Data about Health Data

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The opportunity in health data

- Health data has the potential to improve patient outcomes while reducing costs by…
  - → Enabling medical professionals to have the right information at the right time
  - → Eliminating duplication of diagnostic tests
  - → Optimizing processes to improve efficiency
  - → Facilitating evidence-based decision making
  - → Accelerating medical research through better data on short- and long-term health outcomes
  - → Etc!

The challenges in health data

- Many analysts *hope* that big data, electronic medical records (EMR), and analytics can dampen the increase in costs,
- Yet, the evidence so far has been overwhelmingly based on case studies
- Many attempts to identify systematic benefits from cutting edge health IT have failed to find anything significant for either costs or benefits
- Thus, while EMR, data, and analytics dominate conversation and seem to be increasingly adopted by hospitals, evidence of their effect on hospital productivity has been somewhat elusive

Health IT as enterprise IT

- This debate echoes an older debate about the impact of information technology on business productivity
- In 1987, Nobel prize winning economist Robert Solow noted that "You can see the computer age everywhere but in the productivity statistics"
- Since then, economists have gained an understanding on when and how IT increases business productivity
- If we see health IT as another version of enterprise IT, then we can use the apply the insights from enterprise IT to understand why the successful implementation of health IT is so challenging.

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What if health isn't so special?

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Why is Enterprise IT so difficult to do well?

- Enterprise IT, like other business process innovations, alters organizational practices and involve:
  - → Changes in the discretion given to employees
  - → Changes to the knowledge and information that employees are expected to retain and employ
  - → Changes to the patterns of communications between employees and administrators within an organization.

- Broadly, by itself new IT has little impact.
  - → Requires a sequence of complementary investments and organizational changes after the initial adoption.
  - → Productivity impact depends on whether the employees of the adopting organization – in the case of hospitals, administrative staff, doctors, and nurses – find new uses and invent new services ("co-invention").

What we expect to see if health IT is like enterprise IT

- Lags in payoffs
- Variation based on availability of complementary factors across locations such as
  - → Skilled labor
  - → Third-party software support and services
  - → Infrastructure
- Variation based on experience

- Sources: Bresnahan, Brynjolfsson and Hitt (2002), Forman, Goldfarb, and Greenstein (2005, 2008, 2012), Arora and Forman (2007), Greenstein and McDevitt (2011)

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Lots of cases of success & failure

- Symptom of the need for co-invention: A large (anon) teaching hospital rolls out new physician order entry system
  - → Works for severely ill, not for routine; doctors in satellite locations complain about wasting patient time scrolling through useless pages they do not need for "kids w/colds."
  - → No procedure for "update" emergency room information. Satellite location ends up with unwanted follow up work "cleaning up the records."
  - → Dip in billing as physicians learn systems. Cost per patient increase as staff takes more time to learn to input key data. Departments can be slow to implement b/c they tend to give info but do not get much, yet, entire org benefits from pervasive use.
  - → Not optimized to local physician practice. CMIO thinks it will take two decades to fix the interface. Ophthalmologists cannot draw their diagrams w/new formats, cannot integrate old forms, and complain about loss of diagnostic information.

- Situation is better than should be expected
  - → Nurturing location: El Camino Hospital in Mountain View (Silicon Valley), a community hospital on frontier of EMR, though its size would suggest it should not be….
  - → Good support: Milwaukee hospitals use frontier EMR b/c Epic has HQ in Madison, WI.
  - → Long experience: Major medical center invests in large internal staff to make up for local labor market. Mayo, Cleveland Clinic…

- But these are just examples from the field. Will it show up as general statistical pattern?

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The trillion dollar conundrum

American Economic Journal: Policy, Forthcoming

David Dranove, Northwestern University
Chris Forman, Georgia Tech
Avi Goldfarb, University of Toronto
Shane Greenstein, Northwestern University

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What is the research question?

- What impact do Electronic Medical Records (EMR) have on a key determinant of an existing organization's productivity, such as its operating costs?

- If EMR is viewed through the lens of the productivity paradox, how does that change the understanding of EMR's impact?

What the paper does, the big picture

- Frame EMR as a type of enterprise IT,
  - → Look for evidence consistent with this framing by examining cost-related gains from adoption EMR in detail…
- This type of innovation requires complementary inputs and complementary investments in order to succeed.
  - → When is EMR associated with reduced operating costs or increased operating costs?
- While our empirical analysis focuses on EMR, the key lesson likely applies to any sophisticated health IT.

