On the Feasibility of Laddering

Joshua Ronen
New York University

Bharat Sarath
Baruch College

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1. Introduction

In this paper we address the question of whether laddering is feasible as an equilibrium phenomenon. In initial public offerings (IPOs), laddering is described as the commitment to and the actual purchase of shares in the aftermarket in addition to what the purchasers would have purchased in the absence of laddering, where the motivation to purchase such additional shares is a pre-agreement (tie-in agreement) with the lead underwriter. Under such tie in agreements, the underwriter allocates more shares to the counter parties of the agreement (ladderers) in return for the commitment to purchase additional, possibly pre–specified, quantities of shares (in excess of what they otherwise would have purchased) so as to boost the price of the stock in after-market trading of the IPO. Ladderers could stand to profit from such tie-in agreements by selling their large allocation of IPO shares as well as their after-IPO purchases at inflated prices resulting from the laddering activities. In turn, the underwriter stands to profit by receiving higher than normal commissions from the ladderers or by sharing in the profits of the ladderers through other means.[1] The goal of our paper is to analyze the profitability of laddering in different market settings. Specifically, we show that laddering is not a sustainable activity unless (1) Underwriters act as a cartel; (2) there is a ready supply of momentum traders and (3) a lack of short-sellers or other skeptics in the aftermarket.

The main question of interest is whether laddering as defined above can be sustainable in equilibrium, that is, whether investors and underwriters operating in a competitive environment find it in their own self-interests to enter into tie in agreements with the objective of inflating the price in the aftermarket. Our analysis shows that this typically is not the case. Specifically, we can show that unless underwriters form a cartel that is able consistently to maintain a monopoly, they would compete to eliminate incentives for inducing laddering to inflate prices: competition to gain market share in the IPO market would lead underwriters to increase offer prices and thus gain more IPO commissions. But even if underwriters form a cartel such that ladderers earn abnormal profits, stock prices need not be inflated; if they

[1] One possibility is that Ladderers in one IPO are promised extra allotments in other IPOs such that both ladderers and underwriters are better off.

ever climb above the equilibrium value, sellers, including short-sellers, are likely to act fast to bring the price down to its equilibrium value.

In a competitive environment, under-pricing would provide normal returns for the risk faced by underwriters in estimating demand, manifested in the cost of aftermarket support (Derrien [2005], Hao [2007]). Alternatively, underpricing is the cost paid for inducing truthtelling from investors about market demand (Beneveniste and Spindt [1969]). And while allocants (investors who are allocated shares at the offering price in the IPO) may make profits by flipping, such profits could be seen as compensation for bearing the risk that the IPO could turn cold. Also, underwriters may "over-allocate" to some allocants in return for a promise not to flip and/or to purchase additional shares for the purpose of ensuring that the issued stock is held over the long term so as to provide a stable source of funding for the issuers.

A recent paper providing an economic model of laddering is Qing Hao (2007). Our paper shares some important features with the model constructed by Qing Hao (2007) but is different in motivation and in some very critical assumptions. Both papers examine a similar market-trading model with downward sloping demand curves; along with Hao [2007], we view this assumption as consistent with investors valuing new issues heterogeneously (Miller [1977], Rock [1986]) as well as with empirical evidence of negatively sloping demand (e.g., Table 4 of Wurgler and Zhuravskaya, [2002] and the references therein). In such a market, ladderers can boost the stock price by "restricting" the supply of shares available for trading; they do this by holding onto their allocations and by making additional aftermarket purchases. Qing Hao assumes that laddering is feasible economic behavior and examines how the initial underpricing changes in the decision to ladder. In contrast, we seek to examine whether laddering can be optimal economic behavior in the first place. The critical differences between our framework and Qing Hao's framework concern (1) the determination of the initial IPO price and (2) market conjectures about whether laddering has taken place.

In Qing Hao's framework, underwriters act like monopolists and set the initial offer price in such a way as to profit subsequently from laddering activities. This rather implausible assumption, combined with the ability to overallocate shares, makes laddering economically desirable for underwriters and their favored clients (ladderers). But again, even under Hao's assumptions, that is, even if underwriters form a cartel, laddering becomes feasible only in the sense that the profits made through the initial overallocation at low issue prices outweigh the losses made in the aftermarket; it does not mean that prices are inflated for any significant length of time. Depending on the trading intensity of momentum traders and information traders (that include short-sellers), any inflation induced by laddering activities can dissipate quickly.

The interest in Qing Hao's model stems from its ability to make predictions about the strategic level of underpricing as a function of laddering activities. In contrast, our paper assumes that the underwriting industry is competitive and that issuers will agree to leave only the minimum amount of money on the table. Therefore, in our setting, it is not the initial underpricing but whether the subsequent manipulation of the market that could lead to potential profits for ladderers that is the focus of interest.

