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From health care capital to innovation hub: Positioning Nashville as a leader in health IT

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Summary

Among U.S. advanced industries, significant attention has begun to focus on the promise for local economic development of a number of regional "health IT"(HIT) or "digital health" clusters. Given their promise, several regions have begun to implement strategies to strengthen local HIT clusters.

One metropolitan area that concentrates singular HIT assets is Nashville, Tennessee.

A national center of hospital management, the Nashville area possesses important expertise relevant to HIT, including in clinical care, disease management, behavioral health and wellness, diagnostic testing, data management, and the management of physician transactions. At the same time, the region's university-based medical research lacks a heavy focus on IT, its solid medical and health business workforce remains thin on software competencies, and the area's emerging tech ecosystem has not fully integrated efforts to sustain small-firm growth in HIT.

Given that, this report finds that metropolitan Nashville possesses a unique opportunity to leverage its strengths in health management in developing a unique HIT cluster. To that end, the report assesses Nashville's current positioning on HIT and recommends three actions by which Nashville (and other metros) strengthen their HIT ecosystem. These steps include:

- Expand the region's innovation infrastructure

- Build the HIT skills base

- Deepen the HIT ecosystem

Introduction

Rooted in the founding of the Hospital Corporation of America, Nashville's unique health care cluster encompasses 15 publicly traded companies that own and operate nearly 40 percent of all investor-owned hospitals in the United States, and more than 4,000 establishments engaged in some form of the business management and delivery of care.[1] National care networks that extend out of Nashville provide inpatient and outpatient clinical care, disease management, behavioral health and wellness services, diagnostic testing, physician transaction management, and other back-office functions that together

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1. Murat Arik, "Health Care Industry Nashville MAS 2015: Trends, Scope, and Impact on Regional Economy" (Nashville: Nashville Health Care Council, 2015).

distinguish the region as the managerial nerve center for industry-defining decisions.

Massive changes underway in the U.S. health care system are shifting the competitive landscape, however, opening up new opportunities for some regions and undermining traditional strengths in others. Information technology (IT) is playing a revolutionary role in these trends, and in Nashville, health IT (HIT) represents a unique and potentially major source of new growth and opportunity.

The opportunity for Nashville revolves around multiple areas of competitive advantage: large and stable health care companies making major investments in IT; substantial flows of high-value products and services generated in the region and sold through its extensive networks in national markets; and a high concentration of health-related research at Vanderbilt University. All position the region to emerge as a center for inno-vation in HIT.

During the last decade, moreover, Nashville has taken significant steps to strengthen its entrepreneurial ecosystem, creating the Entrepreneur Center and attracting aspiring technology developers. With venture capital funds that specialize in health care and the recent decision to headquarter the Center for Medical Interoperability in the region, Nashville has assembled a strong portfolio of relevant assets.

The region's traditional strengths in health care management imbue it with significant expertise in every aspect of how the system works—knowledge that should provide important competitive advantages even over regions with more extensive IT capabilities. However, its traditional strengths also pose potential barriers. Its major proprietary health care systems compete against one another, making collaboration difficult, and, in the face of disruptive change, Nashville's present success and the dominance of legacy industries could hamper movement into new directions. Further, studies of the region's workforce have found significant skill gaps and weaknesses in IT fields, where both wages and pay increases have exceeded other sectors.[2]

This project is part of a series of studies that have examined the IT industry and workforce in Nashville, exploring how best to position the region as a national hub for leadership in HIT. Drawing from interviews and a series of roundtable discussions with more than 30 local leaders in health care and related fields, as well as national

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2. See, for example, KPMG, "Strategies to Address the Health Care Information Technology Workforce Shortage" (2011).

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industry experts at McKinsey & Co. and other firms, the present report first summarizes a series of national trends that are creating new opportunities for innovation in the use of data, analytics, and IT for the management and delivery of health care, prevention, and access. The report then reviews the current state of the Nashville health, health management, and HIT sectors. It defines the sector expansively to explore areas where IT could empower health care firms and industries and to explore the current state of the field and growth trajectory in Nashville. Drawing on new analytics, the report then takes the measure of Nashville industries in these areas and compares the region with selected other regions in terms of capacity for innovation, workforce, and the overall economic ecosystem in the area.

