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| Hide and Seek Search: Why Angels Hide and Entrepreneurs Seek |
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# Abstract

Angel capital investment poses a puzzle for search theory. In the finance literature, angel investors are often described as hiding from entrepreneurs seeking angel capital investment. Hiding behaviour by "angels" forces entrepreneurs to engage in costly search for angels. In our model, high-productivity entrepreneurs have a greater value of search than low-productivity entrepreneurs. Therefore, the hiding strategy of angels may screen out low-productivity entrepreneurs who would otherwise inundate angels. Interestingly, social surplus is often increased when angels hide, though in some circumstances surplus may fall. "Hide and seek search" stands in contrast to the traditional search theory, where the search friction represents inherent physical and informational impediments to trade, as well as directed search, where inherent coordination problems generate impediments to matches.

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# INTRODUCTION

"...the search is also extremely inconvenient for the seller, entrepreneur, because angel investors prize their privacy. For good reason, they make themselves extremely difficult to find. The entrepreneur has a difficult time indeed locating investors with discretionary net worth, the inclination to subject themselves to the high levels of risk associated with this type of investment and the skills necessary to evaluate and add value to these ventures."

Benjamin and Margulis (2001 p. 15)

The informal venture capital market, or angel capital market is usually described as highly inefficient because entrepreneurs arduously search for angel investors. The difficulty for entrepreneurs in finding angels is usually attributed to a lack of information about angels and their preference for anonymity.[[2]](#footnote-2) Benjamin and Margulis (2001) reinforce this view by claiming that information about angels is simply not readily available. Furthermore, they state (see the opening quote): "For good reason they [angels] make themselves extremely difficult to find". According to Van Osnabrugge and Robinson (2000), angels would be swamped with hundreds of project proposals were information about them widely available. The implication we explore in this paper is that angels deliberately hide to avoid being swamped by low-productivity entrepreneurs. When angels hide, only high-productivity entrepreneurs find it profitable to seek them out.

Entrepreneurs seeking angels in the venture capital market appears to be a classic search story. There are scattered agents on both sides of the market who do not know much about each other. However, as the literature indicates, the search problem in the angel capital market does not spring from the standard spatial, information and coordination impediments. Rather angels face a market that is too "thick" and would rather face fewer and higher productivity entrepreneurs. Angels erect additional barriers to matching giving the appearance of a classic search environment. The additional barriers effectively induce greater search by entrepreneurs.

Is forcing greater search by entrepreneurs the best screening mechanism? In contrast to angel investors, venture capitalists are typically well-known entities in the venture capital market. Venture capitalists are usually distinguished from angels as having greater funds as well as a greater flexibility to take on and support different types of projects. They usually take on quite a few projects whereas angels usually only take on less than a handful projects at a time (Van Osnabrugge and Robinson 2000). Sometimes an entrepreneur first secures an angel investor and then, if the project is successful, subsequently both the angel and entrepreneur approach a venture capitalist to grow the business. There have been efforts to form angel consortiums and networks to screen and direct entrepreneurs (Wong, 2010). In fact a formal group of angels sometimes form a venture capital firm. However, these alternative structures are not the norm, even though they are often supported by governments. The fact that the angel capital market is as large as the venture capital market and contains many lone angels suggests that this structure fills an important role.[[3]](#footnote-3) Also, the fact that these lone angels choose to hide and force greater search on entrepreneurs suggest that hiding is a proven strategy.

In this paper, we develop a theoretical model of hide and seek search. Unlike the traditional search models, there are no natural impediments to angels seeking an entrepreneur. If angels do not hide, they can encounter entrepreneurs with certainty. Thus, the main feature of our model is that search frictions, if any, arise from *choice* (by angels), rather than technology.

Hiding is relevant in our model because there are low and high-productivity entrepreneurs. Angels would prefer to match with high-productivity entrepreneurs, but cannot identify them prior to matching and forming a firm. Hiding provides a way to screen entrepreneurs because it discourages entrepreneurs from searching. Specifically, angels could choose to hide sufficiently hard (being appropriately elusive) to discourage low-productivity entrepreneurs, while high-productivity entrepreneurs would still find it worthwhile to incur the costs of search. Interestingly, social surplus is often increased when angels choose to hide, though in some circumstances surplus may fall.

