The Search for Information

Lecture 5: Stigler's Rational Search Model of the Demand for Information

(U. Bayreuth, Spring 2006)

Last week we explored Friedrich von Hayek's analysis of the importance of information heterogeneity for economic policy in particular and social welfare in general. This week we look at more modest effort to analyze the economic effects of imperfect information by another Nobel Prize winner, George Stigler, whose famous paper on the "Economics of Information" appeared 16 years after Hayek's piece, in 1961.

> "One should hardly have to tell academicians that information is a valuable resource: knowledge is power. And yet it occupies a slum dwelling in the town of economics. Mostly it is ignored: the best technology is assumed to be known, the relationship of commodities to consumer preferences is a datum. And one of the information producing industries is treated with a hostility that economists normally reserve for tariffs or monopolists."
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> "Ignorance is like subzero weather: by a significant expenditure its effects upon people can be kept within tolerable or even comfortable bounds, but it would be wholly uneconomical entirely to eliminate all its effects. And, just as an analysis of man's shelter and apparel would be somewhat incomplete if cold weather is ignored, so also our understanding of economic life will be incomplete if we do not systematically take account of the cold winds of ignorance."
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> (Stilger, G. J. (1961)

Stigler's classic paper on the economics of information addresses a narrower problem than that addressed by Hayek, despite of his broad introductory and concluding remarks. Namely, Stigler focuses on the demand and supply of price information, rather than information in general.

I. Introduction

A. The advantage of such a modest analysis is that both the nature of the information and the benefits received are clear.

B. Moreover, the problem itself is important, because "price theory" is often regarded to be the heart of modern micro economics.

i. By shedding light on how imperfect information affects market prices, Stigler addresses a potentially very important determinant of prices.

ii. And, his analysis can (and has been) extended to other cases in which "search" is a useful way to think about the demand for information.

- Stigler extends his analysis to learning the identities (or locations) of specific sellers of products.
- A series of *voluntary* unemployment models were developed in the 1970's and 80's. In these models, unemployment is simply a cost-effective method of searching for better employment opportunities.

C. On the other hand, Stigler's search-based representation of the demand for information captures only one of the many ways in which imperfect information affects market outcomes.

II. Rational Choice and the Demand for Price Information

A. The setting of search models is one in which the searcher already knows a good deal about what one is looking for.

i. For example, when a person searches for the best price of a particular good or service, the missing bit of information is simply a real number.

- The nature of the good (say an I-pod) is already well understood as is its value to the consumer.

ii. The nature of the information that might be acquired is also well understood as is its value to the consumer.

- A lower price allows consumers to spend money on other valued goods and services.

B. The effect of price search in the Stigler model is to reduce the variation in prices that exists in the market of interest.

i. Although Stigler does not spend much time linking his work to Hayek's idea that prices themselves provide information, it is clear that the quality of the information provided increases as the variation in prices diminishes.

ii. Thus, "Stiglerian" search tends to increase the efficiency of the "Hayekian" informational efficiency of markets.

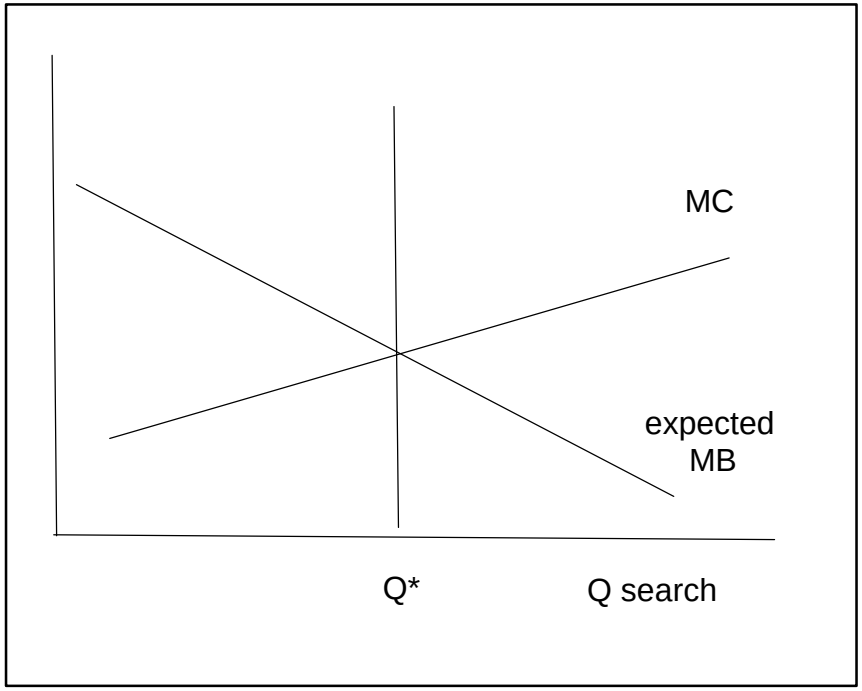
C. Stigler's price search model can be represented as follows:

