Security Design with Status Concerns

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Motivation

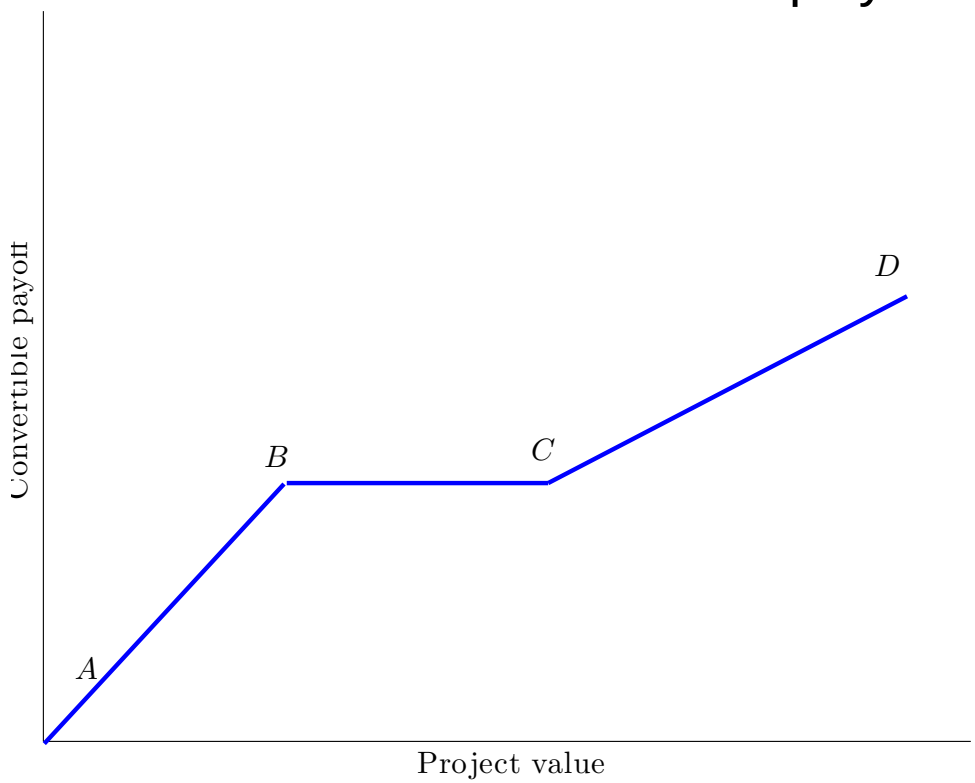
- Financial securities play a key role in the economy
  - they are at the center of interaction between entrepreneurs and financiers
  - economic growth depends on the ability of entrepreneurs to finance their projects
- There is great variety of securities used in reality; security design literature seeks to explain their role
- Despite extensive evidence of status concerns, how they affect the choice of security to be issued remains unexplored
  - there are studies documenting status concerns specifically among entrepreneurs
- *This paper*: the first work to examine security design in the presence of status concerns

Our Work

- Continuous-time security design framework
- Status-driven entrepreneur has a project idea and a financier has funds
  - no asymmetric information, no agency problems
- Status concerns: preferences with a local convexity (Friedman and Savage, 1948)
- External financing: entrepreneur finances the project by issuing a security to the financier
- Internal financing: entrepreneur invests own money
- We solve analytically for the optimal security (and other quantities of interest)
  - the solution method is non-standard due to non-concave preferences

Preview of the Results

- Optimal security is considerably similar to a convertible security
  - widely used in venture capital and private equity
  - *hybrid* security: combines features of debt (*A*-*B*-*C*) and equity (*C*-*D*)
  - slope of segment *C*-*D* is conversion ratio
  - not the same as a mix of debt and equity



Preview of the Results, cont'd

- Our model can explain why convertible securities are primarily used to finance relatively volatile projects
- It can also explain why convertibles have different conversion ratios
- The model can be adapted to explain "fixed salary plus bonus" compensation schemes
  - such schemes have a similar payoff profile to that of a convertible

