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Location Matters: The Adoption of New Medical Technologies

By Leila Agha and David Molitor

Introduction

U.S. spending on health care has increased dramatically over the past six decades, outpacing GDP growth by an average 2.5 percentage points annually and rising as a share of GDP from 4.5 percent in 1950 to 18 percent in 2012. Over that same period, health outcomes have improved substantially. For example, since 1950 infant mortality has plummeted from 30 deaths per 1,000 live births to a current rate of 6, and life expectancy at age 20 has increased by more than 7 years.

There is broad consensus that new medical technologies are largely responsible for both these trends in rising health care costs and improved outcomes. But what explains how new technologies spread to medical providers, and does this process lead some providers to adopt innovations more quickly than others?

We explore the role clinical research activities play on the propensity for physicians located near research centers to adopt resulting innovations. From the high-tech ecosystem of Silicon Valley to the clustering of investment banks in New York City, there is abounding anecdotal support for the idea that geographic proximity can speed the dissemination of new ideas and technologies and boost firm productivity. A key question is whether a similar dynamic of geographic spillovers exists in the health care industry.

At least since sociologists Coleman, Katz, and Menzel pioneered the science of technology diffusion in their famous 1957 drug study, it has been recognized that social and professional interactions between physicians may be an important channel for spreading innovations. The belief that physician knowledge about new technologies has a component that is not easily transmitted through textbooks or medical journals but rather through face-to-face interactions underlies the medical education mantra "see one, do one, teach

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About The Authors

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one." Physicians who practice alongside or near clinical investigators of new medical technologies may gain an early informational advantage and adopt the new technologies more quickly as a result.

In this brief we look at whether clinical research on new cancer drugs results in faster adoption of those drugs by physicians who practice near where the research activity was undertaken. Understanding whether innovative activity locally boosts subsequent technology adoption in health care is important for at least two reasons. First, it suggests that the spatial organization of health care activity could drive differences in health care productivity across regions. Second, an important health policy issue is what drives regional disparities in patient access to health care treatments. Understanding the effect of clinical research activities on the treatments offered by providers has implications for which patients are likely to have better access to new treatments based on where the patients live.

We find that proximity to pioneering clinical researchers causes neighboring doctors to adopt new drugs earlier, but that effect diminishes within four years as the technology becomes widely used.

Cancer Drugs

We analyze the adoption of new cancer drugs within the Medicare patient population from 1998 to 2008. During this period, the Food and Drug Administration (FDA) approved 20 new cancer drugs covered by traditional Medicare. Drugs that demonstrate sufficient efficacy and safety in clinical trials receive FDA approval for specific indications defined in a drug's official labeling.

Off-label use, which refers to the administration of a drug in any manner that has not been approved by the FDA, is legally permitted in the United States. We categorize drug use as being "on label" if it was used on a patient with the broad type of cancer (e.g., colon cancer) indicated on the initial FDA approval. Drug use is categorized as "off label" if the patient does not have that broad type of cancer. Our approach is likely to provide a lower bound on the full degree of off-label drug usage, since we cannot identify all of the usage restrictions on the FDA label in the Medicare claims data. Across the 20 drugs in our sample, 78 percent of drug use was within the broad cancer type indicated on the original label; the remainder were clearly off-label applications.

Access to New Drugs

The quality of America's prestigious academic hospitals is often cited as a significant strength of our health care system. These hospitals innovate and experiment with new medical technologies, generating knowledge and technological improvements that ultimately diffuse widely and benefit patients treated across the country. We explore whether patients treated at prestigious hospitals have improved access to new technologies and whether prestigious hospitals contribute to diffusion of new information.

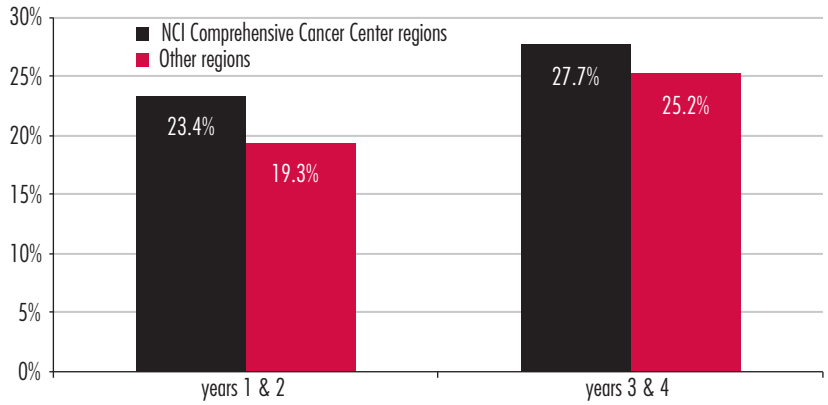
One measure of an area's cancer care expertise is designation by the National Cancer Institute as a Comprehensive Cancer Center (CCC), a mark of excellence based on quality of both research and clinical care. There were 41 CCCs designated in 2012, spanning 36 different hospital referral regions.

