Capital Structure, Hurdle Rates, and Portfolio Choice Interactions in an Entrepreneurial Firm

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Introduction

- Entrepreneurial firm is a typically closely held because of issue of control [e.g. Jensen and Meckling (1976), Hart and Moore (1994, 1995), and Zweibel (1996)].
- Capital structure is likely to influence the actions of entrepreneurial or closely held firm because it affects the allocation of risk.
- The entrepreneur has some control over the exposure to idiosyncratic risk by including debt in the capital structure. This has implications for the interaction between capital structure and:
  - Characteristics of the projects: hurdle rates and riskiness.
  - Savings, and portfolio choice.

Papers have looked at project and/or portfolio choice in this context:

- Leland and Pyle (1997)
- Bitler, Moskowitz and Vissing-Jørgensen (2002)
- . . .

Capital Structure and Portfolio Choice

- Households with a business value of $10,000 or more hold 38% of publicly traded stock.
- Conditioning on a controlling interest in the business gives similar results.
- Proprietary business income is a priced factor [Heaton and Lucas (2000)].
- Incomplete risk sharing due to information problems such as adverse selection or unobservable effort.
- The entrepreneur is faced with an internal capital structure and substantial idiosyncratic risk.
- Creates a connection between capital structure and portfolio composition.
- Can be optimal to hold a leveraged position in own firm and a large portfolio of common stock. Potentially Consistent with portfolio allocations of entrepreneurs [Heaton and Lucas (2000)].

Project choice and Portfolio Choice

- With limited access to outside funding entrepreneurs set hurdle rates much higher than predicted by a model like the CAPM.
- Entrepreneur with moderate risk aversion sets a high hurdle rate but still has substantial investment in the stock market.
- Provides potential explanation for findings of Graham and Harvey (1999):
  - Small firms and firms with high management ownership are significantly less likely to use the CAPM
  - Among small firms, CAPM is inversely related to managerial ownership
- and Poterba and Summers (1995):
  - Survey of Fortune 500 firms found that even these large firms use hurdle rates that exceed on average those from pricing model by about 5%.

- Potential explanation for high hurdle rates required by many venture capitalists.
- Moskowitz and Vissing-Jørgensen (2002) find that empirically that the return to entrepreneurial activity is close to the return on a broad-based stock portfolio. Our analysis provides a benchmark for whether these returns are “too low.”

Other Literature:

- Influence on access to capital markets to become an entrepreneur [e.g. Evans and Jovanovic (1989), Holtz-Eakin, Joulfan and Rosen (1994), Gentry and Hubbard (1998)]. Here we allow for risk aversion.
- Link between managerial risk aversion, agency problems and financing variations over the business cycle [Rampini (1999), and Levy (2000)].
- Influence of improved risk sharing via capital markets on growth and income distribution [e.g. Greenwood and Jovanovic (1990), Banerjee and Newman (1991), Obstfeld (1994), Devereux and Smith (1994)].

Basic Model:

- Entrepreneur can finance a risky private technology using endowed wealth and debt. Remaining wealth can be invested in risk-free debt and publicly traded equity.
  - Single factor production technology, linear in capital invested I. Maximum investment of $I_{\max}$.
  - Output is ρI where ρ is distributed on $[0, \rho_{\max}]$ with distribution $F(\rho)$. Assume that ρ is independent of the publicly traded equity return.
  - $F(\rho)$ is common knowledge.

- Entrepreneur maximizes:

$$E\{u(c)\} \tag{1}$$

subject to:

$$\begin{aligned} I &= D + \chi \\ D &\leq D_{\max} \leq I \\ I &\leq I_{\max} \\ \chi &+ S + B \leq W \\ c &= max\{\rho I - r(D,\chi)D, 0\} + r_s S + r_b B \end{aligned}$$

- Assume: $u'(\cdot) > 0$, $u''(\cdot) < 0$, $u'(0) = \infty$, $u(0) = -\infty$.