What we found

Hospitals that adopted EMR between 1996 and 2009 did not experience a reduction in operating costs. This average masks important variation:

1. Costs **rise** immediately following adoption (particularly for the more advanced technologies), and then fall back to pre-adoption levels
2. Hospitals in locations with IT-intensive industry enjoyed a significant **reduction** in costs after 3 years
3. Hospitals in other locations faced a significant **increase** in costs
4. The initial cost increase was smaller for hospitals with IT experience

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Data Sources

We combine data from several sources into an unbalanced panel, annually from 1996 to 2009.

- HIMSS Analytics
- Medicare Hospital Cost Report
- American Hospital Association Annual Survey of Hospitals
- Decennial US Census
- US Census County Business Patterns
- Harte Hanks Computer Intelligence Database

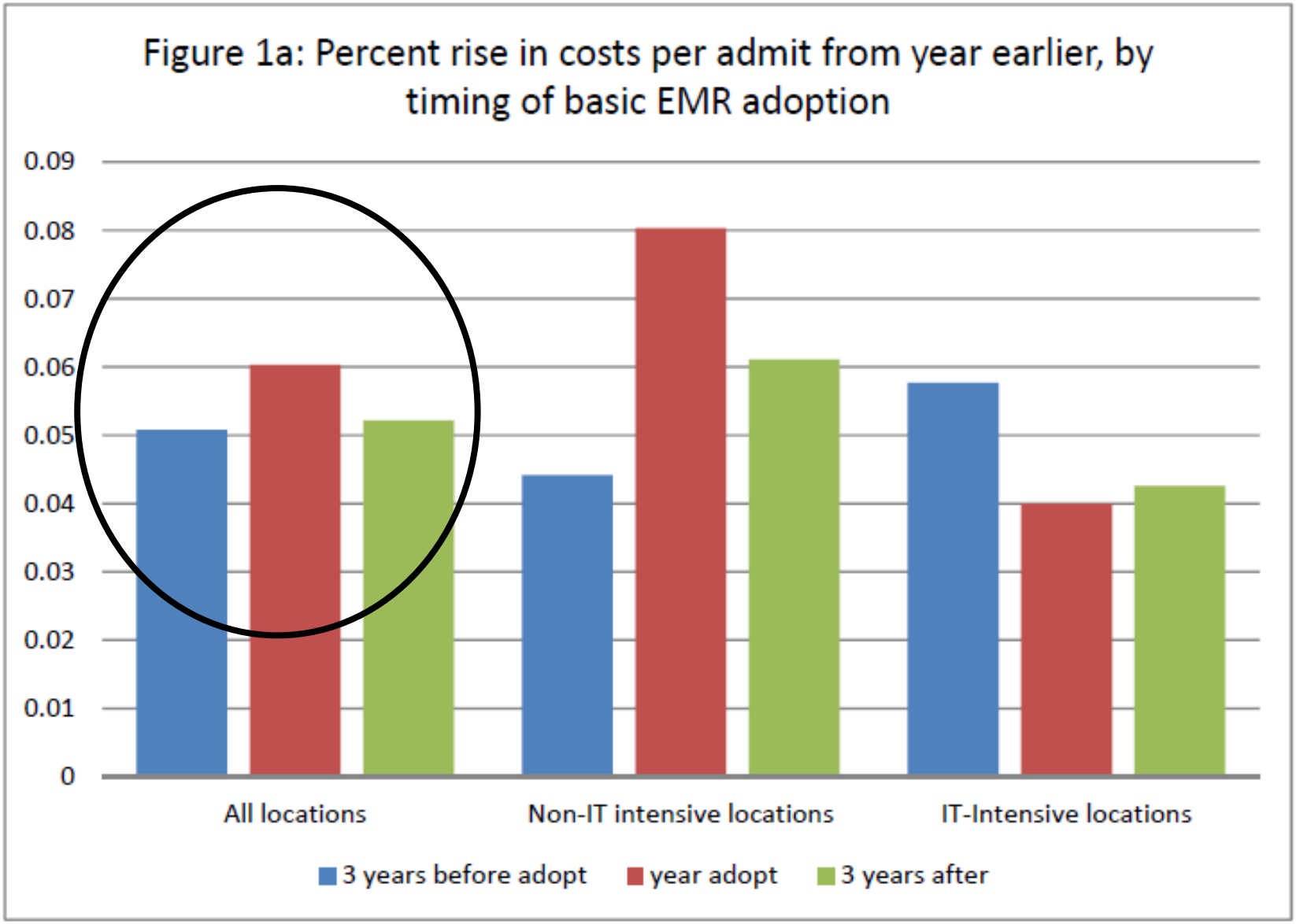
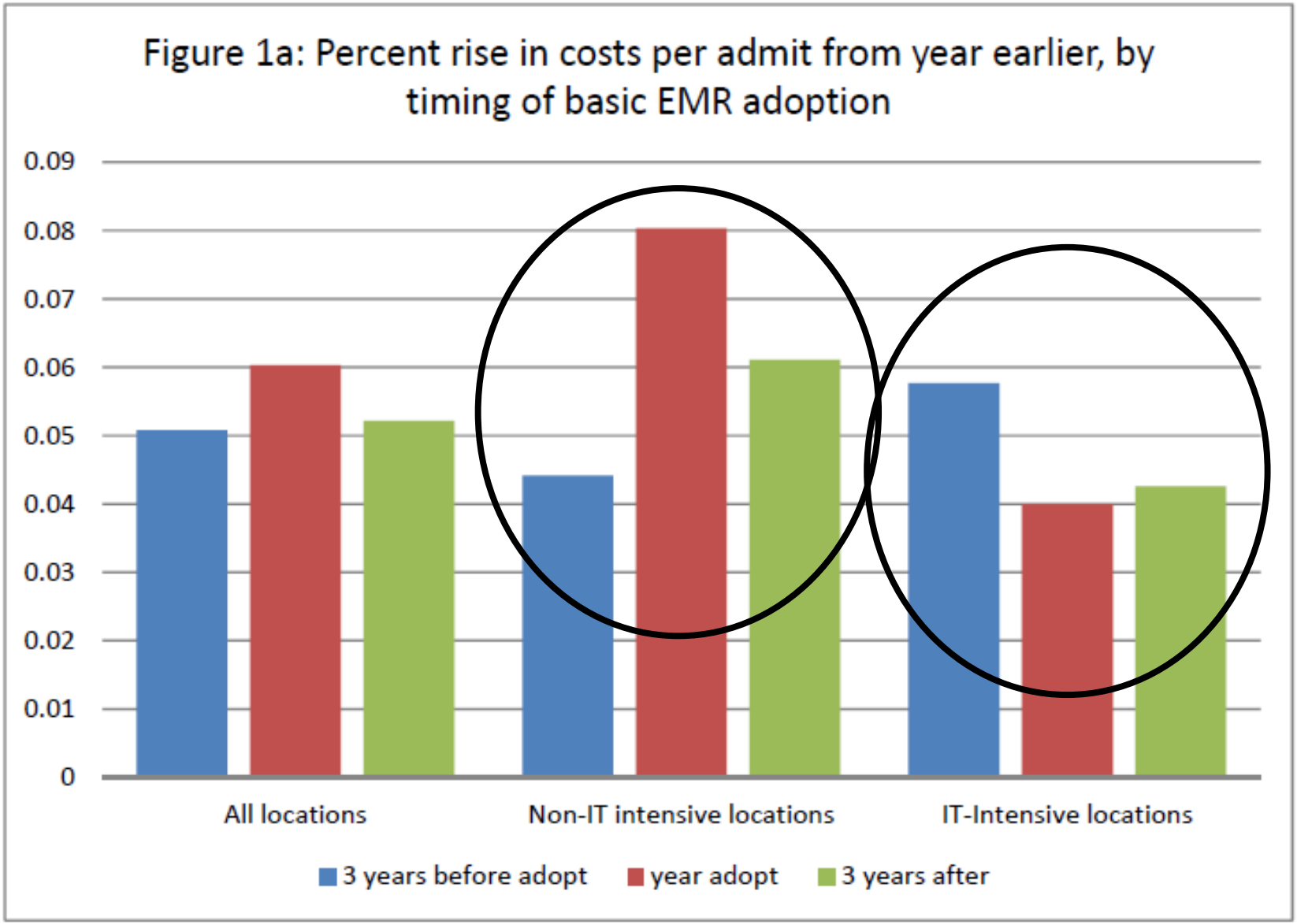


Figure 1a: Percent rise in costs per admit from year earlier, by timing of basic EMR adoption
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
All locations
Non-IT intensive locations
IT-Intensive locations
3 years before adopt
year adopt
3 years after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3 years before adopt
year adopt
3 years after

Correlation or causation?

