FINAL (?) DRAFT NOT FOR QUOTATION

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> "It turns out that even American radiologists, with their years of training and annual salaries of $250,000 or more, worry about their jobs moving to countries with lower wages, in much the same way that garment knitters, blast-furnace operators and data-entry clerks do. Radiology may just be the start of patient care performed overseas."
>
> -The New York Times "Who ís Reading Your X-Ray?" (Pollack, 2003)

Offshoring and Radiology

by Frank Levy and Ari Goelman[1]

Introduction

The quote above appeared when offshoring was rapidly entering public consciousness. The author had chosen a dramatic example. At the time, economists argued that while technology made the offshoring of some work inevitable, the U.S. could still prosper with a sufficiently educated workforce. But skilled software jobs were already being offshored (Thurm 2004), and if offshoring could threaten the work of radiologists, an occupation requiring 8-10 years of post-college education, the economists' argument appeared suspect.

In this note, we argue that the situation of U.S. radiologists remains quite different from that of U.S. software engineers and other professionals whose jobs are being offshored. Media stories notwithstanding, only a tiny number of radiological images now are read by a medical equivalent of cheap foreign labor. However, these stories have a

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kernel of truth; it has become technically feasible to receive and interpret radiology images from a distance. The current lack of offshoring reflects current economic, social and regulatory conditions as much as immutable technical constraints. While low cost offshore radiology reads now occur only rarely, the horizon is less clear.

The differences between radiology and software programming begin with the cognitive structure of the radiologist's work that makes it particularly time-consuming to monitor. Because work quality is hard to monitor, a U.S. doctor who refers an image to an unfamiliar radiologist relies heavily on the radiologist's credentials, in particular their U.S. board certification. One could imagine international agreements that allowed radiologists credentialed in one country to practice in another. In fact, no such agreements exist with respect to radiologists practicing in the U.S., a reflection, in part, of U.S. doctors' group power.

U.S. radiologists' power to restrict foreign competition is reinforced by malpractice insurance, Medicare reimbursement regulations and, in all likelihood, by consumer preference. Software professionals have few of these protections and so face strong foreign competition. Conversely, these same factors do little to protect radiologists against other U.S. medical specialties and inter-specialty competition to read images is sometimes quite intense.

We tell the story of offshore diagnostic radiology[2] in five brief sections. We begin by sketching a cognitive framework to describe the jobs (of any kind) that are most easily offshored. We then situate the radiologist's job in this framework. Next, we describe the economic conditions and regulatory factors that define the current U.S. market for

[2] Radiology has several sub-specialties. A diagnostic radiologist reads images and typically does not deal directly with patients. An interventional radiologist both reads images and performs procedures on patients – e.g. the image-guided insertion of a stent – and so their work is not at issue here.

radiologists. In the fourth section, we describe the nighthawk radiology industry, the industry that handles most offshored U.S. radiology reads. We close by speculating how some parts of offshore radiology might come to resemble the offshoring described in the opening quote and the implications of such a shift for the cost of medical care.

Offshoring in Cognitive Terms

Last year, Levy and Richard J. Murnane (2004) argued that there were broad similarities between the work most vulnerable to offshoring and the work most vulnerable to computer substitution. Their argument can be summarized as follows:

> All workplace tasks involve processing information: an engineer reading a report, a chef tasting a sauce, a farmer looking to the sky to check for rain, and so on. The tasks most vulnerable to computer substitution are those where the information processing can be described in rules. When a task can be fully described in rules, it can be programmed for a computer. When significant parts of a task can be described in rules, it is vulnerable to offshoring since it can be assigned to offshore producers with reduced risk of miscommunication and lower costs of monitoring. When a task's rules cannot be articulated - when the task involves extensive tacit knowledge - neither computerization nor offshoring are readily available alternatives.[3]

The rules to which the argument refers can be either deductive or inductive. Deductive rules arise from the logical structure of the process - for example, the rules that describe issuing an airline boarding pass in a self-service kiosk ("Does this credit card number match a number in the reservation data base? Yes/No"). This kind of information processing is often described as Rules-Based Logic.

Inductive rules - a more complicated situation - typically refer to the equations of probits, neural nets and other statistical models whose parameters are estimated on "training samples" of data before the model is put into use. Familiar examples include

[3] See also, Autor, Levy and Murnane (2003). A second characteristic required for computerization is that the information being processed can be digitized. For simplicity, we do not discuss that characteristic here.

models estimated on credit card purchase histories to flag the possibility of fraud and speech recognition software for a personal computer that must be trained by the user before it is used. This kind of information processing is usually described as Pattern Recognition.

