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Rationing of excessive demand on crowdfunding- platforms

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Working Paper No. 126

Rationing of excessive demand on crowdfunderingplatforms

by

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Rationing of excessive demand on crowdfinancing- platforms

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Abstract

On crowdfunding-platforms, non-publicly traded companies can offer equity to private investors. Currently, platforms like Crowdfunder.com in Great Britain or Seedmatch.de in Germany are using a mechanism for the allocation of available shares best described by the phrase “first come, first served”. This paper argues that this kind of allocation of shares or rationing of excessive demand is not optimal. It describes the characteristics that rationing of excessive demand has to imply to protect the interests of involved parties in an appropriate manner. A recommendation for a concrete practical implementation is offered as well.

Keywords: crowdfunding, market microstructure, rationing, equity, underpricing, excessive demand

JEL-Codes: D40, D45, G21, G32, L10

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1. Introduction

So-called crowdfinancing-platforms are a recent development in the financial sector. On these platforms, private investors can buy shares of non-publicly traded companies guaranteeing investors claims on upcoming profits and on some platforms even voting-rights.

On crowdfinancing-platforms, entrepreneurs describe their business ideas and choose a fixed investment target. If the investment target is completely funded within a fixed period¹, the raised capital less charges is handed out to the entrepreneur. If the investment target is not reached within this time period, capital that has been already invested is given back to private investors².

Some crowdfinancing-platforms, such as Crowdfunder.com, stop the financing period immediately once the investment target is reached³. Consequently, the demand of investors running late with formulating their individual demand is rationed completely.

It is assumed here that a successful funding on a crowdfinancing-platform necessitates some degree of excessive demand. This assumption coincides with the evidence of initial public offerings (IPO). In an IPO, corporate equity is sold to external investors, just as on crowdfinancing-platforms. Stocks initially sold to the public tended to be underpriced on all international stock exchanges in the last decades⁴. This underpricing is usually measured as the difference between a stock's price at the end of the first day of trading and the stock's issue price⁵. This initial price

¹ On Crowdfunder.com this period is 90 days (<http://www.crowdfunder.com/pg/crowdfunder-faq-20#howlong> (11/19/2011))

² <http://www.crowdfunder.com/pg/crowdfunder-faq-20#howlong> (11/19/2011)

³ <http://www.crowdfunder.com/pg/crowdfunder-faq-20#howlong> (11/19/2011)

⁴ For example, Ljungqvist (2007) in Figure 2 on p.383 showed that 4079 IPOs conducted on European stock exchanges have been underpriced on average. Despite national differences, the mean underpricing is positive for every national stock exchange. Figure 1 on p.382 showed the mean underpricing of US-stocks in 172 quarters between 1960 and 2003. The mean issue price was overrated only in 13 of these quarters.

⁵ Ljungqvist (2007): p.381

increase can only be achieved, if the issue price implies some degree of excessive demand for the asset.

These platforms have a very young appearance. Consequently, academic literature related to this topic is very rare or available in the form of yet unpublished discussion papers⁶. However, the IPO-underpricing literature was useful in developing the following argumentation⁷. Theories of this finance discipline describe motives of several parties explicitly to create excessive demand as well as benefits arising from excessive demand when corporate shares are initially sold to the public.

This paper identifies four theoretical criteria of an optimal rationing mechanism. First, the rationing mechanism should maximize the number of investors, because the maximized investor base will maximize the post-emission liquidity and market value of shares. Second, the diffusion of the investor base should also be maximized to protect the control of the initial entrepreneurial team and reward their market participation. Third, informationally disadvantaged investors should be protected to guarantee their market participation. Fourth, early investors should receive a preferential treatment in the rationing process due to their comparatively high costs of information production and positive effects on succeeding investors.

This paper also includes a recommendation for practical implementation. A so-called zero-rationing threshold is recommended to guarantee early investors that they would not be rationed up to a certain individual demand. This preferential treatment acts as a reward for their individual contribution to a successful funding and induces investors to make early investments. Once the fixed investment target has been surpassed, a so-called soft ending of the financing round would allow informationally

⁶ Contributions to the broader topic of crowdfunding have been made, for example, by Belleflamme, Lambert and Schwienbacher (2011), Hemer (2011), Rubinton (2011), Agrawal, Catalini and Goldfarb (2011).

⁷ Useful surveys of this literature are the articles of Ljungqvist (2007) or Ritter and Welch (2002)

disadvantaged investors to wait for investments of informationally advantaged investors first. This would reduce the probability that informationally disadvantaged investors face a winner's curse when they buy corporate shares. Beyond the zero-rationing threshold, an iteration process that maximizes the size and the diffusion of the investor base is recommended to satisfy the remaining criteria of an optimal rationing mechanism.