To summarize, the issue analyzed in Qing Hao (2007) is that if underwriters act as monopolists (or as a monopolistic cartel along with ladderers, it becomes feasible for ladderers to make abnormal profits from their initial (low price) allotments, but this need not inflate prices beyond equilibrium values; any such inflation could be fast undone by information seeking traders. In contrast, our paper analyzes whether the attempted after market price boosting behavior by ladderers can allow them to cash in on aftermarket purchases and their competitively priced allotments at the time of issue.

A second feature that differentiates our model from Qing Hao (2007) concerns market perceptions about laddering. Qing Hao assumes that the market is not aware of laddering and behaves as if the market price (subsequent to tie-in purchases) is a result of market dynamics rather than illegal behavior. We assume that there is some proportion of traders in the market who suspect that laddering might have taken place and assign a positive probability to laddering. These traders would consequently short the stock or, equivalently, revise their fundamental expectations downward thereby reducing their optimal holding levels, i.e., sell the stock.[2] That is, we assume there are two types of traders in the market: momentum

[2] Edwards and Hanley [2007] observe that "Contrary to popular belief, we find that short selling occurs in 99.5% of IPOs in our sample on the offer day and the majority of first day short sales occur at the open of trading." They go on to add that

traders who react to the upward movement of prices by revising their beliefs about the stock upwards, and rational information seekers, who react by trying to acquire information about the fundamentals of the stock. The ability to profit from laddering in the after market depends on the existence of traders of each type. In particular, within our framework, traders who suspect that laddering has taken place can put downward pressure on the stock price which negates the effects of laddering both directly, and in the way it affects the behavior of momentum traders such as to dissipate any inflation in the stock price.

Griffin, Harris, and Topaloglu [2007] (hereafter, GHT) provide an in-depth empirical analysis of IPOs conducted on NASDAQ in the years 1997-2002. They show that the clients of lead underwriters are net purchasers of about 9% of the IPO in the after-market and that such purchasing behavior extends to cold IPOs.[3] They argue that such purchases lead to considerable increases in the closing price at the end of the first day. However, the analysis does not extend to the period where these clients then sell the stocks. While GHT show that early buyers in the aftermarket sell their additional holdings by the end of the first year, they do not investigate whether the process of buying in the aftermarket followed by subsequent selling was actually profitable for the ladderer. In general, we rely on the empirical features discussed in GHT [2007] in constructing our model. We assume that ladderers will buy or hold on the first-day after trade and sell at some much later point in time. The interval between the initial buying point and the later selling point results in enough time to allow other traders to gather information as to whether laddering may have taken place and whether prices are artificially inflated. If these information seeking traders react quickly, prices will stay inflated for a very short duration.

Our model considers multiple rounds of trade starting from the IPO. The IPO price is set competitively, and absent laddering, will not lead to any abnormal profits. The first round of trade takes place with ladderers simply holding on to their initial allotments. The next round of trade allows Ladderers to increase the price through after market purchases.

"Greater short selling is observed in IPOs with positive changes in the offer price, high initial returns and large trading volume."

[3]It is worth noting that the empirical evidence provided in GHT differs in one notable way from the theoretical predictions in Qing Hao (2007). GHT show that net purchasing by clients of lead underwriters is most frequent in cold IPOs whereas Qing Hao's model predicts that such net purchase, to the extent that it represents laddering, is most profitable in hot IPOs.

The final round of trade takes place when ladderers cash out. We show that this laddering process itself cannot be profitable if: (1) some traders investigate whether fundamental values justify the observed price in the time period between when ladderers buy and sell; or (2) non-ladderers react instantaneously to selling pressure by reducing their holdings as well. That is, laddering cannot move the price away from its equilibrium value conditional on available information on fundamentals (future cash flows and their risk) unless the market is inefficient in a specially defined sense. Specifically, ladderers can cash out at a profit if momentum traders that increase their expectations about the stock upwards based on price increases form a sufficiently large proportion of the market. More generally, laddering only works by manipulating expectations rather than through the manipulation of demand and supply. If the only forces at work were the equilibriation of demand and supply, laddering would always fail. Only if the process of restricting supply leads to changes in expectations of a sufficiently broad class of traders *that do not revert back when the ladderers cash out or others sell or short the stock* can laddering be sustained. If there is a group of traders who can spot (or suspect) laddering and start selling out their positions (or shorting the stock), then prices will cease to be inflated except for very short periods and laddering will fail to make any money. So in general, the phenomenon of laddering is sustainable in equilibrium only if there is a large group of traders whose expectations can be manipulated and insignificant trading by those who suspect that laddering is taking place. Needless to say, neither of these restrictions will hold in an efficient market, and consequently, laddering will fail to be a sustainable phenomenon within an efficient market.

2. The Model

The model we develop is based on a market where beliefs about fundamental value may diverge from price. Three sets of traders, insiders, outside momentum traders and outside private information seekers interact in the after-market trading of IPO's. The true value of the security depends on an underlying parameter, $\mathbf{x}$ which is unknown. For example, $f(x|\mathbf{x})$ may represent the distribution of cash flows from the security and the value depends on these cash flows. Traders form inferences about $\mathbf{x}$ based on both information signals and prices.

