earnings and assets. So when do debtholder become owners of the firm's assets? In the case of a secured debt, the debt contract includes a provision stating that the lender will become owner of the collateral asset if the firm fails to service the debt.

Overall, equity holders have access to the assets of the firm while debtholders have veto. The former get ownership when they hold majority, while the later get ownership in case of default.

3. The model

There are two entrepreneurs (E and E') who hold some assets (respectively a and a') and an investor I with a financial asset f. E wants to finance a new project which requires both a and f. To fix ideas a (or a') could be a physical asset like a machine and f could be the amount needed to buy a stock of components that can be assembled and transformed into a final product by the machine. Or a (or a') could be an intangible asset like an idea for a new product and f could be the amount needed to develop and market the product. a (or a') could also be a human capital asset like the professional knowledge of a dentist and f could be the amount needed to buy the equipment necessary for exercising the activity.

A group (coalition) of agents S can access a set of assets A or veto a set of assets A'. We note $\lambda(S) = A$, the set of assets that S can access and $\mu(S) = A'$, the set of assets that S can veto. We will say that S *controls* a set of asset A if it can access it and no one else outside of S can veto it. Hence, the set of assets controlled by S is noted $\beta(S) = \lambda(S) \setminus \mu(N \setminus S)$ where $N = \{E, E', I\}$.

The agents invest some human capital effort $e_i (i = E, E', I)$ on the assets, where e_i represents the level and the cost of effort. When a subset of agents S control and invest efforts on a set of assets A that they control, they produce a value $v_S(A)$ where v is concave in e_i. Together, the three agents compose the grand coalition and produce a value V, concave in e_i. We assume that, for a given level of effort, $v_{ij} \geq v_i + v_j, \forall i, j$ and

$V \geq v_{ij} + v_k, \forall i, j, k$. So there is asset specificity and it is always desirable for the agents to reach an agreement. At date 0, rights over assets are allocated among the agents. At date 1, agents make unobservable investment on the assets that they control. Then they produce and share the surplus at date 2. Except the allocation of rights, which is enforceable at date 2, no variable is contractible, and the agents share the surplus through bargaining, using the Shapley value[8] as the solution concept[9]. We also assume that side payments between agents are allowed, so that efficient trading at date 0 leads to an allocation of rights that maximizes the overall surplus at date 2. The model proceeds as follows.

In a coalition S, an agent i's marginal return on investment is given by $\partial v_S(A)/\partial e_i \equiv v_S^i(A)$, and we assume that the marginal return with no asset is equal to zero ($v_S^i(\varnothing) \equiv 0, \forall i \in S$). Furthermore, as in Hart and Moore (1990), an agent's investment only affects the value of coalitions of which he is a member, i.e. we focus on *human capital* investment ($v_S^i(A) = 0$, if $i \notin S$), investments are complementary at the margin ($(\partial/\partial e_j) v_i^i(A) \geq 0, \forall i \neq j$), there is superadditivity in agents and assets ($v_S(A) \geq v_{S'}(A') + v_{S \setminus S'}(A \setminus A')$, and the marginal return increases with the number of agents and is highest for the grand coalition controlling all assets ($v_S^i(A) \leq v_{S'}^i(A) \leq V^i, \forall i \in \{E, E', I\}, \forall S \subseteq S'$).

- Optimal allocation of rights

Given an allocation of rights, each agent will choose her/his level of investment at date 1 in order to maximize her/his ex-ante net benefit, anticipating that the ex-post value will be shared through bargaining. Noting $\beta(S)$ the set of assets that coalition S will control at date 2, and computing the Shapley value, the ex-ante net benefit of the agents is:

[8] For a non-cooperative justification of the Shapley value, see Gul (1989) and Stole and Zwiebel (1996b).
[9] We use the Shapley value for simplicity, but our results would generalize, with some adaptation, to any fixed probabilistic distribution of the value among the agents.

$$E:\frac{1}{3}v_E(\beta(E))+\frac{1}{6}\left[v_{EI}(\beta(E,I))-v_I(\beta(I))\right]+\frac{1}{6}\left[v_{EE'}(\beta(E,E'))-v_{E'}(\beta(E'))\right]$$
$$+\frac{1}{3}\left[V-v_{IE'}(\beta(I,E'))\right]-e_E$$
$$I:\frac{1}{3}v_I(\beta(I))+\frac{1}{6}\left[v_{EI}(\beta(E,I))-v_E(\beta(E))\right]+\frac{1}{6}\left[v_{IE'}(\beta(I,E'))-v_{E'}(\beta(E'))\right]$$
$$+\frac{1}{3}\left[V-v_{EE'}(\beta(E,E'))\right]-e_I$$
$$E':\frac{1}{3}v_{E'}(\beta(E'))+\frac{1}{6}\left[v_{EE'}(\beta(E,E'))-v_E(\beta(E))\right]+\frac{1}{6}\left[v_{IE'}(\beta(I,E'))-v_I(\beta(I))\right]$$
$$+\frac{1}{3}\left[V-v_{EI}(\beta(E,I))\right]-e_{E'}$$