The closing section summarizes challenges and opportunities for Nashville and offers potential action steps. The section adds to other voices urging the region to adopt a comprehensive strategy to pursue a larger role in this rapidly growing market. The question for Nashville, as one entrepreneur put it, is whether it will "step up its game" to emerge as a national hub for innovation in the use of data, analytics, and IT for health care.
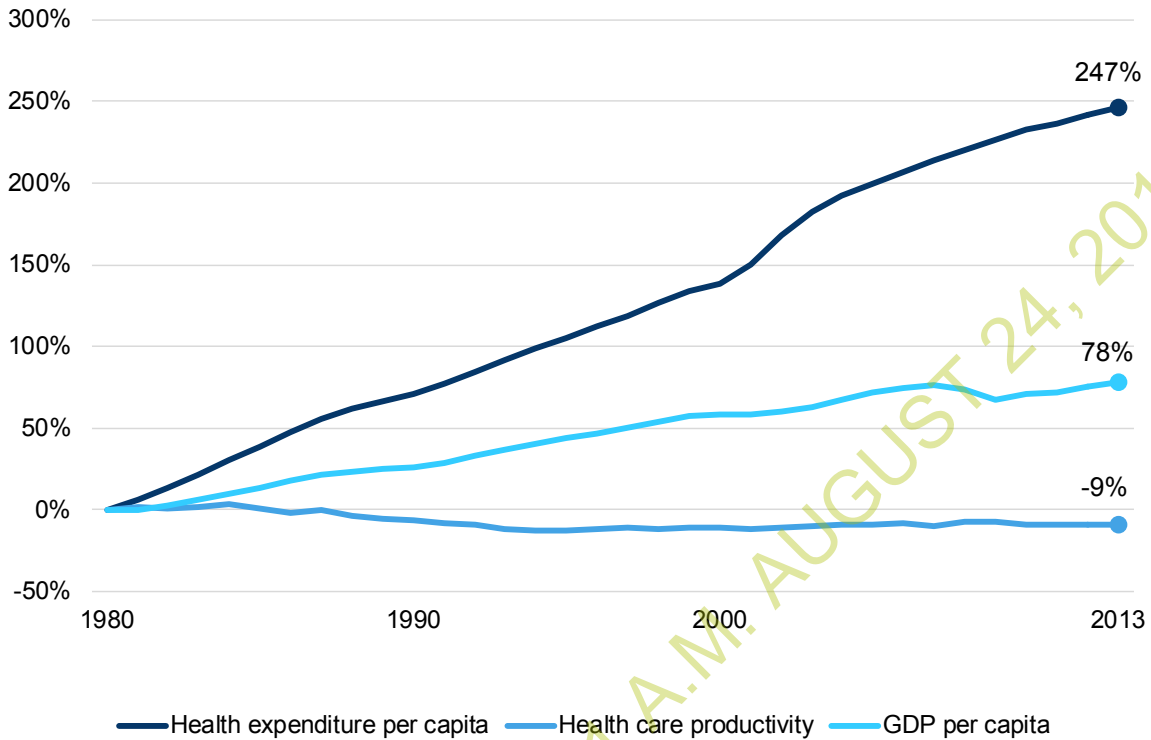
Forces at work in health care

Health care as an economic activity has been both an asset and liability to metro-politan regions and the nation. On the one hand, employment growth in the sector has outstripped most other segments of the economy.[3] On the other hand, the nation's health care costs continue to rise too fast, while productivity lags. As Figure 1 shows, health care costs have increased at a higher rate than gross domestic product (GDP) each year for the past three decades—a fundamentally unsustainable pace, although the rate of growth in health care costs has slowed significantly in recent years. Productivity growth is lower than in any other sector of the economy, with the exception of construction, and a significant body of research has highlighted areas of weakness in terms of the quality of care, the prevalence of medical errors, and inconsistent access to care and outcomes. [4]

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3. In the 10 years preceding 2014, employment in the health care sector grew by 24.8 percent, while the economy as a whole grew only 5.8 percent. Brookings's analysis of Moody's Analytics estimates.

4. Brenda Buescher and Patrick Viguerie, "How U.S. Healthcare Companies Can Thrive Amid Disruption" (Detroit: McKinsey & Co., 2013).