Not all patients have access to care at a CCC. Only 31 percent of Medicare cancer patients in our sample were treated in a region that contains one of these CCCs. While physicians practicing in CCCs are no more likely to prescribe a cancer drug within the broad types of cancer for which the drug was initially approved, the fraction of new drug use on off-label applications is 19 percent higher in CCC regions compared with other regions. As illustrated in Figure 1, this gap closes over time, with off-label applications 9 percent greater three and four years after drug introduction.

The evidence suggests that prestigious academic cancer hospitals provide improved access to cutting-edge treatments, particularly for experimental and off-label uses of new technology. For any particular drug, practice differences will shrink over time, providing suggestive evidence of spillovers from the CCCs to other care providers.

A similar pattern of results emerges when we compare utilization across regions with high and low concentrations of practicing oncologists. Regions with a large supply of oncologists are no more likely to use a new drug within the cancer type indicated on the

Figure 1:
Fraction of New Cancer Drug Use Off-Label



Note: New cancer drug use in traditional Medicare population in years 1-4 following initial FDA approval.

label, but high supply regions are substantially more likely to use a new drug off-label.

The observed pattern of convergence in off-label prescribing between CCC and non-CCC regions over a drug's first few years suggests that the exploration in prestigious cancer care centers may generate information about a drug's value and appropriate applications that eventually diffuses to a wider group of regions. As information about new drug applications improves over time, we see an overall pattern of rising off-label utilization, suggesting that the early experimentation was valuable in identifying a broader group of patients with potential benefit from treatment.

One challenge to interpreting these differences in prescribing patterns between CCCs and other hospitals is that both the patients and the providers select their locations. For example, if CCC regions see many more complex or severe cases, we may observe higher rates of experimental cancer care in CCC regions, even when CCCs and other hospitals have the exact same practice patterns for any given type of patient. In addition, we cannot directly document spillovers across CCC hospitals and other providers; the observed convergence of other providers toward the CCC practice patterns could occur, even if non-CCC providers were isolated from any contact and there were no potential information spillovers with CCC providers. The evidence suggests the presence of spillovers, but cannot prove their existence.

Proximity Effects of Principal Investigators

To address these limitations, we exploit a quasi-experimental research design that allows us to identify and isolate the impact of providing specific physicians with high-quality information about a new drug. We then observe how this information affects the drug adoption of doctors practicing near the high-expertise doctor, holding the patient population treated fixed. This exercise allows us to identify the extent to which lack of information about a new drug slows early adoption as well as test for local spillovers from high-expertise providers.

Our quasi-experiment is to test whether geographic proximity to early clinical investigators leads to faster adoption of new technologies. For each new FDA-approved cancer drug, we recorded the geographic location of the principal investigator (PI) of the pivotal clinical trial used in the FDA approval process. The locations of these PIs are shown in Figure 2. We then measured the rates of use of each drug over appropriate patients within each hospital referral region based on Medicare reimbursement claims.

Establishing the effect of clinical investigators on the adoption rates of nearby physicians is complicated by the fact that the location of clinical investigators is not randomly assigned. Suppose for example that Chicago-area doctors adopt a new cancer drug with a Chicago-based PI more quickly than the national average. This could be a result of proximity to the PI, due to local knowledge transfers. But an alternate explanation is that Chicago doctors are simply fast adopters of all new medical technologies.