Given the human capital investment assumption, the Nash equilibrium investment is characterized by the first order conditions:

$$\frac{1}{3}v_E^E(\beta(E))+\frac{1}{6}v_{EI}^E(\beta(E,I))+\frac{1}{6}v_{EE'}^E(\beta(E,E'))+\frac{1}{3}V^E=1 \tag{1.1}$$

$$\frac{1}{3}v_I^I(\beta(I))+\frac{1}{6}v_{EI}^I(\beta(E,I))+\frac{1}{6}v_{IE'}^I(\beta(I,E'))+\frac{1}{3}V^I=1 \tag{1.2}$$

$$\frac{1}{3}v_{E'}^{E'}(\beta(E'))+\frac{1}{6}v_{EE'}^{E'}(\beta(E,E'))+\frac{1}{6}v_{IE'}^{E'}(\beta(I,E'))+\frac{1}{3}V^{E'}=1 \tag{1.3}$$

In a first-best world, the three agents would cooperate and the first-best level of investment $\hat{e}$ would be determined by $V^i=1,\forall i\in\{E,E',I\}$. But in an incomplete contracting world, we have the following result[10].

LEMMA. There is always underinvestment.

Proof. The equilibrium level of investment e satisfies (1.1)-(1.3). For agent E, we get $V^E\geq\frac{1}{3}v_E^E(\beta(E))+\frac{1}{6}v_{EI}^E(\beta(E,I))+\frac{1}{6}v_{EE'}^E(\beta(E,E'))+\frac{1}{3}V^E=1$ since $v_S^i(A)\leq V^i,\forall i,\forall S$, and the same is true for each agent. Then $e\leq\hat{e}$ since V is concave.

[10] With the assumptions above, the framework follows Hart and Moore (1990). This Lemma is similar to their *Proposition 1*.

Hence, the optimal (the second-best) allocation of rights β^* is the one that will maximize the equilibrium levels of investment for the agents.

Since we are interested in the optimal capital structure of E, we focus on agents E and I. In equations (1.1) and (1.2), the second and fourth terms are independent of the allocation of rights between E and I, so an allocation of rights that (weakly) increases the first and third terms will increase the two agents' incentives. Moreover, by symmetry, if $v^{E}_{EE'}(\beta(E,E'))$ increases, then $v^{E'}_{EE'}(\beta(E,E'))$ also increases (idem for $v^{I}_{IE'}(\beta(I,E'))$ and $v^{E'}_{IE'}(\beta(I,E'))$). Thus, this new allocation of rights can only increase agent F's incentives, provided that it does not affect $\beta(F)$. Hence maximizing E and I's incentives will consist in finding an allocation of rights that increases:

$$\frac{1}{3}v^{E}_{E}(\beta(E))+\frac{1}{6}v^{E}_{EE'}(\beta(E,E')) \tag{1.4}$$

$$\frac{1}{3}v^{I}_{I}(\beta(I))+\frac{1}{6}v^{I}_{IE'}(\beta(I,E')) \tag{1.5}$$

Initially, E,E',I respectively own a,a',f, so in the equations above we have: $\beta(E)=a$, $\beta(I)=f$, $\beta(E,E')=a,a'$, $\beta(I,E')=a',f$

Bel (2008) has shown that the relationship between assets *at the margin* is a key determinant for the optimal allocation of rights.

DEFINITION. *(i)* An asset a_l is said to be complementary [substitute] at the margin to an asset a_k if its presence raises [decreases] the marginal return obtained with a_k ($v^{i}_{S}(a_k,a_l)\geq[\leq]v^{i}_{S}(a_k)$, $\forall i\subseteq S$) *(ii)* It is *always* complementary [substitute] at the margin to a_k if its presence raises [decreases] the marginal return obtained with any set of assets containing a_k ($v^{i}_{S}(A\cup\{a_l\})\geq[\leq]v^{i}_{S}(A)$, $\forall i\subseteq S,\forall A\supseteq a_k$) *(c)* a_k,a_l are *independent* in case of equality.

When assets are substitutes at the margin, *focusing* on fewer assets raises the marginal return on investment[11]: the focus effect represents this increase of marginal return.

