TNIT newsletter

Toulouse Network for Information Technology

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Dear Readers

After a long silence, here is a new issue of the TNIT Newsletter. We hope that you will enjoy it. We have an interview with TNIT member Suzanne Scotchmer, who discusses her research on Intellectual Property; a piece by IDEI researcher Paul Seabright who discusses the economics of scarce attention, an extremely important topic in this age where more information is available than we are able to pay attention to; and a "How to" article by Glenn Ellison, who uses his research on student achievement to shed light on how more students could be induced to study IT.

Please do not hesitate to tell us what you think. If you want to add something to one of these articles or to express a disagreement, send us your thoughts - we could be interested in publishing them.

Jacques Crémer

CONTENT

The network is now managed by Jacques Crémer (jacques@cremeronline.com) and Yassine Lefouili (yassine.lefouili@tse-fr.eu) who has replaced Astrid Hopfensitz. Do not hesitate to contact us if you have any questions.

The Toulouse Network for Information Technology (TNIT) is a research network funded by Microsoft and managed by the Institut d'Economie Industrielle. It aims at stimulating world-class research in the Economics of Information Technology, Intellectual Property, Software Security, Liability, and Related Topics.

http://idei.fr/tnit/index.html

INSTITUT D'ÉCONOMIE INDUSTRIELLE

Toulouse School of Economics

Interview with **Suzanne Scotchmer**

TNIT: How did you begin working on intellectual property and R&D? What do you find particularly interesting/challenging in this field?

SS: I was appointed to the Berkeley faculty in 1986, in the midst of the biotechnology revolution. Disputes over intellectual property rights were in the newspapers daily, mostly involving the breadth of rights, patentable subject matter, and the problems that erupt when science proceeds in its natural way, with each discovery building on others.

There was a chasm between the way economists had conceptualized R&D and how it plays out in the lives of scientists and engineers: economists had mostly considered innovations in isolation. Thinking of innovation as a cumulative process led me to realize the contradiction between rapid technological change, which often occurs through rapid turnover in the market, and rewarding innovators, which requires enough longevity to recover costs. It was a puzzle to figure out how intellectual property rights can be structured to resolve this contradiction. I was hooked!

TNIT: You began life as a theorist. Is there any connection between your life as a theorist and your current interest in innovation?

SS: My work on R&D has deepened my interest in economic theory, and vice versa.

Economic theory has two large branches. General equilibrium theory studies how interrelated markets clear in anonymous interactions. Game theory studies strategic behavior where interactions are not anonymous, and where agents' strategies affect each other directly rather than through prices. Game theory and general equilibrium theory have not been unified in any grand unified theory. Nowhere is this more apparent than in the R&D context, which, in my view, has not been adequately integrated into either branch of economic theory.

Innovation does not fit into traditional models of general equilibrium because those models do not accommodate the introduction of new products or of cost-reducing innovations. Endogenous growth theory has made some strides, but only with a sterile stylization of the incentive problem that, in my view, is neither descriptive nor prescriptive.

Game theory, especially mechanism design, is the more natural tool for constructing theories of R&D incentives. However, mechanism design must begin from a well posed problem. In posing the problem, it seems to me that the most vexing and interesting aspect of the R&D problem is lost. For instance, to design an optimal patent system we should try to model the objectives of the legislators and all the constraints that they face when trying to influence the innovation process. An impossible task.

TNIT: Can you be more precise about the main difficulties in conducting this analysis. What are the most interesting questions?

SS: Innovation has two parts. Before there can be an investment in R&D, there must be an idea of what to invest in. The important first step, which economists have not much contemplated, is to understand where investment opportunities themselves come from. Once the investment problem is articulated, then the problem becomes "well posed", and traditional tools of mechanism design can be applied to find the best incentive mechanism.

Traditional questions that mechanism design is well suited to are, for example: Which firm can offer the lowest cost? Which of several firms can offer the highest quality innovation? How do we know whether the innovation is worth its R&D cost?

How should the efforts of several simultaneous contributors be coordinated? Should rewards be given as prizes? Patents? Contract payments? What should rewards be contingent on?

