

Debt Capacity for Short-Term Financing in Financial Crises

Katrin Kölker*

Introduction

The following work analyzes the relationship between short-term financing and financial crises. Due to several financial crises in recent years, there has been an increasing amount of literature on short-term financing. Most of them question whether short-term financing is origin, accessory phenomenon or just the consequence of crises. Answering the question would exceed this paper. For this study it suffices to approve the fact that short-term financing and financial crises occur simultaneously.

The most likely causes of short-term financing are adverse selection and moral hazard problems. On the one hand this is because information can be handled more quickly and effectively. On the other hand lenders gain the power of retrieving capital from poor firms. Therefore, short-term debt is cheaper and more attractive to firms. However, short-term debt can lead to several problems concerning the amount of debt, which will be presented in the following work.

Debt capacity is generally understood to mean the amount of money that can

* Katrin Kölker received her degree in Economics (B. Sc.) from the University of Bonn in 2012. The present article refers to her bachelor thesis under the supervision of Prof. Dr. H. Hakenes, which was submitted in December 2011.

be borrowed against an asset using the very asset as collateral. Thus, it can be described as the amount of money the firm is able to raise at the maturity of the debt. The firm strives to estimate their debt capacity precisely in order to draw up long-term capital investment planning. Moreover, the creditor needs to know the debt capacity to determine the amount of money he is willing to borrow. Consequently, for both it is important to estimate the debt capacity, which will be shown in this paper.

There is a large volume of published studies describing different influences on debt capacity. Shleifer and Vishny (1992) endogenize the liquidation value and analyze the impact of agency problems. They find that illiquidity reduces the debt capacity by decreasing the optimal price of the asset. The work of Acharya, Gale, and Yorulmazer (2011) can be seen as a generalization of this. Martin and Scott Jr. (1976) show that higher risk of insolvency induces decreased debt capacity. This is intensified in times with low cash flow and in times of financial crises. Rampini and Viswanathan (2010) show that debt capacity is influenced by productivity and equity capital. Hence, firms have higher refinancing costs in financial crises. Debt capacity can also be increased by leasing capital instead of financing with collateralized loan (Eisfeldt and Rampini (2009)). Furthermore, Aivazian, Qiu, and Rahaman (2010) show that diversified companies have less capital costs and thus higher debt capacities.

This paper is organized as follows. A model of Acharya et al. is presented in section 2. A critical view and the inclusion of interest rates are shown in section 3. Section 4 concludes.

Maximum Debt Capacity

Acharya, Gale, and Yorulmazer (2011) present a model to explain the sudden drop in the debt capacity. A long-term asset, which is purchased at $t = 0$ with

lifetime $T = 1$, is financed by short-term debt with maturity $\tau \ll 1$. Thus, the debt is to be rolled over frequently, namely $N = \frac{1-\tau}{\tau}$ times. Two states of nature are considered. State L indicates low information state, while state H means high information state. Depending on the state, the fundamental value of the asset is v_L or v_H at maturity (i.e. $t = 1$), where $v_L < v_H$.

States of nature are modeled as a stochastic process and can be determined completely with markov chains. The probability of transition from a high state at time t_n to a low state at time t_{n+1} is constant and indicated by p_{HL} . This probability is chosen very small, which means that the occurrence of a low state being in a high state, for example a financial crisis, is unlikely to happen. The other transition probabilities, p_{LL} , p_{HH} and p_{LH} , are defined in the same manner.

If the borrower has to default at some point, the collateral will be liquidated by the creditor with liquidation cost $(1 - \lambda)$ of the sale price.

To calculate the maximum debt capacity, note that the amount of money which is borrowed should not exceed the debt capacity of the next roll-over date. Otherwise the creditor would take unreasonable risk. It can be shown that in state L the optimal face value of debt D is always the fundamental value of the asset in state L . Therefore, the debt capacity in state L at time n , denoted by B_n^L , is constant in time:

$$B_n^L := v^L$$

If the economy is in the high state, the debt can be set to the expected value of next term's fundamental value:

$$B_n^H := p_{HH}B_{n+1}^H + p_{HL}\lambda v^L$$

Backward induction leads to:

$$B_n^H = (p_{HH})^{N-n}(v^H - \lambda v^L) + \lambda v^L$$

If the face value of debt is set to the future debt capacity, the debt capacity will be maximized over the whole time.

