Does Rationing of Shares Increase Revenues in Initial Public Offerings?

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Abstract

We provide a new explanation for the apparent underpricing of initial public offerings applicable to large, regulated firms like telecommunications companies. Under the assumption that regulation is subject to political pressure by voters we demonstrate that it may be rational for issuers to ration investors in order to insure a broad distribution of shares in the population. At the same time we explain the common practice of bonus systems designed to prevent investors from taking profits immediately.

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1 Introduction

In several recent privatizations of formerly state owned enterprises the issue of shares was characterized by substantial oversubscriptions. In some cases the demand for shares exceeded supply by as much as ten times and more. Typically, this resulted in huge windfall gains for the lucky ones who managed to get hold of shares. For example, in the case of the Deutsche Telekom private investors could have earned more than 21%.[1]

Underpricing of initial public offerings (IPOs) is a big topic in the finance literature. Empirical studies find underpricing on average of about 15% and more (see e.g. Ibbotson *et al.*, 1988). There is a variety of theoretical models offering explanations for this apparent irrationality of issuers. After all, it seems that issuers forgo a considerable amount of funds by underpricing. Most theories are based on some form of asymmetric information between the agents involved, namely, the issuer, the investors and the underwriters. Issuers may want to use the low price as a signal for a high–quality firm (Welch, 1989). Investors may require underpricing as compensation against the 'winner's curse' (Rock, 1986). And finally, underwriters may ask the issuer to underprice in order to lower their risk and to improve their reputation (Baron, 1982).

We offer a new explanation for underpricing of IPOs applicable to firms which are regulated. Underpricing always requires use of a rationing scheme. Somewhat surprisingly, we show that issuers can *increase* revenues by announcing a rationing scheme (and thereby provoking excess demand for shares). At the same time we provide a rationale for the common practice of bonus systems, which give small investors inducements to hold on to their shares rather than taking profits on the first day of trading.[2]

Consider an industry which was formerly dominated by a large, state–run enterprise. We suppose that even after privatization the industry requires regulation either because of the still dominant position of the privatized firm or because there are related markets in which the firm has a natural monopoly. Our standard example will be the telecommunications market. Large telephone companies like Deutsche Telekom or France Telecom will

[1]The privatization of 50% of Deutsche Telekom in 1996 was the second largest issue of new shares in history. It was about six times oversubscribed. More than two million private investors bought shares – many for the first time.

[2]For example, Deutsche Telekom introduced a scheme which promises investors who keep their shares for 2 years a bonus of 10% for up to 300 shares. A similar scheme was employed by British Telecom (see Spiller and Vogelsang, 1996).

require regulation for years to come just like AT&T is still regulated many years after its break up.

For firms which operate in regulated markets it is clear that expected profits depend on regulation in the future. Regulation may be tough on the firm or it may be soft. An example are the interconnection charges new competitors have to pay to the national telecommunications companies. Those regulatory issues have important effects on stock prices of the privatized firms. For example, when the German minister in charge of telecommunications announced lower than expected access prices in September 1997 the stock price of Deutsche Telekom plummeted substantially.

It becomes therefore crucial for stock holders to anticipate the future policy of regulation agencies. Determining the objectives of such an agency should be the first step. In particular, the question arises whether the regulation agency is independent of politics. While it is stated policy in many countries to found independent agencies, there is considerable doubt whether this can be achieved. For example, in Germany the Ministry of Postal Services and Telecomunication is being replaced by a new regulatory agency, which is supposed to have some kind of independence.[3] However, important decisions like those about interconnection charges have already been taken by the Ministry. Further doubt about independence of the new agency was created by choosing a former undersecretary of the Minstry as the designated chief of the new agency. We assume, therefore, that regulatory agencies will still be subject to substantial political influences.

It seems natural to suppose that a voter who is also a share holder in the privatized company would favor regulation which is of advantage to the company.[4] Furthermore, it seems natural to assume that for privatizations like those of the national telecommunication companies, where millions of voters become share holders, it is true that the higher the number of shareholders, the more favorable the regulation. This does not mean that a share holder necessarily becomes the median voter but that the group of share holders represents a voting block and lobbying power that is too large to be ignored.[5] Accordingly, regulation will probably turn out to be more

[3]Similarly, the regulation authority in Fance called ART is supposed to be independent. However, major decisions like price cap regulation, licence requirements etc. are still taken by the French government (Waverman and Sirel, 1997).

