Computers and the Supply of Radiology Services: The Anatomy of a Disruptive Technology

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Over the next decade, computers will augment the supply of radiology services at a time when reimbursement rules are likely to tighten. Increased supply and slower growing demand will result in a radiology market that is more competitive with less income growth than the market of the last fifteen years.

Key Words: Income, PACS, Teleradiology, Computers

INTRODUCTION

Computerized work is transforming the U.S. labor market in ways that advantage some people and disadvantage others. Writing as a labor economist who studies the radiology profession, I believe radiologists are not immune from this transformation. As a result, radiologists as a group will find the next decade more unsettled and somewhat less rewarding than the last decade has been.

I will begin my argument with brief descriptions of trends now reshaping the U.S. labor market and the role of computers in driving those trends. I then review the multiple ways in which computers are reshaping the market for radiology services. I conclude by giving my best guess of the profession's prospects over the next decade.

TWO LABOR MARKET TRENDS

Over the last two decades, the U.S. labor market has evolved around two broad trends:

- Within the economy, bargaining power has shifted away from labor and toward capital and the persons who allocate capital.

- Within the labor force *per se*, bargaining power has shifted toward the highest skilled workers and away from most other workers.

A window into the first trend begins with the summary statistics on income inequality. As you know from the business pages, the top one percent of households now receives roughly 17 percent of all income.[ii] Being in this top one percent of households currently means having household income of about $400,000 a year. As I read various data sources including *Salary.com* and *AuntMinnie.com*, something over half of all U.S. radiologists currently fall into this category.

Half of all radiologists account for only 15,000 households out of 1.1 million households in the top one percent. This leads to the obvious question: Who else is in there? A number of CEO's. Tiger Woods and Alex Rodriguez, of course. But if we think about people by profession, the largest group in the top one percent are people in finance – people who allocate capital.[iii]

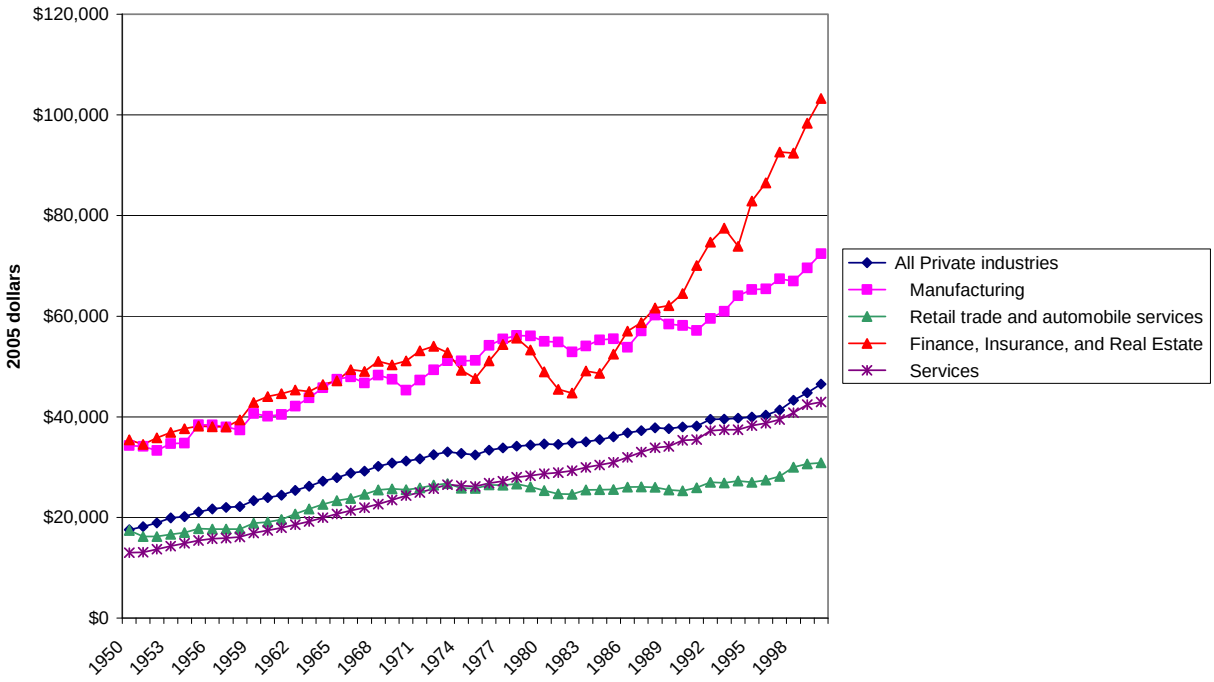
This is not news to you but we should remember that things were not always this way: Capital and the people who allocate capital were not always in the economic driver's seat. My economist colleague, Peter Temin, and I have been researching this history[iv] and in the course of our work, we received this piece of biography from a friend of Peter's who I will call "Robert".