The explicit model we develop involves a matching function, similar to Pissarides (2000) except that the default of not hiding involves angels matching with probability 1. For generality we have developed the model where there are a continuum of angels. We make assumptions that result in all angels being active and we normalize their number to 1. The choice of the hiding intensity then is a collective decision for angels. However, we could also interpret the model as having only one angel, in which case the choice of hiding intensity is an individual decision. This later interpretation is consistent with the angel capital market being highly heterogeneous.

Whereas our analysis is motivated and framed in terms of the angel capital market, we believe it applies more broadly. Interestingly, the origin of the term "angel" refers to well-heeled individuals who financed Broadway theatre productions in the beginning of the 20th century.[[4]](#footnote-4) Like the angel capital market, the entertainment financing market seems to be characterized by reclusive financers trying to hide from large numbers of people with ideas of variable quality. Indeed the theme of a number of movies is about the obstacles placed in front of writers trying to find an agent to promote their work as plays and movies.[[5]](#footnote-5) Similarly, in the labour market the common practice of not postings jobs, but rather letting workers search for jobs has a hide and seek aspect.

The paper proceeds as follows. Section 2 describes the angel capital market and provides details on entrepreneurs and the angels. Section 3 examines the angel and entrepreneurs' optimization problems and market equilibrium. The efficiency of the angel capital market is examined in Section 4. Section 5 summarizes the results of the model and discusses a way to generalize of the analysis.

# The MoDeL

## **Overview**

There are two groups of risk neutral agents in the angel capital market: angels and entrepreneurs. Entrepreneurs have no capital, but each has an idea for a project that requires an upfront investment of *K*. Entrepreneurs differ in their productivity level; a mass  of the in total *E* entrepreneurs are high-productivity, while the remaining ones are low-productivity. Angels have no idea for a project, but do have the capital to fund one. They can either store their capital to earn a zero net return, or become active on the angel capital market with the intention to match with an entrepreneur and finance her project. For simplicity normalize the mass of angels to . Assume  where the upper bound  is specified later.

Angels and the entrepreneurs can only meet after searching for each other. By assumption, search is free for angels, while entrepreneurs incur a search cost  in the process. This search cost includes shoe leather cost, the costs of composing a business plan, opportunity cost, etc. By assumption the entrepreneurs’ productivity levels are unknown to angels during the search and matching process.

A Pissarides-like matching function matches searching angels with searching entrepreneurs. But a key difference is that we allow angels to choose how hard to hide (the degree of elusiveness) which directly affects its functional form. By assumption, all angels hide equally hard, i.e. the chosen level of elusiveness is the "industry standard" in the angel capital market. Consequently, the number of matches depends on three components: the mass of searching entrepreneurs, the mass of searching angels, and the level of elusiveness chosen by the angels.

The timing of actions and events is as follows:

* Stage 1: Angels choose whether to be active on the angel capital market, and, if so, how hard to hide.
* Stage 2: Entrepreneurs decide whether to search.
* Stage 3: The matching technology matches active angels with searching entrepreneurs. A successfully matched angel-entrepreneur pair will be called a firm.
* Stage 4: The return is realized and shared between the parties according to an exogenous sharing rule known to both parties.

## **FIRMS**

A firm is the outcome of an agreement to match between an entrepreneur and an angel. The firm produces a return that depends on the productivity level of the entrepreneur, if the firm is managed by a low-productivity entrepreneur and with a high-productivity entrepreneur. By assumption the productivity level of an entrepreneur is private information during the search stage and only revealed to the angel after investment takes place. Also, for simplicity, we assume that angels and entrepreneurs receive an exogenously determined fixed proportion of a firm’s return. To make the problem relevant, we will assume that the angels’ share  is large enough to make a possible match with a high-productivity entrepreneur worthwhile: [[6]](#footnote-6)

## **THE matching technology**

The matching technology has been studied at length in the labour literature. The angel capital market resembles the labour market in at least two ways. First, angels and entrepreneurs appear to engage in a search process in the same way as employers and unemployed workers in the labour market. Second, there may be traditional search frictions that characterize the angel capital market much like in the labour market, because of heterogeneity on both sides of the market combined with substantial information problems. A difference between the labour and the angel capital market is that angels often do not decide to reveal they are available to fund projects, whereas firms often do post job vacancies. Consequently, we employ a variation of the Pissarides’ matching technology used in the labour market: [[7]](#footnote-7)

  (1)

where and are parameters bounded by , and *m* is the number of matches if angels’ hiding intensity is *h*, and there are active angels and searching entrepreneurs (that is, provided we have as the number of matches cannot exceed the mass of agents on either side of the angel market).