Pricing in debt market:

- Competition implies that lenders expect to earn the risk-free rate (or risk-adjustment with CAPM when returns are correlated with the stock market):

$$\int_0^{r(D,\chi)\frac{D}{I}} \rho(D+\chi)dF(\rho) + \int_{r(D,\chi)\frac{D}{I}}^{\infty} r(D,\chi)DdF(\rho) = r_b D \tag{2}$$

- For simplicity we sometimes assume:
  - $E(\rho)$ is large or
  - Wealth, W large enough
- so that invest $I_{\max}$. The only choice is over how much to borrow.
- Let $\delta = D/I_{\max}$.
- Return on debt depends on δ: $r(\delta)$.

Results with perfect information:

- First order conditions:

$$E\{u'(c)(r_s - r_b)\} = 0 \tag{3}$$

$$\int_{r(\delta)\delta}^{\infty} E_s\{u'(c)(-r'(\delta)\delta - r(\delta))\}dF(\rho) + E\{u'(c)(r_b(1-s) + r_s s)\} \geq 0 \tag{4}$$

- Hence

$$\int_{r(\delta)\delta}^{\infty} E_s\{u'(c)(-r'(\delta)\delta - r(\delta)\}dF(\rho) + E\{u'(c)r_b\} \geq 0$$

- Fair pricing:

$$\int_{0}^{r(\delta)\delta} \rho dF(\rho) + \int_{r(\delta)\delta}^{\infty} r(\delta)\delta dF(\rho) = r_b\delta$$

- **Lemma 1:** The entrepreneur is indifferent to issuing risk-free debt.
- With higher debt levels default occurs in some states and debt serves to reduce idiosyncratic risk borne by the entrepreneur.

Results

- *Theorem 1:* Assume W and $F(\rho)$ are such that $I = I_{\max}$ without borrowing. If debt is fairly priced then it is optimal for the entrepreneur to borrow to the maximum extent possible.
- Borrowing can also affect the scale of investment through risk sharing.
- It is possible that entrepreneur will invest less than the maximum amount without debt. For example:
- *Lemma 2:* Assume that $u(0) = -\infty$, $W < I_{\max}$, and that the probability that $\rho = 0$ is positive. Then $\chi < W$.
- Debt will be used both for risk sharing and to increase the scale of investment.

Limits on Borrowing

- In practice it appears that small firms often pay a high price for borrowing and the use of leverage is limited. For example, Cole and Wolken (1996) report that only 55.5% of the small business firms in their survey report using any form of credit.
- We consider a model of these limitations due to advserse selection:
  - Assume that each entrepreneur privately observes the distribution of output $F_j(\rho)$ and investments in marketable assets are assumed to be private information.
  - Lenders know the aggregate distribution of output but not the distribution for individual firms.

- For simplicity assume:
  - Return on investment can take on the value 0 or ρ with probability p_j.
  - Two types with $p_{\text{high}} > p_{\text{low}}$. Fraction q are endowed with the good projects.
  - Entrepreneurs know their type, lenders do not
- In a pooling equilibrium:

$$r = \frac{r_b}{qp_{\text{high}} + (1-q)p_{\text{low}}}$$

First order conditions for optimal debt:

$$\left\{p_j E\left[u'(c_{j,\text{high}})\right] + (1-p_j)E\left[u'(c_{j,\text{low}})\right]\right\} r_b \qquad (5)$$
$$-p_j E\left[u'(c_{j,\text{high}})\right] \frac{r_b}{p_{\text{high}} q + p_{\text{low}}(1-q)} \geq 0$$

- As $q \to 1$ conditions of Theorem 1 hold for both types so $\delta = 1$.
- For some q and p_{low} small, interest on debt not fair for high-type and can be made arbitrarily large. (5) is violated for high-type.
- As δ decreases, difference between

$$E[u'(c_{\text{high,low}})] \text{ and} E[u'(c_{\text{high,high}})]$$

  increases.
- Hence there are combinations of δ, q and p_{low} such that (5) holds with equality for high types for δ^* less than 1.

- Assume that lenders believe that any deviation is from a low type.
- Sufficient condition for no deviation is that $p_{\text{low}}\rho \geq r_b$.
- Necessary condition for pooling is:

$$E\left[u(c)|\delta = 1, r = \frac{r_b}{p_{\text{low}}}\right] < E\left[u(c)|\delta = \delta^*, r = \frac{r_b}{p_{\text{high}}q + p_{\text{low}}(1-q)}\right]$$

Hurdle Rates, the Availability of Debt, and Portfolio Choice

- Hurdle rates will vary with:
  - Scale of project relative to wealth
  - Interest on debt
  - Amount of debt available
  - Risk aversion
  - The quantity of idiosyncratic and systematic risk.