Related Literature

- Existing explanations of convertibles focus on agency problems
  - Constantinides and Grundy (1989), Stein (1992), Cornelli and Yosha (2003), Schmidt (2003), Repullo and Suarez (2004), Hellmann (2006), Chakraborty and Yilmaz (2011), Lyandres and Zhdanov (2014)
- Most of the security design models also consider agency problems
  - see recent reviews by Sannikov (2012), Biais, Mariotti, and Rochet (2013)
  - exceptions are Cadenillas, Cvitanic, and Zapatero (2007), Bolton and Harris (2013)
- Works on status concerns in other contexts
  - Becker, Murphy, and Werning (2005), Moldovanu, Sela, and Shi (2007), Auriol and Renault (2008), Besley and Ghatak (2008), Roussanov (2010), Dijk, Holmen, and Kirchler (2014), Georgarakos, Haliassos, and Pasini (2014), Hong, Jiang, Wang, and Zhao (2014)

Setting: Project

- Entrepreneur has a project idea requiring an initial investment V_0
- The project value V follows

$$\frac{dV_t}{V_t} = \phi_t \mu dt + \phi_t \sigma d\omega_t$$

- Entrepreneur chooses the *product novelty* parameter ϕ
- Increasing product novelty is associated with
  - higher expected profits due to lower competition $\Rightarrow$ higher mean growth rate of project value
  - more uncertainty about future demand $\Rightarrow$ project value is more volatile

Setting: Status Concerns

- Friedman and Savage (1948) seminal idea: capture status concerns via a utility function featuring a local convexity
- Marginal utility *increases* in the wealth region between low and high-status regions
- Decreasing marginal utility reflects satiation
- Once one is wealthy enough, she switches from “low status” to “high status” goods $\Rightarrow$ satiation mechanism is not at work
- Subsequent research have formally derived preferences with a convexity
  - Patel and Subrahmanyam (1978), Gregory (1980), Robson (1992)

Setting: Entrepreneur's Preferences

Entrepreneur's utilify function $u_E(\cdot)$ over time-τ wealth $W_{E\tau}$

$$u_E(W_{E\tau}) = \begin{cases} \frac{(W_{E\tau})^{1-\gamma_E}}{1-\gamma_E} & W_{E\tau} < L, \\ \frac{(W_{E\tau}-\alpha)^{1-\gamma_E}}{1-\gamma_E} + B & W_{E\tau} \geq L, \end{cases}$$

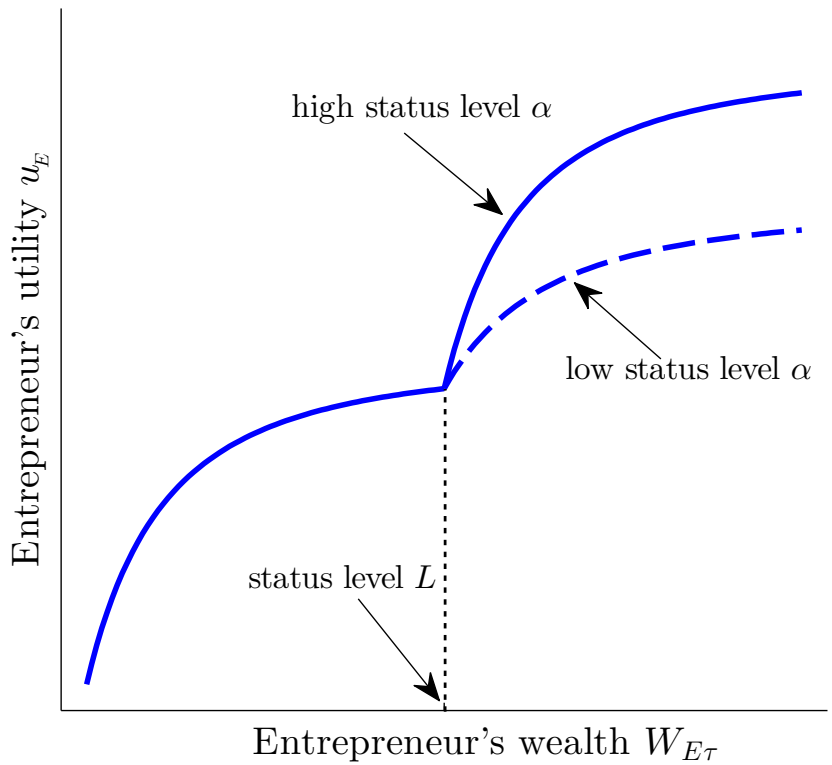
Parameters are:

concern for status α

status level of wealth L

attitude towards risk γ_E

B ensures continuity



Setting: Internal Financing

- Though our focus is on security design, we start with the internal financing case
  - entrepreneur invests own money in the project $\Rightarrow$ no security is issued
  - she dynamically chooses the product novelty ϕ to maximize expected utility
  - this analysis clarifies the mechanism playing a key role in the security design problem
- Entrepreneur's problem with internal financing is

$$\max_{\phi_t} E\left[u_E(V_\tau)\right]$$

$$\text{subject to} \quad dV_t = V_t\phi_t\mu dt + V_t\phi_t\sigma d\omega_t.$$

Setting: External Financing

- To raise the initial investment V_0, the entrepreneur issues a security $W_{FT}(V_T)$ to the financier
  - Specifies financier's payoff W_{FT} for each possible project value V_T at time $T < \tau$
- Financier expected utility has to be higher than $\bar{u}_F$
  - financier has CRRA utility function $u_F(W_{FT}) = \frac{(W_{FT})^{1-\gamma_F}}{1-\gamma_F} \Rightarrow$ no status concerns
  - reservation utility $\bar{u}_F$ reflects outside investment opportunities and bargaining power
- Entrepreneur's problem with external financing is

$$\max_{\phi_t, W_{FT}(V_T)} E[u_E(V_\tau)]$$

$$\text{subject to} \quad dV_t = V_t\phi_t\mu dt + V_t\phi_t\sigma d\omega_t - W_{FT}d1_{\{t=T\}},$$

$$E[u_F(W_{FT})] \geq \bar{u}_F.$$

Analysis: Internal Financing Case

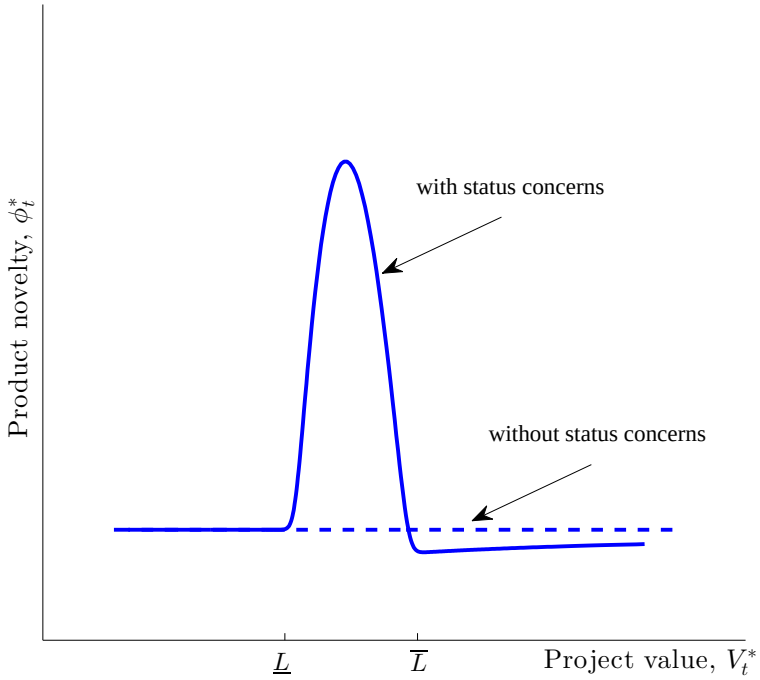
- The optimal product novelty ϕ^* and project value V^* are