Robert wrote:

> In 1974 as a successful young investment banker with 8 years experience, I was paid less than my peers in the large industrial companies or utilities and had no benefits of significance. Everyone left the office at 5:00 o'clock and it was resented if you tried to come into the office on weekends (doors locked, no staff, no lights, a/c almost off). By 1985 I was a mid-level partner earning $4 million a year, working 12-14 hour days and frequent weekends, and the busiest parts of the firm had second shifts of support staff every day and all weekend.

You can see the economy-wide version of Robert's story in Figure 1 that shows, for different industrial sectors, the sum of Corporate Profits plus Compensation per Person Employed.[v] Think of the number as an index of how well the sector is doing. Through the early 1980s, the index grew at fairly similar rates across all sectors. Then, with the deregulation of financial markets and the wave of industrial restructuring, the Finance/Insurance/Real Estate (FIRE) sector took off. Since then, Corporate Profits plus Compensation in the FIRE has continued to grow at relatively high rates reflecting a continued shift of bargaining power toward capital and away from labor.

Figure 1
(Compensation + Corporate Profits) per Full-Time Equivalent Employee
in Selected Industrial Sectors

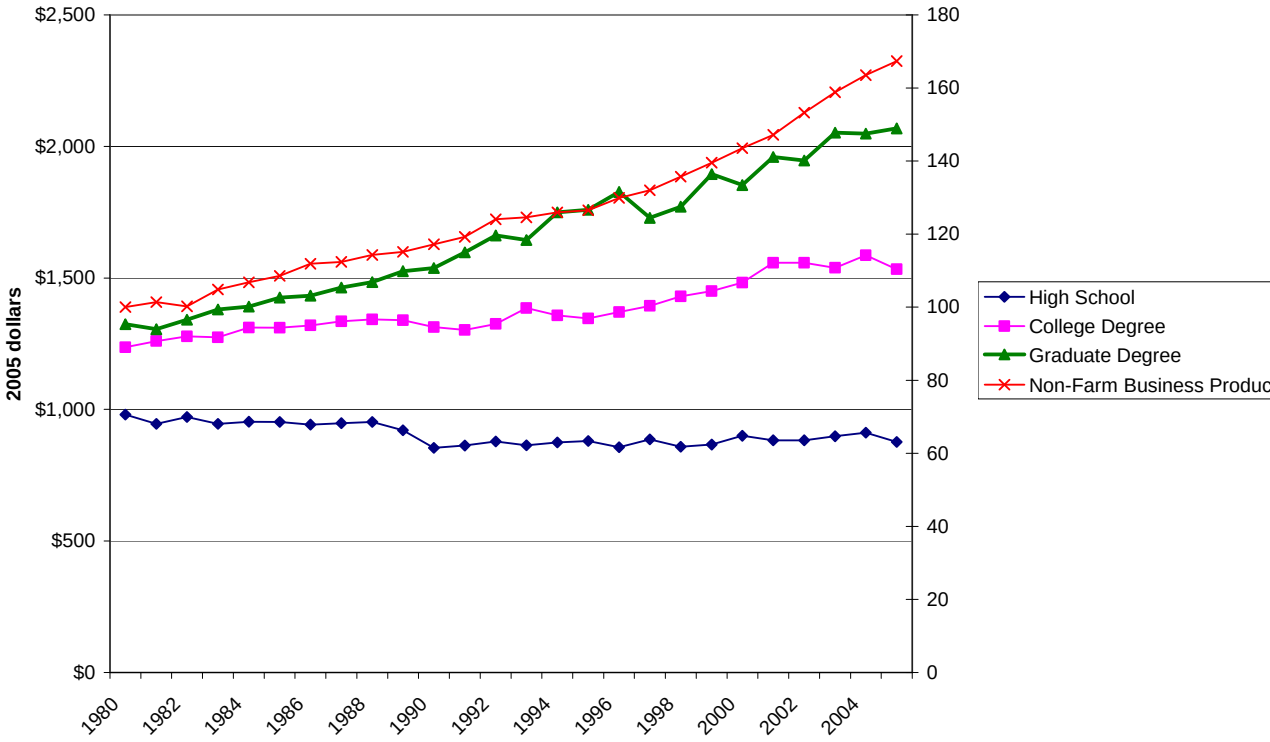


Now consider the second trend – the shift of bargaining power **within** labor. We can see this shift by looking at compensation trends for workers with different levels of education. The basic driver of compensation is labor productivity – the average value of output per worker in the economy. The year-to-year growth of labor productivity determines the pool of money available for increased compensation per person.

In the first 35 years after World War II, the labor market, with help from unions and other institutions, distributed productivity gains fairly evenly across people. Between 1947 and 1973, labor productivity doubled and the income of the average family also doubled from $23,000 to $46,000 (in today's dollars). More

recently, however, productivity gains have gone only to the most educated and most skilled workers.

Figure 2
Median Weekly Compensation of 35-44 Year Old Men who Work Full Time:
Non Farm Business Productivity (Right Hand Axis)



To illustrate the point, Figure 2 shows both productivity and median weekly compensation, including estimated fringe benefits, for 35-44 year-old men who work full time. As Figure 2 shows, since 1980, labor productivity has grown by about 67 percent, but:

- The median weekly compensation of male high school graduates in this age range has *declined* by 10 percent.