DEFINITION. An agent is said to be LP [HP], i.e. have low [high] productivity with an asset if her marginal return with the asset alone is lower [higher] than half the benefit of focusing on other assets : $v_i^i(a_i) \leq [>] \frac{1}{2}[v_{ij}^i(a_j) - v_{ij}^i(a_i, a_j)], \forall j \neq i, \forall a_j \neq a_i$

In this framework, assets are all complementary (superadditivity assumption) and what matters is their complementarity or substitution at the margin. From now on, to simplify exposition, we will sometimes omit the term 'at the margin' when referring to complementarity or substitution.

- Allocation of rights on the financial asset

Here, we assume that the financial asset f is always complementary at the margin to the other assets a and a': the entrepreneurs need cash and the financial asset can only increase their marginal return with their asset. A consequence is that the investor is HP with her asset, since the focus effect with the other assets is negative.

Should the entrepreneur receive rights on the financial asset?

a) Access: if E gets access on f, we now have $\beta(E) = a, f$, $\beta(I) = f$, $\beta(E, E') = a, a', f$, and $\beta(I, E') = a', f$. It increases E's incentive to invest without decreasing I's.

b) Veto: giving veto on f to E, would be worse since it would decrease I's incentives without increasing E's.

c) Ownership: giving ownership on f to E, would increase his incentives but would decrease I's, since we would now have $\beta(I) = \varnothing$ and $\beta(I, E') = a'$.

[11] Several authors have studied this effect under different concepts, for example decreasing returns to the entrepreneur function (Coase, 1937), diminishing return to scope of monitoring (Williamson, 1967), economies of specialization and coordination (Rotemberg and Saloner, 1994) downsizing (Dial and Murphy, 1995) or corporate focus (Daley *et al.*, 1997).

In our model access is inclusive: giving access on f to E does not decrease I's incentives because she keeps access. This raises the question of the rivalrous nature of f: how can two different agents simultaneously access a financial asset? Isn't it that if one agent uses the financial asset, the other agent cannot access it anymore? In fact the entrepreneur and the investor exercise different roles on the asset. The entrepreneur works on the asset to generate revenue, while at the same time the investor monitors the use of the asset by the entrepreneur, which may increase her own revenue from the asset. Both the entrepreneur and the investor have claim on the revenue generated with the asset.

- Allocation of rights on the entrepreneur's asset

Which rights should be given to the investor?

a) Access: giving access doesn't change E's incentives. Thus, it is easy to see that E should give access to I on a if $v_I^I(a,f) \geq v_I^I(f)$ and $v_{IE'}^I(a,a',f) \geq v_{IE'}^I(a',f)$, i.e. if a is always complementary to f

b) Veto: giving veto to I doesn't affect I's incentives. Thus E should give veto on a to I if $\frac{1}{3}v_E^E(\varnothing)+\frac{1}{6}v_{EE'}^E(a') \geq \frac{1}{3}v_E^E(a)+\frac{1}{6}v_{EE'}^E(a,a')$, i.e. if :

$$v_E^E(a) \leq \frac{1}{2}[v_{EE'}^E(a') - v_{EE'}^E(a,a')] \qquad (1.6)$$

The entrepreneur should give veto to the investor if he is LP with his asset.

c) Ownership: E should give ownership on a to I if the two conditions above are realized.

This is summarized in the Table 1 below.

Allocation of rights on a to I	*E HP*	*E LP*
a always complementary to f	***Access***	***Ownership***
a substitute to f or substitute in presence of a'	***None***	***Veto***

TABLE 1

Given the governance features of debt and equity analyzed above, we can now derive the following result, highlighting the optimal capital financing decision.

PROPOSITION 1. *(a)* Equity financing should be chosen when the entrepreneur's asset is always complementary to the financial asset *(b)* Secured debt financing should be chosen when the entrepreneur is LP with his asset *(c)* The investor should take ownership when the entrepreneur is LP and his asset is always complementary to the financial asset

This result is summarized in Table 2 below[12].

Allocation of rights on a to I	*E HP*	*E LP*
a always complementary to f	***Minority equity***	***Majority equity/ Ownership***
a substitute to f or substitute in presence of a'	***Retained earnings/ Unsecured debt***	***Secured debt***

TABLE 2

[12] Dewatripont and Tirole (1994) predict debt-holder control after bad performance (i.e. low $v_E^E(a)$, i.e. LP) and equity-holder control after good performance (i.e. high $v_E^E(a)$, i.e. HP), which resembles our result.

- Summary: the optimal allocation of rights

The optimal allocation is summarized in the following Table.