Chapter 2 of this paper specifies the criteria for an optimal rationing mechanism. Chapter 3 discusses the tradeoffs arising in the implementation, since certain criteria suggest conflicting measures. Chapter 4 delivers an example of a practically applicable mechanism. Chapter 5 concludes this paper.

2. Criteria for an optimal rationing mechanism

The following chapter reviews four theoretical criteria that an optimal mechanism has to fulfill. These four criteria will be used in Chapter 4 to recommend practical implementation.

2.1 Maximization of the investor base and post issue liquidity

The term liquidity describes the conditions of availability of a trade partner when buying or selling an asset. High liquidity is given when an asset can be traded in a short time and with low associated costs. Looking at two assets generating identical gross cash flows, an investor will be willing to pay a higher price for an asset that is more liquid. Amihud and Mendelson (1986) have confirmed that the market value of an asset relates positively to its liquidity⁸.

This relationship motivated Booth and Chua (1996) to develop a model of emitters using IPO-underpricing to optimize the resulting after-market liquidity of their companies' shares. In this model entrepreneurs deliberately selected an underrated issue price to attract various investors. The resulting excessive demand allows them to allocate the fixed supply of shares in an investor base maximizing way. The increased number of involved investors n should increase the expected market value of the asset in the aftermarket $E[V(n)]$. Thus, there is a positive relationship between $E[V(n)]$ and n , that is $dE[V(n)]/dn > 0$ ⁹.

Emitters are faced with a number of uninformed investors with different costs of information production. Assumably only informed investors will buy issued shares

⁸ Amihud and Mendelson (1986): Proposition 2 on p.228

⁹ Booth and Chua (1997): p.295

and trade the firm's assets in the secondary market¹⁰. In equilibrium, aggregated profits of investors implied by underpricing ($E[V(n)] - P_0$) have to equal aggregated costs of information production $C(n)$. It is assumed here, that $dC(n)/dn > 0$ and $d^2C(n)/dn^2 < 0$. An entrepreneur knowing the optimal number of investors n^* will choose an issue price P_0 fulfilling the following equation¹¹:

$$[E(V(n^*)) - P_0] - C(n^*) = 0. \quad (1)$$

For a given rationing mechanism the necessary degree of underpricing will relate positively to the number of investors that should be attracted. However, when choosing a rationing mechanism, it is decisive that this mechanism implies a maximization of the number of investors to minimize the required underpricing.

The resale of shares of non-publicly traded firms is also an important topic in the venture capital literature¹². These financial institutions are usually planning a so-called exit-strategy to resell the assets of supported companies via an IPO or a takeover. Nevertheless, shareholders should be interested in liquid trade even before an exit. If a company does not grow fast enough to realize an exit via an IPO, a broad investor base will increase the probability of an internal sale of shares to another shareholder. This considerations lead to the following criterion:

Criterion 1: The rationing mechanism of a crowdinvesting-platform should imply a maximization of the number of investors to maximize the liquidity of shares in the informal secondary market as well as the shares' expected market value.

¹⁰ Booth and Chua (1996): p.294. The authors actually assume informed investors are just more likely to trade on the secondary market. The simplification here that only informed investors are allowed to trade on the secondary market is of course a stronger although only an illustrative assumption.

¹¹ Booth and Chua (1996): Formula (2) on p.295. The notation of the issue price OP has been changed to P_0 .

¹² For example Bascha and Walz (2001)

2.2 Protection of the founders' benefits of control

An entrepreneur trying to finance his firm via a crowdfundering-platform faces a tradeoff. On the one hand, he/she needs capital, which he is not willing or able to raise in a traditional way, like taking out a bank loan. On the other hand, he wants to stay in control of his company. This conflict arises because external equity usually implies voting rights for investors.

If an entrepreneur sells more than 50% of his company's equity, external investors may enforce a new management against the entrepreneur's will. The entrepreneur has two opportunities to avoid this scenario.

First, the entrepreneur could sell non-voting shares. However, these shares are less attractive for investors, since they increase the scope of the management to maximize private benefits instead of shareholder value. This disadvantage lowers the price of non-voting shares, documented for example by Zingales (1994), and makes some institutional investors abstain from buying such shares¹³. An issuer on a crowdfundering-platform should not be forced to use even more underpricing to compensate investors for their missing voting rights.

Second, an entrepreneur could just sell less than 50% of his company's equity. Nevertheless, in some cases, this might necessitate truncation of the investment to a suboptimal level.