For me, the most interesting question is “where do investment opportunities come from? ” rather than “how do we give incentives to invest once the opportunity is realized? ” Think for a moment about Mark Zuckerberg and Facebook. Would it have been possible to design an incentive mechanism to encourage the spark of the idea of Facebook? The essential step was the act of imagination that led to it, not the investment in server farms that reified it. Economists have no theory of imagination, and hence no theory for how to stimulate imagination.

TNIT: Many studies of R&D conclude that investments in R&D have a greater rate of return than investments in ordinary capital, such as plants and equipment. Why would that be so? Shouldn’t firms therefore invest more in R&D, and less in physical capital?

SS: My own interpretation is not that firms are irrational or short sighted, but rather that they don’t know what to invest in. All economics is about scarcity. In R&D, it is not the resources that are scarce as much as the imagination that is scarce. The high rates of return are not returns to resource investment, but rather to the scarcity of investment opportunities. It is imagination that is scarce.

Neither branch of economic theory has addressed the problem of stimulating imagination. By starting with a well posed problem, game theory suppresses the act of imagination, and general equilibrium theory either does not accommodate the introduction of new knowledge or takes the investment opportunities as given.

TNIT: You recently worked on open-source collaboration. How do you think this will change the way we write papers ?

SS: Academic life at its best has always been “open source.” We are free to use the work of others with appropriate attribution, and we must return the privilege. Perhaps that is why academics find open source so congenial.

TNIT: Some of your co-authors are law scholars. How would you convince a young economist about the benefits of collaborating with lawyers?

SS: The most precious asset for a young scholar is a good problem to work on. Lawyers and judges, as opposed to academics, deal with hard problems not of their choosing. This forces them to work on important, new problems. The Microsoft and Google antitrust disputes are good examples. These firms fell into conflict with the competition authorities largely because neither the relevant market theories nor the right competition policies had been worked out. Their disputes continue to be a fertile ground for new thinking in economics.

TNIT: And now some quick opposites. Touch Type or Secretary?

SS: I am waiting for a direct digital line from my brain to yours.

TNIT: Facebook, or address book?

SS: I lose one and get lost in the other.

TNIT: JSTOR or paper copies in library?

SS: Where is the library?

TNIT: Coffee or mineral water?

SS: Do they put caffeine in mineral water?

TNIT: Twitter or not?

SS: Do I really have that much to say? *(Answer from the editors of the Newsletter: yes, you do!)*

TNIT: And finally, any plans for a new book?

SS: Yes, of course, don’t we all?

Why didn't we see it coming?

A perspective from neuroscience

by Paul Seabright

One of the more unusual recent contributions to the economics literature is a letter beginning "Madam" and later addressing its recipient at several points as "Your Majesty". In late 2008 Queen Elizabeth II visited the London School of Economics and asked TNIT member Luis Garicano why no-one had seen the financial crisis coming. Evidently no-one had seen the Queen's question coming either, which is why the British Academy convened a conference in June 2009 and in July wrote the monarch a letter of explanation. The letter included the observation that "Risk management was considered an important part of financial markets. One of our major banks, now mainly in public ownership, reputedly had 4000 risk managers. But the difficulty was seeing the risk to the system as a whole rather than to any specific financial instrument or loan. Risk calculations were most often confined to slices of financial activity, using some of the best mathematical minds in our country and abroad. But they frequently lost sight of the bigger picture."

The question why and how attention to detail prevents us from grasping the bigger picture is one on which the neuroscience of attention might be able to cast some light. In September 2011 Luis was one of a number of participants at a workshop in Toulouse on "The Psychology and Economics of Scarce Attention", which brought together economists, neuroscientists and social psychologists. An excellent summary of the conference has been written by Diane Coyle. In addition to presentations by economists, several fascinating presentations by neuroscientists looked at the way in which the brain allocates attention to different aspects of our perceptual space. Among the important points to emerge:

1) The impression most of us have that we "see" a complete visual field, albeit more finely at the centre than at the edges, is an illusion. Our actual perception is subject to many gaps, but our subjective consciousness "fills in" these gaps to create the impression of seeing the whole picture.

2) We can normally detect changes in the periphery of our visual field, but the sensitivity of our change detectors can sometimes fail us: either when too many changes occur at once, or when changes occur very gradually, even if their cumulative impact is large.