Acharya et al. use numerical examples to show that for sufficient small τ this strategy can result in a market freeze. Figure 1 shows the debt capacity and fundamental value in the different states. If economy changes to state L, the debt capacity will drop to a minimum rapidly, while the fundamental value does not change noticeably. Because of this, the lender cannot raise enough money and has to default. The market for short-term debt is frozen.

Acharya et al. present a model which shows the correlation between debt capacity and the expected fundamental value at maturity. The impact of interest rates on this model is analyzed in the next section.

Interest Rates

For the following study we assume that the creditor has refinancing costs and shifts these to the borrower. Thus, we define an interest rate r_n at time n . Since we have complete financing and do not want to generate income streams throughout the model period, we add the interest payment to the next period's debt. Therefore, the cash flow at time n , $CF_n = -(1 + r_{n-1})D_{n-1} + D_n$, is set to zero. This leads to:

$$D_n = (1 + r_{n-1})D_{n-1} = \dots = \prod_{u=0}^{n-1} (1 + r_u) D_0$$

In order to avoid payment at $t = 0$, D_0 is set to the acquisition value of the asset. Let V_n be the fundamental value at time $t = n$. The net present value can be

calculated as follows:

$$NPV_n = \frac{V_{N+1} - r_N D_N}{(1 + r_n)^{N+1-n}} = \dots = \frac{V_{N+1} - r_N \prod_{u=n}^{N-1} (1 + r_u) D_n}{(1 + r_n)^{N+1-n}}$$

We can now describe the fundamental value¹:

$$\begin{aligned} V_n^L &= p_{LL}(n) \cdot NPV_n^L + p_{LH}(n) \cdot NPV_n^{LH} \\ V_n^H &= p_{HL}(n) \cdot NPV_n^L + p_{HH}(n) \cdot NPV_n^H \end{aligned}$$

The fundamental value is to be compared to the debt capacity. The latter can be calculated as follows. The creditor anticipates the interest payment of the next period and the debt capacity is reduced by this. We get:

$$\begin{aligned} B_n^L &= (1 - r_n^L) B_{n+1}^L = (1 - r_n^L)(1 - r_{n+1}^L) B_{n+2}^L = \dots = \prod_{t=n}^N (1 - r_t^L) v_L \\ B_n^H &= p_{HH}(1 - r_n^H) B_{n+1}^H + p_{HL} \lambda v_L \end{aligned}$$

If we assume low interest rates in financial crises and therefore in information state L and growing rates in state H , we can use the formulas for several numerical analyses. Let the debt maturity be one month. Figure 2 shows that after including interest rates the difference between the debt capacity and the fundamental value is significantly smaller than in the model without interest rates (figure 1). Therefore, if the information state changes to L , the default of the borrower is not necessarily occurring. This effect increases as the debt period is

¹ $p_{IJ}(n)$ is the transition probability that nature has state I at time n and at time $N + 1$ it has state J and can be calculated as follows :

$$\begin{pmatrix} p_{LL}(n) & p_{LH}(n) \\ p_{HL}(n) & p_{HH}(n) \end{pmatrix} = \begin{pmatrix} p_{LL} & p_{LH} \\ p_{HL} & p_{HH} \end{pmatrix}^{N+1-n}$$

The net present value NPV_n^H , NPV_n^L and NPV_n^{LH} can be determined with the formula above, where all variables depend on the state of nature.

extended (see figure 3 and 4).