Allocation of rights between E and I	*E HP*	*E LP*
a always complementary to f	$\lambda(E)=\{a,f\}, \mu(E)=\varnothing$ $\lambda(I)=\{a,f\}, \mu(I)=\varnothing$ $\lambda(\{E,I\})=\mu(\{E,I\})=\{a,f\}$	$\lambda(E)=\{a,f\}, \mu(E)=\varnothing$ $\lambda(I)=\{a,f\}, \mu(I)=a$ $\lambda(\{E,I\})=\mu(\{E,I\})=\{a,f\}$
a substitute to f or substitute in presence of a'	$\lambda(E)=\{a,f\}, \mu(E)=a$ $\lambda(I)=f, \mu(I)=\varnothing$ $\lambda(\{E,I\})=\mu(\{E,I\})=\{a,f\}$	$\lambda(E)=\{a,f\}, \mu(E)=\varnothing$ $\lambda(I)=f, \mu(I)=a$ $\lambda(\{E,I\})=\mu(\{E,I\})=\{a,f\}$

TABLE 3

Which gives rise to the following control structures.

Control structures	*E HP*	*E LP*
a always complementary to f	$\beta(E)=\{a,f\}$ $\beta(I)=\{a,f\}$ $\beta(\{E,I\})=\{a,f\}$	$\beta(E)=f$ $\beta(I)=\{a,f\}$ $\beta(\{E,I\})=\{a,f\}$
a substitute to f or substitute in presence of a'	$\beta(E)=\{a,f\}$ $\beta(I)=f$ $\beta(\{E,I\})=\{a,f\}$	$\beta(E)=f$ $\beta(I)=f$ $\beta(\{E,I\})=\{a,f\}$

TABLE 4

We will now analyze those four optimal structures, but first some conceptual clarification is needed. To get (shared) access on the entrepreneur's asset, the investor pays a share price. Access is valuable to the investor, since it allows him to generate revenue with the asset, by investing his own human capital: the investor can generate revenue by monitoring the entrepreneur and negotiating a higher dividend, or by speculating and reselling his share with a profit. By issuing equity, the entrepreneur sells

access to her asset. By issuing debt, the entrepreneur sells veto to an investor and the investor pays this veto, that will give him a claim to the ex post share of surplus, by lending money to the entrepreneur. The entrepreneur sells veto to bond himself and prevent him to engage in additional investment opportunities. These investment opportunities could arise on assets complementary, but substitute at the margin. Without external veto, it would decrease its marginal return.

(a) The entrepreneur is HP and his asset is always complementary to the financial asset

The intuition is the following. When the entrepreneur's asset is complementary to the financial asset in presence of other physical assets, giving access on the entrepreneur's asset to the financial investor will increase its incentives and its marginal productivity *without* decreasing the marginal productivity of the productive agent (they both are residual claimants). Thus it is efficient from a welfare point-of-view. Accessing a and f, the investor can monitor their use by the entrepreneur and exchange information with him. Moreover the investor will bring both assets (or information about them) in her relationship with the other entrepreneur (E'), increasing both the investor and the second entrepreneur's marginal returns ($v^{I}_{IE'}(aa'f) \geq v^{I}_{IE'}(a'f)$ and $v^{E'}_{IE'}(aa'f) \geq v^{E'}_{IE'}(a'f)$).

If equity is characterized by extensive intrusion, we find here two roles for shareholders: monitoring of individual entrepreneurs (or managers) and allocation (of information, advices,…) between firms on the capital market.

Moreover, the control structure of equity is characterized by *joint access* and *joint control* on the assets by both the entrepreneur and the investor.

(b) The entrepreneur is HP and his asset is not always complementary to the financial asset

Here, the substitution between a and a' is stronger than the complementarity between a and f. Giving access on a to the investor would reduce his marginal return or the marginal return of the second entrepreneur in their relationship ($v^{I}_{IE'}(aa'f) \leq v^{I}_{IE'}(a'f)$ or $v^{E'}_{IE'}(aa'f) \leq v^{E'}_{IE'}(a'f)$). This may happen because the monitoring capabilities of the investor are limited or because the second entrepreneur would be skeptical about the

influence of a shareholder who also holds shares in a competing firm. In that case E should not give access to the investor and should finance his investment by retained earnings, keeping control on both assets.