[4]This will always be the case unless the share holder is such a good costumer of "his" company that he would profit more from competitive prices than from higher dividends.

[5]For a general model on pressure groups see e.g. Becker (1983). For evidence on how telecommunication firms can influence regulators' behavior see e.g. Teske (1991).

favorable to such a company.

However, it is of no use to distribute shares widely if small investors take their profits on the first day of trading. Therefore, incentives have to be created to induce investors to hold on to their shares for a longer time. In the following we show that neither a bonus system nor a rationing scheme work in isolation. Only in combination can those instruments increase revenues for the issuer.

The paper is structured as follows. The model is introduced in Section 2. In Section 3 we answer the question whether rationing can increase revenues for the simpler case in which the bonus is so high that all investors keep their shares. Section 4 presents a short conclusion. The analysis of the general case in which some investors may sell their shares is relegated to an Appendix.

2 The model

We consider a model with three time periods. In t_0 shares are issued, t_1 is the first trading day, and t_2 is some later date at which the value of the firm (e.g. sum of discounted dividends or profits) has materialized. Regulation affects profits between periods t_1 and t_2.

We suppose that investors demand stocks for two reasons. The first motive is given by the possibility of making a windfall gain, $g := p - e$, due to the difference between the price p of the stock in t_1 and the emission price e in t_0. This motive can influence only the demand in period t_0. The second motive is the usual desire to hold a broad portfolio. For this the "fundamental" value of the stock, v, the bonus system, and the market price p are important.

Furthermore, we make the assumption that demand for shares is increasing in wealth of the investor, which seems realistic as it is typically observed that richer investors hold larger amount of stocks in their portfolio.[6] We assume that wealth, w, of investors is distributed on the interval $[0, \bar{w}]$ according to the distribution function $F(w)$ with continuous density $f(w)$. The number (mass) of investors is normalized to one.

The bonus system is simple. For each issued share which the original investor has still in his possession at time t_2 he receives a additional shares.

[6] We could derive this assumption from standard utility maximization models but this would only unnecessarily complicate the analysis.

Demand for issued shares in t_0 is thus

$$x^e(w,(1+a)v,e,g),$$

with $x^e_w > 0$, $x^e_v > 0$, $x^e_g > 0$, and $x^e_e < 0$.[7] $x(\cdot)$ is assumed to be twice differentiable.

The issuer has the option whether to announce that rationing will take place. We consider the following simple rationing scheme. Every investor demanding less than m shares receives all the shares he demands. All investors demanding more, receive m.[8]

$$x^r = \begin{cases} x^e(w,(1+a)v,e,g) & \text{if } x^e \le m \\ m & \text{if } x^e > m \end{cases}$$

Let w^m denote the wealth of the marginal investor whose demand is exactly m

$$x^e(w^m,(1+a)v,e,g) = m.$$

Note that if m is chosen high enough such that $w^m \ge \bar{w}$, the situation is equivalent to no rationing.

Let n denote the (exogenously determined) number of shares issued. Given a rationing scheme market clearing in t_0 requires

$$n = \int_0^{w^m} x^e f(w)\,dw + m\left[1 - F(w^m)\right]. \tag{1}$$

Effective demand is simply given by the sum of the demand of the not rationed consumers plus m times the mass of the rationed consumers. With respect to the price p investors rationally anticipate the market clearing price of period t_1.

Consider now period t_1. Investors have to make two decisions. First, they have to decide how many of their shares they should keep. Let $x^b \le x^r$ denote this amount,

$$x^b(w,(1+a)v,p),$$

with $x^b_w > 0$, $x^b_v > 0$, and $x^b_p < 0$.

The second decision to make is whether additional shares should be bought in period t_1. Since traded shares in t_1 loose their bonus, only rationed

[7] Subscripts of functions denote partial derivatives.

[8] There may exist better rationing schemes for the issuer. Since we are only intersted in showing that rationing *can* increase revenues, our simple scheme suffices.

investors may want to buy additional shares. Let $x^t(w, v, p, m, a) \geq 0$ denote the demand for traded shares, with

$$x^t(w, v, p, m, a) > 0 \text{ only if } x^b \geq x^r.$$

In the special case $a = 0$ traded and issued shares have the same value. In this case x^t is given by

$$x^t(w, v, p, m, 0) = \max\left\{x^b(w, v, p) - m, 0\right\}$$

However, for $a > 0$ issued shares and traded shares are valued differently. We assume with respect to partial derivatives of x^t that $x^t_v > 0$, $x^t_p < 0$, and $-1 < x^t_m \leq 0$. The last assumption implies that a rationed investor compensates only partially for the shares he did not receive on the emission stage.