Each trader has a demand function $\mathcal{Q}(P, \mathbf{x})$ which depends both on their beliefs $\mathbf{x}$ and the observed price P. In equilibrium, the aggregate demand of traders should equal the aggregate supply. However, we assume that insiders manipulate the supply by buying or holding shares in a strategic fashion while traders who gather private information act to increase supply if they feel that the IPO price is inflated (by being laddered or otherwise manipulated). The market clearing price devolves to one where the shares supplied by outsiders equals the demand by outsiders. We begin by outlining the different types of investors, their belief processes and their demand functions.

Assumption 1 (Investor types)
We posit three distinct types of investors who participate both in the initial offering and in aftermarket trading

(1) Insiders who are party to tie-in agreements (see Qing Hao [2007]) and participate in aftermarket trading patterns that boost the price of the stock. For the purposes of our paper, all insiders are assumed to be participants in the laddering scheme.[4]

(2) Outsiders who are momentum traders; these investors revise their beliefs about the fundamental value of the security based on price changes.

(3) Outsiders who have rational expectations; these investors suspect that laddering might be taking place and attempt to gather information on whether price movements are due to laddering.

We assume that there are I insider traders, M outside momentum traders and N outside rational expectations traders. Each trader has a demand function $\mathcal{Q}(P, \mathbf{x})$; we use i as an index for insiders and m, n respectively as the index for the two groups of outsiders. So we have $I + M + N$ demand functions $\mathcal{Q}_i(P, \mathbf{x}), \quad i = 1, \cdots, I$, $\mathcal{Q}_m(P, \mathbf{x}), \quad m = 1, \cdots, M$ and $\mathcal{Q}_n(P, \mathbf{x}), \quad n = 1, \cdots, N$. For each sequence of prices, $P_0, \cdots, P_t$, we associate an inferred value of the parameter $\mathbf{x}(P_0, \cdots, P_t)$; we then write $\mathcal{Q}(P, \mathbf{x}(P_0, \cdots, P_t)) = \mathcal{Q}(P|P_t, \cdots, P_0)$

[4] This is an oversimplification. In reality, only some insiders may be participants in the scheme, in which case, the non-participating insiders who are not party to tie-in agreements would join the ranks of the informed investors that would act immediately to remove price inflation.

for the associated demand function. With this notation, the general properties of the demand functions can be formalized.

Assumption 2 (Properties of the Demand Functions, and Inferences)
The conditions on the demand function $\mathcal{Q}$ are summarized below:

(1) The demand functions $\mathcal{Q}(P, .)$ are decreasing in P.

(2) The demand functions $\mathcal{Q}(., \mathbf{x})$ are increasing in $\mathbf{x}$. The higher the inferred value, the larger the demand.

(3) $\mathcal{Q}(P|P_t, \cdots, P_0)$ is decreasing in P. In other words, the inferences are consistent in that higher current prices lead to lower demand irrespective of the past price sequence.

(4) $\mathcal{Q}(P, \mathbf{x})$ is convex decreasing in P for fixed $\mathbf{x}$.

(5) We assume in addition a "substitutability" between belief revisions and price increases (decreases) as stated in the next equation:

$$\text{For any two prices } P, P', \quad \mathcal{Q}(P, \mathbf{x}(P)) = \mathcal{Q}(P', \mathbf{x}_(P')) \tag{1}$$

The properties (1),(2) and (3) in the assumption above follow directly from the definition of a demand function. (4) can be derived through some restrictions on the utility function but we state it as a direct assumption.[5] (5) states the following: if the price increases (decreases) and beliefs about fundamental value increase (decrease) to a level consistent with the price, then demand does not change. Consider first a price increase. A price increase will result in a reduction of demand. Now suppose simultaneously with the price increase, there is also an increase in the beliefs about fundamental value. Then demand will increase. We need an assumption on how these two simultaneous effects offset each other. Our assumption states that if the belief rises to the level consistent with the price increase, then these two factors exactly offset each other.

[5]Suppose U denotes a trader's utility function and $\tilde{w}$ their random wealth from all other investments beside the IPO. For any sequence of observed prices $P_t, \cdots, P_0$, let $f(w, x|P_t, \cdots, P_0)$ represent the expected joint distribution of w and x (x is the wealth derived from the IPO). Then the demand for the IPO security, Q is chosen to maximize $E[U|Q] = \int_{x,w} U(w + (x - P)Q)f(w, x|P_t, \cdots, P_0)$, that is $\frac{\partial}{\partial Q}\Big(E[U|Q]\Big) = 0$. Differentiating this first-order-condition totally in P gives us the required condition on the utility function to ensure $\mathcal{Q}(P|P_t, \cdots, P_0)$ is convex in P.