(c) The entrepreneur is LP and his asset is not always complementary to the financial asset

Here the entrepreneur should not give access to the investor but he should give her some veto rights. Giving veto to the investor will prevent the entrepreneur to make investment in substitute assets, i.e. to merge his asset with the second entrepreneur's asset or to invest in a second project that would reduce his marginal return. Hence, the role of the debt is to focus the entrepreneur on his current project. By giving veto to the investor, the entrepreneur bonds himself. We find here the classical role of debt: by creating a strain on the entrepreneur's cash flow, it prevents him to invest in risky ventures that would ultimately reduce his marginal return. How much debt should the entrepreneur borrow? He should borrow up to the point where he no longer is LP.

Looking at Table 3 above, one can realize that the investor does not have veto on f, precisely the asset that she brings, but rather on the entrepreneur's asset a. This may seem strange, but here f is always complementary to the entrepreneurs' assets. Hence the focus effect between f and the other assets is negative and the entrepreneur is HP with f. Therefore the investor should not have veto on it. In other words, in an optimal secured debt contract, the collateral should be provided by the complementary asset.

The control structure of secured debt is characterized by *joint control* on the financial asset by both the entrepreneur and the investor, and veto by the investor on the entrepreneur's asset.

This role of debt in our framework provides one testable prediction: debt contracts should in general include clauses preventing/limiting investment in substitute assets (e.g. prohibition to invest in new, unrelated lines of business) and aimed at *focusing* the firm.

(d) The entrepreneur is LP and his asset is always complementary to the financial asset

The entrepreneur must give both access and veto to the investor, who will take ownership of the firm. Here the investor must exercise both a monitoring role (which increases her

incentive to invest on the entrepreneur asset) and a disciplining role (to focus the entrepreneur).

When should shareholders or debtholders become owners? Shareholders get ownership when the entrepreneur becomes LP with their own asset: at this stage the entrepreneur must cede the majority control of the equity to external shareholders in order to bond himself and prevent him to engage in additional risky investments. Shareholders must then exercise a disciplining role[13]. The framework also rationalizes the difference between an individual shareholder and the group of shareholders, or between minority shareholders and majority shareholders. Suppose the firm needs a financing $f = \overline{f} + \underline{f}$ with $\overline{f}$ being the *essential* part of the financing (the 'must have') and $\underline{f}$ the 'nice to have'. The firm may be HP without $\underline{f}$ but will become LP without $\overline{f}$ since $\overline{f}$ is essential to E. This explains why the (minority) shareholders who bring $\underline{f}$ only have access to a (they receive dividends) while the majority shareholders who provide $\overline{f}$ have ownership (i.e. access and veto) on a. This also explains the difference between an individual shareholder whose financial asset is not essential and the collectivity of shareholders whose collective financial asset is essential[14]. In our framework, individual or minority shareholders do not have veto rights while majority shareholders (or the entire shareholder group) do.

On the other hand, debtholders should get ownership when the entrepreneur's asset becomes always complementary. This happens when the entrepreneur defaults and the debtholder must take a monitoring role by seizing the asset (and reselling it).

Having characterized the capital structure decision, we will now have a closer look to its determinants.

4. Determinants of capital structure

It will be useful to characterize some particular types of assets and relationships between agents and assets.

[13] Berkovitch and Israel (1996) show that absolute control (i.e. ownership) is allocated to shareholders when the marginal product of managerial effort (i.e. $v_E^E(a)$ in our model) is relatively high, while veto power is allocated to debtholders when it is relatively low, which resembles our model.

[14] See Williamson (1996)

DEFINITION. An asset a_i is *(i) differentiated* if it is complementary to all other assets, i.e. if $v_S^i(A \cup \{a_i\}) \geq v_S^i(A)$, $\forall i, S, A$ *(ii) idle*, if for all agents the asset is irrelevant to their marginal return, i.e. when $v_S^j(A) \equiv v_S^j(A \setminus \{a_i\})$, $\forall j$, *(iii) unproductive*, if the agent marginal return is equal to zero with any asset and any coalition $v_S^i(A) \equiv 0$, $\forall S, \forall A$

PROPOSITION 3. *(i)* Owners of independent assets should finance their asset through retained earnings, *(ii)* owners of idle assets through debt, and *(iii)* owners of differentiated assets through (minority) equity

Proof. (i) If a is independent from f ($v_I^I(af) \equiv v_I^I(f)$ and $v_I^I(aa'f) \equiv v_I^I(a'f)$), then it is not always complementary to f, so I should not have access on a. Moreover if a is independent from a' the focus effect between a and a' is equal to zero ($v_{EE'}^E(aa') = v_{EE'}^E(a')$) and E is HP ($v_E^E(a) > \frac{1}{2}[v_{EE'}^E(a') - v_{EE'}^E(a,a')] = 0$), so E should not give veto on a .*(ii)* If a is idle, then it is not always complementary to f (since $v_I^I(af) \equiv v_I^I(f)$ and $v_I^I(aa'f) \equiv v_I^I(a'f)$), and E is LP with a ($v_E^E(a) = 0 = \frac{1}{2}[v_{EE'}^E(a') - v_{EE'}^E(a,a')]$) *(iii)* If a is differentiated, it is complementary to all other assets, hence it is always complementary to f and E is HP (since the focus effect is negative)