For the following analysis, it is assumed that an entrepreneur does not sell non-voting shares and sells more than 50% of his company's equity, that is $\alpha_e < 0.5$. In such a situation, non-managing shareholders could force a change in the management, potentially increasing the shareholder value. Assumingly a shareholder value increasing change of management will not be conducted voluntarily by the

¹³ Brennan and Franks (1997): p.395/396

entrepreneur, since he/she realizes so-called benefits of control $U_{control}$. These benefits are an overcompensation for losses due to potentially suboptimal management, that is $U_{control} > \alpha_e V_{new} - \alpha_e V_e$. Variables V_{new} and V_e describe the value of the firm under the new management and under the founder's management. Benefits of control can arise for example due to the wage of the manager but also due to non-monetary benefits like prestige¹⁴.

According to Shleifer and Vishny (1986), the probability of an entrepreneur to be removed from the management depends particularly on the monitoring incentives of the biggest external investor. They used the simplified assumption that a change in the management can be realized only if one external investor owns at least 50% of a firm's equity¹⁵. Thus, two conditions must be fulfilled to realize a change in the management. First, the biggest external investor must perform costly monitoring, verifying suboptimal management by the entrepreneur. Second, the biggest external investor must own at least 50% of shares.

The expected utility of monitoring and taking over the firm by the biggest external investor, initially not involved in the company's management, is¹⁶:

$$E[U_{external}(I, \alpha_{external})] = I[0.5(V_{new} - V_e) - (0.5 - \alpha_{external})\pi(\alpha_{external}) - c_I]. \quad (2)$$

Formula (2) describes the expected utility of the biggest external investor owning $\alpha_{external} < 0.5$ in the beginning. The monitoring intensity I can be interpreted as the

¹⁴ For example Moskowitz and Vissing-Jorgensen (2002, pp.771 ff.) described several monetary and non-monetary returns of entrepreneurial activity besides pure dividends, which seem to motivate becoming an entrepreneur.

¹⁵ Shleifer and Vishny (1986, p.465) assumed that only the biggest external investor has access to the monitoring technology. Therefore the outcome of the assumption formulated here and the assumption in the source is essentially the same.

¹⁶ Shleifer and Vishny (1986) stated that since expectations only need to be formed about variable Z , the formula has been changed to formula (3) on p.469. Moreover they assumed that $E[U_{external}(I, \alpha_{external})]$ can be negative. In addition, monitoring costs c_I , mentioned in Vishny and Shleifer (1986) on p.465, were also included in the formula.

probability that a systematic management mistake is detected resulting in the removal of the entrepreneur from the management. The cost of monitoring is c_I , while the cost of taking over the firm is $(0.5 - \alpha_{external})\pi(\alpha_{external})$. These costs arise because the biggest external investor has to buy further shares $(0.5 - \alpha_{external})$. Since other investors anticipate an upcoming increase in shareholder value, a takeover premium $\pi(\alpha_{external})$ has to be paid.

It is important to understand that the marginal net benefits of increased monitoring are positively related to $\alpha_{external}$. This is obvious, because the marginal costs of monitoring and taking over the firm are inversely related to $\alpha_{external}$. Thus a concentrated ownership structure with a large external investor will imply more monitoring than a diffuse ownership structure. At the same time, the probability of the entrepreneur losing his role as the lead manager of the firm and his benefits of control is positively related to the share of the biggest external investor.

Brennan and Franks (1997) developed an underpricing theory of emitters using underpricing to generate excessive demand to realize a dispersed ownership structure protecting the initial management's control. The same might be true for firms selling equity via crowdinvesting-platforms. If entrepreneurs faced with a fixed rationing mechanism use underpricing as a tool to disperse external ownership, then a rationing mechanism implying maximal dispersion of shares will lower required underpricing.

This line of argumentation might be dubious to some readers, as it depends crucially on the assumption of benefits of control. This motivated Stoughton and Zechner (1998) to develop a model contrary to Brennan and Franks (1997). In their model of IPO-underpricing, firms use underrated issue prices to attract one big investor, implying maximum monitoring. Nonetheless, in the context of crowdinvesting-

platforms, it is plausible to assume that a major motivation for young entrepreneurs is the realization of benefits of control. Neuberger, R athke, and Bruder (2007) have conducted a survey showing that the main motivation to become an entrepreneur is the implied independence of being your own boss. By implementing a rationing mechanism that does not protect this elementary motive, the participation of entrepreneurs on these platforms is jeopardized. This leads to the following criterion:

Criterion 2: The rationing mechanism of a crowdfunding-platform should imply a maximal dispersion of shares to minimize the probability of loss of control of the initial entrepreneurial team.