Apart from the parameter  the matching function is completely analogous to the standard matching technology in the labour literature. All else constant, an increase in or increases the number of matches at a diminishing rate. The probability of a match for an active angel and for a searching entrepreneur denoted by and  respectively are

  (2)

  (3)

 The key feature in our analysis is the inclusion of the hiding parameter *h*,which directly affects the severity of the search friction*.* Observe from equations (2) and (3) that the harder angels hide (larger *h*), the smaller becomes the probabilities that angels and entrepreneurs will match. In the extreme angels can essentially choose to sabotage the matching process; i.e, and .

 Angels can also choose not to hide. Not hiding in some sense corresponds to Van Osnabrugge and Robinson’s (2000) claim that an angel would be swamped with hundreds of project proposals if their information becomes widely known. In our model, we assume not hiding implies a matching probability of one for angels. Assuming there are enough searching angels, i.e. , we have *m* = *a* and hence  if . Without loss of generality we restrict the analysis to  -- this corresponds to a matching probability of one for angels if all *A*=1 angels and *E* entrepreneurs decided to enter the angel market:.

# Optimization and Equilibrium

Below we examine the agents’ problems. In stage 2, entrepreneurs choose whether to search or not to search. Before that, in stage 1, angels choose hiding intensity to maximize their expected return from search. It can be shown that angels all choose to enter because a match with a high-productivity entrepreneurs delivers positive profits and angels do not face search cost: *a = A = 1*.

## **THE EnTREPRENEUR’s** **PRoblem**

The expected return from search for a high-productivity entrepreneur is given by:

  (4)

It is the difference between the expected return of the project and the search cost . A high-productivity entrepreneur chooses to search if and only if. Similarly, the expected return from search for a low-productivity entrepreneur is

  (5)

 and a low-productivity entrepreneur chooses to search if and only if .

Observe that the expected returns between the types differ only because of the different project returns. As, it follows that . Thus, if the low-productivity entrepreneurs choose to search, , then so do the high-productivity entrepreneurs, . The converse is of course not necessarily true: if high-productivity entrepreneurs choose to search,  , then low-productivity entrepreneurs may still find it unprofitable to search. This later situation occurs if the probability lies within the following bounds

 

Moreover, if  is smaller than the left-hand bound, then no entrepreneurs search; if it is greater than the right-hand side bound, then all entrepreneurs search. Taking this logic one step further, we can derive the number of searching entrepreneurs as a function of  because we learn from equation (3) that is inversely related to .

  (6)

The bounds on *h* in this equation follow trivially from equation (3) and : *hmin* has been defined such that all angels are active; is the highest hiding intensity for which all entrepreneurs choose to search; is the smallest *h* for which no low-productivity entrepreneurs choose to search; and  the greatest *h* for which all high-productivity entrepreneurs choose to search.

Figure 1 illustrates the relationship between the number of searching entrepreneurs and hiding intensity.

Figure 1: Number of searching entrepreneurs (*e*) as a function of hiding intensity (*h*)

*h*

*e*

*hE*

*EH*

*E*

*hmin*

Number of Searching Entrepreneurs (*e*)

 Hiding Intensity (*h*)

In equation (6) and Figure 1 we have assumed for convenience that . At  an angel’s matching probability is  In Section 2.1 we introduced the upper bound on the mass of entrepreneurs, and assumed is exceeded one . Defining hereby the upper bound to be  we see that .

## **the RePReSentative angel’s problem**

In stage 1, angels anticipate entrepreneurs’ entry behavior as described in equation (6). Therefore a representative angel's expected profit function is given by

  (7)

Here represents the expected profit of a match for an angel. Letting be the number of searching high-productivity entrepreneurs, we have



Note that is bounded by , where

 and 

At the lower bound  all entrepreneurs search, , and at the upper bound  only high-productivity entrepreneurs search, . Figure 2 graphs the expected profit of a match .The lower bound  obtains for , and the upper bound  obtains for .