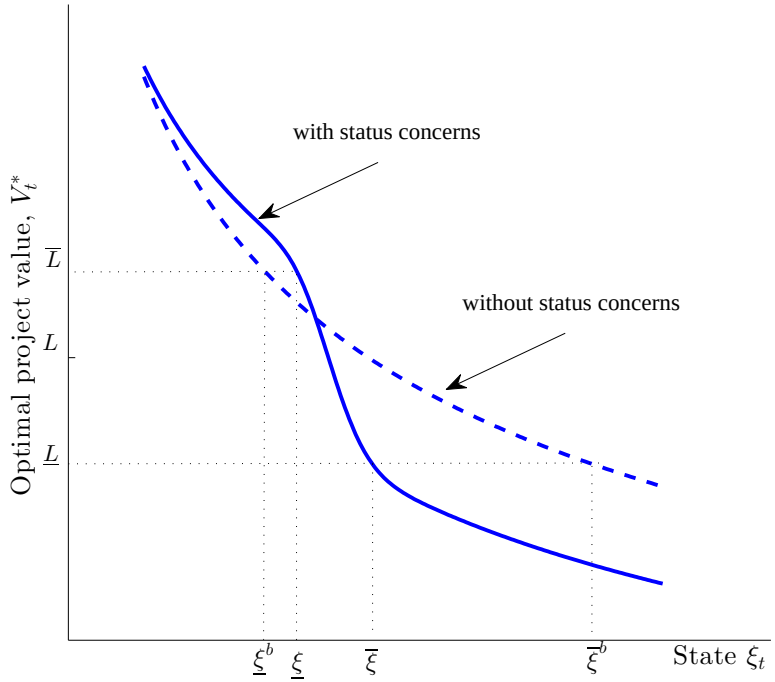
$$\phi_t^* = \frac{\mu}{\sigma^2 V_t^*}\left[\frac{K_{1t}}{\gamma_E}(y\xi_t)^{-1/\gamma_E} + \frac{\alpha}{K_{3t}} n\left(\frac{\ln\frac{B}{\alpha y \xi_t} - K_{2t}}{K_{3t}}\right)\right]$$

$$V_t^* = K_{1t}(y\xi_t)^{-1/\gamma_E} + \alpha N\left(\frac{\ln\frac{B}{\alpha y \xi_t} - K_{2t}}{K_{3t}}\right)$$

  - ξ_t is the state price: ξ_t is low in good states (high ω_t) and is high in bad states (low ω_t)
  - $N(\cdot)$ and $n(\cdot)$ are the standard normal cdf and pdf
  - y, B, K_{1t}, K_{2t}, and K_{3t} are provided in the paper

Analysis: Internal Financing Case, cont'd





- Expected low status for $V_t < \underline{L}$, middle status for $\underline{L} \leq V_t \leq \overline{L}$, and high status for $V_t > \overline{L}$
- Key effect of status concern: entrepreneur seeks to avoid middle status
- To do so, she opts for higher product novelty for middle-status project values

Analysis: Solution for Optimal Security

- The optimal security $W^*_{FT}(V_T)$ is given parametrically through a pair of functions $(W_{FT}(x), V_T(x))$ for $x \in (0, +\infty)$:

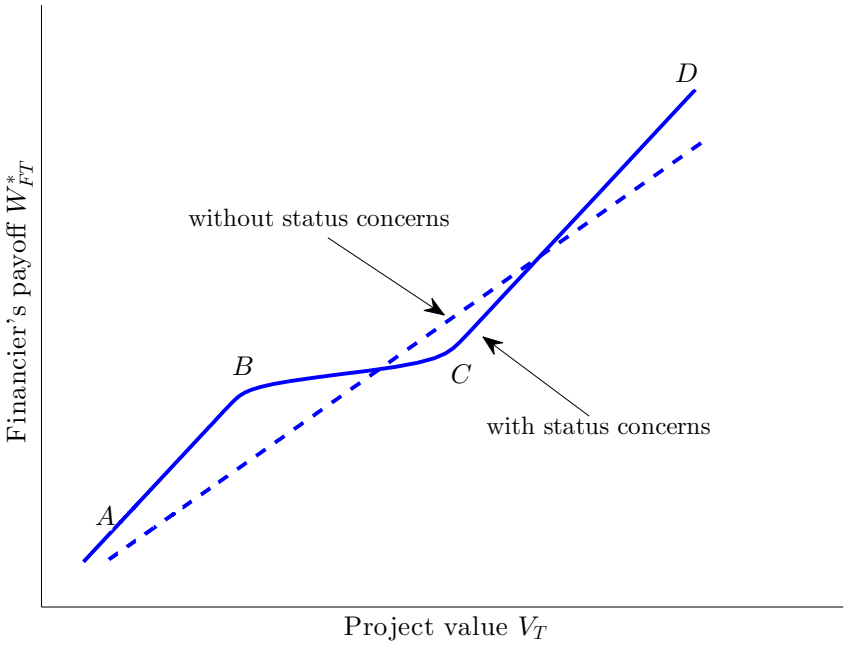
$$W_{FT}(x) = (\bar{u}_F(1-\gamma_F))^{-1/(\gamma_F-1)}\, e^{-\mu^2/(2\gamma_F^2\sigma^2)} x^{-1/\gamma_F},$$