We will use the term Pure Pattern Recognition to describe information processing that is too complex - at least for the moment - to construct even inductive rules. Tasks based on Pure Pattern Recognition arise at both the high and low end of the skill distribution. It is hard to infer the rules involved in writing a convincing legal brief. It is equally hard to infer the rules a janitor uses to convert a two-dimensional array of photons on his retina into a three dimensional understanding of an unfamiliar room. From a cognitive perspective, Pure Pattern Recognition also rests on rules but the rules are too deeply

FIGURE 1

VARITIES OF INFORMATION PROCESSING

Increasingly Hard to Program or Offshore

Conscious Application Of Deductive Rules (Rules-Based Logic)	Application of Deductive Rules (Pattern Recognition)	Rules Cannot be Articulated (Pure Pattern Recognition)
Examples		
Issuing an Airline Boarding Pass	Speech Recognition, Cancerous Cell Cluster Recognition in Mammograms	Writing a Legal Brief, Making Visual Sense of an Unfamiliar Room

embedded to articulate. Figure 1 illustrates this typology.

Within this framework, the same structure that makes a task easier to computerize often makes the task easier to send offshore. A computer executes rules: a task cannot be computerized without instructions for every contingency (including, in the case of the boarding pass kiosk, "Unable to Process Your Request - See Desk Agent"). Similarly, when a firm assigns a task to an offshore contractor, the transaction is much simpler when the firm can specify, step by step, how the task is to be done. The absence of such instructions risks quality problems and complicates the assignment of responsibility in the case of errors. Alternatively, the absence of instructions requires a higher level of contractor skill.

Multiple examples illustrate this computer-offshoring overlap. Call center work is subsumed by speech recognition software and call center work is sent offshore using operator-read scripts (a kind of rule). Doctors' dictated case notes are sent offshore for transcription but speech recognition software is subsuming that work too. Production of Boeing aircraft modules is sent offshore using digitized machine tool instructions[4] while other production jobs are lost in this country to assembly line robots. Basic tax preparation is sent to offshore accountants (who use the tax code's rules) while other tax preparation work is done by TurboTax and TaxCut software.

As other countries gain in expertise (i.e. tacit knowledge), the need for fully specified rules will decline. Offshored software work is an example of this transition, an occupation that involves tacit knowledge but rests on the rules of programming languages. In the near term, however, the rules-based nature of both computerized and

[4] The machine tool instructions come from the computer assisted design software on which the aircraft was designed. See Levy and Murnane, op. cit., Chapter 3 for further discussion.

offshore work is a reasonable characterization.

Where Radiology Reads Fit In

In contrast to these examples, reading most radiological images is Pure Pattern Recognition – work that so far defies easy characterization in rules. Several U.S. centers work on computer assisted diagnostic (CAD) software to scan radiological images for abnormal patterns. [5] To date, only two applications have received approval from the Food and Drug Administration: software to scan mammograms for potentially cancerous cell clusters and software to scan lung images for cancerous nodules.[6] A third application – scanning virtual colonoscopies for polyps – is on the horizon. Most other images are currently too complex to infer the underlying rules. This is not surprising. An abdominal scan CT can reveal many different abnormalities and even normal abdominal scans vary significantly among individuals. MRI's are particularly complicated.

In organizational terms, the radiologist is usually the agent of the referring doctor who ordered the scan. In this situation the absence of articulated rules can create a serious agency problem. For the sake of the patient and to minimize malpractice issues, the referring doctor has to be confident that a radiologist reads images correctly. The problem is not limited to radiologists many miles away. As a surgeon in a large Boston area hospital told us:

> When I get night call from "Bob" or "Jim" (the supervising radiologists in the emergency room) and they say I have to come in to operate, I come right in. When I get a night call from a radiology resident and they say I have to come in, I want much more information. I've been burned too many times by residents misreading a film. (personal communication, April 2005).

[5] For example, the Kurt Rossmann Laboratory at the University of Chicago Medical School. Note that the radiologist must both recognize an abnormal pattern (which is what the software does) and identify the abnormality, a potentially harder job.

[6] One developer of such software is R2 Technologies in Santa Clara, CA. at http://www.r2tech.com.