- Compare hospital costs before and after EMR adoption
- Check that the cost change does not precede EMR adoption
- Control for hospital characteristics and time trends
- Check that costs less related to EMR do not rise

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The math…

Overall effects

$$Log(c_{it}) = \alpha X_{it} + \beta_t X_i + \gamma_t Z_i + \theta EMR_{it} + \tau_t + \mu_i + \varepsilon_{it}$$

- τ_t is a time dummy
- μ_i is a hospital-specific fixed effect
- EMR_{it} is a discrete variable for whether hospital *i* had adopted a particular EMR technology by time *t*.
- X_{it} are controls for hospital characteristics that change over time such as inpatient days and outpatient visits (specified using a translog function).
- X_i are controls for hospital characteristics that we fix at 1996 levels such as beds, hospital type (for profit, foundation), etc..
- Z_i are controls for county-specific characteristics.

- For this part of our analysis, our identification relies on the assumption that any systematic changes in hospital costs after EMR adoption are captured by the changes in the hospital-level controls over time and the time trends for the locations.

Costs and adoption

Table 3: Main effects by technology

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Log total costs per admit	Log total costs per admit	Log total costs per admit	Log total costs per admit	Log total costs per admit	Log total costs per admit	Log total costs per admit
Technology	**CDR**	**CDSS**	**Order entry**	**Basic EMR adoption**	**CPOE**	**Physician documentation**	**Advanced EMR adoption**
Adopted EMR	0.0123 (0.0055)**	0.0114 (0.0059)*	0.0018 (0.0053)	0.0045 (0.0064)	0.0103 (0.0068)	0.0248 (0.0075)***	0.0195 (0.0070)***
Observations	31175	27849	33388	23418	38167	37519	34407
# of hospitals	2964	2679	3161	2228	3653	3597	3306
R-squared	0.58	0.57	0.58	0.58	0.56	0.56	0.56

Unit of observation is hospital-year. Annual data from 1996 to 2009. Regressions include hospital-specific fixed effects, year fixed effects, translog specification of inpatient days and outpatient visits, hospital ownership, hospital type, hospital size, and local demographics. Robust standard errors clustered by hospital.

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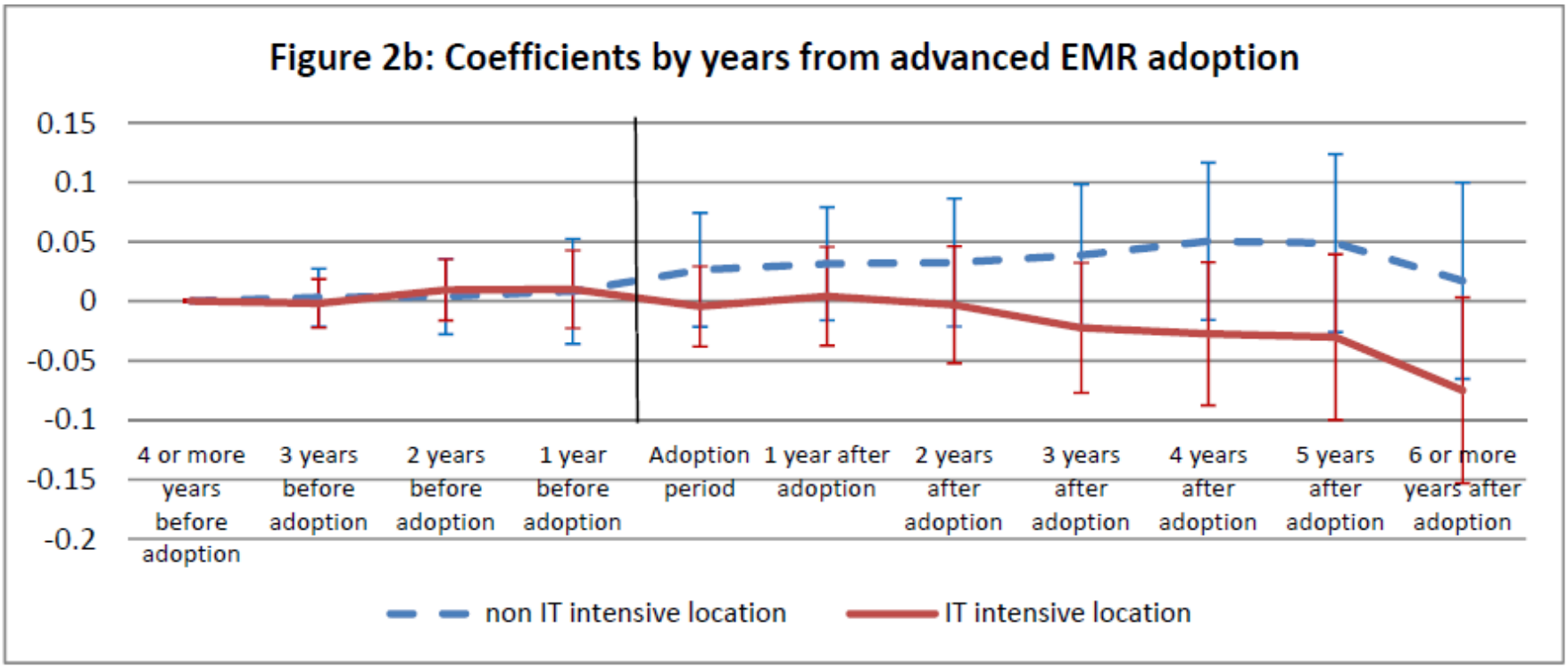
Lots of controls