Setup:

- Wealth can be invested in the project, in a risk-free bond, or both.
- Scale of the investment is fixed (take it or leave it).
- Gross returns to the project are summarized by $\{\rho + \Phi_i\}$.
- Availability of and interest on debt are taken as given.

Hurdle rate:

ρ^* that solves:

$$\left[\frac{(Wr_b)^{1-\gamma}-1}{1-\gamma}\right] -$$

$$\sum_{i=1}^{M} p_i \times \frac{[max(0,(\rho+\Phi_i)I^*-rD)+(W+D-I^*)r_b]^{1-\gamma}-1}{1-\gamma} = 0$$

Calibration:

- Fix r_b at 5%.
- Project risk:

Project Risk	Standard Deviation of Φ
Low	28%
Medium	36%
High	50 %

Limits corresponds to variation in 5 stock portfolio to a 1 stock portfolio.

- Assumption about Φ:

$$\Phi_i \in \{0, \mu - \phi, \mu + \phi\}$$

with probabilities $\{p, (1-p)/2, (1-p)/2\}$. We let p take on the values 0 and 5%.

Summary of Table 4.1:

- Hurdle rate is highly sensitive to availability of debt.
- Hurdle rate is significantly above the 5% level required by diversified investors.
- When debt is risk-free the hurdle rate is unaffected by the amount of debt.
- For calibration comparison volatility of consumption of stockholders 10% to 15% annually as in Attanasio, Weber and Tanner (2002) or Vissing-Jørgensen (2002), for example.