i. The expected price that an individual pays for the good falls with the extent of his or her search for the best price.

- This is an implication of sampling theory. If ten numbers are placed in a hat, the minimum number found in a sample of N is (in expected value terms) smaller than the minimum of a sample of N-1.
- Thus, the larger the sample, the lower is the expected price.
- However, there tends to be **diminishing marginal returns** to sampling. The expected reduction in price (marginal benefit of additional search) tends to fall as the sample size increases.

ii. The cost of searching for information is the opportunity cost of spending time looking for prices in shops, newspapers or on the internet.

- In some cases, the cost may involve purchases of information, as when one hires someone to do the searching for you, or purchases data sets, etc. .



- Geometrically, the demand for information about a given purchase can be represented very simply, as illustrated above.
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iii. To imbed the choice into a standard consumer choice model is somewhat more complex, but simply involves making a consumer's expected prices a declining function of search time or sample size.

D. Mathematical Illustration

i. Suppose that a consumer, Al, has a Cobb-Douglas utility function defined over goods N and M: $U = M^{a}N^{(1-a)}$ and has W dollars to spend on these two goods, with $0 < a < 1$..

ii. A somewhat unusual property of Cobb-Douglas utility functions is that the consumers will divide up expenditures across the two goods according to the size of the exponents *a* and *(1-a)*, for example if $a=0.5$, this consumer would spend the same amount of money on each good.

- In this case, $M^* = W/2P_M$ and $N^* = W/2P_N$
- Which implies that the consumer's utility is: $U = (W/2P_M)^{0.5} (W/2P_N)^{0.5}$

iii. [Demonstration of the above, for those who are interested.]

- Maximize $U = M^{a}N^{(1-a)}$ subject to budget constraint $W = P_M M + P_N N$
- Note that the budget constraint implies that $M = (W-P_N N)/P_M$
- So we can simplify the problem to a one dimensional optimization problem by substituting for M which yields:
- $U = [(W-P_N N)/P_M]^{a} N^{(1-a)}$
- Differentiating with respect to N (the only control variable in this representation of U) yields: $[a (-P_N/P_M)] [(W-P_N N)/P_M]^{a-1} N^{(1-a)} + (1-a)[(W-P_N N)/P_M]^{a} N^{(-a)} = 0$ at N^*
- which looks difficult but can be simplified:
- subtracting the first term from both sides:
- $[a (P_N/P_M)] [(W-P_N N)/P_M]^{a-1} N^{(1-a)} = (1-a)[(W-P_N N)/P_M]^{a} N^{(-a)}$
- multiplying both sides by $[(W-P_N N)/P_M]^{1-a} N^{-a}$
- yields $[a (P_N/P_M)] N = (1-a)[(W-P_N N)/P_M]$
- and then by P_M yields $[a P_N] N = (1-a)[W-P_N N]$
- gathering the Ns yields $(a) P_N N + (1-a) P_N N = (1-a)[W]$
- which is just $P_N N = (1-a)[W]$

- so $N^* = (1-a)W/P_N$
- and in the case where a = 1/2 this implies that $N^* = W/2P_N$
- $M^* = aW/P_M$ can be obtained by substituting N* into the budget constraint.

iv. Incomplete price information can be easily incorporated into this model by assuming that the price of M is given, but the expected price of N falls with expenditures on search, S.