If markets are commonly believed to be efficient, the last price is sufficient for all previous prices and $\mathbf{x}(P_0, \cdots, P_t) = \mathbf{x}(P_t)$. In contrast, some traders may believe that prices will sustain their momentum. In the context of our framework, we model momentum traders as those who revise their believes about fundamental value based on momentum, that is, they tend to believe that the fundamental value is likely to be higher in the future than the current price *provided that prices have been rising in the past*. In addition, these traders use price information observed up to time $t-1$; this formulation describes more accurately a market where observed prices (i.e., dealer quotes) differ from the actual price at which the order will clear. In contrast, rational expectations traders condition on all prices including time t price. This describes sophisticated traders who not only observe dealer quotes but also have information on market trends such that they are able to adjust their demand schedules on a rapid basis. As our analysis will show, laddering is only profitable in a market where (1) belief revisions are based on past momentum and (2) there is little or no private information acquisition about whether laddering has taken place or whether prices are inflated to levels unjustified by fundamentals.

We next describe the belief process of each of our three groups of investors.

Assumption 3 (Different types of investors and belief revisions)
We denote insiders by the subscript i, outsiders who are momentum traders by the subscript m and outsiders who suspect laddering by the subscript n. We write $\mathcal{Q}_j^t(P|P_t, \cdots, P_0)$ for trader j's demand (j can be either i or m) at time t.

(1) For insiders, $\mathbf{x}_i(P_0, \cdots, P_t) = \mathbf{x}(P_0) = \mathbf{x}_0$. Insiders know the true valuation parameter $\mathbf{x}_0$ and never update their beliefs about it. So their demand functions are given as $\mathcal{Q}_i^t(P, \mathbf{x}_0) = \mathcal{Q}_i^0(P, \mathbf{x}_0)$ and are time invariant.

(2) Outsiders who are momentum traders have demand functions that depend on price changes. Given a sequence of prices $P_0, \cdots, P_t$, $t \geq 2$

$$\mathcal{Q}_m^t(P, \mathbf{x}(P_0, \cdots, P_t) = \mathcal{Q}_m\left[P - (P_{t-1} - P_{t-2}), \mathbf{x}(P_0)\right] \tag{2}$$

When $t = 1$, we assume that the demand is $\mathcal{Q}_m(P_1, \mathbf{x}(P_0))$.

(3) Outsiders who are rational expectations traders have demand functions

$$\mathcal{Q}_n^t(P, \mathbf{x}(P_0, \cdots, P_t) = \begin{cases} \mathcal{Q}_n(P, \mathbf{x}(P_0)) & \text{with probability p} \\ \mathcal{Q}_n(P, \mathbf{x}(P_t)) & \text{with probability } (1 - \text{p}) \end{cases}$$

That is, with probability p, these traders discover the true fundamental value and with probability $(1-p)$ they adjust their beliefs to that consistent with the observed price and adjust their demands accordingly.

We assume that the insiders (including investment bankers) have some private beliefs about the fundamental value parameter, denoted by $\mathbf{x}_0$. This is the parameter that will define the long-term price once the initial trading restrictions and the underwriters duty to supply price support end. Consequently, they base their demands (absent laddering considerations) on the true underlying value parameter, $\mathbf{x}_0$. The momentum traders move their demand curves up and down based on past price momentum. This can be modeled in several different ways. Our choice represents momentum trading as follows: at time t the momentum trader demands the same amount at a higher price P as they would have demanded at time 0 at the lower price $P - \Delta P$ where ΔP is the momentum $P_{t-1} - P_{t-2}$. Clearly, this choice is consistent with the notion of momentum trading and is technically convenient because it parsimoniously represents a family of momentum driven demand curves. The rational expectations traders have two features: (1) they suspect that laddering takes place (or that the price is inflated) and discover it with probability p and (2) even if they fail to detect laddering (with probability $1-p$), they respond instantaneously to selling pressure by revising their beliefs downwards. The two features together ensure that rational expectations traders cannot be exploited through laddering schemes.

a. IPO pricing and overallotments

Absent other strategic considerations, the IPO price will be set to maximize the long term market value $P\mathcal{Q}(P, \mathbf{x}_0)$. However, there is a cost to issuing the IPO that is borne by the underwriters which we denote by $C(P, \mathbf{x}_0)$. $C(P, \mathbf{x}_0)$ is the cost of providing price support if the IPO price is set at P (in this formulation, we are following Qing Hao [2007] and Derrien

[2005]). In consequence, the IPO price P_0 maximizes the amount

$$P\mathcal{Q}(P, \mathbf{x}_0) - C(P, \mathbf{x}_0). \tag{3}$$

The number of shares issued, S is given by $\mathcal{Q}(P_0, \mathbf{x}_0)$. The insider's demand at this IPO price P_0, denoted by S_1, and outsider's demand, S_2, are given by:

$$S_1 = \sum_{i=1}^{I} \mathcal{Q}_i(P_0, \mathbf{x}_0); \qquad S_2 = \sum_{m=1}^{M} \mathcal{Q}_m(P_0, \mathbf{x}_0) + \sum_{n=1}^{N} \mathcal{Q}_n(P_0, \mathbf{x}_0) \tag{4}$$

