Lecture # 3 -- Market Failures

I. The Invisible Hand

- A key reason why science and technology policy deserves our attention is that it often involves market failures. Today we'll look at the types of market failures that occur in science and technology.
- First, however, we look at how the market should function when working properly.
    - Adam Smith's idea of an "Invisible Hand": a free market of individuals acting in their own self interest leads to a socially desirable result.
- Why does this occur?
    - Demand = Marginal Benefit (MB) that consumers receive from an additional unit of the good.
        - That is, it tells us how much they are willing to pay for the good.
    - Supply = Marginal Cost (MC) of production
        - That is, how much firms will sell the good for.
    - In equilibrium, P = MB = MC
        - No further beneficial transactions are possible.
        - Note importance of marginal analysis
- If we are not at the equilibrium, there is a welfare cost. This is the deadweight loss.
- The above analysis assumes that all costs and benefits are known and accounted for by each actor in the economy.
    - If they are, and there is perfect competition, the free market will provide an efficient solution.
    - When marginal private benefits do not equal marginal social benefits, or marginal private costs do not equal marginal social costs, there is a market failure. The efficient outcome is not reached.
    - Note that a market failure is when the social and private values differ, so that the market is unable to provide an efficient solution.
    - In the case of knowledge, market failures result in MSB >MPB.

II. Market Failures in Knowledge

- Three generic sources of market failure. Each affects knowledge.
    1. Indivisibilities
        - Motivation: economics depends on MC = MB. Ideally, P = MB to consumers = MC.
        - However, when goods can not be divided into small units, such MC pricing might not be possible.
        - Application to knowledge:
            - Knowledge is discrete. Thus, it cannot be sold in small units.
            - Knowledge requires large fixed costs (R&D). Thus, MC < AC

        - As a result, the price must be high enough to cover fixed costs.
        - Efficiency requires P = MC. However, in this case, P = MC => P < AC, and the firm loses money.
        - Example: drug companies claim they need to sell their products at high prices to cover fixed costs of research. Generics don't have this fixed cost, and so can sell for less.
2. Uncertainty
    - NOTE: It isn't uncertainty itself that is a market failure. Markets can rationally adjust for risk aversion.
    - However, there are market failures with how markets deal with uncertainty.
    - The key market failure here is moral hazard.
        - Moral hazard results from imperfect monitoring.
        - Since research often is unsuccessful, managers cannot tell if a project is unsuccessful because of the nature of the research or because of a lack of effort from the researcher.
        - Also makes it difficult to develop insurance markets for R&D
3. Public goods
    - Knowledge is a public good. This is the most important of the market failures.
    - Public goods are goods that can benefit everyone, and from which no one can be excluded.
    - Public goods have two key characteristics:
    - Non-rival – one person's enjoyment or consumption of the good does not prevent others from using it.
        - Knowledge is not in short supply. One person using an idea does not preclude others from using the idea.
    - Non-excludable – people cannot be prevented from using the good.
        - Thus, it is difficult to collect money for the good.
        - Non-excludability leads to the free rider problem:
            - A free rider is a consumer or producer that benefits from the actions of others without paying.
    - The public goods problem is related to the problem of positive externalities.
        - An externality is an activity of one entity that affects the welfare of another and is not reflected in market prices.
        - As a result of positive externalities, too little research is done.

III. Flows of Knowledge in the Economy

- Before considering how firms can (or cannot) capture the benefits of technology, we first discussed examples of how knowledge flows through the economy.
- Knowledge spillovers are involuntary flows of knowledge between sectors. They are examples of positive externalities.
    - Note that they are involuntary to the inventor. They are not necessarily involuntary to the recipient of the spillover.
    - Knowledge spillovers occur when an idea gives rise to new inventions in other sectors.
        - In contrast, if new knowledge is embodied in a firm's product, the price of that product should reflect, at least in part, the benefits of the technology.
            - Embodied knowledge: knowledge that is part of a product sold by the firm.
            - Disembodied knowledge: knowledge that spills over.
- Channels of knowledge flows
    - Publications and presentations
    - Human capital
        - For example, workers who change jobs may take knowledge from the first firm with them.
    - Reverse engineering
- Note that many of these channels are ones in which appropriating the knowledge would be difficult.
- The *Research Policy* article by Cappelli *et al*. provides examples of knowledge spillovers.
    - Potential sources of spillovers examined
        - Spillovers between firms
            - Imitation
        - Information from customers
            - May reduce risk associated with introducing new products
        - Information from suppliers
            - May result in process innovation or in improving design of an existing product
        - Spillovers from research institutions
            - Act as an input to innovation
    - *Research question*: do spillovers lead to the development of new and/or improved products?
        - Consider both innovation (e.g. new products) and imitation (e.g. developing or improving upon a competitors existing product)
    - Data
        - Use 2003 survey of firms from the Mannheim Innovation Panel
            - Annual innovation survey done by the Center for European Economic Research (ZEW)
            - 2003 survey includes questions on spillovers