2.3 Protection of informationally disadvantaged investors

It is plausible to assume informational heterogeneity among investors on stock exchanges or crowdfunding-platforms. Institutional investors, for example, should have an informational advantage compared to retail investors. Rock (1986) attempted to illustrate this situation by assuming two types of investors participating in an IPO, informed and uninformed investors. Informed investors can observe the true value of a firm, while uninformed investors can only form uncertain expectations.

Behavior of an informed investor in this setting is trivial. If the issue price is higher compared to the true value, informed investors will not buy any shares. If the issue price is lower compared to the true value, informed investors will buy shares. This kind of behavior has a negative effect on uninformed investors.

When an uninformed investor wants to buy underpriced shares, the probability of being rationed is comparatively high. The reason for this is the fact that informed investors also demand underpriced shares. When an uninformed investor applies for

overpriced shares, the probability of rationing is comparatively low, since informed investors abstain from buying these shares.

The expected utility of an uninformed investor from participating in an initial equity offering is¹⁷:

$$EU_{uninformed} = \hat{b}p(\hat{V} > P_0) E[U(\alpha_{uninformed}(\hat{V} - P_0)) | \hat{V} > P_0] \quad (3)$$

$$+ \hat{b}'p(\hat{V} \leq P_0) E[U(\alpha_{uninformed}(\hat{V} - P_0)) | \hat{V} \leq P_0] \quad \text{with } \hat{b} < \hat{b}'.$$

The utility of an uninformed investor implied by allocation $\alpha_{uninformed}$ depends on the difference between the true value V and the issue price P_0 . Variables $p(\hat{V} > P_0)$ and $p(\hat{V} \leq P_0)$ display the probabilities that the (estimated) true value of a share \hat{V} is strictly bigger or smaller (or equal) than P_0 . Variables \hat{b} and \hat{b}' are the estimated probabilities of an uninformed investor receiving an allocation of underpriced or overpriced shares.

The disadvantage of uninformed investors does not arise from rationing in general, but from the bias in rationing, that is from the fact that $\hat{b} < \hat{b}'$ ¹⁸. If uninformed investors were rationed equally in case of underpriced and overpriced issues, profits and losses would be balanced. In an extreme scenario, uninformed investors applying for overpriced shares are possibly not rationed at all ($\hat{b}' = 1$) while in the case of underpricing they are rationed completely ($\hat{b} \approx 0$). Thus, uninformed investors would abstain from buying shares in an initial offering.

In Rock's (1986) model, the participation of uninformed investors is necessary to guarantee the successful conduct of equity issues, since informed demand is not big

¹⁷ Rock (1986): Equation (3) on p.193. The notation of Rock (1986) has been modified to match the notation used in the rest of this paper. Moreover I assumed that uninformed investors do not have an outside option of buying riskless assets, implying that an uninformed investor does not realize positive utility in case of rationing.

¹⁸ Rock (1986): p.194

enough to absorb the entire supply of assets¹⁹. Therefore, emitters choose an issue price low enough to compensate uninformed investors for the allocation bias. When implementing this underpricing strategy optimally, uninformed investors should realize zero-profits from participating in the issue market. For example Levis (1990), Koh and Walter (1989), Amihud, Hauser and Kirsh (2002) or Keloharju (1993) provided convincing evidence for this implication.

As shown before, crowdfundering-platforms should be interested in the maximization of the number of potential investors. This necessitates the protection of informationally disadvantaged investors. The rationing mechanism used, for example on Crowdfunder.com, does not achieve this goal. The reason for undesirable discrimination of informationally disadvantaged investors is that investors observing underpriced shares can buy all available shares and stop the financing period immediately leaving only overpriced shares in the market. Probably informationally advantaged investors are wealthier and conduct a quicker evaluation process due to superior experience. Aggressive bidding of these investors on crowdfundering-platforms could create a winner's curse for informationally disadvantaged investors, if rationing mechanisms are not adjusted²⁰.

The main argument of Rock (1986) was that for a given rationing mechanism emitters have to underprice their shares to guarantee informationally disadvantaged investors' participation. Consequentially, an optimal rationing mechanism should not discriminate against informationally disadvantaged investors. This leads to the following criterion:

¹⁹ Rock (1986): Assumption 3 on p.191.

²⁰ A strategy of random bidding by informationally disadvantaged investors as a response to their comparatively slow evaluation process, will not generate nonnegative profits if a critical number of "bad" projects reach the investment target making their investment binding.

Criterion 3: The rationing mechanism of a crowdfinancing-platform must not discriminate against informationally disadvantaged (small and slow) investors, to guarantee their participation.

2.4 Compensation and reward for initial investors

These investors, who are first to invest on a crowdfinancing-platform, differ from succeeding investors in two aspects. First, initial investors face bigger costs associated with information production. Second, they have a comparatively big effect on the probability of a successful funding, since their investment implies positive externalities.