3) The selectivity of our attention allocation means we can sometimes fail to see developments of first-order importance. Examples manipulated by experimenters include subjects who, after a brief disruption, fail to notice that they are talking to a completely different person; subjects who fail to see a person in a gorilla suit arrive among a group of basketball players because the subjects are too focused on counting the passes among the players; and subjects who fail to notice that the background color of a scene has changed over ten seconds or so from green to red. Examples from everyday life include pilots who fail to see other aircraft on a runway and drivers who fail to see other cars, even when these are apparently "right in front of them".

4) The allocation of attention by the brain does not appear, superficially at least, to be a process that much resembles the way economists would think of the allocation of a scarce resource. It appears instead to emerge out of a bottom-up process of competition among lower-level perceptual neurons for influence on higher-level processing capacities in the brain.

There was much discussion at the workshop about whether this bottom-up competition among neurons might have any features in common with economic competition, and indeed whether it might have any kind of optimality properties due to the outcome of natural selection. It's fair to say that the economists present were keener on the analogy than the neuroscientists. Indeed, one economist participant expressed it this way: *"I don't agree that the economics approach is all that different - you think we're different but we don't think we are."*

There was also much discussion about whether the kinds of selective attention phenomenon studied by neuroscientists could illuminate our inability to see financial crises coming. Many of the neuroscientists were also skeptical, because of the relative timescales: their experiments show attention blindness and change blindness over a period of seconds, while economists are worried about why we might fail to pay attention to financial crises developing over a much longer period. A pilot failing to see another plane on the runway didn't seem to involve the same kind of mechanism as a central banker or financial regulator failing to see a problem of excessive leverage in the banking system. A central banker or regulator would have, after all, much longer in which to make observations and to put right any initial failure to spot potential dangers.

However, here is a fascinating article about the crash of the Air France flight 447 from Rio to Paris in 2009 which appears to have relevance to both phenomena. Be warned it makes uncomfortable reading if you're planning to travel by air any time soon.

What it describes is the way a disaster can unfold over a period longer than a few seconds - nearly half an hour, in fact - in spite of the fact that individuals are trying very hard to focus on what is going wrong; nevertheless they can fail to see the cause of the problem that is right in front of them. They can also fail to react to very clear auditory warnings using what should be a standard trained response to such warnings. In this sense the phenomenon appears to indicate that something like what the neuroscientists have showed experimentally can persist even when the time scale is extended from a few seconds to something at least two orders of magnitude longer. The reasons for this reveal some interesting parallels with what may have happened in the financial crisis: notably confusions over who was responsible for what, with an associated tendency to assume that others were taking care of key steps in the safety procedure, blindness to some risks (in this case the risk of stalling) because of a belief that the automatic safety systems were more foolproof than they really were. The very impressiveness of the autopilot under normal conditions may have made this particular risk harder to see coming. The reader will easily be able to find many other parallels to the situation we all find ourselves in every day: too much information and not (yet?) the right IT to help us make sense of and prioritize it.

Finally, an intriguing recent book *Sleights of Mind* by two neuroscientists Stephen Macknik and Susana Martinez Conde with science journalist Sandra Blakeslee addresses the way in which professional magicians systematically exploit the weaknesses of our selective attention allocation to persuade us that the impossible has happened. If magicians, whose earnings rarely exceed more than a small fraction of those of financial traders, are able to fool intelligent observers through manipulating their selective attention, it doesn't seem far-fetched to suppose that some participants in financial markets may have done something similar with regulators. Certainly, the time scales are different. The collective failure of regulators, central bankers and the economics profession to see the financial crisis coming may not have been solely an accident; many of the financial world's greatest magicians had staked a lot of money on just such an outcome. And maybe some websites can direct your attention to one side of the page, and put the warnings about the use of your personal data where you are less likely to see them.

news

We promise that you will not have to wait too long for the next Newsletter: it should come out in June and will be a special issue featuring recent research by TNIT members.

Some of you might be interested in the NSF call for proposals on cybersecurity, which can be found at **http://1.usa.gov/JZRFm5.** It explicitly calls for proposals from "Social, Behavioral and Economics" perspectives.

As many of you already know, once every two years the IDEI organizes a very successful conference on the **"Economics of Intellectual Property, Software and the Internet".** The next one will take place on **January 10 and 11, 2013.**

You should receive a call for paper shortly but mark your calendars! Links to past conferences can be found at **http://idei.fr/display.php?**pv=1007.