Longer periods imply an asset period of several months. However, extending debt period is equivalent to raising interest rates. This allows us to consider the situations to be realistic. It can be seen that the calculable interest rates compensate the risk of default. This is a result of lower fundamental values because, being financed with high interest rates, the asset has less value in the first periods. The liquidation value is rated higher as its value does not have to be discounted. This leads to a smaller difference between fundamental value and debt capacity in the low information state.

Furthermore, figures 5 and 6 present fundamental value and debt capacity if the debt has to be rolled over 200 times. During low states and early periods, the fundamental value exceeds the debt capacity. This difference is again higher if interest rates are considered. Comparing it to the results for $N = 100$ in figure 2, the difference increases with the number of periods. Figure 7 shows that a debt which needs to be rolled over 1000 times has less debt capacity even in high information state. This means that in case of a financial crisis the drop of the debt capacity is less crucial and, thus, might not lead to default. Notice that interest rates are not considered here.

A positive cash flow produced by the asset will also increase the sharp difference in debt capacity, which can be proven similarly.

Conclusion

The study was designed to determine the effect of interest rates on debt capacity. It shows that the default of a borrower using an asset as collateral while financing it with short-term debt depends on different aspects. The longer the asset period or the shorter the debt periods are, the smaller is the possibility of the default after a financial crisis is observed. This is caused by a smaller drop of debt

capacity. Furthermore, the study shows that including interest rates leads to decreased risk of default. The fundamental value has to be discounted and is closer to the estimated debt capacity. Taken together, this leads to the conclusion that the debt capacity of collateralized debt is positively correlated with the interest rates as well as with the length of the period and both must not be neglected when estimating debt capacity.

References

- ACHARYA, V. V., D. GALE, AND T. YORULMAZER (2011): “Rollover Risk and Market Freezes,” *New York: Penguin Books*.
- AIVAZIAN, V. A., J. QIU, AND M. M. RAHAMAN (2010): “Debt Capacity and Corporate Diversification,” <http://ssrn.com/abstract=1623427>.
- DIAMOND, D. W., AND R. G. RAJAN (2000): “Banks, Short Term Debt and Financial Crises: Theory, Policy Implications and Applications,” *Cambridge: NBER Working Paper 7764, National Bureau of Economic Research*.
- EISFELDT, A. L., AND A. A. RAMPINI (2009): “Leasing, Ability to Repossess, and Debt Capacity,” *Review of Financial Studies, Oxford University Press for Society for Financial Studies*, 22(4), 1621–1657.
- HE, Z., AND W. XIONG (2011): “Dynamic Debt Runs,” *Working Paper, Princeton University*.
- MARTIN, J. D., AND D. F. SCOTT JR. (1976): “Debt Capacity and the Capital Budgeting Decision,” *Financial Management*, 5(2 (Summer, 1976)), 7–14.
- RAMPINI, A. A., AND S. VISWANATHAN (2010): “Collateral, Risk Management, and the Distribution of Debt Capacity,” *The Journal of Finance* 65.
- SHLEIFER, A., AND R. W. VISHNY (1992): “Liquidation Values and Debt Capacity: A Market Equilibrium Approach,” *The Journal of Finance*, XLVII(4).

Appendix

The data for the following figures is collected with a C++ program and the charts are designed with MS Excel.

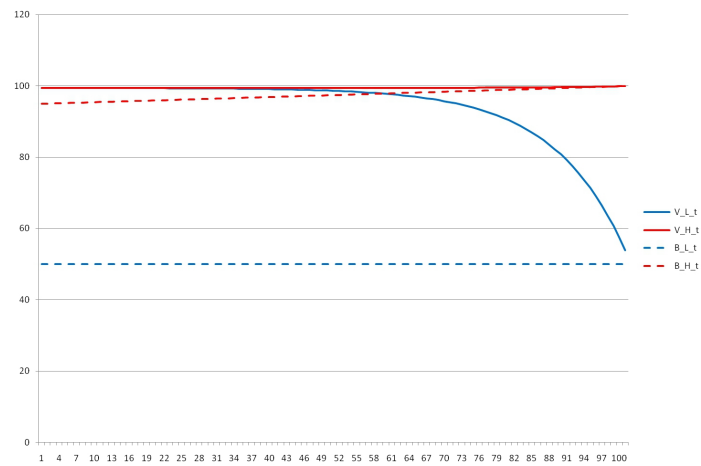


Figure 1: Maximum debt capacity (B) and fundamental value (V) in low state L and high state H , $N = 100$