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Figure 1. Healthcare costs and productivity growth
2010-2013

Legend: Health expenditure per capita — Health care productivity — GDP per capita

Data points: 247%, 78%, -9%

Source: Brookings analysis of Centers for Medicare and Medicaid Services and Moody's Analytics data

The passage of the Patient Protection and Affordable Care Act in 2010 inaugurated an era of unprecedented expansion in access to both care and health insurance. It also signaled the government's intent to drive health care toward a value-based system based on health outcomes, threatening the margins of underperforming providers. For example, under the law, the Centers for Medicare and Medicaid Services (CMS) appropriated $10 billion annually to value-based care reforms, and CMS aims to have value-based payments represent one-half of all Medicare reimbursements by 2018.[5]

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5. For example, among exchange plans created by the law, Medicare Advantage margins are four times higher for 4+ star (high-quality) plans than lower-quality plans. Other programs include the Accountable Care Organization model, the Medicare Shared Savings Program (MSSP), and the Bundled Payments for Care Improvement (BPCI) initiative. These programs are growing. In 2014, 220 organizations participated in MSSP and more than 7,000 in BPCI. The U.S. Department of Health and Human Services set a goal of tying 50 percent of payments for traditional Medicare benefits to value-based payment models by 2018. See Wendy Gehardt and others, "The Road to Value-Based Care" (Washington: Deloitte, 2015).

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This section discusses the larger forces unleashed as a result of both these historic changes in public policy and the mounting pressures from consumers, payers, and employers for change, and the potential role of IT in reshaping nearly every aspect of health care.

With the influx of millions of new patients and the rapid decline in the number of uninsured Americans, the new risk-sharing and value-based payment models spreading through the system will disadvantage firms that cannot analyze, improve, and document outcomes. These pressures essentially create a "big data" race among payers, providers, and auxiliary services such as medical device manufacturers. Larger, integrated health care systems formed through a wave of mergers and acquisitions, as well as more complex partnerships, will reward operational efficiency. In addition, with the emergence of interoperable IT systems and new payment models, firms will need smarter revenue management and systems for tracking and analyzing the massive quantities of data produced on the "business side" of health care. Finally, and perhaps most important, the onset of consumer-driven care will create incentives that elevate the digital delivery of care and other nontraditional locations and business models, particularly outside hospital settings.

Together, these trends require that both insurgent and incumbent health care companies take their HIT capabilities seriously and adopt new levels of sophistication in the collection, analysis, and use of health data.

## Cost and productivity pressure is intensifying

Beyond the basic economics of health care, new reimbursement models are creating downward pressure on profit margins and driving care providers to reduce operating costs and improve efficiency. During the last decade, new models of risk-sharing, including capitation and value-based care, have begun to replace the fee-for-service system, in which hospitals were paid for volume, not necessarily value. Deloitte has estimated that by 2025 value-based payments will represent one-half of all provider compensation.[6] With time, greater risk-sharing and outcome-driven payment structures—and, eventually, population health management—will reward providers that can apply data to improve outcomes and cost-effectiveness.

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6. Gehardt and others, "The Road to Value-Based Care." For example, Aetna invests 15 percent of its revenue in value-based care and intends to increase that to 47 percent by 2017. Blue Cross Blue Shield health plans spend $65 million annually on value-based care, or 20 percent of the company's spending on claims.

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At the same time that the industry is under pressure to cut costs, demographic forces are also affecting the health care system's traditional business models and sources of revenue. Health care companies have traditionally made most of their revenue from employer-based health insurance plans, which provided higher payments than government-sponsored plans or direct payments by individuals. However, as Figure 2 shows, an increase in individually purchased care and an aging population are shifting care away from high-value, employer-based coverage. Between 2000 and 2014, the number of consumers with employer-sponsored insurance declined by 14 percent, while those covered by Medicare and Medicaid increased by 105 percent and 89 percent, respectively.[7] Spending on Medicare for older and disabled Americans has outpaced growth in employer-sponsored coverage as the baby boom generation has started to reach retirement age. Similarly, the expansion of Medicaid coverage for low-income Americans under the Affordable Care Act has substantially increased the number of patients with coverage, but Medicaid also typically provides lower fees to providers than private insurance.[8] Moreover, the temporary increase in Medicaid fees under ACA has now expired, eliminating the initial bump in reimbursements for primary care services.