Not all doctors face a surgeon's decisions but learning to trust a radiologist 9,000 miles away - a relationship with no face-to-face contact – is a potentially significant problem. Since the task is not defined by rules, the problem's current solution is to rely heavily on the radiologist's qualifications. The radiologist must be U.S. board certified, which, in turn requires they have done their residency in an approved U.S. program.[7] The radiologist must also be licensed in the state and accredited in the hospital in which the images were generated. As with most professional standards, these standards simultaneously address quality and limit competition.

The U.S. Radiologist Market

U.S. trained radiologists face a very tight market for their services. The website Salary.Com reports a median cash compensation for diagnostic radiologists of $276,000 and 75'th percentile compensation $330,000. The *RSNA News,* a publication of the Radiological Society of North America, reports that median 2003 compensation for a diagnostic radiologist in a group practice was $346,000. Radiologists' income has also increased faster than the income of many other doctors. In a particularly stark comparison, radiologists reported real annual increases of 9.1% in their income between 1998 and 2000, compared to general internal medicine physicians who saw a real annual decrease of 1.3% (Kane and Loeblich 2003).

This tight market reflects both supply and demand factors. In classical cobweb fashion, today's limited supply of radiologists has its roots in the mid 1990s when the federal government capped the number of supported radiology residency positions. At that time, the number of radiological residents was relatively low as medical students

[7] But residency does not require having attended a U.S. medical school, a point we return to below.

perceived a weak job market for radiologists and federal policy was being designed around the primacy of the family practitioner (Grumbach, 2002).

While it was unclear then, multiple factors were beginning to expand demand for radiologists' services. Continued improvements in scanning equipment increased both the regions of the body that could be scanned and the number of images produced in a given case. One doctor notes that 15 years ago, a CT scan could produce 20 "slices" (cross-sectional body images) in 10-15 minutes. Today, a CT scan can turn out several hundred slices of similar resolution in less than a minute producing "a flood data to analyze." (personal communication, July 2004). As Goelman (2005) describes, imaging also became more important to diagnosis, in part due to concerns of malpractice liability. A final factor in increased demand for radiologists' services was the rapidly expanding supply of scanning equipment. After brief governmental attempts to ration equipment purchases – the "certificate of need" programs - many community hospitals now have the kinds of advanced equipment that used to be found only in regional medical centers. Several doctors have suggested to us that this increased access and convenience tilt the referring doctor's decision toward ordering a scan.

In the 1990s, the software industry responded to a skill shortage by using H1B visas to import foreign labor. The U.S. healthcare system pursues a highly restricted version of the same strategy. Each year, U.S. hospitals hire more residents than the number of students who graduate from U.S. medical schools. The system makes up the difference by hiring foreign-educated medical students who have passed a series of U.S. certification exams (Mullan 2002,) Once through residency, these students are eligible to take U.S. board certification exams with the result that one quarter of the physicians currently practicing in the United States received their medical training elsewhere in the world

(Mullan 2003). While the cap on funded residency slots means that the increment of foreign students is more limited than previously, Mullan estimates that every year 5000 out of 100,000 first year residents are foreign medical school graduates (Mullan 2002). From the perspective of offshore radiology, interviews conducted in India by our colleague Kyoung-Hee Yu[8] indicate that the market for U.S. board certified radiologists in India is tight largely because many Indian students who have received U.S. board certification choose to remain in the U.S..

Board certification itself points to the overriding difference between doctors and software professionals: U.S. doctors have a professional dominance (Friedson, 1970) in which doctors themselves are allowed to determine who qualifies as a doctor – a power that software professionals, call center operators and production workers do not have. As noted above, radiologists reading images generated in the United States must be board certified, licensed in the particular state and credentialed at the specific hospital at which they practice. While radiologists, like other doctors, detest malpractice litigation, fear of that litigation helps to enforce these requirements. A doctor who must defend his treatment in court does not want to explain why he referred an image to an uncertified or unlicensed radiologist.

"Outsourcing" and "Offshoring" of Radiology Reads

Given these strict limits on who can read images, the economics of outsourced radiology involves not cheap labor, but economies of scale. Outsourced reads are sent to "nighthawk" radiology services, services provided by a large hospital or a private nighthawk firm. The typical client for nighthawk services is a small private radiology practice at a hospital with an emergency room that generates several images a night

[8] Kyoung-Hee Yu is a PhD Candidate in MIT's Sloan School of Management.

requiring immediate reads. A small private practice cannot afford a fulltime night radiologist to read half a dozen images. Putting a daytime radiologist on night call – potentially waking him/her up at 3:00 in the morning - risks errors, reduces the number of the more remunerative day shifts they can work, and makes the practice a less desirable place to work at a time when the radiology market is very tight. In this situation, sending images to a nighthawk service is an attractive alternative. The nighthawk service, in turn, keeps its rates competitive by consolidating the work generated by multiple hospitals to keep its radiologists busy for the duration of their shifts.