In the beginning of a financing period, every investor has to decide whether the sold shares are underpriced or overpriced. To answer this question, investors will undergo a time-consuming evaluation-process.

Investors could choose a free-rider strategy to invest exclusively in projects that other investors identified from preceding investments have evaluated positively. This kind of strategy would reduce or eliminate individual costs of information production.

If it is individually optimal to leave the costly evaluation process to others, equilibrium with no information production and no investment at all could develop. The first investor faces the highest individual costs of information production, c_1 with $c_1 > c_2 > \dots > c_n$. Assuming underpriced shares and excessive demand, the expected profits of the first investor are:

$$E(U_{initial}) = E[\hat{b}\alpha_1(\hat{V} - P_0)] - c_1 \quad (4)$$

Again, \hat{b} describes the probability that the initial investor receives the desired allocation α_1 . The problem is if $E(U_{initial}) < 0$, no potential investor will produce information. This problem can be reduced if initial investors are treated preferentially in the allocation process, resulting in a bigger allocation probability $\hat{b}_{initial} > \hat{b}_{succeeding}$.

The comparatively high effect of initial investors on the probability of a successful funding can justify their preferential treatment because their investment has a major influence on the funding dynamics. The investment of initial investors has a positive but trivial influence on the willingness of succeeding investors with monetary motives to buy shares, because the initial investment signals a positive evaluation. It is more difficult to understand the effect of early investments on investors with non-monetary benefits. To explain this positive externality, it is necessary to take a closer look at the science and practice of charitable funding.

A comparison of commercial projects that are trying to raise money on crowdfunding-platforms, such as Crowdcube.com, with noncommercial projects that are trying to raise money on charitable crowdfunding-platforms, such as Mysherpas.com, reveals only small differences. On donation platforms, various individuals, for example, artists or musicians, try to attract financial support. In a world of individuals with exclusively monetary investment motives, it is puzzling that projects on these platforms have ever been able to realize a successful funding because financial support on these platforms takes place without financial rewards for investors.

In the course of donation campaigns, behavior has been illustrated in the economic literature by analyzing private individual contributions to a public good²¹. Behavior of individuals in course of donation campaigns can be explained by illustrating the theoretical model of Andreoni (1998) in a formally simplified way. Assume there are two individuals i and j owning identical endowments $m_i = m_j$. Each of these individuals can use its endowment to contribute g_i or g_j to the public good. The utility of individual i is²²:

$$u_i = \begin{cases} u_i(x_i, G) = u_i(m_i - g_i, g_i + g_j) & \text{falls } g_i + g_j \geq \bar{G} \\ u_i(x_i, 0) = u_i(m_i - g_i, 0) & \text{falls } g_i + g_j < \bar{G} \end{cases} \quad (5)$$

Formula (5) says that each individual realizes a positive utility by consuming its private good x_i or x_j and the public good G . However, the public good will only generate a positive utility if the threshold \bar{G} is passed.

Consider a simultaneous contribution game. Under certain assumptions, equilibrium, which implies that the threshold \bar{G} is not passed, exists because it is optimal for both individuals not to contribute, if they expect their counterparts to do the same²³. Therefore, it is not guaranteed that the socially optimal amount of G will be contributed.

Under certain assumptions, this socially undesirable equilibrium can definitely be avoided in a sequential game where individual i makes his contribution g_i in the first stage while individual j makes his contribution g_j in the second stage after observing

²¹ Pure public goods are characterized by two characteristics: Non-rivalry in consumption and non-excludability from consumption of this good. A classical example is environmental protection.

²² Andreoni (1998) on p.1191 illustrated that formula is a combination of the optimization problem of an individual and on p.1192, showed the distinction of cases for public goods with threshold.

²³ Andreoni (1998) on p.1193 proposed the main assumption that no individual is better off when making a contribution sufficient to pass the threshold \bar{G} on its own.

g_i ²⁴. Then there is an individual contribution $g_i = \tau_j < \bar{G}$ on the first stage, that guarantees that individual j will make a contribution sufficient to surpass the threshold, that is contribution $g_j = \bar{G} - g_i$ with $\bar{G} = g_j + \tau_j$, on the second stage ²⁵.

Thus, the contribution in the first stage, named “seed-money” by Andreoni (1998), can guarantee that at least the threshold amount of the public good \bar{G} will be provided. That is, seed-money increases the probability of a successful funding. Behavior of succeeding donators can be described as conditionally cooperative, assuming individual i makes a sufficient contribution in stage 1, individual j will also contribute.