- Expenditures on S reduce the amount of money left over to spend on the goods to W - S, but reduces the price of good N.
- In this case, the consumer's expected utility is: $U^e = [(W-S)/2P_M]^{0.5} [(W-S)/2P_N]^{0.5}$
- or $U^e = (1/2) [W-S] [P_M P_N]^{-0.5}$

v. The utility maximizing degree of search can be found by differentiating U^e with respect to S and setting the derivative equal to zero.

- $(1/2) [-1] [P_M P_N]^{-0.5} - (1/4) [W-S] [P_M P_N]^{-1.5} (dP_N/ dS) = 0$ at S*
- The first term is the (subjective) marginal cost of search generated by spending "S" on search and thereby the reducing the consumption of both goods.
- The second term is the expected marginal benefit of search from reduced prices paid for N.

vi. Without knowing the rate at which prices fall with search we cannot determine an exact solution, but the implicit function theorem implies that S* can be represented as a function of the other model parameters:

- $S^* = s (W, P_M)$
- This can be regarded as Al's demand for information function.
- It is clear that the faster the price of N is expected to fall, and the more money one expects to spend on N, the more searching makes economics senses for the consumer.
- The implicit function differentiation rule can be used to determine the comparative statics of the demand function: e.g. whether demand for information increases or decreases with an increase in income (W).
- which is $\{- (1/4) [P_M P_N]^{-1.5} (dP_N/ dS)\} / \{soc\} > 0$ at S*
- (For those who are interested in the mathematics behind this see my lecture notes from mathematical economics: http://rdc1.net/class/MathEcon/ec630lc4.pdf)

III. The Supply of Price and Location Information

A. Stigler also models a firm's interest in supplying price information to consumers through advertisements.

B. In the case, of a monopolist, this is relatively straight-forward.

i. By improving the price information of consumers, expected sales and sales revenues will increase insofar as it reduces the expected price of the product (or reduces the risk) associated with shopping for it.

ii. A similar argument can be applied to other "imperfect" market structures in which firms face downward sloping demand curves.

C. Similarly, firms may advertise to inform consumers of their existence (as with signs, newspaper adds, tv adds, and websites).

i. Again the relevant consideration is how much additional revenue is generated by providing this information to consumers.

ii. This depends partly on the size of the market and the cost of the information transmission mechanism.

D. As price information becomes more widely available, clearly buyers tend to converge on firms that provide the best prices (other things being equal) and the high price firms either lower their prices or diminishing in importance.

- In this manner, the variation in prices tends to decrease with all the parameters that affect the supply and demand of information.
- Stigler provides some "information" about the effect in his paper. He notes that items which are both expensive and routinely purchased tend to have less price variation than products that are rarely purchased and/or relatively inexpensive.

E. In the end, Stigler argues that **the market for information is much like any other market**.

i. There are suppliers and demanders, and implicitly market clearing prices for information (prices for adds in newspapers, links on googols website, etc.).

ii. The market clearing quantity of information, thus, reflects cost and demand considerations.

- Relatively more valuable information will be in relatively great supply.
- Reductions in the cost of search or information transmission tends to increase the information available and reduce price dispersion.
- (For example, the internet should have relatively obvious and important effects on price variation and information flows.)

IV. Applications and Limitations of the Search Model

A. There are a reasonably broad range of circumstances in which the search characterization of information is a very useful one.

- That is to say there are lots of cases in which we demand specific information about something we already know a good deal generally about.
- In addition to prices and location, one might include the weather, the quality of "typical commodities" (ice cream, pizza, bicycles, etc.), and some basic factual information (names, dates etc.).
- We often know that such information exists and also know quite a bit about the "values" that the specific unknown bits of information are likely to take.
- (That is to say, we may have a fairly good idea of the probability function defined over the specific unknown values, as we know the values on a typical dice.)

B. However, it is clear that this is not always the case that one knows so much about the information they are seeking.

- In many cases we search for something "new" (unfamiliar and unknown) rather than something "old" (known and familiar).
- This is one reason that stores have shop windows and displays--to inform us about products we may not be familiar with (as well as their prices).

C. This dichotomy is also commonplace in science as well, as within normal science we may know a good deal about what we are likely to find with a given experiment, but not in new areas of research.