$$V_T(x) = K_{1T} g(x)^{-1/\gamma_E} + \alpha N\left(\frac{\ln(B/\alpha) - \ln g(x) - K_{2T}}{K_{3T}}\right) + (\bar{u}_F(1-\gamma_F))^{-1/(\gamma_F-1)}\, e^{-\mu^2/(2\gamma_F^2\sigma^2)} x^{-1/\gamma_F},$$

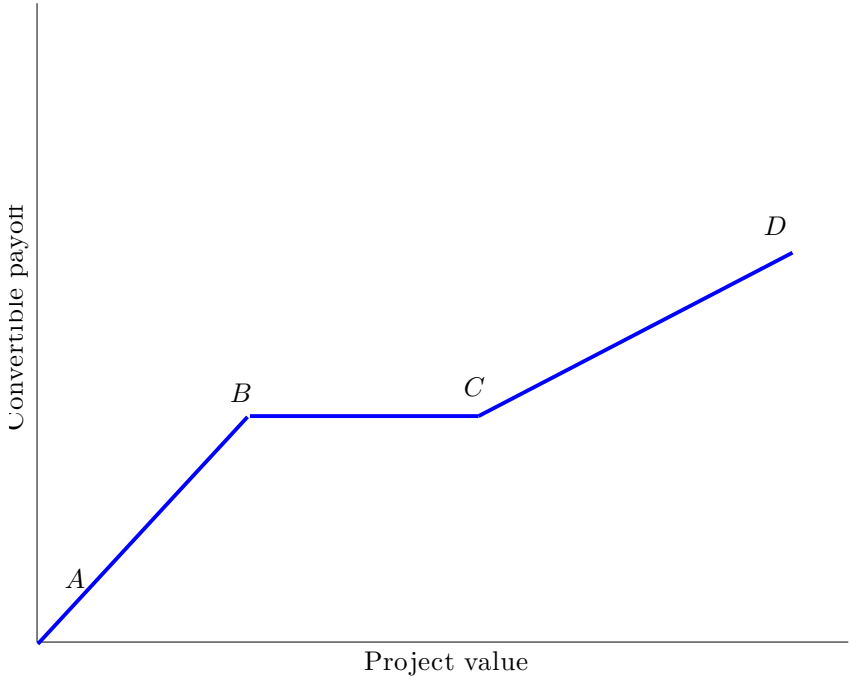
where the function $g(x)$ is implicitly given by

$$\frac{K_{1T}K_{3T}\, g(x)^{(\gamma_E-1)/\gamma_E} + \gamma_E\, B\, n\left(\frac{\ln(B/\alpha)-\ln g(x)+K_{2T}}{K_{3T}}\right)}{K_{1T}K_{3T}\, g(x)^{-1/\gamma_E} + \gamma_E\, \alpha\, n\left(\frac{\ln(B/\alpha)-\ln g(x)-K_{2T}}{K_{3T}}\right)} = zx. \tag{1}$$

