Innovation and Growth with Financial, and Other, Frictions: A Proposal by Randall Wright, University of Wisconsin & NBER

It is commonly understood that the generation and implementation of *ideas*, or *knowledge*, is crucial for economic performance and growth, and that financial institutions play a role. I study this process in a formal model of endogenous growth. Productivity increases with knowledge, and knowledge increases with research and development. I model the decisions of agents to try to come up with, and implement, new ideas. Since some agents are better than others at implementation, I explicitly model the exchange of ideas, or *technology transfer*. I use tools that I developed in search theory and monetary economics to derive new insights into these issues. What makes the research novel is that my idea market incorporates several explicit frictions, including search, bargaining and commitment problems. These frictions make it hard to find the right people to develop projects, and they impede credit arrangements, hindering the advance of knowledge. Financial intermediation ameliorates these frictions, and thus enhances growth.

I am interested in both the generation of ideas, and their reallocation from innovators to those with comparative advantage in implementation – say, from academics to entrepreneurs. On the former issue, I study how we can achieve a socially optimal level of innovative activity – given that knowledge is a public good, what policies provide the right incentives for innovation and development? On the latter issue, I believe the idea market is a thin market, where agents are not generally price takers. Search-and-bargaining theory is exactly the right way to model this. In my 2010 paper, "Search and the Market for Ideas" (J. Economic Theory 145, 1550-73), we modeled technology transfer using these methods. The techniques work well, and I am currently applying them to venture capital (VC) markets in work with Linda Wong, who has access to a rich VC data set, and am working with other coauthors to develop growth models using this approach.

Modern monetary theory, as summarized in my 2010 chapter with Steve Williamson in the *Handbook of Monetary Economics*, is ideal for studying these issues, as it is all about exchange in the presence of frictions like those in the idea market. Coming up with innovations involves fixed costs that cannot be recouped, due to holdup problems in bargaining, leading to inefficiently low innovative activity. There is also the basic matching problem of getting innovators with good ideas together with the right entrepreneurs. And there are financial frictions that make it difficult to pay for ideas – e.g., it is hard to sell knowledge on credit, since, if the buyer reneges, it is hard to take it back, depending on intellectual property rights and related factors. Hence, it can be important to think about *liquidity* in the idea market, with assets being used either as a means of payment or as collateral, and to model institutions that help get liquid assets to those that need them most to facilitate technology transfer.

To sketch my framework, individual producers have access to the frontier technology Z, which

is in the public domain, but they can also try to innovate and increase their own productivity z. Increases in z raise profits in the short run, while knowledge spills into the public domain in the longer run (how long is a key issue). In the simplest case, an innovator i with an idea tries to develop it on his own, and succeeds with probability σ_i, capturing the quality of the match between an idea and i's expertise. Each innovation advances individual z by some amount, and this aggregates to move the frontier Z. I can prove the model has a balanced-growth equilibrium, where the growth rate depends on the number of innovators, their success probabilities, the distance by which individual innovations affect knowledge, and the way this moves the frontier. But this benchmark is only a stepping stone toward the more interesting case, where innovators do not necessarily implement ideas on their own, but may trade them.

This activity is described in terms of the following trade-off: When innovators come up with new ideas, should they try to implement them themselves? Or should they try to trade them to others, say entrepreneurs, who may be better at development, marketing and related activities? If agents are heterogeneous in their ability to come up with ideas and to extract their returns, it makes sense for some to specialize in research and others in development. I model this occupational choice – how many agents become innovators and how many go into project development. Given this specialization, the exchange of ideas leads to a more efficient use of resources and increases the incentive to innovate.[1] Again, financial intermediation affects growth generally by facilitating the redirection of resources from less to more productive uses. Here the resources in question are ideas.

Direct technology transfers are but one mechanism by which innovators and entrepreneurs interact to share knowledge and develop ideas. Other mechanisms, including VC and other partnerships, will be studied down the road, but for now I focus on situations where an innovator wants to sell his idea outright. One advantage of this is that it allows him to get back to the drawing board in an effort to come up with more new ideas, which is his specialty, rather than getting tied up in the development stage. It also avoids strategic problems with joint implementation. I plan to study these points more in the context of explicit growth theories. For now, I am concentrating on liquidity, bringing to bear my expertise in monetary economics. This determines the ability of entrepreneurs to pay up front, which is important, given knowledge is hard to collateralize. This is where financial intermediaries can help. I will model all of this explicitly.

[1] As Katz and Shapiro (1986) put it "Inventor-founded startups are often second-best, as innovators do not have the entrepreneurial skills to commercialize new ideas." *The Economist* (2005) reports "As the patent system has evolved, it ... leads to a degree of specialization that makes business more efficient. Patents are transferable assets, and by the early 20th century they had made it possible to separate the person who makes an invention from the one who commercializes it. This recognized the fact that someone who is good at coming up with ideas is not necessarily the best person to bring these ideas to market." Lamoreaux and Sokoloff (1999) say "The growth of the U.S. economy over the nineteenth century was characterized by a sharp acceleration of the rate of inventive activity and a dramatic rise in the relative importance of highly specialized inventors as generators of new knowledge."