The positive influence of seed-money on other individuals has been proven empirically. In a field experiment, List and Lucking-Reiley (2002) contacted 3000 households to ask for a donation for the local university. The authors manipulated the call for donations in the following way: In one third of calls for donations, they indicated that 10%, 33%, and 67% of the fixed funding target has already been collected. They found, for example, that the increase in seed-money from 10% to 33% increased the share of contributing households from 3.4% to 8.4%. The mean donation amount grew from \$11.88 to \$35.36²⁶.

Donation platforms like Mysherpas.com try to use the positive external effect of seed-money by displaying the share of the funding target that has already been contributed at any time during the funding period. The same is true for crowdinvesting-platforms. By displaying the amount of money that has already been

²⁴ According to Andreoni (1998), these claims include the assumption, that no individual is better off when making a contribution sufficient to surpass the threshold \bar{G} and the assumption that τ_i and τ_j , described on p.1196, exist.

²⁵ Andreoni (1998): p.1196

²⁶ List and Lucking-Riley (2002): Table 1 on p.221

invested, the willingness to cooperate with succeeding investors with charitable motives increased.

Considering initial investors on crowdfundering-platforms, in the presence of investors with non-monetary motives, the investment of initial investors will increase the mobilization of this type of investors. Early investments decrease the probability of free-rider equilibrium.

It is difficult to obtain a funding started because initial investors face comparatively high costs of information production and they cannot draw any conclusions from preceding investments. This makes investments of early investors very valuable and requires offering some preferential treatment to initial investors, leading to the following criterion:

Criterion 4: The rationing mechanism of a crowdfundering-platform must compensate initial investors for their comparatively high costs of information production as well as their positive effect on the probability of a successful funding.

3. Conflicting implications of mentioned criteria

The described criteria of an optimal rationing mechanism are meant to protect interests of parties involved in the funding process on a crowdfundering-platform. Unfortunately it is not always attainable to realize a maximum protection of one party's interests without violating others.

Criterion 4, which is meant to guarantee the participation of initial investors, is in conflict with the remaining three criteria. Preferential allocations to initial investors can create concentrations in the ownership structure. Such a concentration obviously does not fulfill criterion 2 requiring a maximum dispersion of shares. If there are restrictions on the minimum size of sold shares preferential treatment of initial investors can even avoid a maximization of the number of investors required by criterion 1²⁷. Finally, if initial investors are informationally advantaged, their privileges in the rationing process are inconsistent with criterion 3 meant to protect informationally disadvantaged investors.

A closer look at the nature of the conflicting criteria is necessary to find a reasonable compromise. On the one hand, criterion 4 is meant to guarantee the participation of initial investors. Though their participation is necessary for smooth operating markets, the underlying criterion does not need to be maximized. On the other hand, criterion 1 is meant to maximize the liquidity and market value of shares. Therefore, an optimal compromise in choosing the market microstructure of a crowdfundering-platform should allocate shares to initial investors preferentially to guarantee their participation. Once this goal is achieved, the size and dispersion of the investor base should be maximized and small and slow investors should be protected.

²⁷ For example, on Seedmatch.de an investor must invest at least €250 (<https://www.seedmatch.de/ueber-uns/fuer-investoren> (04/17/2012))

4. Rationing mechanisms for practical purposes

The purpose of the following chapter is to construct a mechanism that would satisfy the theoretical criteria mentioned in Chapter 2. First, practical features able to fulfill the mentioned theoretical criteria are listed. Second, an illustrating example is presented.

4.1 Practical features of an optimal rationing mechanism

An optimal rationing mechanism must include three features. First, it should include a zero-rationing threshold described later. Second, beyond that threshold the shares should be rationed to maximize a firm's investor base size and diffusion. Third, it should include a soft ending of the financing period.

4.1.1 A zero-rationing threshold

If initial investors were rationed in the same way as succeeding investors a problem may arise due to differences in costs of information production, as illustrated in formula (4). If $E(U_{initial}) < 0$, no investor will ever start producing information. To create incentives for information production, you could guarantee initial investors a fixed allocation $\bar{\alpha}$. In this case, the expected utility of an initial investor would rise to $E(U_{initial/preferred})$:

$$E(U_{initial/preferred}) = \bar{\alpha}E(\hat{V} - P_0) + E[\hat{b}(\alpha_1 - \bar{\alpha})(\hat{V} - P_0)] - c_1 \quad \text{with } \alpha_1 > \bar{\alpha} \quad (6)$$

The fixed allocation $\bar{\alpha}$ does not mean that initial investors get an allocation free of charge. The variable $\bar{\alpha}$ just says that in the case of excessive demand a certain amount of initial investors demand is not rationed. For example, $\bar{\alpha} = 10\%$ implies that the individual demand of investors who contribute the first 10% of the investment

target will not be rationed up to this threshold, but they will be rationed in the same way as succeeding investors beyond that threshold.