At the time of the IPO ($t = 0$), shares are overalloted to insiders, that is, the shares allotted to insiders and outsiders are $S_1 + K_0$, $S_2 - K_0$. Thus K_0 denotes the level of overallotment to insiders. Insiders hold on to these extra shares and do not trade them in the initial aftermarket ($t = 1$) (see Qing Hao [2007]). This, together with the initial underpricing based on the necessity of price support, result in a price rise in the aftermarket. To summarize, the IPO process modeled here reflects underpricing to compensate underwriters for the cost of price support. In addition, overallotments to chosen clients who agree not to flip the shares minimizes price support costs for the underwriter and also leads to an additional upward pressure in the after market.

Let P^* denote the value of P that will maximize gross proceeds absent the cost (to the underwriter) of ensuring that the IPO succeeds. Then $P^* - P_0$ denotes the underpricing that is inherent in the IPO and

$$r^* = \frac{P^*}{P_0} - 1 \tag{5}$$

denotes the normal returns to issuing IPO's.[6] The question that we shall address is whether laddering will yield a greater return than r^*. That is, we assume from the outset that there are some competitive returns to participants of an IPO based on institutional and informational factors and examine whether laddering can create abnormal profits

b. Laddering

As documented in GHT [2007], the insiders step in and buy further shares so as to push up the price and convince some traders that the shares are likely to rise further in the future.

[6]If $C(P, \mathbf{x}_0)$ is an increasing positive function of P, it is easy to show that $P* > P_0$.

In our model, this event takes place at time ($t = 2$). Keeping to the empirical structure documented in GHT [2007], we assume that the ladderers have to hold their shares for some period of time (perhaps until price support is no longer needed). This is part of the initial tie-in agreement with the underwriter. In the interim period, traders may update their beliefs as to whether momentum has been caused by fundamentals or because of laddering. Traders who decide that laddering is present revise their beliefs downwards and sell (or short) the security (at $t = 3$). In turn, this affects the beliefs of other traders about whether the price momentum is upwards or downwards. Finally, the insiders dump their shares at $t = 4$. The time line is summarized below.

Time Line

t=0 IPO issued consisting of S shares at a price P_0. K_0 shares overallotted to insiders.

t=1 The outside investors trade among themselves to reach a market equilibrium price P_1.

t=2 Insiders step in and buy K_1 additional shares driving the price up to P_2.

t=3 Outside investors update beliefs and trade with each other at a price P_3. If there are no traders that suspect laddering, no trade takes place at time $t = 3$.

t=4 The price support period ends and Insiders sell their shares at a market clearing price P_4.

At time 1, the insiders do not trade. The momentum traders base their beliefs about fundamental value based on past price P_0 whereas rational expectations traders use the current price P_1. As a consequence, the market equilibrium price P_1 is given as the price that solves:

$$S_2 - K_0 = \sum_{m=1}^{M} \mathcal{Q}_m(P_1, \mathbf{x}(P_0)) + \sum_{n=1}^{N} \mathcal{Q}_n(P_1, \mathbf{x}(P_1)) \tag{6}$$

Note that we are fixing the momentum traders beliefs about fundamental values to be consistent with the IPO price. For simplicity, we shall assume that:

$$\mathbf{x}(P_0) = \mathbf{x}_0 \tag{7}$$

that is, momentum traders start with the correct initial beliefs but subsequently adjust their demand based on momentum. At time $t = 2$, insiders step in and buy an additional K_1 shares . Thus the equilibrium price P_2 solves:

$$S_2 - K_0 - K_1 = \sum_{m=1}^{M} \mathcal{Q}_m(P_2 - (P_1 - P_0), \mathbf{x}(P_0)) + \sum_{n=1}^{N} \mathcal{Q}_n(P_2, \mathbf{x}(P_2)) \tag{8}$$

At time $t = 3$, the outsiders trade with each other where some might have acquired inside information about the possibility of laddering. So P_3 solves:

$$S_2 - K_0 - K_1 = \sum_{m=1}^{M} \mathcal{Q}_m(P_3 - (P_2 - P_1), \mathbf{x}(P_0)) + \sum_{n=1}^{N} [(1-p)\mathcal{Q}_n(P_3, \mathbf{x}(P_3)) + p\mathcal{Q}_n(P_3, \mathbf{x}(P_0))] \tag{9}$$

Finally, at time $t = 4$, the insiders sell all their excess shares and revert to the (unmanipulated) optimal holdings – that is

$$S_2 = \sum_{m=1}^{M} \mathcal{Q}_m(P_4 - (P_3 - P_2), \mathbf{x}(P_0)) + \sum_{n=1}^{N} [(1-p)\mathcal{Q}_n(P_4, \mathbf{x}(P_4)) + p\mathcal{Q}_n(P_4, \mathbf{x}(P_0))] \tag{10}$$

The question we address is whether this process could possibly lead to excess profits for the insiders.