Professionals such as dentists, medical doctors, accountants or architects own independent assets: their specific skills and knowledge. They usually finance their physical assets by their own means or through unsecured debt. Regarding differentiated assets, our framework rationalizes a statement from Williamson (1988) for whom debt will be used for financing highly deployable assets while equity will be favored for highly nonredeployable (i.e. highly specific) assets. Here specific assets are called differentiated assets, while redeployable assets are assets which are substitute at the margin with other assets (and hence cause the entrepreneur to be LP).

DEFINITION[15]. An asset a_i is *essential* to an agent i if the agent marginal return is equal to zero without the asset, i.e. when $v_S^i(A) \equiv 0$ if $a_i \notin A$

PROPOSITION 4. Owners of essential assets or intangible assets should finance their projects with retained earnings (or unsecured debt) or minority equity.

Proof. If a is essential to E, the focus effect between a and a' is negative ($v_{EE'}^E(a') - v_{EE'}^E(aa') = -v_{EE'}^E(aa')$) and E is HP with his asset. Intangible or knowledge assets tend to be complementary at the margin (more knowledge can only increase marginal return). So their owners are more likely to be HP.

DEFINITION. *(i)* An agent i is *indispensable* to an asset a_i if without i in a coalition, a_i has no effect on the marginal return of the coalition's members i.e. when $v_S^j(A) \equiv v_S^j(A \setminus \{a_i\})$ if $i \notin S$ *(ii)* a_i is *idiosyncratic* to i if for all other agents the asset is irrelevant to their marginal return, i.e. when $v_S^j(A) \equiv v_S^j(A \setminus \{a_i\})$, $\forall j \neq i$

PROPOSITION 5. *(i)* Indispensable owners or owners of human assets or idiosyncratic assets should finance their projects with retained earnings or debt *(ii)* In an industry where all assets are idiosyncratic to their owners, they should finance their projects with retained earnings (or unsecured debt)

Proof. *(i)* If E is indispensable to a or if a is idiosyncratic to E, then a is not always complementary to f ($v_I^I(af) \equiv v_I^I(f)$ and $v_I^I(aa'f) \equiv v_I^I(a'f)$). On the other hand, in absence of slavery, human assets are unalienable (and idiosyncratic): only the owner of the human asset has the right to use it ($\lambda(E) = a$ and $\lambda(i) \neq a$ if $i \neq E$). *(ii)* Moreover, if a' is also idiosyncratic to E', then the focus effect between a and a' is negative ($v_{EE'}^E(a') - v_{EE'}^E(aa') = -v_{EE'}^E(a)$) and E is HP with his asset.

Here also the example of professionals (who own idiosyncratic knowledge assets) is relevant.

[15] This definition and the following are from Hart and Moore (1990)

PROPOSITION 6. An entrepreneur should choose debt financing if he is unproductive or the financial asset is essential to him or the investor is indispensable

Proof. If E is unproductive or f is essential to E, then E is LP with his asset alone ($v_E^E(a) \equiv 0$ and $\frac{1}{2}[v_{EE'}^E(a') - v_{EE'}^E(a, a')] \equiv 0$). If I is indispensable to a, then E is LP with his asset alone ($v_E^E(a) \equiv 0$ and $\frac{1}{2}[v_{EE'}^E(a') - v_{EE'}^E(a, a')] \equiv 0$)

PROPOSITION 7. An entrepreneur should choose equity financing if his asset is essential to the investor

Proof. If a is essential to I, or f is dependent from a, then a is always complementary to f since $v_I^I(af) > v_I^I(f) = 0$ and $v_I^I(aa'f) > v_I^I(a'f) = 0$.

PROPOSITION 8. *(i)* Firm profitability, R&D intensity, advertising intensity, should correspond to a lower leverage ratio, *(ii)* Asset tangibility, liquidity, and diversification should correspond to a higher leverage ratio.

(i) High profitability means that $v_E^E(a)$ is high and hence the entrepreneur is more likely to be HP. On the other hand a high level of R&D or advertising investment will tend to differentiate the assets of the firm and hence decrease the substitution effect with other assets. The entrepreneur will be more likely to be HP.