If we denote by w^t the marginal investor who does not sell any shares in t_1

$$x^b(w^t, (1+a)v, p) = m,$$

we obtain the market clearing condition in t_1

$$\int_0^{w^t} x^b f(w)\, dw + m\left[1 - F(w^t)\right] + \int_{w^t}^{\bar{w}} x^t f(w)\, dw = n \qquad (2)$$

What remains to explain is how the fundamental value of the stock, v, is being determined. Since we consider a large firm which even after privatization will require regulation due to its dominant position in the market, the expected value of future profits, π, will depend crucially on the type of regulation. The tougher the regulation is, the lower the profits. Instead of describing in detail how the political process works which determines regulation, we make the assumption that regulation will be more favorable to the firm if more voters are share holders between t_1 and t_2 and vice versa.[9]

Let $\underline{w}$ denote the lowest wealth level at which an investor would decide to keep any shares in t_1.

$$x^b(\underline{w}, (1+a)v, p) = 0 \qquad (3)$$

[9] The same logic was apparently applied by the Conservative Party in the UK. As argued by Spiller and Vogelsang (1996, p. 95) "At the time the Conservative government was being threatened by a Labour Party victory in the upcoming spring 1992 elections, and relinquishing most of the governments's remaining shares certainly intended to make it more difficult for a Labor government to undo the privatization. ....widespread ownership actually provides safeguards against future opportunistic behavior by government,..."

Given that demand for stocks is increasing in wealth, all investors with $w \geq \underline{w}$ will keep some of their shares as well. The number of stock holders is then $1 - F(\underline{w})$. To reflect our view that expected future profits should depend on regulation we assume that $\pi(\underline{w})$, with $\pi_{\underline{w}} < 0$.

The value v per share depends positively on π and negatively on the total number of shares, N, in t_2, which is the sum of the number of emitted shares n and the bonus shares B.

$$\begin{aligned} v(\pi, N) &= v(\pi, n + B) \\ B &= a\left[\int_0^{w^t} x^b f(w)\, dw + m\left(1 - F(w^t)\right)\right] \end{aligned} \tag{4}$$

With (1), (2), and (3) the model is closed. Implicitly they determine the emission price $e(a, m)$, the market price $p(a, m)$, and the expected profits of the company $\pi(a, m)$.

3 Does rationing increase revenues?

Suppose the government's objective is to maximize revenues. Of course, this is a strong assumption as governments are usually driven at least partially by other objectives, e.g. by distributional motives. Thus, those objectives could then provide further reasons why rationing should be considered.

When selling the shares the government has in principle two options. It could let e be determined as the market clearing price, which amounts to selling the shares to the highest bidders. Or, it could announce a rationing scheme which takes affect if demand for shares exceeds supply.

Consider first the case of no rationing. The two market clearing conditions are then given by

$$\begin{aligned} \int_0^{\bar{w}} x^e(w, (1+a)v, e, p - e)\, f(w)\, dw &= n \\ \int_0^{\bar{w}} x^b(w, (1+a)v, p) f(w)\, dw &= n \end{aligned}$$

Markets clear simultaneously only if $e = p$ holds, and thus $g = 0$. Note, that introducing a bonus would not change anything since it would be equivalent to simply increasing the total number shares, which leaves total revenues unaffected.

Now consider the situation with rationing. The purpose of rationing is to distort the allocation of shares away from the distribution that would come about in an auction. If, however, all small investors took profits on the first day of trading, rationing would be pointless from the government's point of view as future regulation would be unaffected by it. In particular, this would be the case for $a = 0$. Rationing would yield a positive windfall gain but the market clearing condition in t_1 would be unaffected. Therefore, to make the change in the distribution of shares permanent, the government has to provide incentives for holding on to the shares.