Figure 2: Angel's matching probability (*pa*) and expected profit of a match () as a function of hiding intensity (*h*)



*h*

*pa ,*



**

*hE*

*hmin*

Matching Probability

Expected Profit of a Match

 Hiding (*h*)

The other component of expected profits is the matching probability. Figure 2 illustrates that is decreasing in. Taking the derivative of (2) with respect to yields:

  (8)

The first term on the right hand side describes the direct effect of an increase in *.* An increase in makes it more difficult for existing entrepreneurs to find angels and hence reduces the probability of an angel meeting an existing entrepreneur. This effect is negative throughout the range of *.* The second term describes the indirect effect through  as described by (6). It is non-negative as  is shown in Figure 1. An increase in  makes it more costly for the entrepreneurs to search. Over parts of the range, and , some existing entrepreneurs will cease searching. The kinks in Figure 2 correspond to this indirect effect turning on and off. In particular, the indirect effect turns off at , thus the slope of is less steep at this point.

**3.3. WHEN HIDING MAXIMIZES THE PROFITS OF ANGELS**

Figure 2 reveals that there are three candidates for the profit maximizing *.* First generates greater profits than any . Second, there is the possibility of a profit maximizing internal to the range  ; this is because payoff  is increasing in but is decreasing in . Third, generates greater profits than . The first two possibilities involve angels hiding sufficiently to discourage some entrepreneurs from searching. The third possibility is when angels do not hide. Figure 3 draws the profit function for the case where angels are best off hiding at .

Figure 3: Case when hiding maximizes the angels' expected profits

*h*

*πa*

*hE*

*hmin*

Expected Profits

 Hiding (*h*)

In the Appendix we show that over the intermediate interval the maximum profit is atwhen  (or equivalently, the low-productivity project is unprofitable ); otherwise, the maximum is at . As , we can identify the maximum by comparing the profits from hiding at  to that from not hiding at **, where . Angels are best off hiding at  if and only if , where

  (9)

Hiding occurs over the whole range of *E* when . Proposition 1 summarizes.

Proposition 1. If , then a non-empty interval  exists over which angels are best off hiding at ; if the lower bound profit is sufficiently small, , angels are best off hiding over the entire range . Otherwise*,* angels are best off not hiding at hmin.

The proof to all the propositions are found in the Appendix.[[8]](#footnote-8) Hiding at discourages low-productivity entrepreneurs from searching while not discouraging high-productivity entrepreneurs from searching. This is an optimal strategy when the expected profits in a match of all entrepreneurs searching, , is less than the expected profits in a match of just high-productivity entrepreneurs searching weighted by their proportion . Observe that  is required for . Hiding is only desirable when the proportion of high-productivity entrepreneurs is sufficiently great that it is worthwhile increasing *h* which has the negative consequence of reducing the chance of meeting a high quality entrepreneur.

# Social welfare

When does the representative angel's hiding choice maximize social surplus? To answer this question, we look at the constrained welfare optimum where the planner is constrained by the profit participation constraints of agents as well as the sharing rule *σ*. Thus, the planner only chooses *h.*

**4.1 MAXIMIZING SOCIAL SURPLUS**

Expected social surplus is simply the population weighted sum of the expected profits of angels and entrepreneurs. As before all angels receive positive profits if active and therefore participate, *a* =1. The participation decision for entrepreneurs is again given by *e(h)* as described in equation (6). Substituting *e*(*h*), the planner's problem is to choose *h* to maximize the following welfare function:

  (10)

where *m* is the number of matches given by equation (1) , and the expected social surplus in a match is given by . is bounded , where  and .

The planner's problem has many of the same features as that of the representative angel's problem because we have

.

The only difference between the planner's problem the angel's problem is that the former includes the entrepreneurs' costs of search,. These costs are drawn in Figure 4 along with the profiles for number of matches and social surplus.

 Figure 4 shows that, similar to the angel's problem, there is no internal optimum in the interval  and that again two candidates emerge as possible choices for *h.* First yields the greatest social surplus over the range . Second, yields the greatest social surplus over the range . The former implies hiding is socially optimal and the latter implies hiding is not socially optimal.