- The median compensation of male college graduates (without graduate work) has grown by 24 percent – about one-third the rate of overall productivity growth.

- Only the median compensation of men with post-graduate training has kept up with productivity growth. [vi]

It's worth taking a minute to think about these data. We know that beginning with the blue collar recession of 1980-82, the demand for high school graduates fell sharply, particularly for men, as the Midwest heartland of U.S. durable manufacturing became the Rust Belt. The data in Figure 2 say that the market forces that devalued a high school diploma are now nibbling away at a bachelors' degree as well. As the figure shows, almost all of the 24 percent gain for men with a BA occurred before the year 2000. Since 2000, compensation for men with a BA has been largely flat, despite continued gains in overall productivity. Again, this is a story of weakening bargaining power.

Figure 2 comes with two caveats. First, the earnings data for women look somewhat more optimistic than the data for men. The compensation of women with bachelors' degrees BA's as well as women post graduates are both keeping up with productivity growth (though the significantly larger group of women high school graduates are not). Second, as the mutual fund ads say, past results are no guarantee of future performance. By next year, any of these trends may have reversed. But for the present, it appears that the income gains from increased productivity are going to a fairly narrow group of people.

How do we explain these trends? In any situation, an economist's first line of attack is supply and demand. In this case, the shift in bargaining power from labor to capital over the last two decades suggests a rapidly growing supply of labor. As

more workers compete for jobs, their competition undermines their bargaining power and ultimately undermines their compensation growth.

Similarly, the shift of bargaining power *within* labor to the highest skilled individuals suggests a rapidly growing labor supply of less skilled individuals (though, as we have seen, the market is classifying some holders of bachelors' degrees among the "less skilled").

If Adam Smith had been writing this article, he would have given you roughly the same explanation I just gave you. But an important difference between Adam's time and our time is the role of computers in increasing the effective labor supply. In other words, because of computers operating through various mechanisms, many kinds of workers face significantly more competition than they faced ten or twenty years ago.