Analysis: Payoff Profile of Optimal Security



Optimal security



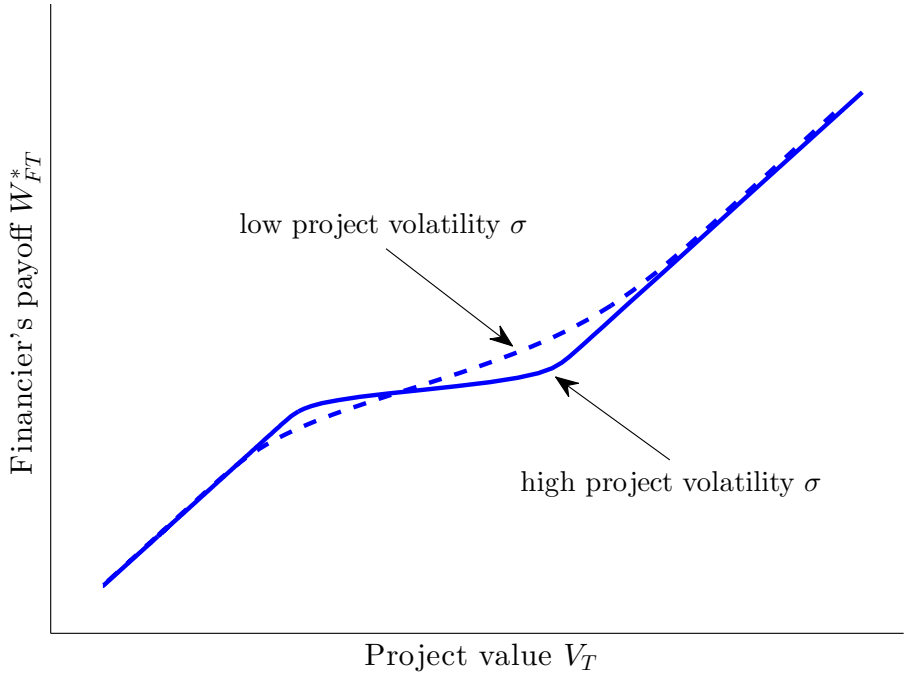
Actual convertible security

- Debt-like segment occurs middle-status project values – entrepreneur keeps to herself an increase in project value
- This allows to better avoid middle status (than equity-like component)

Who Issues Convertible Securities?

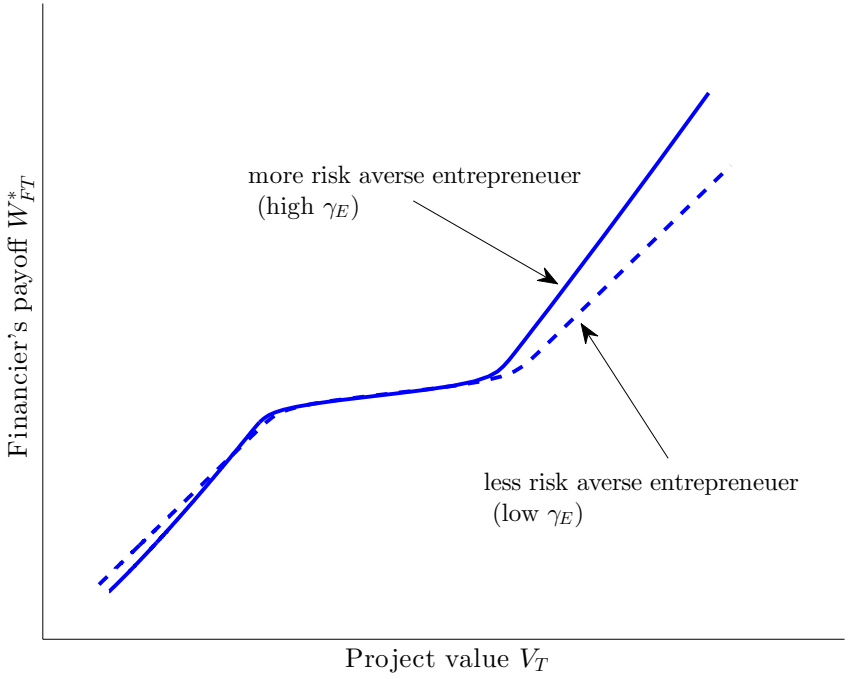
- Some projects are financed with convertibles, some rely on other securities – can our model shed light on this?
- Simple explanation is that managers differ in status concerns
  - convertible securities are issued by those who care about status more
  - possible, but this has not been tested empirically
- Empirically established link – convertibles are mainly used to finance more volatile projects
  - venture capital and private equity projects
  - “convertibles tend to be issued by the smaller and more speculative firms” (Brealey, Myers, and Allen, 2010)
- In our model, how does project volatility affect the optimal security?