(ii) Tangible assets and liquid assets are more likely to be substitute at the margin, because this kind of asset can be easily traded on the market and can be managed by different entrepreneurs. Hence their level of substitutability is higher and the entrepreneur is more likely to be LP. Similarly, a high level of asset diversification corresponds to a lower level of focus and increases the chance that the sub-assets constituting the main asset be substitute to other external assets. Here also, the entrepreneur is more likely to be LP.

These determinants have been empirically tested or theoretically justified by Long and Malitz (1985), Morellec (2001), Sayilgam *et al.* (2006). Long and Malitz argue that

R&D investments are firm specific (they create knowledge-based assets that have value within the firm): this is another way of saying that the assets are not substitute ($v^E_{EE'}(a,a') \equiv v^E_{EE'}(a')$, hence $\frac{1}{2}[v^E_{EE'}(a') - v^E_{EE'}(a,a')] \equiv 0$) and the firm is more likely to be HP. They show that debt provides inappropriate governance for investments in R&D. Morellec shows that asset liquidity increases debt capacity but only when bond covenants restrict the disposition of assets (i.e. veto). But with unsecured debt, greater liquidity reduces optimal leverage: this is alike our results. In the Turkish context, Sayilgan *et al.* show that both profitability and asset tangibility are associated with a lower debt level. The later argument contradicts our finding, but other studies (Bradley *et al.*, 1984, Allen, 1995, Rajan and Zingales, 1995, Ooi, 1999, Gaud, 2005) tend to confirm our theory. In those studies, the argument evoked is different from ours: tangible assets serve as 'solid' collateral and increase the willingness of lenders to provide funds.

5. Generalization

The model can be generalized to n agents. In that case, the definition of a LP [HP] agent becomes[16]:

$$v^i_i(a_i) \leq [>] \frac{n-2}{2}[v^i_S(A \setminus \{a_i\}) - v^i_S(A)], \forall S \supset i, \forall A \supset a_i \qquad (1.7)$$

A new factor now comes into play. For a given level of marginal productivity with his asset, the lower the number of agents in the industry, the more likely the entrepreneur will become HP. Which indicates other determinants for the financing decision.

PROPOSITION 9. *(i)* The likelihood of equity financing increases with the degree of concentration in the industry and with the maturity of the industry *(ii)* Industries with more JV and strategic alliances and industries with higher R&D intensity are more likely to use equity financing *(iii)* The likelihood of debt financing increases with the number of investment opportunities or the intensity of industry rivalry

[16] The proof can be found in Bel (2008).

(i) When the degree of concentration increases, n decreases. When an industry becomes more mature it is generally more concentrated and the number of investment opportunities (in substitute assets) is limited

(ii) Industries with more JV and alliances are industries where firms own assets which are more likely to be complementary at the margin. The same is true for industries with higher R&D intensity. Hence the focus effect between the firms' assets is more likely to be negative and the individual firms are more likely to be HP.

(iii) When the number of investment opportunities (as in young industries) is high, n is high. When the level of rivalry or competitiveness is high, firms' assets are more likely to be substitutes at the margin, hence the focus effect is high and firms are LP

Investigating the link between firm's leverage and the characteristics of its suppliers and customers, Kale and Shahrur (2007) confirm our predictions. They show a negative relationship with R&D intensities of suppliers and customers and with the prevalence of joint ventures and strategic alliances with customers and suppliers. But, unlike us, they also show a positive relationship with the degree of concentration in supplier and customer industries.

6. Applications

We will now cover two specific but important applications: R&D financing and venture capital financing.

- R&D intensity and financing choices

What is the link between the level of R&D investment and the choice of financing? A first intuition would suggest a linear relationship between these two variables. Higher R&D intensity increases the differentiation of the firm, i.e. leads to a lower focus effect, therefore increasing the likelihood of the firm being HP. Hence, from our framework, higher R&D intensity firms would tend to use more equity (*Proposition 9*). Aghion *et al.* (2004) use data on 900 publicly traded UK firms from 20 industries (1990-2002) to

determine whether the choice of financing differs with R&D intensity[17]. They find the above linear relationship: the probability of issuing shares increases with R&D intensity. But they find a nonlinear relationship with the debt/assets ratio: firms with positive but low R&D use more debt finance than firms with no R&D, then the use of debt finance falls with R&D intensity among firms with positive R&D. If we follow Aghion *et al.* and assume that 'more innovative firms are likely to generate more attractive investment opportunities than less innovative firms' and that with high R&D intensity there is a stronger need for cash, our framework will predict the following. Compared with firms with no R&D, innovative firms will have more investment opportunities therefore more opportunities to defocus, i.e. the focus effect is likely to be higher for innovative firms which are more likely to be LP. Thus innovative firms are more likely to use debt than firms with no R&D. As R&D intensity increases the differentiation benefit of R&D kicks off and/or the complementarity to financial assets and attraction for investors increases (the financial asset becomes always complementary). Innovative firms will then have to issue equity rather than debt which justifies the linear relationship between R&D intensity and equity[18].