Effectively estimating the causal effect of proximity to a new drug's PI on adoption rates by nearby physicians relies on knowing two pieces of information: how intensively the doctors near the PI utilized the

Figure 2:
Locations of New Drug Principal Investigators

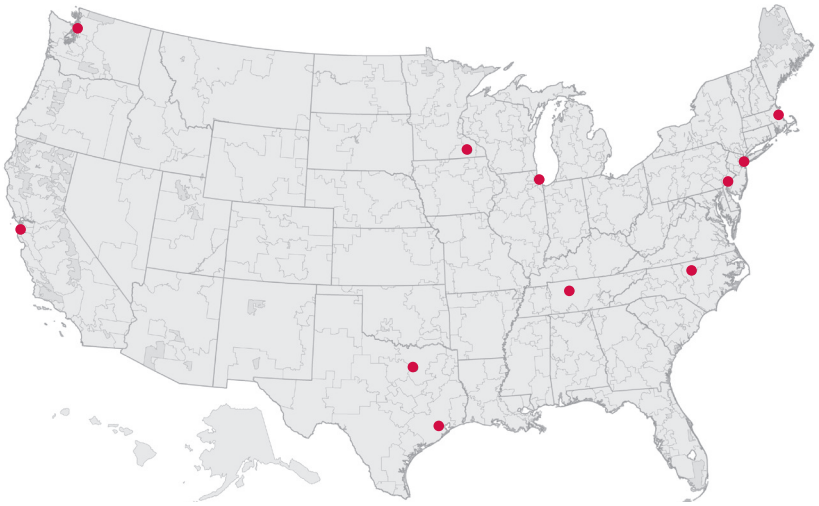
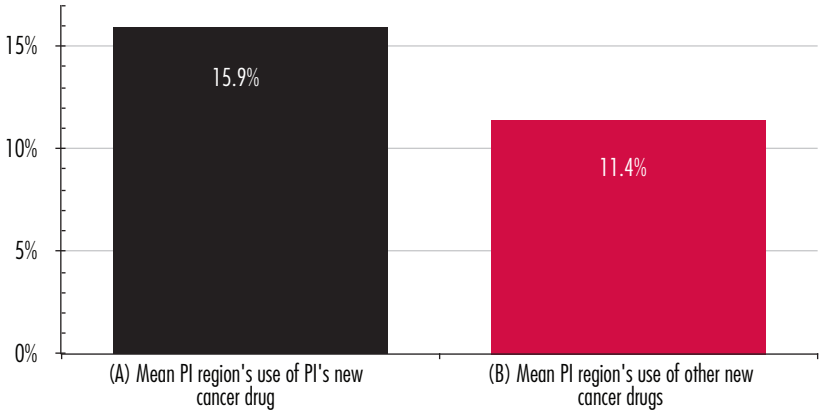


Figure 3:
Impact of Princial Investogator (PI) on Regional Drug Adoption



Note: Mean drug use over first 2 years following FDA approval. The difference between columns (A) and (B) provides an estimate that proximity to a drug's PI boosts early use of that drug by 4.5 percentage points, or nearly 40%.

PI's drug (potentially observable) and how intensively those same doctors would have adopted that drug had the PI been in another region (always unobservable).

The key innovation of our analytic approach is that it allows us to estimate each region's counterfactual adoption rate—i.e., how much each region would have used a new drug had the PI not been located in that region. We do this in two steps. First, we compare adoption of each new drug in the PI's region to adoption of that same drug in other regions, e.g., estimating how much more the new drug with the Chicago PI is used in Chicago compared with other cities. Second, we compare how much more intensively Chicago doctors adopt similar "control" drugs, when the PI is located in another region. The difference between these two rates provides a causal estimate for how a local PI changes the adoption of a new drug.

Figure 3 shows the results of this exercise for the 17 new cancer drugs in our sample that have U.S.-based PIs, focusing only on the 11 regions that contain a PI for at least one of the drugs in our sample (see Figure 2). We find that on average 15.9 percent of indicated patients treated in the PI's region receive the PI's drug within the first two years following FDA approval, as shown in the first column of Figure 3. In contrast, 11.4 percent of indicated patients treated in those same regions receive drugs when the PI for those drugs is located in another region, as shown in the second column of Figure 3. This second measure can be interpreted as how intensively each of these regions adopts new cancer drugs when the PI is not located in its region. The large difference between the first and second columns implies that proximity to a drug's PI significantly impacts adoption, boosting the regional use of that drug by 4.5 percentage points, or nearly 40 percent.