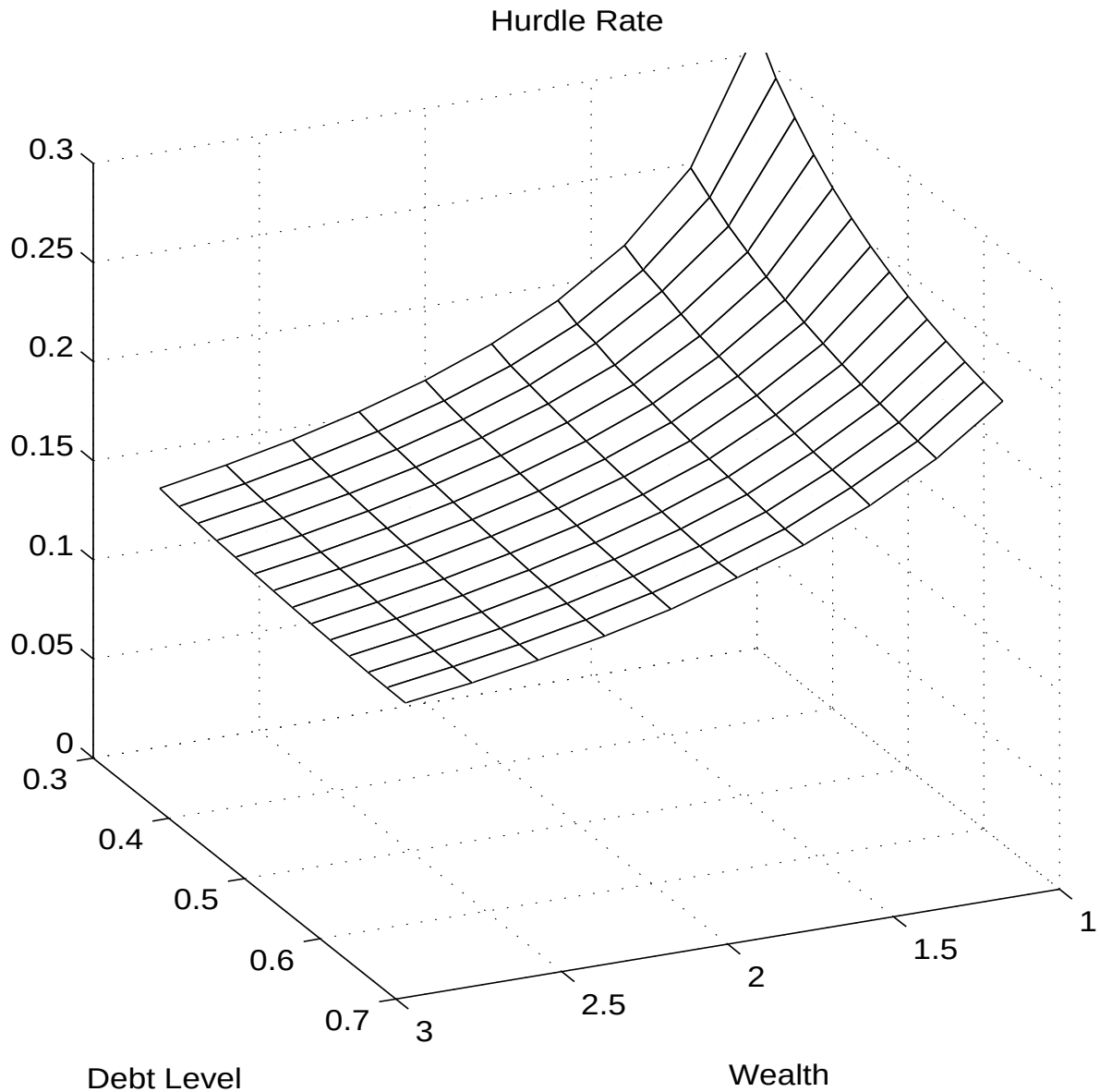
Hurdle rates and Investor Wealth

Table 4.2: The Effect of Varying Initial Wealth
$D/I^* = 0.5$, Medium Risk, $p = 0.05$, $I^* = 1$, $\gamma = 2$

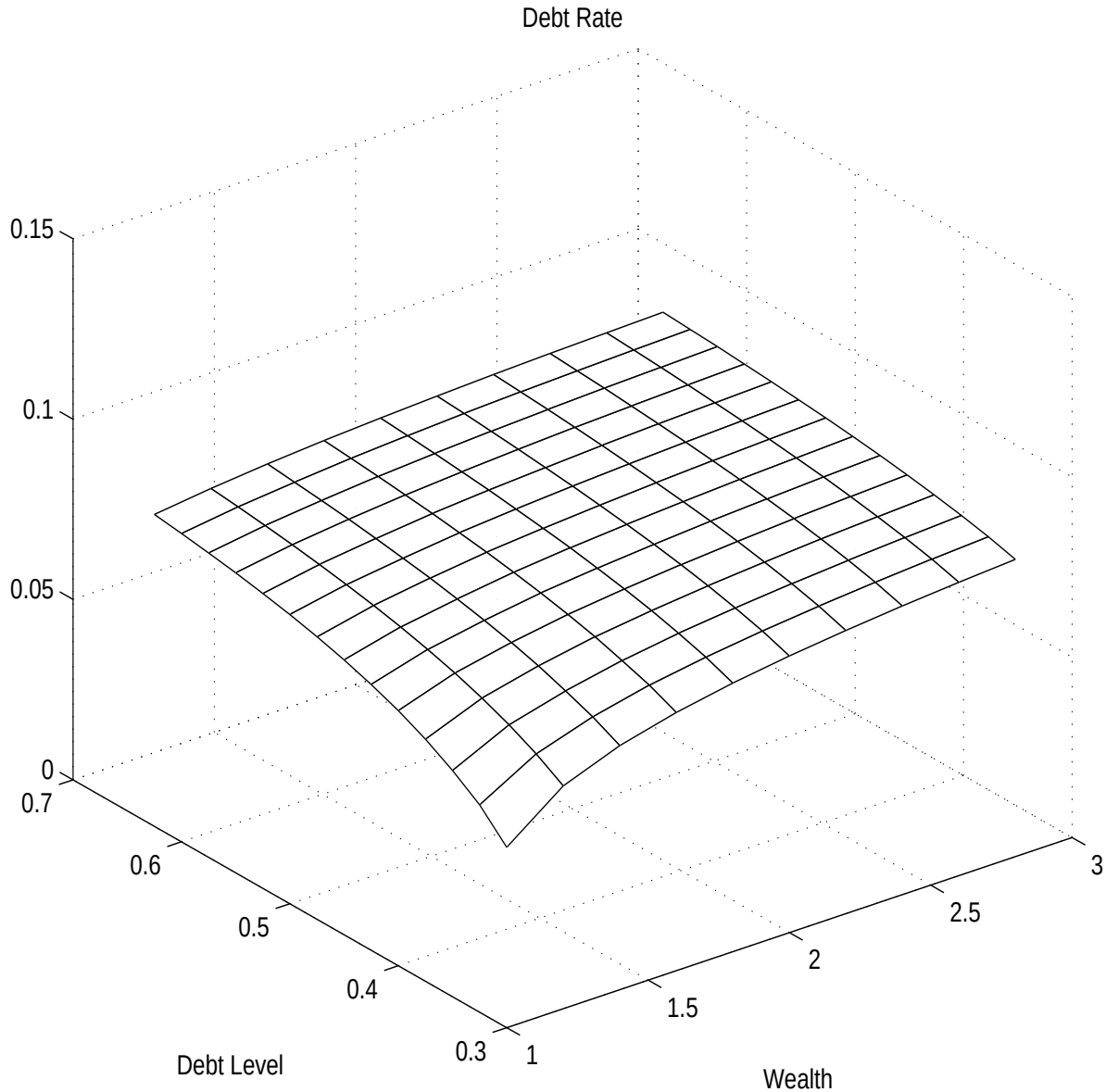
W	r debt	Hurdle Rate	C.V. Cons.
1	0.090	0.144	0.272
1.25	0.092	0.123	0.223
1.5	0.094	0.110	0.188
2	0.095	0.095	0.143
5	0.100	0.050	0.058