Table 3: Main effects by technology

	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
	Log total cos adn	Log total	Log total	Log total	Log total	Log total costs	Log total		
Technology	CDI								
Adopted EMR	0.0(								
	(0.0								
Observations	273								
# of hospitals	219								
R-squared	0.6								
CONTROLS									
Log inpatient days	-0.7								
	(0.1								
Log outpatient visits	0.0								
	(0.0								
Log inpatient days x Log inpatient days	0.0								
	(0.0								
Log outpatient visits x Log outpatient visits	0.0(								
	(0.0								
Log inpatient days x Log outpatient visits	-0.0								
	(0.0								
Log total hospital beds x year	-0.0								
	(0.0								
Independent practice assn. hospital x year	-0.0								
	(0.0								
Mngmt service org. hospital x year	-0.0								
	(0.0								
Equity model hospital x year	-0.0								
	(0.0								
Foundation hospital x year	0.0(								
	(0.0								
Log admissions x year	0.0(								
	(0.0								
Births (000s) x year			0.0003	0.0002	0.0000	-0.0004	0.0012	0.0013	0.0014
			(0.0011)	(0.0011)	(0.0010)	(0.0012)	(0.0010)	(0.0010)	(0.0011)
Percent births x year			0.0309	0.0415	0.0309	0.0440	0.0179	0.0172	0.0197
			(0.0118)***	(0.0120)***	(0.0109)***	(0.0130)***	(0.0117)	(0.0124)	(0.0129)
For-profit ownership x year			-0.0069	-0.0069	-0.0071	-0.0069	-0.0076	-0.0076	-0.0078
			(0.0021)***	(0.0021)***	(0.0019)***	(0.0023)***	(0.0019)***	(0.0019)***	(0.0020)***
Non-secular nonprofit ownership x year			-0.0003	0.0001	-0.0002	0.0007	-0.0010	-0.0008	-0.0011
			(0.0016)	(0.0015)	(0.0015)	(0.0017)	(0.0014)	(0.0014)	(0.0015)
Non-profit church ownership x year			-0.0008	0.0003	-0.0005	0.0006	-0.0008	-0.0008	-0.0003
			(0.0019)	(0.0020)	(0.0018)	(0.0022)	(0.0017)	(0.0018)	(0.0018)
Number of discharges Medicare (000s) x year			-0.0013	-0.0011	-0.0015	-0.0012	-0.0015	-0.0014	-0.0014
			(0.0005)**	(0.0005)**	(0.0005)***	(0.0006)**	(0.0005)***	(0.0005)***	(0.0005)***
Number of discharges Medicaid (000s) x year					(0.3924)	(0.3992)	(0.3713)	(0.4332)	(0.3557)	(0.3630)*	(0.3841)
Number of discharges total (000s) x year					0.5103	0.2070	0.4160	0.3233	0.5502	0.6673	0.5732
Residency/Mmbr Council Teaching Hosps x year					(0.4312)	(0.4386)	(0.4081)	(0.4760)	(0.3910)	(0.3990)*	(0.4222)
Year 1997					0.5459	0.2083	0.4412	0.3392	0.5846	0.7150	0.6105
					(0.4704)	(0.4783)	(0.4451)	(0.5190)	(0.4266)	(0.4354)	(0.4606)
Year 1998					0.6055	0.2447	0.4910	0.3812	0.6536	0.7956	0.6831
					(0.5096)	(0.5182)	(0.4823)	(0.5624)	(0.4623)	(0.4717)*	(0.4990)
Year 1999					-0.0084	-0.0080	-0.0076	-0.0078	-0.0065	-0.0068	-0.0072
					(0.0017)***	(0.0017)***	(0.0016)***	(0.0019)***	(0.0016)***	(0.0016)***	(0.0017)***
Year 2000					0.0006	-0.0002	0.0005	0.0002	0.0001	-0.0001	0.0001
					(0.0007)	(0.0007)	(0.0006)	(0.0008)	(0.0006)	(0.0006)	(0.0006)
Year 2001					0.0099	0.0116	0.0090	0.0095	0.0134	0.0147	0.0139
					(0.0068)	(0.0066)*	(0.0064)	(0.0069)	(0.0061)**	(0.0063)**	(0.0066)**
Year 2002					-0.0081	-0.0076	-0.0099	-0.0075	-0.0085	-0.0057	-0.0059
					(0.0049)	(0.0049)	(0.0047)**	(0.0052)	(0.0045)*	(0.0045)	(0.0047)
Year 2003					-0.0592	-0.0397	-0.0436	-0.0404	-0.0479	-0.0522	-0.0436
					(0.0192)***	(0.0199)**	(0.0182)**	(0.0211)*	(0.0175)***	(0.0178)***	(0.0185)**
Year 2004					0.0157	0.0034	0.0193	0.0071	0.0162	0.0271	0.0232
					(0.0152)	(0.0143)	(0.0149)	(0.0149)	(0.0142)	(0.0148)*	(0.0155)
Year 2005					0.0822	0.0810	0.0821	0.0763	0.0851	0.0880	0.0865
					(0.0226)***	(0.0220)***	(0.0212)***	(0.0237)***	(0.0202)***	(0.0206)***	(0.0214)***
Year 2006					-0.0013	-0.0116	-0.0094	-0.0066	0.0029	0.0067	0.0106
					(0.0152)	(0.0158)	(0.0145)	(0.0171)	(0.0139)	(0.0145)	(0.0153)
					-0.0051	-0.0009	-0.0048	-0.0025	-0.0058	-0.0078	-0.0069
					(0.0046)	(0.0046)	(0.0044)	(0.0050)	(0.0042)	(0.0042)*	(0.0044)
					13.5173	13.7717	13.5496	14.3606	13.3371	13.4341	13.4861
					(0.9396)***	(1.1750)***	(1.1345)***	(1.2214)***	(0.9068)***	(0.9100)***	(0.9416)***