- *Venture Capital*

Suppose that an entrepreneur starts with a business concept (her main asset) which needs some financial asset to generate return for the entrepreneur. Obviously the financial asset is always complementary to the business concept, which has no value without it, the financial investor is indispensable to the business and the entrepreneur is LP without a financial investor. In addition, the business concept is essential to the investor, who cannot generate return without it. Following our framework, the financial investor should have ownership (veto and access) on the entrepreneur's business while the entrepreneur should have access to the investor's finances. If after some time the business is a success, the marginal productivity of the entrepreneur increases and it may become HP without the financial asset (the financial investor is not indispensable anymore). At that stage, the

[17] Anderson and Prezas (1999) take the opposite approach and provide a model where debt affects a firm's decision between real and intangible (e.g. R&D) assets. They conclude that increasing debt financing exogenously may increase investment in intangible assets.
[18] Aghion *et al.* use a similar 'pecking order' explanation for their findings.

entrepreneur should get veto rights back and the financial investor should be left with access rights only. This is what happens with Venture Capital.

Kaplan and Strömberg (2003) analyze 213 VC investments in 119 portfolio companies by 14 VC firms. They find out that the characteristics of Venture Capital (VC) financing follow the following pattern. The VC firm can separately allocate control rights, i.e. cash-flow rights, board rights, voting rights, liquidation rights and other control rights, contingent on firm's performance. Board rights, voting rights and liquidation rights are allocated such that the VC firm obtains full control if the firm performs poorly. As performance improves, the entrepreneur obtains more control rights. When the firm performs very well, the VC firm retains cash flow rights and relinquishes other rights to the entrepreneur.

7. Concluding remarks

Fama and French (2002) remark that both the trade-off and the pecking order theories rely on two main factors to explain the choice between debt and equity (expressed by leverage and dividend payout ratio): the profitability of the firm and investment opportunities. In our framework those two factors can be thought of as representing respectively the marginal productivity of the firm with its asset alone ($v_E^E(a)$) and the level of the focus effect ($\frac{n-2}{2}[v_S^i(A\setminus\{a_i\})-v_S^i(A)]$): with more investment opportunities/projects the focus effect is likely to be higher. Using various proxies for the concepts used in the two theories, Fama and French test their predictions by screening Compustat for the period 1965-1999 (including in average more than 3000 firms). They find the following results[19].

(i) More profitable firms are less levered (confirming pecking order model but contradicting the trade-off model): this is justified by our framework which predicts that, holding investment fixed, when $v_E^E(a)$ is higher the firm is more likely to be HP and to use equity rather than debt, explaining a lower ratio of debt vs. equity.

[19] Fama and French (2002) also test the theories and bring results on other parameters, such as dividend payouts, which are outside the scope of our model.

(ii) Firms with more investments have less market leverage (consistent with the trade-off theory and a *complex version* of the pecking order model): with more investments the focus effect is likely to be higher (more risk of de-focus), so the firm is likely to be LP and to use debt[20] rather than equity, justifying a *higher* leverage. Here our model is consistent with the simple version of the pecking order model but contrary to the empirical results of Fama and French. However the authors report another 'more complex' version of the pecking order model: firms balance current and future financial costs. For this reason they maintain debt capacity to avoid foregoing future investments or financing them with risky securities. That would explain that firms with larger expected investments have less current leverage. Unfortunately our framework, being a static model, is unable to capture this effect.

We believe our work can be extended in three directions. First, taking a dynamic perspective would allow capturing the effect of time, risk and expectation: after all investors and entrepreneurs often use strategic behavior in their financial choices. Second, the model could be extended to more classes of rights. The right to resell the share is certainly playing a very important role in investors' decisions. Third, the results in this paper are linked to the notions of complementarity and substitution *at the margin* but these are difficult to measure empirically. A promising line of research would be to develop empirical proxies for those concepts.

A next major step forward in solving the capital structure puzzle should take those dimensions into account.

[20] Regarding the structure of the debt, Hosono (2003) analyses data from Japanese machine manufacturing from 1990 to 1996 and finds that firms with abundant growth opportunities (and scarce collateral) are likely to borrow from banks rather than to issue bonds.

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