- Wealth has a large effect on hurdle rates. Consistent with evidence from Gentry and Hubbard (1998) that wealth has a significant effect on entry into entrepreneurial activity.
- More wealthy entrepreneurs are in a better position to receive risk-sharing benefits of debt.

Hurdle rate as function of wealth and debt. $\gamma = 2$, high risk case



Debt rate as function of wealth and debt. $\gamma = 2$, high risk case



Project Choice and Portfolio Choice

Setup:

- Risky stock has a mean return of 11% and standard deviation of 16%.
- Project risk as before

Determined s_0 (share of stock without entrepreneurial investment), s (share with investment) and ρ^* from first-order conditions for portfolio investment and:

$$E_s\left\{\frac{[W(r_b+s_0(r_s-r_b))]^{1-\gamma}-1}{1-\gamma}\right\}-$$

$$E_s\sum_{i=1}^{M}p_i\times\frac{[max(0,(\rho+\Phi_i)I^*-rD)+(W+D-I^*)(r_b+s(r_s-r_b))]^{1-\gamma}-1}{1-\gamma}$$

$$=0$$

Results:

- Hurdle rates are quite high.
- Entrepreneur often takes a leveraged position in stocks.
- When project is taken the share of stock is larger but the level is lower. Also stocks relative to total wealth is smaller.