If this were the 1950s, I would explain that computers increase the supply of labor through sci-fi robotic humanoids that replicate everything humans do. We see only a few of those humanoids today. What we see instead is a large variety of less obvious mechanisms by which computers increase the labor supply. Consider two short examples.

One is the ATM machine. The ATM doesn't replace a bank teller's entire job, but it replaces parts of a bank teller's job. We can call this mechanism *Task Substitution.* Because of the ATM, tellers spend less of their time handing out cash and taking deposits and so they can spend more time on the other parts of

their job. As a result, a bank needs fewer human tellers for every 1,000 customers. The demand for tellers has declined and the bargaining power of tellers has fallen.

A second example is fast Information and Communication Technology links - ICT links for short. ICT links increase the labor supply by allowing an employer to move work, including interactive service work, to employees in distant locations. Examples include call centers, credit card processing, software programming and, as you know, radiology reads. Within a given geographic area, ICT links increase the effective labor supply in the sense that workers in Boston can now face competition from workers in Bismarck, North Dakota and Bangalore.

I will return to these and other computer mechanisms shortly. Before doing that, I want to summarize what I have said so far.

My main point is that for many workers, average compensation is declining or growing more slowly than economy-wide productivity numbers would suggest. A major explanation for is that the labor supply of many of groups is growing faster than labor demand. Computers play an important role here by effectively increasing labor supply. The result is declining bargaining power for many workers that puts downward pressure on compensation and shifts power to capital and the people allocating capital.

I have discussed these economy-wide labor market trends because I believe they provide a framework for understanding how computers are shaping the radiologist's work today and over the next decade. It is to that subject I now turn.

HOW COMPUTERS AFFECT RADIOLOGY

Radiology is a highly skilled profession. If my story is to have any credibility, radiologist salaries, should have risen rapidly in recent years, at least as fast as the general rise in labor productivity. In fact, that this is the case.

We can start in the mid-1990s. As you know, these were dark days for radiologists and contained much uncertainty. The uncertainty translated into weak demand but as I read the data, this weakness was expressed in fewer jobs rather than falling salaries. The median income for diagnostic radiologists in 1996 was about $300, 000 expressed in today's dollars. Today, as I mentioned earlier, the median income of a diagnostic radiologist is something over $400,000.

This roughly 33 percent increase in inflation-adjusted radiologist income is in line with the 36 percent rise in economy wide productivity over the same period. It is much higher than the 10 percent increase in the median compensation of 35-44 year old men with a bachelors' degree over those years (e.g. Figure 2).

In the mid-1990s, James Thrall argued that the then bleak market conditions were a poor predictor of the better times that were coming[vii]. I believe the very strong market of the last ten years similarly mis-predicts a market that will begin to soften in the future.

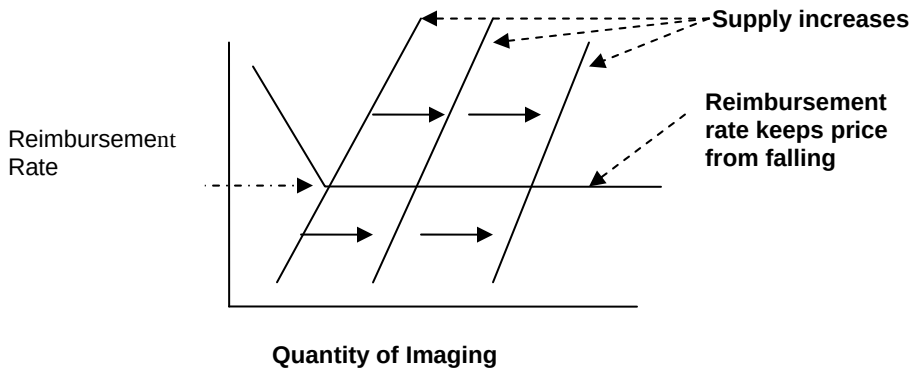
As I see it, compensation growth is likely to slow and radiologists will be pushed into practicing in larger organizations. They will lose some bargaining

power from both the demand side and the supply side of the market with computers having a significant impact on the supply side.