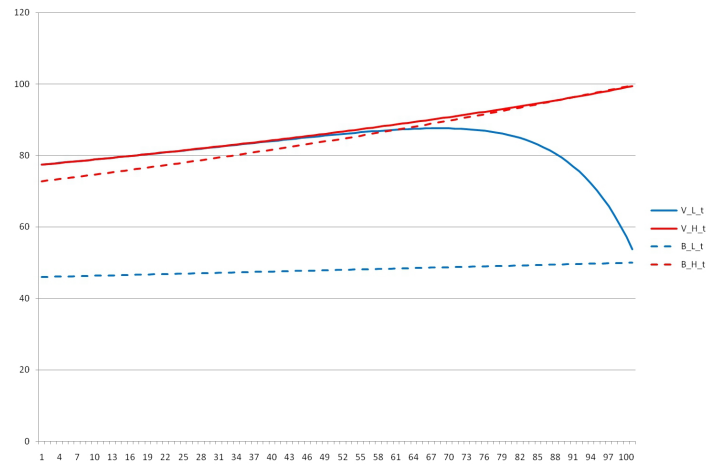


Figure 2: Maximum debt capacity (B) and fundamental value (V) in low state L and high state H with interest rates, $N = 100$, credit period = 1 month

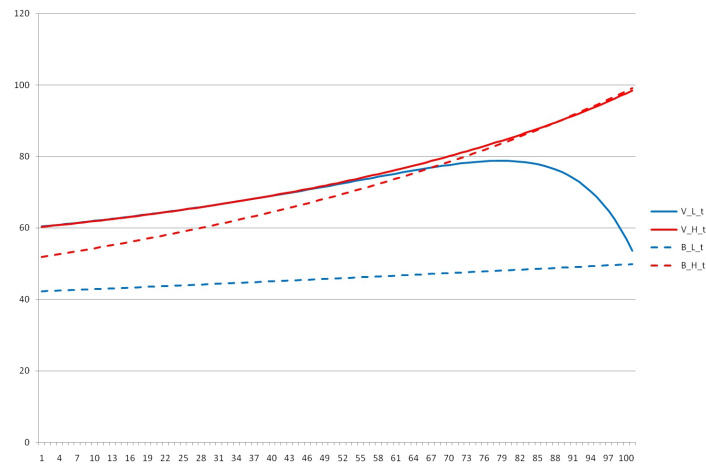


Figure 3: Maximum debt capacity (B) and fundamental value (V) in low state L and high state H with interest rates, $N = 100$, credit period = 2 months

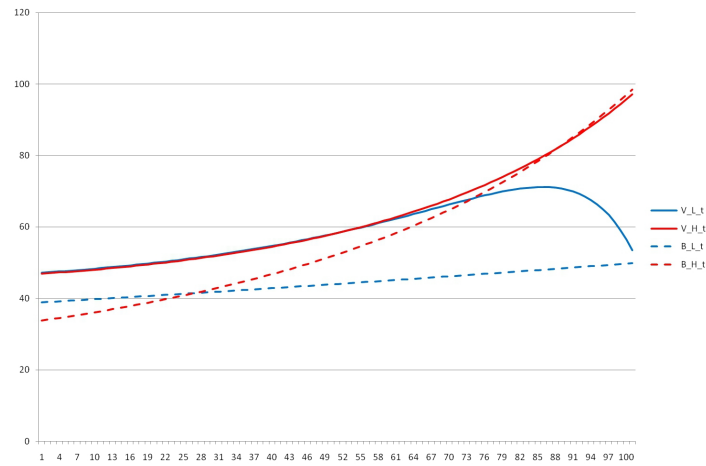


Figure 4: Maximum debt capacity (B) and fundamental value (V) in low state L and high state H with interest rates, $N = 100$, credit period = 3 months