Figure 2. Health insurance coverage by type
2000-2014
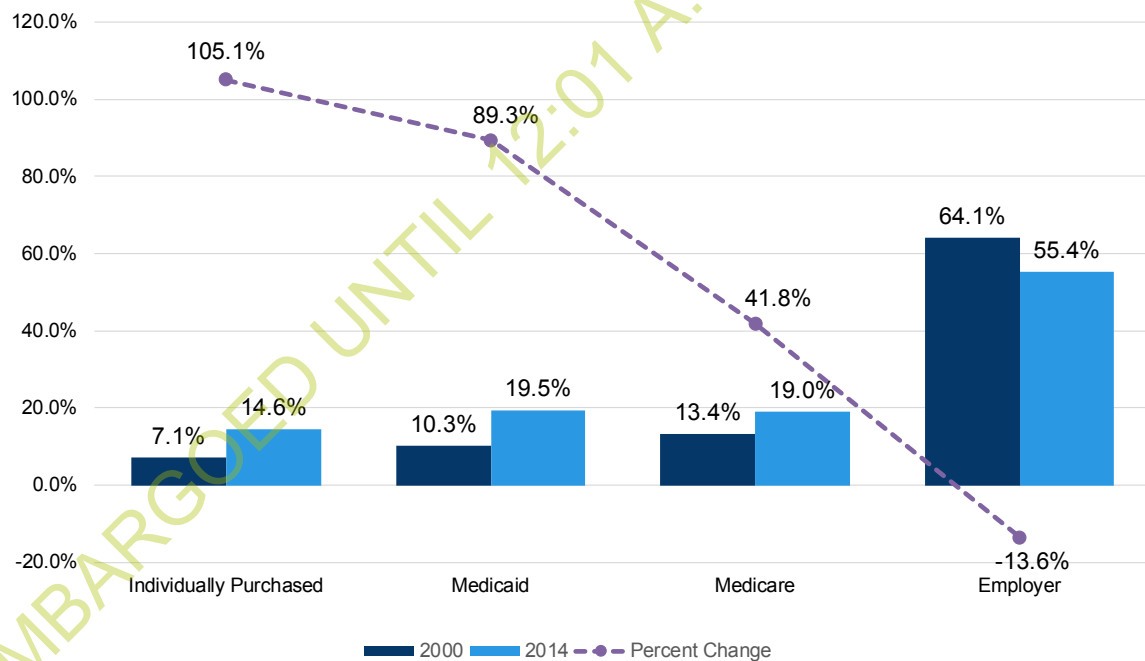
Source: U.S. Census Bureau, "Health Insurance Coverage in the United States: 2000-2014."

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7. Michelle Long and others, "Trends in Employer-Sponsored Insurance Offer and Coverage Rates 1999-2014" (Washington: Henry Kaiser Family Foundation, 2016).

8. Centers for Medicare and Medicaid Services, "NHE Fact Sheet" (2013)..

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According to research by McKinsey & Co., the expansion of risk-sharing and reduced reimbursement rates will together require hospitals and health care systems to reduce operating costs during the next decade by 5 to 10 percent.[9] Increased costs and the move toward value-based care will further pressure providers, payers, and vendors to find ways to drive efficiency. A critical mechanism for doing so will lie in better information technology. Firms will need to invest in IT systems and the skilled workforce capable of gathering, analyzing, and leveraging the use of data to improve efficiency and manage costs.

New provider relationships and payment structures are increasing organizational complexity

The market for health care in the United States rewards scale. In 2014, hospital and health care systems with more than $5 billion in revenue generated margins nearly 2 percentage points higher than those with less than $1 billion in revenue (see Figure 3).[10] The surge of market consolidation through mergers, acquisitions, and affiliation strategies has strengthened providers and created scale. As providers lose some of their ability to set prices, consolidation strategies offer them greater bargaining power with payers, cushion against the high variation in operating performance among individual physicians and institutions, and provide the scale needed to meet ongoing capital requirements.[11]

However, provider systems are growing not only in size but also in complexity as a result of the wide range of nontraditional partnerships and affiliations emerging along every