The excess profits (to all insiders) are determined as follows:

$$K_0(P_4 - P_0) + K_1(P_4 - P_2)$$

On a per-share basis, this becomes:

$$\frac{K_0(P_4 - P_0) + K_1(P_4 - P_2)}{K_1 + K_0} = \left[\frac{K_0}{K_1 + K_0}\right](P_4 - P_0) + \left[\frac{K_1}{K_1 + K_0}\right](P_4 - P_2) \tag{11}$$

The basic question we shall address is whether the quantity in Equation (11) can be positive, for then, every insider gains more than their normal IPO return by becoming a part of the laddering cabal.

The excess profit measure in equation (11) is structured to be consistent with our assumptions that the IPO offer price is set competitively and the issue is whether manipulation is possible in the *after market*. If IPO prices are set competitively, there is no reason to add the returns on the optimal (unmanipulated) holdings to the left-hand-side of Equation (11). Note that we are *not* assuming a normal return on all the "excess" shares allocated and are only assuming a normal return with respect to their unmanipulated holdings. Similarly, we are not examining potential costs that may be imposed on the ladderers as a result of refusing tie-in agreements (such as an exclusion from future IPO's conducted by the underwriter). If issuers can be forced to a low initial offer price, ladderers benefit from the initial overallocation; under such a circumstance, they would be willing to enter into laddering schemes even though they may lose money on their aftermarket purchases. But again, this need not give rise to inflated prices; the existence of information seeking traders will bring back prices to their equilibrium value levels. Again, these types of strategic collusion between the underwriter and ladderers lie outside our model. Our focus is to examine whether ladderers, acting on their own or in concert with the underwriter, can make abnormal profits *under a maintained assumption* that there is no price manipulation at the offer.

3. Results

The key theme in our formal analysis is to examine conditions when the excess profits determined in (11) has a determinate sign; that is, we examine conditions under which excess profits are positive or have to be negative. If ladderers can successfully manipulate the after market prices, then laddering is a rational equilibrium phenomenon. On the other hand, if the conditions are such that the excess profits have to be negative, then laddering is unsustainable. The main result that we establish (Proposition 3) is that the presence of traders who indulge in private information search can result in laddering becoming unsustainable.

The first result that we examine considers the benchmark situation where no traders suspect that laddering is taking place and assume instead that the manipulated prices reflect information about fundamental values. We do not believe this situation is realistic – in a Bayesian-rational market with laddering, there will be some prior beliefs that laddering is taking place. However, we start with this benchmark of no priors on laddering both because it is the situation analyzed in prior literature (Qing Hao [2007]) and because it provides a contrast with rational and efficient market behavior. Under this restrictive hypothesis, it turns out that laddering is a positive payoff strategy.

Proposition 1 (Momentum Traders and the Profitability of Laddering)

Suppose that $N = 0$, that is, that there are no outsider traders who suspect that laddering is taking place. Then ladderers earn abnormal positive profits by purchasing shares in the aftermarket.

Proof:

In this case, there is no trade at $t = 3$ so we only have an observed price sequence P_0, P_1, P_2, P_4, (or alternatively, set $P_3 = P_2$). Therefore, momentum traders have a demand function $\mathcal{Q}(P + P_2 - P_1, \mathbf{x}(P_0))$ at time $t = 4$. So the period $t = 4$ market clearing price (with $N = 0$) solves:

$$S_2 = \sum_{m=1}^{M} \mathcal{Q}_m(P_4 - (P_2 - P_1), \mathbf{x}(P_0)) \quad \Longrightarrow \quad P_4 - (P_2 - P_1) = P_0 \tag{12}$$

where the last implication follows from Equation (4). Let $\alpha = \frac{K_0}{K_1+K_0}$ and $1 - \alpha = \frac{K_1}{K_1+K_0}$. Then (11) transforms to showing that:

$$\alpha(P_4 - P_0) + (1 - \alpha)(P_4 - P_2) \geq 0 \tag{13}$$

Equivalently, substituting for $(P_4 - P_0)$ and $(P_4 - P_2)$ from Equation (12), it suffices to show:

$$\alpha(P_2 - P_1) + (1 - \alpha)(P_0 - P_1) = \alpha(P_2 - P_1) + (1 - \alpha)P_0 \geq 0 \tag{14}$$