Figure 4: number of matches (*m*), expected social surplus of a match (), total search cost () as a function of hiding intensity (*h*)







*h*







*hE*

*hmin*

Number of Matches

Expected Social Welfare of a Match

Total Search Cost

 Hiding (*h*)

It is socially optimal to hide when . In the Appendix we show this requires that the number of entrepreneurs is sufficiently large:

  (11)

where. It can be shown that  if and only if the lower bound surplus is sufficiently small,  . As  , *RL* > 0, 0 < *λ* < 1, 0 < *σ* < 1 and *η* > 0 there exists combinations of parameters for which  is satisfied. As before we consider the range of *.*

*Proposition* 2. If , a non-empty interval  exists over which hiding at **maximizes social surplus, and if  it is socially optimal to hide over the entire range . Otherwise,not hiding at  is socially optimal.

 It turns out that to maximize social surplus, angels should only hide when the lower bound profit for angels is sufficiently small. This is a similar feature to the angel's profit maximizing problem. However, as we show below, there is a range of *E* where angels should not hide according to the surplus maximizing criteria.

**4.2 WHEN ANGELS SHOULD AND SHOULD NOT HIDE**

Comparing Propositions 1 and 2 reveal that there is only one case in which hiding prescriptions differ:  and . In the Appendix we show that  provided that social surplus maximization does not always involve hiding  (or, equivalently, ). We have the following proposition.

Proposition 3. Angels profit maximizing hiding behavior maximizes social surplus in all cases except one: if  and , a non-empty interval  exists over which angels hide at **but social surplus maximization involves not hiding at .

 Angels may hide over a greater range of *E* than is socially desirable. In the Appendix the source of the divergence in outcomes related to the term  which describes the average project return across all entrepreneurs. The planner hides over a shorter interval because this average return includes the surplus for low quality entrepreneurs. Other factors affect the length of the interval . For example, increasing entrepreneur's search cost, *η,* decreases the interval.

# conclusion

Search in some markets does not fit into either the traditional matching search theory (e.g. Mortensen and Pissardes (1994)) or directed search (e.g. Julien et. al. (2000), Burdett et. al. (2001)). These theories assume inherent frictions related to physical, information or coordination impediments. However in some markets the main impediment for matches is an endogenous search friction created by the hiding behavior on one side of the market. Hiding behavior induces search effort by the other side of the market and imposed search costs can hence form a screening mechanism. We have made the argument that the angel capital market is one market that is described by such hide and seek search. Angels hide to avoid being inundated by the low-productivity entrepreneurs. At the same time angels hope to be sought out and found by the high-productivity entrepreneurs. They can do this by choosing to be elusive but not too elusive. In this way, only high-productivity entrepreneurs enter the search, as they are the only ones that generate sufficient surplus to compensate for the higher search cost.

In this paper, we model hide and seek behavior in the context of our leading example of the angel capital market. By choosing how hard to hide, angels change a parameter of the standard labor-search matching technology. In our model angels can ensure complete matching by not hiding, while hiding results in incomplete matching. Angels only hide to discourage low-quality entrepreneurs when an encounter would result into a negative profit. We also examine when angels profit-maximizing hiding choice maximizes social surplus. If angels are best off not to hide then not hiding also maximizes social surplus. However, depending on parameters, the choice to hide may be to the detriment of social surplus.

Our hide and seek model is kept simple. For example, we have not included hiding costs. If hiding costs were positive then the parameter space over which hiding would be optimal for angels and the planner would be smaller. With prohibitive hiding costs, angels would never hide. We have set our model so that no hiding corresponds to complete matching. We did this deliberately to underscore our main point that search maybe induced, rather than a result of technology. However, in a more general Pissarides type model, zero hiding might well correspond to incomplete matching, and we could model negative hiding similar to advertising as in Pissarides (2000, Chapter 5). More generally, there could be costs to both hiding and advertising and depending on parameters agents might take different hiding and advertising strategies. We leave these and other extensions of our hide and seek search framework to future research.

# 6. Appendix

## **6.1 Proof of Proposition 1**

Recall that *pa* > 0 and we assumed that . Thus,  and all angels choose to be active *a=A=*1. Substituting for *pa* from (2) and *e(h)* from (6) into  gives the unconstrained representative angel’s profit maximization problem.