Let me start with the demand side. From 1995 to 2005, as radiologist real incomes salaries grew by 33 percent, total Medicare Fee for Service Payments for CT, MRI and PET grew by 377 percent, adjusted for inflation - from $809 billion to $3.5 trillion dollars - both figures in 2005 dollars.[viii] I do not have comparable figures for private insurers but I assume they were increasing by similar rates.

Some of the increased expenditure reflected the rapid development of new imaging applications. But imaging benefited enormously from the existing reimbursement structure. With some exceptions, no matter what was being imaged and no matter which doctor was reading the image, Medicare or private insurers reimbursed at a constant price. To an economist, this open-ended demand curve looks like 1950's agricultural price supports applied to medical imaging (Figure 3)

Figure 3
Demand and Supply of Imaging
with a Constant Reimbursement Rate



This demand has already begun to contract. The biggest restrictions to date are reimbursement reductions for non-hospital imaging included in the Deficit Reduction Act of 2005. Those reductions went into effect and reporting in *AuntMinnie.com* suggests they already have had an effect.[ix]

At the same time, a growing number of health care providers, insurers, and benefits managers are working on physician profiling, new protocols and other methods to define and control medically unnecessary imaging. Some of these methods put heavy emphasis on billing originating from doctors offices – i.e. a focus on self-referrals – but it is likely that many radiologists will be affected in one way or another.

In sum, the demand side of the market is unlikely to be as supportive of expansion as it was over the last decade. New applications will continue to generate new orders for images. But if the past is any guide, the new applications will require increased levels of specialization for the radiologists who read the images. I return to this point below.

While demand for images grows more slowly and becomes increasingly specialized, the effective supply of radiology services will continue to increase. The increase will not come from an expansion of resident slots, but rather from computer-driven mechanisms. I would like to review five of these mechanisms beginning with one I already mentioned, *Task Substitution*

When we discuss task substitution in radiology, the cleanest example is the PACS. By eliminating the handling of physical images on light boards, PACs have increased radiologists; available time to interpret studies, just as an ATM has increased a teller's time to time to work on sales of new products and to solve complex customer problems.

Some of this available time is being absorbed by the increased number of slices produced by sophisticated scanners. Increased slices represent an improvement in the quality – not the quantity – of images. But PACs have also allowed radiologists to increase the number of studies they read and this increased reading capacity. So far, increased demand for images has grown in line with this increased capacity for reading. But if demand growth slows, continued increases in reading capacity will lead to increased competition and a downward pressure on rates.

The second mechanism by which computers increase effective labor supply is *Reengineering.* Where Task Substitution focuses on restructuring a particular job to increase efficiency, reengineering focuses on restructuring work in an organization. In the world outside radiology, a good example of reengineering is

the computer backbone of a Wal-Mart store where an item is scanned at check-out and the information is fed directly to inventory systems, accounting systems and suppliers.

In the case of radiology, an example of reengineering is a nighthawk firm – a firm that has organized nighttime reads in a way that can keep a radiologist fully occupied. As with Wal-Mart, these nighthawk firms have been made possible by computer technology – in this case, PACs and ICT links.

From an economist's perspective, nighthawk firms used ICT links and PACs to offer nighttime doctors a trade-off: Give up face-to-face communication with the radiologist in exchange for rapid turnaround time. It was a trade-off many doctors were willing to make. In the process, they lowered the perceived risk surrounding reads without face-to-face communication. Over time, this tradeoff is becoming less severe as ICT links evolve to include face-to-face communication – for example, Cisco Systems' Connected Imaging product [x] - and we can expect remote reads to expand into various kinds of day work, a point to which I return.

Task substitution and reengineering both increase labor supply through increased efficiency – reading more studies with the same number of radiologists. I now want to discuss three other processes that increase labor supply by increasing the actually number of people reading images.

One of these processes, *Deskilling*, refers to new technology that allows many people to do a job formerly reserved for skilled experts. Desktop publishing software is a familiar example. Fifteen years ago, a family who wanted to send out

a holiday letter with embedded pictures would take the job to a small print shop. Now the family does the letter on its own computer.