How can we convince more students to become IT engineers?

by Glenn Ellison

"I know we all want the U.S. to continue to be the world's center for innovation. But our position is at risk. There are many reasons for this but two stand out. First, U.S. companies face a severe shortfall of scientists and engineers with expertise to develop the next generation of breakthroughs."

Bill GATES, Congressional Testimony, March 12, 2008.

Commentators have for years decried the U.S.'s failure to produce more IT engineers. The recent economic slowdown has drawn the problem into sharper relief as high tech firms continue to lament the difficulty of finding qualified workers even as so many are unemployed.

Persistent "shortages" of workers willing to take seemingly attractive jobs is at odds with standard economic models of occupation choice. In the early 1980's Fiorito and Daufenbach empirically analyzed the supply side of the supply-demand equilibrium by examining students' choices of college majors. They found some evidence that students react to labor market conditions, but found even stronger evidence that the decision to enter a scientific field is correlated with students' high school math test scores. Weinberger's study of 1980 high school graduates contains striking statistic along these lines: 30% of the white males who scored highest on a 32 question math test went on to obtain a college degree in a math, science or engineering, whereas only about 1% of the students who achieved an average score did so.

The thought that a key to producing IT engineers is to produce high-achieving high math students in high school (or earlier) is challenging for the U.S.: the U.S. fares very poorly on international assessments. For example, on the 2009 PISA math test administered to 15-year-olds, the U.S.'s average score ranked 25th out of 29 OECD countries. These rankings are rankings of average test scores, but the U.S.'s disappointing performance in secondary school math also extends to the upper tail. Only 1.8% of U.S. students scored in the highest category on the 2009 PISA test. The average OECD country had 3.1% of students in this category. And the city of Shanghai had more than 26% of its students at this level!

One could look to successful foreign school systems for ideas for how to improve math education in the U.S., but it is hard to know whether it is features of a school system (as opposed to the culture or other factors) that primarily account for a country's superior performance. And even if some feature of the school system is important, it is hard to know whether adopting that feature would work in the U.S. Looking for models that are working well at particular schools in the U.S. may be a more fruitful way to find models that could be adopted to improve U.S. performance.

Most of the education literature focuses on average student performance or on failure rates on proficiency tests. But the policies and curricula that most benefit students who are struggling with math could be very different from the policies that will induce more talented math students to reach high achievement levels. This motivates Ashley Swanson and my studies of how high schools do in producing high-achieving math students.

Our analysis uses data from the American Mathematics Competitions: a series of contests offered in about 3000 U.S. high schools. Different schools produce high-achieving students at very different rates. Some of the differences are aligned with demographics: more high scoring students are found in areas with more highly educated parents, fewer low-income students, and more Asian Americans. But we also find that there are large differences among schools with seemingly similar demographics. This contrasts with some of the existing literature on average test scores, which reports, for example, that differences in average SAT scores across schools are more aligned with demographic differences.

Looking at the form of the heterogeneity we find both that there are a large number of schools that rarely produce any high-achieving student and that there is a small but significant number of schools that produce many, many more high-achieving students than the typical school with similar demographics. This suggests there are two avenues by which the U.S. might be able to substantially increase its production of high-achieving math students. One could target schools that rarely produce high-achieving math students to try to help bring them up to the average. And one could examine the practices of the schools that produce many high-achieving students to gain insights into what might be done to make other schools similarly successful. We look forward to seeing future research on these topics.

The long-run shortage of IT engineers is just one of many motivations for improving the U.S. educational system. Our conclusion that many potential high-achievers are not now realizing the potential that they would have realized in other similarly-situated schools is disappointing, but we see it as hopeful as well: it suggests that improving education in a way that bolsters the IT sector may not be as difficult as many of the other challenges in education reform.

Jack FIORITO and Robert C. DAUFFENBACH (1982), *"Market and Nonmarket Influences on Curriculum Choice by College Students,"* Industrial and Labor Relations Review 36: 88-101.

Catherine J. WEINBERGER (2005), *"Is the Science and Engineering Workforce Drawn from the Far Upper Tail of the Math Ability Distribution?,"* working paper, University of California, Santa Barbara.

Glenn ELLISON and Ashley SWANSON (2011), *"Heterogeneity in High Math Achievement Across Schools: Evidence from the American Mathematics Competitions,"* working paper, MIT.