Among the providers of nighthawk services, the large hospitals are all located in the United States. The nighthawk firms are all headquartered in the United States, but many locate their radiologists at offshore sites including Sydney, Bangalore, Tel Aviv and Barcelona. These remote locations allow radiologists to work daytime schedules as they read U.S. images generated at night. As one provider's website says, "When it's the middle of the night in Boston, it's daytime down under."[9]

To our knowledge, all nighthawk firms (and all hospitals) employ U.S. board certified and licensed radiologists. This is partially in order to reassure potential clients who might be concerned about quality, but once again, malpractice insurance plays a role. A referring practice would be cautious about sending images to a nighthawk firm that did not carry malpractice insurance and a nighthawk firm cannot currently purchase malpractice insurance unless it can prove it uses board certified and licensed radiologists. Kyoung-Hee Yu's interviews identified occasional stories of "ghost reads" where individual U.S. doctors send films to non-certified radiologists abroad and then sign the

[9] http://www.nighthawkrad.net/

reads themselves. These examples appear to be rare in part because of the significant financial risk they entail.

The first radiologist firms that focused solely on remote night time readings opened in 2001. In the subsequent four years these firms have grown rapidly, with the leading firms currently reading images from roughly 1000 hospitals, almost 20% of the 5764 hospitals registered with the American Hospital Association in 2003 (Goelman 2005). Given the recent inception of the market, it is unsurprising that the precise number of firms continues to fluctuate but three firms now divide the majority of the market.

Despite using board certified radiologists, nighthawk services chiefly perform what are called "wet" or preliminary reads. These wet reads inform the treatment the emergency room patient is given that night. Then, on the following morning, the referred images are given a second read - a "dry" read – by a staff radiologist at the referring practice who signs off on the report. The two-read system reflects both quality control and regulatory considerations including the fact that Medicare will not reimburse medical procedures done outside the United States (another reason why U.S. doctors put their own names on "ghost reads").[10] In addition, it assuages the fear among the referring practice that they might lose control over their practice (Goelman 2005).

Regulatory barriers aside, the supply of qualified Indian radiologists is uncertain. Kyoung-Hee Yu has collected indirect evidence on this point by assessing to what extent Indian radiologists are supplying radiology services to countries other than the U.S. She reports that as of now, Indian firms are starting to negotiate entrance into the British market and have been invited to begin discussions with Singapore. It is unclear how fast these activities can expand before running into supply constraints.

Given this situation, U.S. radiologists are wary of foreign radiologists but, contrary to the opening *New York Times* quote, they currently do not see offshoring as their main competitive threat. [11] That honor goes to members of other U.S. medical specialties – cardiologists who want to read heart images, obstetricians/gynecologists who want to read ultrasound images and so on. Since this competition comes from certified and licensed U.S. physicians, neither existing professional requirements nor malpractice fears offer radiologists much protection.

An example of these turf battles starts with the recent statement of Mark Miller, Executive Director of MedPAC, before the House Ways and Means Committee (Miller, March 2005). In the statement, Miller asks Congress to tighten the standards by which Medicare reimburses physicians for interpreting images – a tightening that would favor radiologists. Miller's statement was quickly challenged by Michael Wolk, President of the American College of Cardiology, who told his membership:

> Radiology leadership is directly challenging our ability to use the best and latest technology to care for our patients in our offices and in the hospitals in which we work."[12]

Radiologists argue that these turf battles reflect a basic asymmetry. As they see it, radiologists' patients are referred by other doctors. Other specialists who install scanning equipment in their offices can self-refer. Total imaging expenditures are now on a par with pharmaceuticals as drivers of rising medical expenditures (Stein 2003) and many radiologists believe, perhaps incorrectly, that much of the growth reflects self-referrals

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[10] This restriction was adopted a number of years ago to guard against, for example, people going to Mexico or Canada for treatment.