What is a sensible value of the zero-rationing threshold $\bar{\alpha}$ in practice? Since we have seen that an optimal rationing mechanism should protect initial managements' control of a company, an upper bound of a threshold of 50% seems plausible. In the extreme scenario of a firm selling 100% of its equity, a threshold of $\bar{\alpha} < 50\%$ will prevent a single initial investor to take over a majority of shares.

It is more difficult to find a sensible lower bound for $\bar{\alpha}$. The practical donation literature offers an interesting rule of thumb found in an adviser for donation campaigns, indicating that seed-money of at least 20% of the donation target is necessary for a successful funding²⁸. Thus, it seems as if positive external effects on succeeding investors with non-monetary motives can only be realized if the initial investment is bigger than 20%. Of course, the implementation of this rule of thumb is far from being scientifically satisfying. It also remains unclear whether such a threshold sufficiently compensates for the costs incurred by initial investors. To sum up, an optimal zero-rationing threshold $\bar{\alpha}$ should fall within the interval [0.2; 0.5].

4.1.2 Investor base size and diffusion maximizing rationing beyond the zero-rationing threshold

After allocating the shares inside the zero-rationing threshold $\bar{\alpha}$ to initial investors, the remaining supply of shares, that is $\alpha_{R0} = 1 - \bar{\alpha}$, should be allocated to imply a maximum size and diffusion of the investor base.

²⁸ "Why you don't need the 800-pound gorilla" by Robert F. Hartsook: <http://www.allbusiness.com/human-resources/employee-development-leadership/451976-1.html> (2/20/2012)

The first iteration of this allocation process beyond the zero-rationing threshold is to completely satisfy the smallest individual demand α_{min1} . The remaining $n-1$ investors should also receive an allocation of α_{min1} . This is only attainable if the following condition holds:

$$\alpha_{R0} - n\alpha_{min1} = 1 - \bar{\alpha} - n\alpha_{min1} \geq 0. \quad (7)$$

Formula (7) says that the described allocation will be attainable only if the remaining supply of shares α_{R0} is bigger than the shares necessary for the aggregate allocation $n\alpha_{min1}$ of this iteration. If condition (7) does not hold, implying $\alpha_{R0} < n\alpha_{min1}$, the remaining supply of shares α_{R0} should be distributed equally to all investors. In such a situation, every investor would receive $\alpha_i = \alpha_{R0}/n$ of the company's shares. Initial investors would receive this allocation additively to their shares guaranteed by the zero-rationing threshold.

If condition (7) still holds after the first iteration, the same iteration will be applied for a second time. This implies that the second lowest individual demand α_{min2} will be completely satisfied. Therefore, this investor would receive a further allocation of $\alpha_{min2} - \alpha_{min1}$ in the second iteration. The same is true for the remaining investors with still positive individual demand. This iteration is only attainable, if:

$$\begin{aligned} \alpha_{R1} - (n-1)(\alpha_{min2} - \alpha_{min1}) &= \alpha_{R0} - n\alpha_{min1} - (n-1)(\alpha_{min2} - \alpha_{min1}) = \\ &= 1 - \bar{\alpha} - n\alpha_{min1} - (n-1)(\alpha_{min2} - \alpha_{min1}) \geq 0. \end{aligned} \quad (8)$$

If this condition does not hold, the remaining supply will be distributed equally among the remaining $n-1$ investors still having a positive individual demand. In this scenario, every investor, except the smallest investor whose individual demand has been completely satisfied in iteration 1, will receive an additional allocation of $\alpha_i = \alpha_{R1}/n =$

$(\alpha_{R0} - n\alpha_{min1})/(n-1)$. The described allocation procedure can continue in the described way until all shares are distributed.

4.1.3 Soft ending of the financing period

Another goal of an optimal rationing mechanism is the protection of informationally disadvantaged investors. The threat of eliminating informationally disadvantaged investors reaches its maximum if one wealthy informationally advantaged investor can buy all shares at once. Thus, if the financing round would end immediately after reaching 100% of the investment target, the elimination of informationally disadvantaged investors is very likely.

Imagine there are two projects on a crowdfunding-platform. One “good” project implies underpriced shares, while the other “bad” project implies overpriced shares. Assume both projects have the same time left until the definite end of the financing period. Further, the financing round will close after reaching 100% of the investment target. New investors observing the project differ in their speed of evaluation. Informationally advantaged investors can evaluate a project faster compared to informationally disadvantaged investors.

In the described situation, a wealthy informationally advantaged investor will use all of his/her available funds to buy shares of the good project. If he/she is wealthy enough, this will close the financing round immediately. An informationally disadvantaged investor can no longer buy underpriced shares and faces exclusively

overpriced shares. A rational informationally disadvantaged investor will anticipate this situation and abstain from participating²⁹.