In the case of medical imaging, “deskilling” is too pejorative a term but it is easy to recognize how technology has expanded the number of medical professionals who now read images. The development of the extremity MRI machine has allowed orthopedic surgeons and others to produce and read images that formally would have been read by radiologists. The movement of CT scanners into cardiologists’ offices has involved less equipment innovation but it too has sharply expanded the number of people who now compete to read images.

The fourth mechanism, the *Superstar Effect,* describes how technology increases the market reach of persons with unique skills who displace other providers in the process. An example involves the way that television increases Tiger Woods’ income. (Here I am lumping television together with ICT links.) Tiger Woods is a superstar – he is currently better than anyone else in his line of work. For that reason, many golf fans would rather watch Tiger play on television than watch a local tournament live.

But suppose Tiger Woods had lived in an era without television. People could have read about him in the newspaper but his weekly audience would have been limited to people who could travel to the golf course on which he was playing. Advertiser interest and prize money would both have been much lower. Tiger’s income would have been reduced correspondingly. The winners from no

television would have been the second tier players in local tournaments - the only source of live golf for many fans.

In radiology, the comparable example begins with a point we mentioned earlier – the increasing specialization required by new imaging applications. This specialization has created demands for skills that some radiology practices do not have. I live in Newton, Massachusetts and my children went to high school next to a large yellow house which serves as both the home and the office of Dr. Peter Franklin. Franklin is a radiologist and a co-founder of Franklin and Seidelmann, a virtual subspecialty firm concentrating in Musculoskeletal and Neuro radiology. Currently the firm includes 55 board certified specialists. As I understand it, Franklin and Seidelmann get much of their business by offering specialized reading skills that local radiologists do not provide – a superstar effect.

For the fifth and last mechanism, I want to return to *ICT links* and the possibility of expanding the effective labor supply by dealing with workers in distant locations – workers who were previously out of reach. It is a running joke that the media continues to report on the hundreds of low wage radiologists in Bangalore who now read most U.S. medical images. As I understand the situation, these stories reflect reporters not doing their homework. The assumed that if images were going overseas, the people doing the reading must be the equivalent of Indian call center operators rather than U.S. board certified radiologists sitting in Zurich and Sydney or in Arjun Kalyanpur's Teleradiology Associates, the only

Indian firm to my knowledge now serving the American Market. Nonetheless, this non-story contains an important kernel of truth.

Economists have developed a concept of *contestable markets* – markets where new producers might enter at any moment. At a particular moment, a contestable market may contain only a small number of firms. But if those firms get too comfortable, they will quickly face competition from new entrants.

Radiology in the United Kingdom has some of the flavor of a contestable market. As most of you know, the Blair government awarded two rounds of contracts to private radiology firms, the first in 2004 and the second about a year ago. The goal was to increase scanning capacity for national health patients who had to wait as long as a year for an MRI in some rural areas. The two rounds of contracts differed in one important respect. The first round included a guaranteed level of business. The second round did not.

From the perspective of private radiology firms, the process has not gone well. The winner of the first round was Alliance Medical, Ltd. The description of what happened next comes from a young industry consultant who I will call Henry – he wished to remain anonymous. Henry said that after the first round award, a funny thing happened: National Health waiting lines began to shrink even though Alliance had significantly fewer referrals than anticipated. It appears that under pressure of competition, the National Health made better use of its existing capacity to reduce waiting lines on its own.

In this first round, Alliance did well financially because of the guaranteed work. Still, the situation lent itself to several newspaper articles with pictures of empty clinics and descriptions of how Alliance was being paid to do nothing. Henry tells me that the lack of work has continued through the present and several firms who received second round contracts have seen their contracts canceled or have dropped out of the market.

The lesson here is that in contestable markets, even unsuccessful entrants can exert pressure on incumbent firms. The lesson is important because many U.S. radiology practices now operate in markets that are made contestable by teleradiology.