Analysis: Optimal Security and Project Volatility

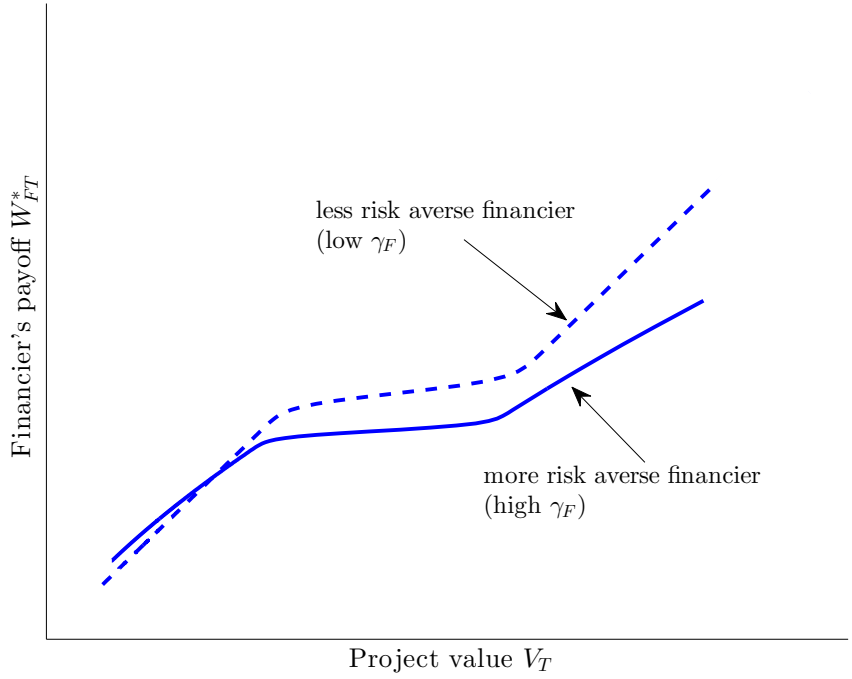


- The more volatile the project is, the more similar is the optimal security to a convertible security
  - to avoid middle status, the entrepreneur has two controls: product novelty and security
  - for high project volatilities, changing product novelty is ineffective $\Rightarrow$
  - as the project volatilities decreases, the optimal security tends to equity