In the simple version of the model we assume that shares carry a bonus $a > 0$ which is high enough to prevent investors from selling their shares immediately (see the appendix for a more general case that allows for trade in t_1).[10] Without trade in t_1 there is no windfall gain to be made. Thus, the market clearing emission price $e(a, m)$ is determined by

$$\int_0^{w^m} x^e(w, (1+a)v, e, 0) f(w) dw + m\left[1 - F(w^m)\right] = n. \tag{5}$$

In order to maximize revenues the government solves the following problem

$$\max_m e(a, m),$$

where $e(a, m)$ is given implicitly by (5). Implicitly differentiating yields[11]

$$\frac{\partial e}{\partial m} = -\frac{1 - F(w^m)}{\left[X^e\right]_e + \left[X^e\right]_v (1+a) v_\pi \pi_{\underline{w}} \frac{\partial \underline{w}}{\partial e}}, \tag{6}$$

where $\left[X^j\right]_i := \int_0^{w^m} \frac{\partial}{\partial i} x^j(\cdot) f(w) dw$, $j = e, t, b$; $i = e, v, p, g$. Note that $\left[X^e\right]_v > 0$ and $\left[X^e\right]_e < 0$.

Letting $\underline{x}^e := x^e(\underline{w}, (1+a)v(\pi(\underline{w}), N), e, 0) = 0$, we find that

$$\frac{\partial \underline{w}}{\partial e} = -\frac{\underline{x}^e_e}{\underline{x}^e_{\underline{w}} + \underline{x}^e_v (1+a) v_\pi \pi_{\underline{w}}}. \tag{7}$$

Substituting (7) into (6) yields the first order condition

$$\frac{\partial e}{\partial m} = \frac{\left(1 - F(w^m)\right)\left(\underline{x}^e_{\underline{w}} + (1+a)\, \underline{x}^e_v v_\pi \pi_{\underline{w}}\right)}{v_\pi\, \pi_{\underline{w}}\, \underline{x}^e_v (1+a)\left(\left[X^e\right]_v \underline{x}^e_e - \left[X^e\right]_e \underline{x}^e_v\right) - \left[X^e\right]_e \underline{x}^e_{\underline{w}}} \leq 0 \tag{8}$$

[10] For Deutsche Telekom the bonus worked well. According to the *Wirtschaftswoche* (issue of 8.5.1997, p. 164) between 70 and 80 % of investors still held their shares 6 months after emission.

[11] Note that the number of shares which carry a bonus is unchanged with rationing if there is no trade.

First, we can dispense with the corner solution $m = 0$ as revenues are obviously zero for this value. Consider next the case of no rationing, i.e. $F(w^m) = 1$. When we consider lowering m marginally such that $F(w^m)$ falls below 1, revenues increase if and only if $\frac{\partial e}{\partial m} < 0$ for $F(w^m)$ close to one. Thus if $\frac{\partial e}{\partial m} < 0$, then no rationing corresponds to a local revenue minimum. But then there must exist an interior maximum, which implies that rationing can increases revenues.

To determine whether this condition is satisfied, the value of $v_\pi \pi_{\underline{w}}$ becomes crucial. Recall that $v_\pi \pi_{\underline{w}}$ measures how strongly the value of the firm depends on regulation and therefore on the number of stock holders. Note first, that if $\pi_{\underline{w}}$ is zero, that is, if the future value of the firm is unaffected by regulation – as is the case with most private competitive firms – then rationing is never optimal.

However, as $v_\pi \pi_{\underline{w}}$ becomes more negative, (8) will eventually be satisfied as the following consideration shows. For

$$v_\pi \pi_{\underline{w}} < -\frac{\underline{x}^e_{\underline{w}}}{(1+a)\underline{x}^e_v} \tag{9}$$

the numerator of (8) becomes negative. But the denominator will remain positive for values of $v_\pi \pi_{\underline{w}}$ even smaller than that (it may even remain positive for all values of $v_\pi \pi_{\underline{w}}$). Therefore, rationing may improve revenues. Furthermore, ceteris paribus the higher the bonus a, the easier it is to satisfy (9).

4 Conclusion

In this note we provided a new possible explanation for the apparent underpricing of initial public offerings applicable to large, regulated firms. The model was based on the assumption that regulation is subject to political pressure by voters. It turned out that rationing investors may actually increase revenues because a broad distribution of shares insures favorable regulation, which it turn increases the value of the stocks. We showed that rationing works only in combination with a bonus system designed to prevent investors from taking profits immediately.

It should be clear now why we used the term “apparent” underpricing. Despite the fact that there was a substantial gap between emission price and opening price of the stocks, the emission price was still higher than what it would have been without the rationing (and bonus) announcement. Without rationing the market clearing emission price would have been lower because many small investors would not have signed up without the prospect of a windfall gain.