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9. Bede Broome and others, "Clinical Operations Excellence: Unlocking a Hospital's True Potential" (Washington: McKinsey & Co., 2013).
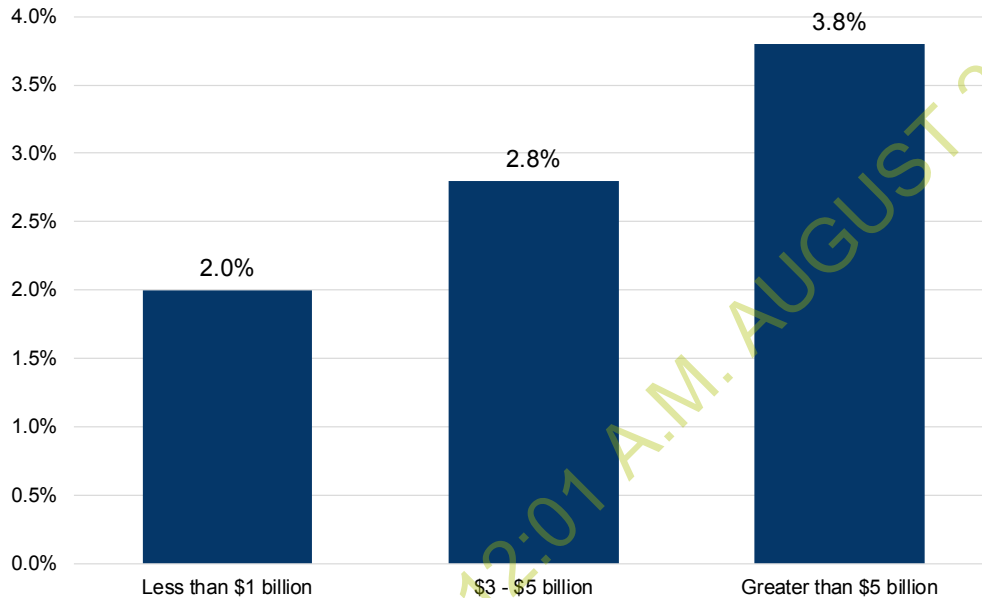
10. Irving Levin Associates, "The Hospital Acquisition Report 2014" (2014). Another metric that suggests the market rewards larger hospital systems is the ratio of downgrades to upgrades by credit rating agencies. Between 2010 and 2011, the ratio of downgrades to upgrades for hospital systems with more than $3 billion in revenue was 0.75:1. This compares with 2.7:1 for systems with less than $500 million in revenue. Rupal Malani, Anna Sherwood, and Saumya Sutaria, "The Smarter Scale Equation" (Washington: McKinsey & Co., 2013).

11. As payers try to rein in costs and consumers choose or find themselves with higher deductible plans, narrow networks have emerged to provide patients access to a limited number of providers in exchange for lower premiums or out-of-pocket costs. Large provider systems are better positioned to offer narrow networks while smaller providers are increasingly boxed out. David Knot and others, "Maximizing Value in High-Performance Networks" (Washington: McKinsey & Co., 2014).

point on the care continuum.[12] As the industry continues to consolidate and reconfigure networks of care, the demand for comprehensive data and IT to manage these complex systems will increase.

Figure 3. Margins by hospital size
2014

Source: Irving Levin Associates, Inc., "The Hospital Acquisition Report 2014."

New insurance markets and expanded access to coverage also increase demand for more sophisticated revenue-management systems, particularly as consumers take on greater responsibility for co-payments and higher deductibles. Adding to these challenges are legacy inefficiencies in revenue management within the health care sector. Prior to ACA, some estimates put the cost of revenue cycle errors at 15 cents for every dollar and indicated that close to one-half of all physician-based payments were neither automated nor digitalized.[13] In contrast, in the retail sector, where more than 99 percent

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12. Between 2013 and 2014, health care M&A deals increased in value by 136 percent to $386 billion. Irving Levin Associates, "Health Care Deal News, 2014: A Record Year for Health Care M&A" (2015).

13. Ibid.

of transactions are automated, billing and payment transaction costs account for less than 2 percent of revenue.[14]

A critical reason for the limited capacity to manage revenue is that prior to health care reform, hospitals considered most debt incurred by uninsured patients as largely unre-coverable. The expansion of insurance coverage under ACA and shifts in cost-sharing in employer-sponsored plans mean that more consumer debt will be from patients whose insurance covers some but not all of their health care bill.[15] The potential for recovering payment from them has been far higher than from uninsured patients, but the systems required to collect are more complex.

In order to reduce the estimated $4 billion written off every year as bad debt, health-care providers will need to move from a "wholesale" model primarily revolving around collections from insurance companies to a "retail" model focused on payments from individuals.[16] This will necessitate greater price transparency and the ability to accurately estimate patients' ability to pay for service. Developing that capacity will entail substantial investments in revenue-cycle management (RCM) software, data warehousing, and a specialized workforce.

In addition, new payment structures and cost-sharing in the wide variety of insurance plans available to consumers on federal and state health care exchanges, through commercial markets and employers, increase the complexities of coding and billing, which will challenge traditional operating procedures. Maintaining margins increasingly will depend on appropriate investments and new systems to handle these complex back-office functions throughout the health care system.