This discrimination of informationally disadvantaged investors is a result of the “hard” ending of financing periods implemented by some platforms. If you want to protect informationally disadvantaged investors, you have to allow them to invest in projects that have already reached the 100% investment target. This gives them the opportunity to wait for positive signals of experienced investors before investing.

The question, what is the optimal form of a soft ending of a financing round, cannot be answered scientifically satisfactorily here. One idea is to continue the financing period, for example, for two further weeks after reaching the 100% investment target. By constructing an optimal mechanism opportunity costs for all the investments contributed so far have to be considered. Therefore, an appropriate soft ending should imply a manageable period for respecting the tradeoff between protecting informationally disadvantaged investors on the one hand and opportunity costs on the other hand.

4.2 Illustrating example for a practically applicable rationing mechanism

In the following chapter, the described desirable features of a rationing mechanism will be illustrated using an example depicted in Table 1. Investors 1 to 7 successively formulate their individual demand (beginning with investor 1) for perfectly divisible shares costing €1 each.

²⁹ If the informational disadvantage takes the form of a slower evaluation process, these investors could choose a strategy of investing a constant amount in every available firm without an evaluation. However if firms selling overpriced shares are able to reach 100% of their investment target, then this strategy can generate losses on average.

Investor 1 transfers €50 to the platform expressing an individual demand for 50 shares. Investor 2 transfers €80, expressing an individual demand for 80 shares. Since the aggregate demand of these two investors exceeds the aggregate supply of 100 shares, the soft ending of the financing round is triggered. The soft ending implies a continuation of the financing period for a pre-specified period, for example two weeks.

In contrast to experienced investors 1 and 2, investors 3 to 7 wanted to wait for positive signals from the market. These investors now formulate their individual demand for shares before the ultimate ending of the financing period. The individual demand of these investors varies between 5 and 60 shares. Rationing begins once reaching the ultimate end.

First, the initial investor 1 is rewarded for his pioneer investment by receiving $\bar{\alpha} = 20$ shares implied by the zero-rationing threshold. The remaining 80 shares are now allocated in an iterative process. Investor 6 has the smallest individual demand of $\alpha_{min1} = 5$. Implementing a rationing mechanism that maximizes the size and diffusion of the investor base, the individual demand of investor 6 is fulfilled completely. All other investors also receive an allocation of 5 shares in this iteration process. Notice that initial investor 1 also receives a further allocation of 5 shares.

In the second iteration, the individual demand of the second smallest investor 7, asking for $\alpha_{min2} = 15$ shares should be fulfilled completely. Nevertheless, there is a problem. If the allocation of every investor increased by $\alpha_{min2} - \alpha_{min1} = 10$ shares, the remaining supply of $1 - \bar{\alpha} - 6\alpha_{min1} = 45$ shares would not suffice to realize this process. This triggers the final iteration process. Thus, the remaining shares are distributed equally among the investor with a positive remaining individual demand.

Consequently every investor receives $(1 - \bar{\alpha} - 6\alpha_{min})/(n - 1) = 7.5$ shares. The complete individual allocations are depicted in Table 1.

Table 1: Illustrating example of a rationing mechanism with a zero-rationing-threshold, a soft ending and a size and diffusion of ownership maximizing rationing beyond the zero-rationing-threshold.

Investors (in chronological order)	Individual demand (number of shares)	Received allocations			
		Zero-Rationing- Threshold: $\bar{\alpha} = 20\%$	Allocations after the first iteration process	Allocations after the second iteration process	Allocations after the third iteration process
1	50	20	$20+5 = 25$	$25+10 = 35$	$25+7,5 = 32,5$
2	80	0	5	$5+10 = 15$	$5+7,5 = 12,5$
Trigger of the soft ending					
3	40	0	5	$5+5 = 15$	$5+7,5 = 12,5$
4	60	0	5	15	12,5
5	30	0	5	15	12,5
6	5	0	5	5	5
7	15	0	5	15	12,5
Ultimate End of the financing period					
Sum	310	20	55	$115 > 100$	100

6. Conclusion

Currently, the phrase “first come, first served” best describes the rationing of excessive demand on crowdfundering-platforms. This mechanism is not optimal for several reasons described here. Therefore, four theoretical criteria of an optimal rationing mechanism are discussed and an example for a practical implementation is delivered.

Further research needs to be done, to develop a unified mathematical framework able to depict the mentioned arguments. At the same time further theoretical or experimental research seems promising. The scope for empirical analysis seems limited at this time due to the young age of crowdfundering-platforms.

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