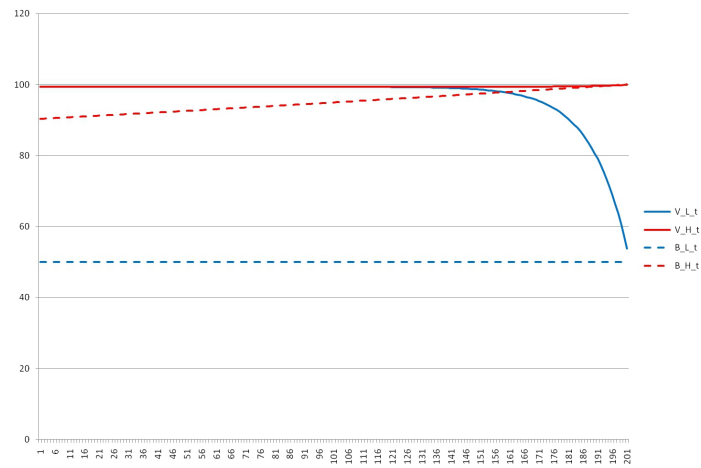


Figure 5: Maximum debt capacity (B) and fundamental value (V) in low state L and high state H without interest rates, $N = 200$

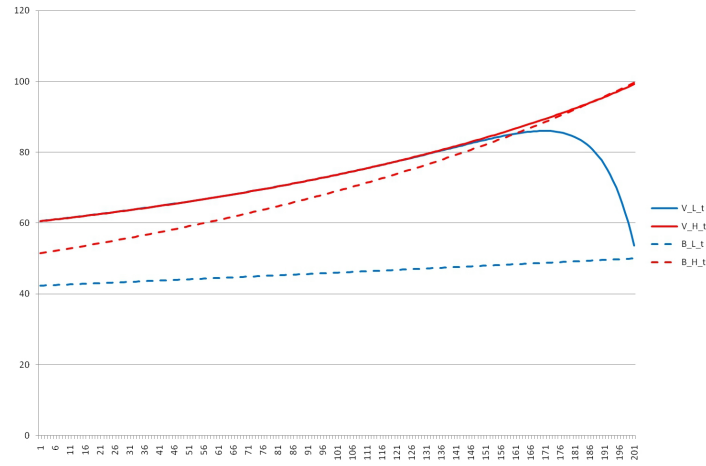


Figure 6: Maximum debt capacity (B) and fundamental value (V) in low state L and high state H with interest rates, $N = 200$, credit period = 1 month

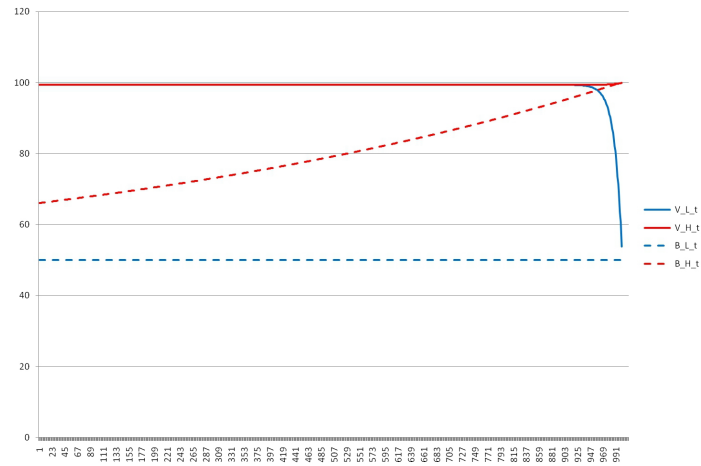


Figure 7: Maximum debt capacity (B) and fundamental value (V) in low state L and high state H without interest rates, $N = 1000$