Adding α times the demand at $t = 2$ (Equation (8))with $(1 - \alpha)$ times the demand in (4), we get:

$$\begin{aligned} \alpha \sum_{m=1}^{M} \mathcal{Q}_m(P_2 - (P_1 - P_0), \mathbf{x}(P_0)) \quad &+ \quad (1 - \alpha) \sum_{m=1}^{M} \mathcal{Q}_m(P_0, \mathbf{x}(P_0)) \\ &= \quad \alpha(S_2 - (K_0 + K_1)) + (1 - \alpha)S_2 \\ &= \quad S_2 - K_0 = \sum_{m=1}^{M} \mathcal{Q}_m(P_1, \mathbf{x}(P_0)) \end{aligned} \tag{15}$$

where the last equality follows from Equation (6). From Equation (15), convexity and the fact that $P_1 > P_0$ we get:

$$\begin{aligned} \sum_{m=1}^{M} \mathcal{Q}_m(P_1, \mathbf{x}(P_0)) \quad &= \quad \alpha \sum_{m=1}^{M} \mathcal{Q}_m(P_2 - (P_1 - P_0), \mathbf{x}(P_0)) + (1 - \alpha) \sum_{m=1}^{M} \mathcal{Q}_m(P_0, \mathbf{x}(P_0)) \\ &\geq \quad \alpha \sum_{m=1}^{M} \mathcal{Q}_m(P_2, \mathbf{x}(P_0)) + (1 - \alpha) \sum_{m=1}^{M} \mathcal{Q}_m(P_0, \mathbf{x}(P_0)) \end{aligned}$$

$$\begin{aligned} &\geq \quad \sum_{m=1}^{M} \mathcal{Q}_m(\alpha P_2 + (1-\alpha)P_0, \mathbf{x}(P_0)) \\ &\Longrightarrow \quad P_1 \leq \alpha P_2 + (1-\alpha)P_0 \end{aligned} \tag{16}$$

Rearranging, we obtain Equation (14).

□

Proposition 1 shows that with momentum traders, laddering can be a viable economic strategy. Before clarifying the intuition, we note that the price at which ladderers exit their excess holdings would, in general, lie between the inflated price P_2 and the IPO price P_0. For this reason, the sign of the expression in Equation (11) is indeterminate. However, momentum traders intensify their demand when the price rises (through laddering). Given the greater demand intensity, the price falls less when ladderers sell than it rose at the time they bought the shares. It is precisely this asymmetry, caused by a manipulation of expectations, that results in abnormal profits to laddering. In contrast, the next result shows that if demand intensity cannot be manipulated, then laddering ceases to be profitable.

The next proposition deals with the opposite benchmark to Proposition 1 in that we assume there are no momentum traders and that all traders are rational expectations traders. The beliefs of these traders is such that they assign some probability to the fact that ladderers are present and they condition their demands on the spot price rather than past prices. Obviously, if they discover that laddering has taken place, they reduce their demands driving the price downwards before the ladderers can exit the market resulting in losses. Less obviously, the fact that they respond instantaneously to selling pressure (observed through the spot price)makes them immune to laddering schemes. We summarize this basic economic point in the next lemma where we show that the demand of rational expectations traders is determined by the initial (fair) offer price.

Lemma 1 (Rational Expectation Traders demands)
For a rational expectations trader n, the demand at time t, $\mathcal{Q}_n^t(P_t|P_t,\cdots,P_0)$ is either $\mathcal{Q}_n^0(P_t,\mathbf{x}(P_0))$ (if the true value parameter $\mathbf{x}_0 = \mathbf{x}(P_0)$ is discovered) or $\mathcal{Q}_n^0(P_0,\mathbf{x}(P_0)) = \mathcal{Q}_n^t(P_t,\mathbf{x}(P_t))$ (if the parameter is not discovered).

Proof:

The assertion is obvious if trader n discovers that laddering has taken place. In contrast, if laddering is not detected, the inferred parameter $\mathbf{x}(P_t)$ is such that the demand at P_t with this belief $\mathbf{x}(P_t)$ is the same as the demand at P_0 with belief $\mathbf{x}_0$ (see Assumption 2 Equation 1). The lemma follows.

□

As might be expected based on Lemma 1, if all traders are rational expectations traders, laddering schemes fail.

Proposition 2 (Rational Expectations and the unprofitability of laddering) *Suppose that $M = 0$, that is, all outside traders are rational expectations traders. Then Laddering is unprofitable.*

Proof:

We follow the same notation as Proposition 1 and will show that the following holds:

$$\alpha(P_4 - P_0) + (1-\alpha)(P_4 - P_2) < 0$$

(where $\alpha = \frac{K_0}{K_1+K_0}$ and $1-\alpha = \frac{K_1}{K_1+K_0}$). When $M = 0$, the $t = 0$ and $t = 4$ equilibrium conditions become:

$$\begin{aligned} S_2 &= \sum_{n=1}^{N} \mathcal{Q}_n(P_0, \mathbf{x}_0) \\ S_2 &= \sum_{n=1}^{N} [(1-p)\mathcal{Q}_n(P_4, \mathbf{x}(P_4)) + p\mathcal{Q}_n(P_4, \mathbf{x}(P_0))] \end{aligned} \tag{17}$$