Our theory does not displace other explanations for underpricing as underpricing occurs with small and unregulated firms as well. An interesting test for our theory would be to compare the degree of underpricing of large, regulated firms with that of other firms. At present we feel that the empirical data base is too limited to allow for formal testing but hopefully such a test will be feasible in the future.

Appendix

In this appendix we derive (8) under the less restrictive assumption that rationing can result in trade in period t_1, that is, that the bonus is not high enough to prevent all investors from selling their shares. Defining

$$X^e := \int_0^{w^m} x^e\, f(w)\, dw,\ X^b := \int_0^{w^t} x^b f(w)\, dw,\ X^t := \int_{w^t}^{\bar{w}} x^t\, f(w)\, dw$$

we can write the market clearing conditions (1) and (2) as

$$\begin{aligned} n &= X^e + m\,(1 - F(w^m)) \\ n &= X^b + m\left[1 - F(w^t)\right] + X^t. \end{aligned}$$

Differentiating (1) through (3) yields

$$\begin{aligned} 0 &= [X^e]_v\,(1+a)v_m + [X^e]_e\, e_m + [X^e]_p\,(p_m - e_m) + (1 - F(w^m)) \\ 0 &= \left[X^b\right]_v (1+a)v_m + \left[X^b\right]_p p_m + \left(1 - F(w^t)\right) + \left[X^t\right]_v v_m + \left[X^t\right]_p p_m + \left[X^t\right]_m \\ 0 &= \underline{x}^b_{\underline{w}}\, \underline{w}_m + \underline{x}^b_v (1+a)v_m + \underline{x}^b_p\, p_m \end{aligned}$$

Since trade influences now the number of shares which entitle to a bonus, we find by differentiating (4)

$$v_m = v_\pi\, \pi_{\underline{w}}\, \underline{w}_m + v_N\, a\left[\left[X^b\right]_v (1+a)v_m + \left[X^b\right]_p p_m + \left(1 - F(w^t)\right)\right].$$

Solving this system of equations one obtains implicit expressions for e_m, p_m, and $\underline{w}_m$. We focus on the case of $m = \bar{m} := x^e(\bar{w}, (1+a)v, e, g)$ and consider lowering m marginally. Since at $\bar{m}$ no investor is rationed, it must hold that

$$\left[X^t\right]_v\Big|_{m=\bar{m}} = \left[X^t\right]_p\Big|_{m=\bar{m}} = 0. \tag{10}$$

Considering limits we have by L'Hôpital's rule

$$\lim_{m\to\bar{m}} \frac{[X^t]_m}{1-F(w^m)} = \lim_{m\to\bar{m}} \frac{\int_{w^t}^{\bar{w}} x_m^t\, f(w)\, dw}{1-F(w^m)} = x_m^t(\bar{w}, v, p, \bar{m}). \tag{11}$$

If we define $\bar{x}_m := x_m^t(\bar{w}, v, p, \bar{m})$, one can show using (10) and (11) that

$$\lim_{m\to\bar{m}} e_m = \lim_{m\to\bar{m}} \frac{(1-F(w^m))\left(\underline{x}_{\underline{w}}^e + (1+a)\, \underline{x}_v^e v_\pi \pi_{\underline{w}} + \bar{x}_m\, \Phi\right)}{v_\pi\, \pi_{\underline{w}}\, \underline{x}_v^e (1+a)\left([X^e]_v\, \underline{x}_e^e - [X^e]_e\, \underline{x}_v^e\right) - [X^e]_e\, \underline{x}_{\underline{w}}^e},$$

where

$$\Phi := (1{+}a)\, v_\pi \pi_{\underline{w}} \frac{[X^e]_v\, \underline{x}_e^e - [X^e]_g\, \underline{x}_v^e}{[X^e]_e - [X^e]_g} - \underline{x}_{\underline{w}}^e \left([X^e]_v\, v_N\left(a^2 + a\right) + \frac{[X^e]_g}{[X^e]_e - [X^e]_g}\right)$$

We claim that $\bar{x}_m = 0$ for a bounded away from zero. Note that $x^t(\bar{w}, v, p, \bar{m}) = 0$, i.e. the richest investor is not rationed at $m = \bar{m}$. If rationing affects this investor marginally, he will not compensate by buying shares without bonus since those are strictly less valuable. Put differently, no other investor would sell shares that entitle to a bonus to a price close to e.

But with $\bar{x}_m = 0$ we have that $\lim_{m\to\bar{m}} e_m > 0$ if and only if (8) is satisfied.

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