For  profit is declining in *h* so that *hmin* gives the greatest profit. As *hmin* corresponds to *pa* = 1, ** and the corresponding profit is .

 Similarly, for  profit is declining in *h* so that gives the greatest profit. As **corresponds the smallest value of *h* that gives *e = EH .*We find and

 

Over the intermediate interval the change in expected profits depends the lower bound profits (or equivalently, on the sign of ): if , then expected profits are weakly increasing in *h* and the maximum is at ; if , then expected profits are decreasing and the maximum is at *hE*. As profits at *hmin* exceeds profits at *hE* the problem reduces to comparing profits at *hmin* to .

Angels are best off hiding if and only if . Substituting for profits from above gives the lower bound  in (9). As we have restricted , angels are best off hiding if and only if . As described in the text, this interval is non-empty if and only if. Otherwise, angels are best off not hiding at *hmin*. ▀

## **6.2 Proof of Proposition 2**

The social welfare function is given by (10). The planner's problem is as follows:



For  social welfare is declining in *h* so that ** gives the greatest social welfare. The corresponding social welfare is given by . Similarly, for  profit is declining in *h* so that gives the greatest social surplus. The corresponding social welfare is given by 

In the interval  the social surplus is increasing in *h* if  , constant if  and decreasing if . Thus, as in Proof of Proposition 1, finding the social maximization *h* reduces to comparing social welfare at *hmin* to  .

Hiding is social optimal if and only if . Substituting in the above welfare values gives the lower bound  in (11). As we restrict , social surplus maximization involves angels hiding when .

 Finally, we show that  if and only if . Substituting from (11) gives

 

The inequality implies and substituting for  gives . ▀

## **6.3 Proof of Proposition 3**

The hiding behavior of angels is social suboptimal when



whenever and . Ignoring the lower bound values of 1 gives the unconstrained difference



Substituting for  gives the following inequality





As  implies, it can simplify to , which is a true statement. This completes the proof. ▀

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2. See, for example, Wetzel (1987), Harrison and Mason (1992), and Freear, Sohl and Wetzel (1994). [↑](#footnote-ref-2)
3. Angel investing is an important source of funds for entrepreneurs. Riding (2008) finds that there are about 15,800 angels investing at least $1.9 billion annually in the entrepreneurial firms in Canada. In contrast, venture capital firms invest less than half that amount, at about $870 million annually. See Shane (2008) for similar information on the US Angel Capital Market. Madill, Haines, and Riding (2005) note that business angel investors not only constitute an important source of financing, they also provide significant non-financial inputs to the growth and viability of the firms through, among other things, mentoring their industry experience and contacts. In this paper, we abstract from the other roles angel investors might play in startup firms. [↑](#footnote-ref-3)
4. See e.g. Benjamin and Margulis (2001). However Wetzel (1983) was a pioneer in employing the term “angel” to describe individuals who provide their own capital to support entrepreneurial ventures. [↑](#footnote-ref-4)
5. Some movies include *The Lonely Lady*, *The Player*, *French Exit*, and *Pitch*. This still seems to be the case Meyers (2009). Similarly, Orrell (2010) describes the difficulty for authors in finding and landing a literary agent to help them find a publisher. [↑](#footnote-ref-5)
6. Our results do not depend on so-called variable bargaining power. See Engineer and Shi (1998, 2001) for a discussion of how variable bargaining power can generate new results in search models.   [↑](#footnote-ref-6)
7. More generally we could have formulated the matching function  whereand . Our explicit form *f*(*h*) = 1/*h* satisfies this requirement.  [↑](#footnote-ref-7)
8. There exists combinations of parameters for which condition  is satisfied as we have assumed  , *RL* > 0, 0 < *λ* < 1, 0 < *σ* < 1 and *η* > 0. It can be shown that Proposition 1 extends to the case where the lower bound is non-positive,  Here condition applies so that angels always hide at and only high-productivity entrepreneurs search. Thus, angel profit is positive and all angels are active. Conversely, observe that if we cannot have an equilibrium where angels do not hide because then all entrepreneurs search and angels would incur negative profits. [↑](#footnote-ref-8)