Timing



Zero identifies costs for non-adopting hospitals

"Advanced adoption" is Stage 4 (CPOE, physician documentation)

Robustness

- Our main identification assumption has been that EMR adoption is not correlated with unobservable cost factors that are differentially trending in hospitals with complementary inputs relative to hospitals that lack these inputs. We explore this (and general robustness) in a variety of ways, including:

- Instrumental variables:
  - → Adoption by other hospitals in same buying alliance
  - → Adoption by other hospitals in same system
  - → Distance of hospital to the nearest EMR vendor HQ
- No controls
- More time-varying controls
- Drop observations with any missing controls
- Only eventual adopters
- Drop high HIT locations
- Only hospitals that appear in all years
- Adjust for case mix of medicare patients

Our interpretation

- Findings help resolve the ongoing debate between supporters and detractors of EMR.
  - → Both sides have seemed to treat EMR as if its impact on costs and patient outcomes is independent of other environmental factors, as if it either works or it doesn't.

- Our results suggest that the debate about EMR can be usefully reframed by drawing on the general literature on enterprise IT.
  - → Using this experience, it is not surprising that EMR can simultaneously have the potential to generate a variety of outcomes, *both substantial savings yet demonstrate mixed results in practice*.

Maybe health isn't so different…

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Maybe health isn't so different…

Just several years behind?

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Maybe health isn't so different…

Just several years behind?

This is an opportunity to learn from past mistakes in enterprise IT!

If we view health IT as another type of enterprise IT

Then we can draw more lessons from the experience of businesses with data and analytics.

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Allocate information and decision rights throughout the hierarchy

Put promotion processes in place that reward correct interpretation of data rather than championing specific ideas

Let data drive management decisions, (not just medical decisions)

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Generate and test hypotheses about management

Then run experiments

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EMR, Analytics, and more…

- Health analytics and big data have the potential to substantially transform healthcare
- But buying the technology is the easy part
- Successful use of healthcare IT involves changing the way the organization operates and significant "co-invention" that adapts technology to your organization's specific needs
- These changes are difficult and require skill and expertise
- Without patience, and a rich local pool of such skills, the full benefits of healthcare analytics will likely be elusive

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Thank you

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