Another way to see this result is in Figure 4. For each of the 17 drugs in our sample, we measure the utilization of that drug among indicated patients for each of the 11 regions containing a PI for at least one drug in our sample. To aid

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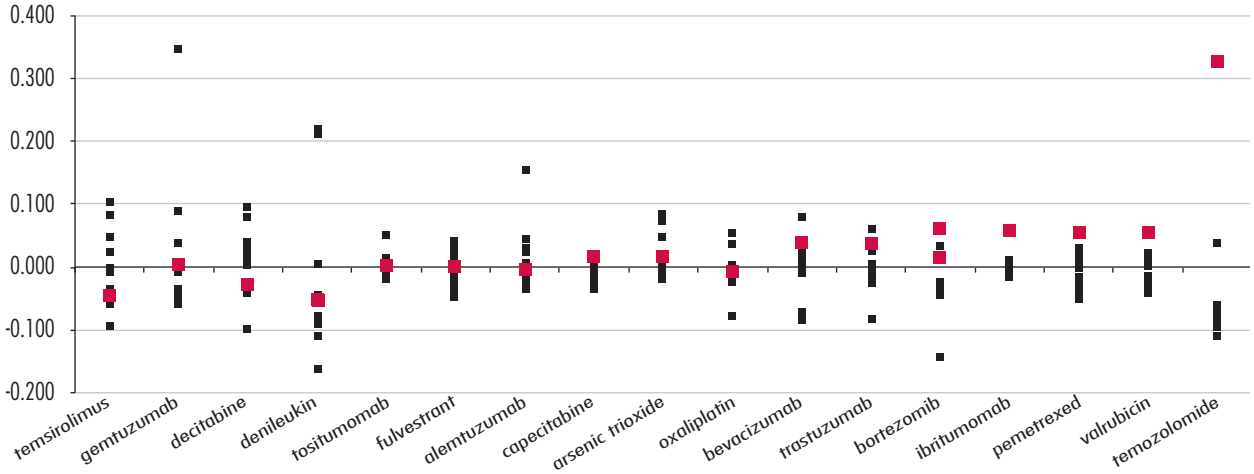
Figure 4:
New Cancer Drug Use Across Regions



Note: Each observation measures the use of a given drug in the 11 regions which contain a principal investigator (PI) for a drug in this sample. The PI region rate is shown in red. Calculated rates are measured as deviations from the sample average use of a drug (i.e. a rate of zero corresponds to average use for that drug). Bortezomib had two pivotal clinical trials, and thus two PIs.

comparison across drugs that have different national usage rates, all rates are measured relative to the sample average for that drug. For each drug in our sample, our calculations show the geographic variation in rates of use across the 11 regions. Finally, we highlight for each drug the utilization rate corresponding to the region containing the drug's PI. As shown in Figure 4, the rate in the PI region is systematically higher than average for most drugs. In fact, the PI region ranks as the highest-intensity region in 5 (29 percent) of the 17 drugs in our sample.

While these results demonstrate that new drugs are adopted more intensively in the corresponding PI's region, a natural follow-up question is how long this "PI-boost" persists. For example, if experience administering a particular treatment leads a physician to specialize in that treatment, then the early boost in experience from proximity to a drug's PI could lead to higher rates of use of that drug in that region even in the long run. On the other hand, if the PI-boost is primarily due to differences in knowledge, then the effect is likely to fade as information diffuses over time. In separate calculations similar to our analysis above, we find evidence more consistent with this latter hypothesis. While the PI boost to adoption is large in the first two years following a drug's approval, this boost fades over time until there is no discernible effect after four years.

Conclusion

Our findings provide strong support for social learning as an important determinant of early technology adoption.

Geographic proximity to clinical researchers leads neighboring physicians to adopt new drugs more quickly. As in other industries, we see evidence that concentration of innovative activity generates important local spillovers, improving patient access to new medical technologies. Over time, other regions catch up in their utilization patterns, approaching the intensity and range of uses initially adopted in the high-expertise areas.

A major obstacle to new drug adoption is not learning about the existence of the drug but rather discovering the specific patients and care contexts in which it is valuable. The evolution of off-label utilization demonstrates that physicians are actively testing new drugs beyond the scope of their initial indications, particularly in high-expertise cancer care centers, and that gradually these utilizations not covered by the initial drug label spread across regions. These findings suggest that lowering the cost of collecting, analyzing, and disseminating information about the clinical value of new medical technologies could be tremendously valuable to improving patient care.

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