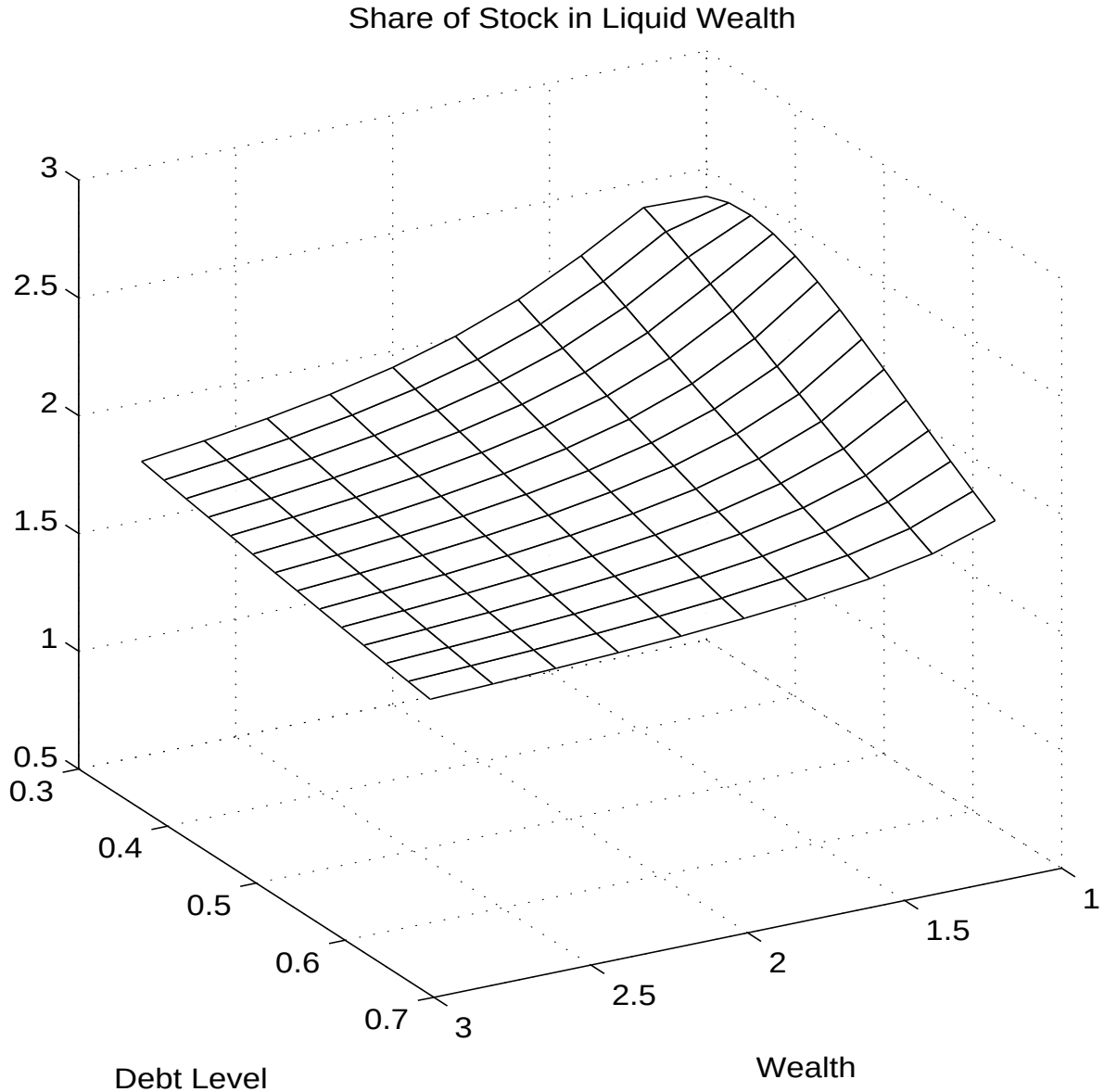
Hurdle Rates, Fair Debt Rate, Stock Share, $\gamma = 2$, $W = I^*$

D/I^*	r debt	Hurdle	s_0	s	S/W	$C.V$	$\rho(c, r_s)$
0.3	0.053	0.312	1.371	2.383	0.715	0.379	0.223
0.5	0.080	0.238	1.371	2.133	1.066	0.386	0.339
0.7	0.089	0.219	1.371	1.616	1.131	0.383	0.368