[11] For example, a principal web site for radiologists, www. AuntMinnie.com, holds an annual poll to choose "The Minnies" denoting the leading people and events in the field. In 2004, competition from foreign doctors was neither the first nor second ranked "biggest threat to radiology". (It had been ranked second in the semi-final voting). The Minnie for biggest threat went to **"**Increased use of medical imaging by physicians in other specialties (turf battles)", discussed later in this section. See http://www.auntminnie.com/index.asp?Sec=nws&Sub=rad&pag=dis&ItemId=63476.

done by other doctors to increase income (e.g. Thorpe et. al. 2004). The MedPAC statement reflects radiologists' attempt to avoid restrictions that are triggered by rising imaging costs. But recent evidence suggests that some radiologists have discovered how to self-refer as well by offering "discounts" (i.e. kickbacks) to doctors who refer patients to them (Armstrong, 2005). We return to this issue below.

The Future of Offshore Radiology

How will offshore radiology evolve? A speculative answer begins by first reviewing how radiologists are paid. The insurance reimbursement for a scan typically involves two pieces. The Professional Fee covers the radiologist's interpretation. The Technical Fee covers the cost of the scanning equipment, the technologist who operates the equipment and so on. For example, the current Medicare schedule reimburses a Chest X-Ray (frontal and lateral) for $43.78 of which the Professional Fee is $12.36 (28%). A CT-Scan of the Spine including a contrast agent receives reimbursement of $424.49 of which the Professional Fee is $68.92 (16%). An MRI of the Spinal Canal with contrast agent is reimbursed at $785.16 of which the Professional Fee is XXXX (14%). The modest reimbursement per read translate into large radiology incomes in part because a private practice radiologist (one who does not teach or do research) can read in excess of 11,000 or 12,000 images per year.

From an insurer's perspective, the cost of interpretation is a relatively small share of the scan's total cost, particularly for the more expensive CT or MRI. Correspondingly, an insurer seeking to control aggregate imaging costs would likely focus on limiting the number of scans through benefits management before they would consider mechanisms for hiring cheaper radiologists.

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[12]As reported in Tracie L. Thompson, March 10, 2005. See also. Thompson, March 17, 2005.

Ironically, it is doctors themselves – both non-radiologists and radiologists- who may have the greater incentives to explore offshore radiology. The apparent contradiction arises because doctors often own their own scanning equipment and so collect Technical Fees regardless of who interprets the image.

At one extreme some self-referring specialists (non-radiologists) described above may recognize they are billing for images that they cannot accurately interpret and may turn to non-board certified foreign radiologists for assistance.

At the other extreme, some radiology practices may openly work to certify offshore radiologists to handle low profit work. Today, for example, Medicare reimburses $101.65 for a screening mammogram including a Professional Fee of $39.61. For many private practices, this fee makes the screening mammogram a loss leader – a frequently requested scan that can displace more profitable work but must be offered as part of a full array of services. More precisely, the large volume of *normal* screening mammograms is a loss leader: abnormal screening mammograms can lead to additional scans that can generate a profit. In this situation, many U.S. radiologists might welcome a mechanism that would triage the normal scans, allowing the radiologist to focus on the abnormalities.

Such triage may be plausible. While the resolution of a mammogram image is lower than, say, that of a CT abdominal scan, a mammogram is scanned for only a limited number of abnormalities. This helps explain why mammograms are one of the two kinds of images receiving FDA approval for computerized scanning. As one radiologist suggested, it is possible to imagine a private offshore firm that offers to screen mammograms twice – once by an offshore radiologist and again by computerized scanning – flagging those mammograms that show any sign of abnormality. The arrangement would require a significant institutional shift beginning with certification for

foreign radiologists to read U.S. mammograms that would be coordinated with U.S. malpractice insurance. Given the status of radiologists however, this scenario is one the easier offshoring scenarios to imagine

Conclusion

In the first stories describing the offshoring of high skilled jobs, radiologists were often paired with software engineers. We have argued in this note that these occupations, while both high skilled, are distinguished by several key differences. Unlike software engineers, it is very difficult to gauge the quality of a radiologist's work. This has contributed to the radiology's profession continuing ability to exercise power over decisions of who is permitted to interpret U.S. radiological images. The radiologists' control of their profession is reinforced by malpractice concerns that, in part reflect U.S. consumer preference. The U.S. consumer may not care who wrote the code in their PC but they do not currently favor having medical treatments influenced by anonymous sources – e.g. a benefits manager – including anonymous foreign-educated doctors. In most markets, consumer behavior is determined by price as well as preferences but U.S. health insurance offers little price incentive for consumers to reconsider their view.

For all these reasons, pairing the threats faced by radiologists and software engineers makes for a terrific headline but not much else.

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