It follows that $P_4 \leq P_0$; for if $P_4 > P_0$, $\mathbf{x}(P_4) > \mathbf{x}(P_0)$ and:

$$\mathcal{Q}_n(P_4, \mathbf{x}(P_4)) = \mathcal{Q}_n(P_0, \mathbf{x}(P_0)); \qquad \mathcal{Q}_n(P_4, \mathbf{x}(P_0)) < \mathcal{Q}_n(P_0, \mathbf{x}(P_0))$$

where the first equality follows from Equation (1); this contradicts Equation (17). In fact, the same argument shows that $P_4 \geq P_0$, that is, $P_4 = P_0$. As $P_2 > P_1 > P_0 = P_4$ (ladderers buy shares at time $t = 2$), we conclude that $\alpha(P_4 - P_0) + (1-\alpha)(P_4 - P_2) < 0$

□

As we had observed earlier, the key issue is whether the price falls by the same level when ladderers sell as it rises when they buy. In the absence of momentum traders, this is precisely what happens, that is, when the ladderers sell their excess holdings, the price reverts to the IPO level. Hence, Laddering is not a profitable equilibrium strategy.

Our last result combines the two benchmark cases and examines what happens when there are both momentum traders and rational expectations traders. The interest in the proposition stems from the fact that the presence of some information traders is enough to create a spiraling effect that ends in laddering being unprofitable.

Proposition 3 (Laddering is unsustainable in Equilibrium)
Let N, p be such as to ensure that $P_3 \leq P_2$, that is, rational information traders who suspect that laddering has taken place, investigate the fundamental value of the security, and sell their holdings driving the $t = 3$ price below the inflated price at $t = 2$. Then the ladderers lose money in equilibrium and laddering is unsustainable.

Proof:
Under the hypothesis of this proposition, some proportion pN of traders act on their rational suspicions of laddering and discover the true fundamental value of the security, $\mathbf{x}_0$. This is below the inferred value based on the inflated price, P_2. Under these circumstances, this subset of traders reduce their holdings creating a downward pressure on prices; if this pressure is sufficient, P_3 is less than P_2. Then the market clearing price at time $t = 4$ is also lower both due to the downgrading by informed traders and due to the reduced demand of momentum traders. Specifically, if $P_3 < P_2$, then it follows that $P_4 = P_0 + (P_3 - P_2) < P_0$. The proof is now similar to Proposition 2. Because $P_4 < P_0 < P_2$, the net payoff in Equation (14) will be negative, resulting in a loss to ladderers.

□

The intuition behind Proposition 3 is a development of the ideas in Propositions 1 and 2. Specifically, the $t = 3$ price fall forces the $t = 4$ price to be lower than the IPO price. The reason is that momentum traders now shift their demand curves downwards resulting in lower demand intensity than at the time of the IPO. We have modeled the price fall at $t = 3$ to be a consequence of Bayesian rationality where at least some traders suspect that laddering might have taken place and therefore investigate the fundamentals underlying the valuation. The same result will hold as long as some traders (rational or otherwise) spend resources to gather information about the security. If the price of the security has been inflated through laddering, private information search leads to a downward trend in prices. This trend is magnified by momentum traders and the price drops significantly if the ladderers try to dispose of their excess holdings.

4. Conclusion

We investigate the feasibility of laddering in an IPO market. Earlier studies have assumed that laddering is sustainable in equilibrium and have investigated its effects on market prices. In contrast, we study whether laddering itself is economically rational. Our model features three distinct sets of traders: insiders who ladder, rational traders who are generally suspicious of price manipulation and willing to invest effort and resources to acquire information about fundamental values, and, finally, momentum traders whose beliefs are conditioned on past prices. Our findings are that laddering cannot be sustained in equilibrium unless there is a significant proportion of traders whose beliefs about fundamental value can be manipulated through strategic purchases – the momentum traders – and there do not exist information traders who have a significant effect on prices. In contrast, if there are traders that behave in a way consistent with rational expectations and remove price inflation, laddering cannot be a profitable strategy.

Our conclusions are dependent on an assumption that offer prices at IPO time are set rationally and that monopolistic (or oligopolistic) setting of issue prices is not feasible. If offer prices can be artificially lowered, then laddering becomes feasible in the limited sense that the profits made through the initial overallocation outweigh the losses made in the aftermarket. With the existence of information traders that include short-sellers, any inflation induced by laddering activities can dissipate quickly and ladderers are saddled with losses in the aftermarket. In particular, if the market for underwriting is competitive with regard to issuers, there are no abnormal returns associated with participating in the IPO. In such a setting, attempts by ladderers to profit from their ability to exploit market sentiment will fail as long as some traders in the market function in a manner consistent with the economics of rational expectations.

These results contribute to a better understanding of markets and shed some light on the recent controversy as to whether laddering takes place, and whether such laddering can be successful in yielding profits to the ladderers and underwriters such as to make it sustainable in equilibrium. Our conclusion is that if underwriters do not act as monopolists, laddering is not a sustainable activity in a semi-strong efficient market in which price – but not the history of prices – is seen as reflecting public information unbiasedly and instantaneously.

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