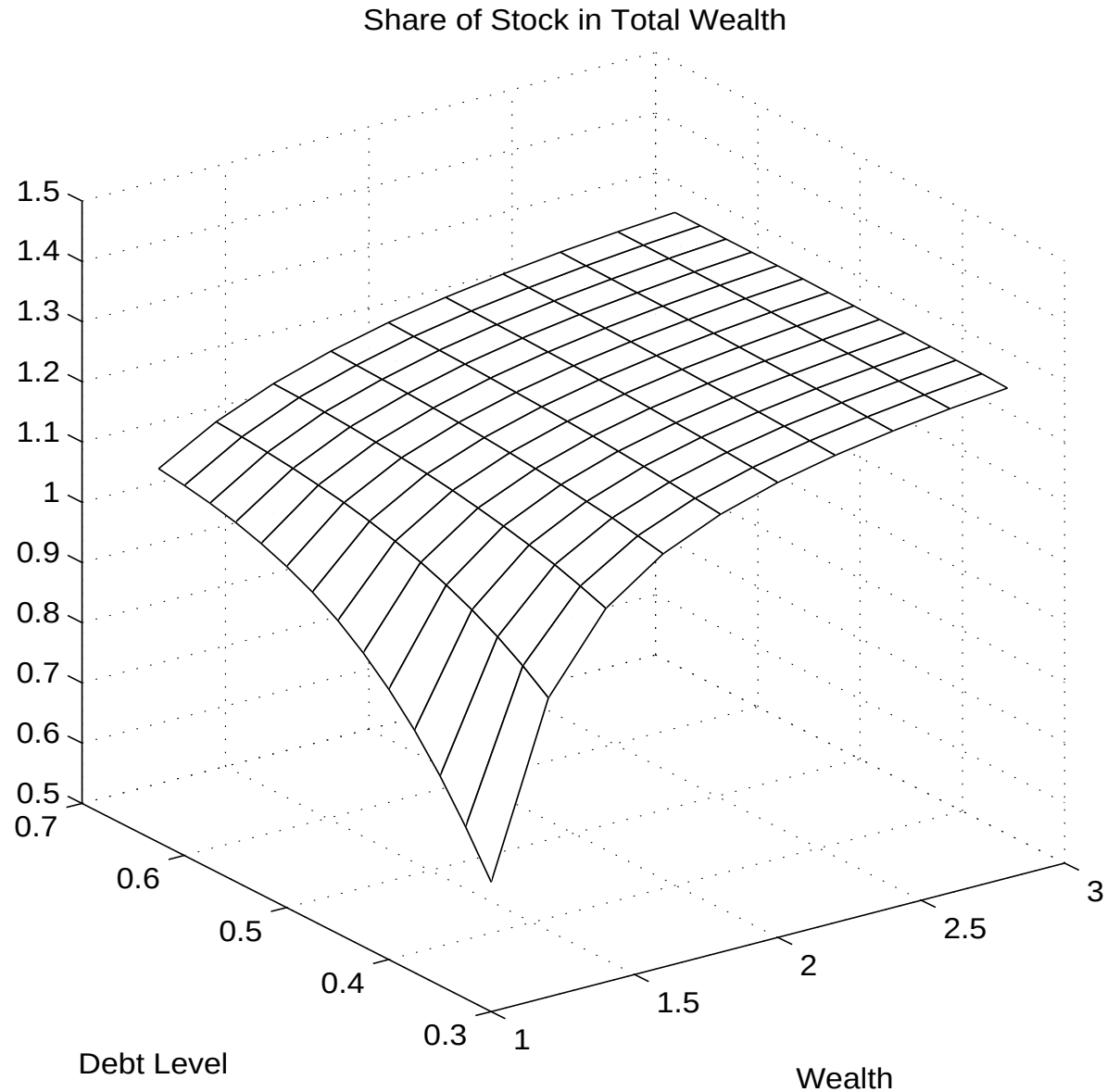
Hurdle Rates, Fair Debt Rate, Stock Share, $\gamma = 2$, $W = 1.5 \times I^*$

D/I^*	r debt	Hurdle	s_0	s	S/W	$C.V$	$\rho(c, r_s)$
0.3	0.070	0.202	1.371	2.170	1.157	0.307	0.494
0.5	0.086	0.181	1.371	1.824	1.216	0.304	0.528
0.7	0.092	0.172	1.371	1.539	1.231	0.300	0.544

Share of stock in liquid wealth as function of wealth and debt. $\gamma = 2$, high risk case



Share of stock in total wealth as function of wealth and debt. $\gamma = 2$, high risk case



Conclusions:

- Ability to issue risky debt improves risk sharing since it allows entrepreneurs to diversify.
- An interior capital structure may obtain when entrepreneurs trade off diversification benefits against information or incentive problems.
- Hurdle rates decrease with availability of risky debt.
- Entrepreneurs choose to hold risky stock in their portfolios despite their undiversified stake in their own firm. Consistent with the finding of Heaton and Lucas (2000).
- Hurdle rates can deviate quite substantially from predictions of a model like the CAPM. They are reduced by availability of debt and to a lesser extent by private wealth that can be held outside the firm.