Last year, for example, Kent Hospital in Rhode Island entered into negotiations to give 70 percent of its radiology reads to Massachusetts General Hospital. The negotiations provoked an uproar from Rhode Island radiologists including Toll Gate Radiology, a three-person group who was Kent's incumbent firm. Ultimately, the uproar caused Kent Hospital to abandon Massachusetts General but they abandoned Toll Gate as well. Kent signed instead with XRA associates, a 10 person firm. In the last article I read, the radiologists of Toll Gate are considering their options including joining with XRA.[xi]

What Comes Next?

I know many readers of these articles have already heard most of the stories I have recounted. My hope is that this article gives a framework to fit these stories together. The framework has three main points.

- The economic position of any occupation is determined by supply and demand.

- On the demand side, the profession of radiology faces tightening conditions as insurers and healthcare providers try to limit unsustainable cost growth.

- On the supply side, many of the computer innovations we have seen work in the same direction: to increase effective supply of radiology services.

In sum, I see slower growing demand for interpretations and an expanding supply of radiology services as creating a radiologist market with much more competition. Large, well capitalized groups will challenge smaller group and many individual radiologists will lose a measure of bargaining power. I am not predicting Armageddon here – it is hard to predict Armageddon for a group where median income exceeds $400,000 per year. Nonetheless, it is clear the booming market for radiologists could not go on forever and in the well chosen words of Stein's law:[xii] "*If something cannot go on forever, it will stop*."

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[i] Rose Professor of Urban Economics, Department of Urban Studies and Planning, M.I.T., Cambridge, MA 20039. This article is adapted from remarks given to the ACR Leadership Forum, Washington DC, January 23, 2008. I have benefited from conversations with Dr. Howard Forman, Dr. Max Rosen, Dr. Jonathan Sunshine and Dr. James Thrall. I am responsible for all errors. I thank the Alfred P. Sloan Foundation for financial support.

[ii] See Thomas Piketty and Emmanuel Saez. 2003. "Income Inequality in the United States." *The Quarterly Journal of Economics.* 118. no. 1 (February), pp. 1-39. The data in this article are updated periodically and can be downloaded from Saez' web site: http://elsa.berkeley.edu/~saez/ The heart of the data involve anonymous groups of federal tax returns and so the data actually refer to the income distribution of "tax filing units" rather than households – e.g. a household in which the husband and wife file separate returns generates two observations.

[iii] Stephen N. Kaplan and Joshua Rauh, 2006. "Wall Street and Main Street: What Contributes to the Rise in Highest Incomes?" Working paper, University of Chicago School of Business, version of September 13.

This paper can be downloaded from the Social Science Research Network at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=931280

[iv] See Frank Levy and Peter Temin, "Inequality and Institutions in 20'th Century America", working paper, Department of Economics, MIT, June 2007, can be downloaded from the Social Science Research Network at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=984330.

[v] All data taken from U.S. Department of Commerce, *National Income and Product Accounts.* In these calculations, "persons" are expressed in full-time equivalents to avoid distortions from variations in the number of part time workers.

[vi] In Figure 2, weekly earnings data come from tabulations of U.S. Bureau of the Census, *Current Population Survey*. These earnings data have been approximately adjusted for the cost of fringe benefits using data from the *National Income and Product Accounts.*

[vii] James Thrall, Personal Communication.

[viii] See Department of Health and Human Services, Office of the Inspector General, *Growth in Advanced Imaging Paid Under the Medicare Physician Fee Schedule* October 2007, Table 2.

[ix] See Kate Madden Yee, "The DRA at six months: How outpatient imaging centers are coping." www.auntminne.com, June 26, 2007

[x] http://www.cisco.com/web/strategy/healthcare/connected-imaging.html
[xi] Wayne Forrest, "Rhode Island Hospital Opts for Local Radiology Service", www.AuntMinnie.com, September 6, 2007.

[xii] Stein's law was coined by the late Herb Stein, an excellent economist who advised Richard Nixon, wrote numerous popular articles and – a rarity among economists – had a sense of humor. He is known today for being the father of sometime economist and entertainment figure Ben Stein.