        - Firms were asked to indicate spillovers indispensable to the development of a product or process
        - Asked about each of the four sources above
        - Have a 0/1 dummy variable indicating a spillover for each
        - Dependent variable separates new innovation from imitation
            - Sales with products newly introduced to the market between 2000-2002
            - Sales with products that were on the market before but new to the firm between 2000-2002 (e.g. imitation)
    - Empirical model:
        - Sales(new or imitated) = f(Spillovers, R&D Intensityt-1, R&D Intensity2t-1, Industry R&Dt-1, Other controls)
        - When possible, lagged explanatory variables used. The goal is to determine causality. For example, does higher employment lead to the development of a new product, or is higher employment needed to respond to increased demand for a new product?
    - Key results
        - Which spillovers matter?
            - Spillovers from customers and research institutions matter for new products
                - Consistent with the idea that university research is a building block for firm innovation
                - Customers provide information on market potential for new products
                - This can be used for developing new products demanded by consumers
            - Spillovers from other firms matter for imitation only
                - Using information about existing products in the market
                - Given the definition of the dependent variable, it would be difficult to get spillovers from competitors for new innovation
            - A firm's own R&D matters, but there are diminishing returns
                - Diminishing returns captured by the squared term for R&D intensity
            - Previous patents matter for creating new innovations
                - Suggest the ability of the firm matters
                - Authors say importance of patents may provide some protection from imitation
                    - Firms with capability to innovate have patents to protect them from some imitation

IV. Appropriating the Returns to R&D

- Market failures in knowledge exist because firms are unable to capture all the benefits to society from their innovation.
- Thus, it is important to ask how firms are able appropriate benefits from R&D, to see why they aren't able to capture all the benefits.
    - This will help us to think about how to correct the market failures.
- Methods of appropriating knowledge
    - Patents
        - Provide firms with temporary monopolies for their inventions.
        - The tradeoff is that the inventor makes the information public.
    - Secrecy
        - Firms can keep new ideas secret.
        - More likely to be successful for process innovations than product innovations. How do you keep a new product secret?
    - Lead time
        - Being the first to bring a product to market at least provides a temporary monopoly.
        - If network externalities are present, lead time can provide the advantage of having complementary products developed for your product.
    - Learning curve advantages
        - Similar to lead time. If firms use knowledge more effectively as they gain experience, the first firm to come up with an idea will be the most effective user.
    - Sales or marketing efforts
    - Licensing/contracts
        - Note that these depend on other methods as well. For other firms to be willing to license your new knowledge, they must not be able to get it elsewhere.
- What determines the effectiveness of various methods?
    - Effectiveness of legal enforcement systems
        - Firms are more likely to use patents when they are likely to be enforced by courts.
    - The nature of technology itself
        - Some knowledge (business ideas, engineering know-how) may be difficult to patent.
    - Barriers to entry in the market
        - When there are few firms in an industry, it is easier to keep new ideas secret.
    - Ease of transmitting the knowledge embodied in an invention
        - Is it tacit or codified?
        - Tacit knowledge may be embodied in human capital of workers.

V. Private vs. Social Rates of Return

- The paper by Mansfield *et al*. (1977) provides empirical evidence of the divergence between private and social rates of return.
- Measuring the rate of return
    - The innovations in the paper all lower costs
    - The measure of social rate of return has two features:
        1. Additional consumer surplus due to lower prices
        2. Resource costs savings because MC < P
            - The difference is economic rent that goes to the innovator.
- Methodology
    - Survey of business firms in the Northeast
        - Had firms pick a recent innovation at random and provide information.
    - Gathered data on these innovations, such as prices, sales, and R&D effort.
    - When possible, got data on unsuccessful R&D.
        - However, for most innovations, few competitors were doing similar innovations, so firm's R&D good measure of society's R&D on the product.
    - Three types of innovations:
        - Product innovations used by firms
        - Product innovations used by households
        - Process innovations
    - Used internal rate of return to calculate ROR
        - Internal Rate of Return – the discount rate that would make a project's net present value equal zero.
- Results
    - Median social rate of return: 56%
    - Median private rate of return: 25%
        - Note that this value is still high. A typical rate of return for a firm investment would be around 7-10%. Mansfield *et al*. argue that this value is higher because of the risk associated with R&D.
        - Large deviation in values is evidence of risk.
            - Private ROR below 10% for 6 innovations, and above 40% for 5.
            - In 30% of the cases, private ROR so low that firms would not have made the investment with perfect foresight.
                - Nonetheless, in each case, social ROR makes it worthwhile.
    - Explaining the gap between social and private ROR:
        - Using regression results (p. 235-238), they find that the gap is larger:
            - for more important innovations, and
            - when the cost of imitation is low.