Analysis: Optimal Security and Risk Aversion



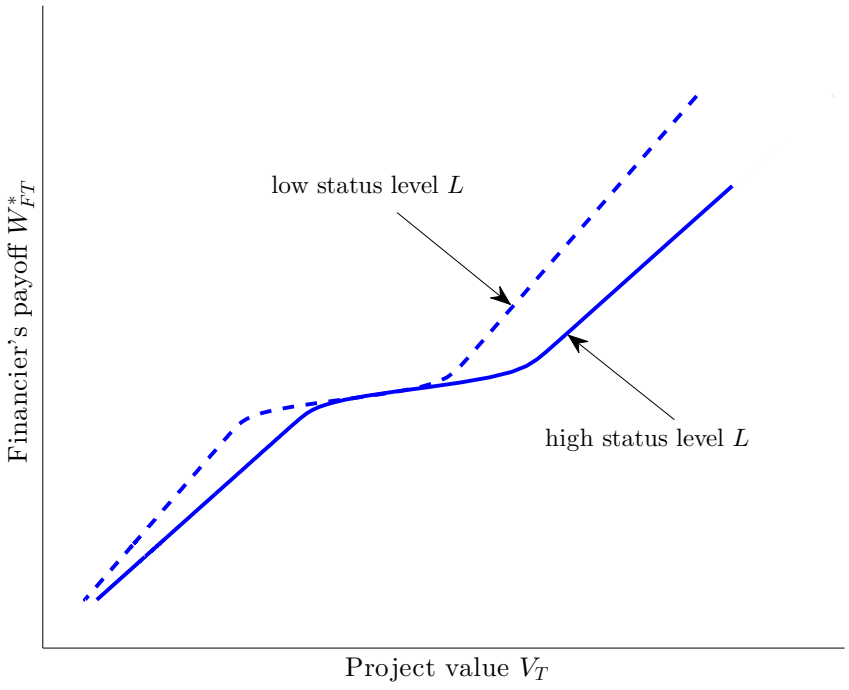
Entrepreneur's risk aversion



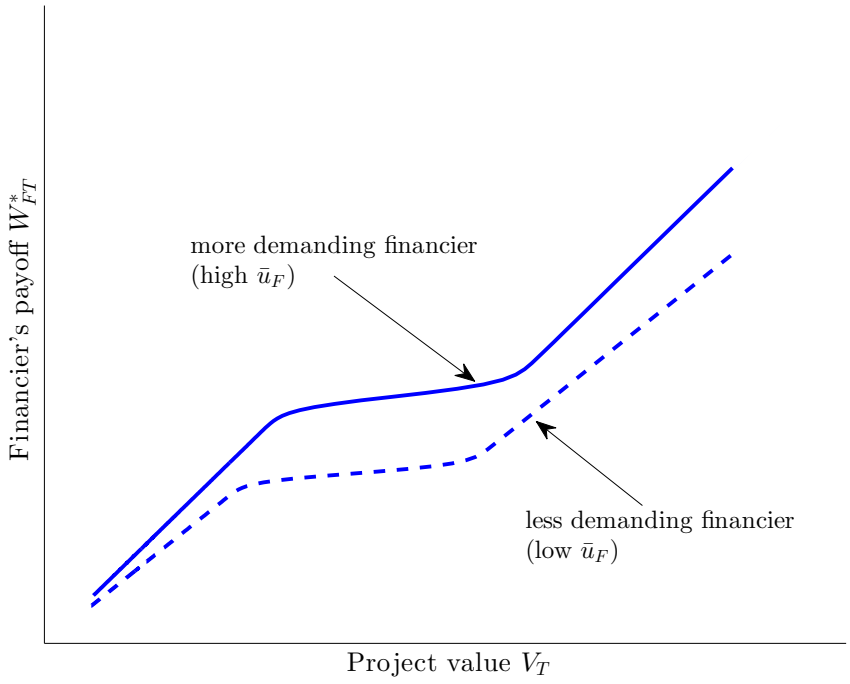
Financier's risk aversion

- Changing risk aversions changes the slope of right-most segment $\Rightarrow$ conversion ratio changes
  - higher entrepreneur's risk aversion implies a higher conversion ratio
  - higher financier's risk aversion implies a lower conversion ratio

Analysis: Other Properties of Optimal Security



Status level



Financier's reservation utility

Alternative Application: Optimal Compensation Package with Status Concerns

- Our framework can be applied to study how status concerns affect the choice of compensation scheme
- Outline of the modified framework:
  - there is a status-driven employer who needs to hire a worker
  - employer offers the worker a performance-dependent compensation
  - optimal compensation scheme: maximizes employer's expected utility and provides the worker with the reservation utility
- Optimal compensation scheme will consist of
  - fixed salary – corresponds to debt component of the security
  - performance-related bonus – corresponds to equity component

Extensions

- We investigate whether our results are robust to an alternative status specification
  - we consider a multiplicative specification
  - motivation: models with multiplicative habits (Abel, 1990) and additive habits (Campbell and Cochrane, 1999) generate different results
  - our main results remain the same
- We allow for different risk aversions for low and high status
  - similar feature is present in Ait-Sahalia, Parker, and Yogo (2004) and Wachter and Yogo (2010)
  - varying high-status risk aversion has an isolated effect on the security's conversion ratio

Conclusion

- We study security design in the presence of status concerns
- We find that the optimal security is considerably similar to a convertible security
- Our model can explain why convertible securities are mainly used by relatively volatile firms, and why they have different conversion ratios
- Our analysis is potentially relevant for understanding “fixed salary plus bonus” compensation schemes