Consumer-driven care is reshaping health care delivery and value

The third major trend affecting the health care sector is the transition to consumer-driven care. The creation of state and federal health care exchanges, insurance subsidies, and

14. Matthew Bayley, "Hospital Revenue Cycle Operations: Opportunities Created by the ACA" (Washington: McKinsey & Co., 2014).

15. McKinsey research suggests that by 2018 the passage of the Affordable Care Act will double the amount of bad debt that is balance-after-insurance (BAI) from 15 to 35 percent. Matthew Bay-ley, "Hospital Revenue Cycle Operations."

16. Bayley, "Hospital Revenue Cycle Operations."

the individual insurance mandate under ACA have turned individually purchased plans into the fastest growing segment of the market. By 2017, it is estimated that nearly one in five Americans will purchase benefits from a health insurance exchange.[17]

As more consumers purchase their own coverage, their demands increase for more options, greater simplicity, and greater access to cost-effective care, often with the effect of driving premiums down and deductibles and other forms of cost-sharing up.[18] Between 2014 and 2015, the number of insurance products offered on the federal and state exchanges increased by 26 percent, and in one-half of the states that reported data, the number of new products grew by two-thirds.[19]

Competition for consumers is rising as well. McKinsey & Co. research has predicted that in 60 percent of markets, the current price leader will be usurped by a competitor within 12 months.[20] The onset of consumer-driven health care is creating opportunities for new entrants to capture market share throughout the value chain. For example, retail chains such as Walgreens and CVS are aggressively moving into clinical care. CVS's Minute Clinics have grown at an average rate of 18 percent annually during the last several years, and between 2007 and 2013, patients using retail clinics increased by 133 percent.[21] In addition to convenience, the primary reason for such growth is cost: a typical visit to an urgent care clinic costs five times less than the average emergency room visit.[22]

As more consumers absorb a greater share of the cost for insurance premiums, deductibles, and out-of-pocket payments, they are demanding that health care catch up to other consumer markets in terms of digital access and convenience, price transparency, and service. In addition, smartphones and tablets are beginning to function as diagnostic tools.[23] Mobile devices can lower costs and put an increasing amount of care delivery, from monitoring to diagnosis, into the hands of patients. Such health IT features will

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17. Richard Birhanzel, Scott Brown, and Joshua Tauber, "Are You Ready? Private Health Insurance Exchanges Are Looming" (New York: Accenture, 2013).

18. PriceWaterhouseCooper, "Top Health Industry Issues of 2014: A New Health Economy Takes Shape" (2013).

19. McKinsey & Co., "2015 OEP: Emerging Trends in the Individual Exchanges" (2014).

20. Ibid.

21. PriceWaterhouseCooper, "Top Health Industry Issues of 2014.".

22. Brookings's interviews with McKinsey & Co., May 2015.

23. Eric Topol, The Patient Will See You Now: The Future of Medicine is in Your Hands (Basic Books, 2015).

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shift the focus of care in ways that are impossible to predict, except that they are clearly increasing the role of consumers in health care decisions. For example, Health Partners, a Minnesota-based nonprofit health maintenance organization (HMO), has developed "Virtualwell," which uses algorithms to diagnose and customize treatment plans that are delivered online to patients for more than three dozen conditions at a cost of $40.[24]

With the increased demand for digital care, data security and privacy are becoming paramount concerns for the health care system. Currently, information breaches in health care cost the industry $5.6 billion annually.[25] Lost or stolen data not only violates privacy agreements between patients and care providers—as well as the law under the Health Insurance Portability and Accountability Act (HIPPA)—but it also significantly undercuts patient-provider trust and brand loyalty. Although consumers are prone to forgive retailers who lose control of their data, they are far less willing to do so when it comes to their personal health information. Going forward, the interplay between consumer-generated data (often mobile and stored in the cloud) and data warehouses owned by providers and electronic health-record systems will grow more complex. Firms also will find it difficult to balance proprietary systems with the demand for interoperability and the easy transfer of data, particularly records that patients technically own.

Tech companies are also entering traditional health care markets with new digital products that may produce important innovations in the delivery of care. HeartFlow, a Silicon Valley start-up run by a former Google executive, has created a 3-D modeling system that can digitally test for coronary disease at 40 percent the cost of a standard, and invasive, cardiac catheterization.[26] Although pure-play technology companies struggle to obtain the necessary clinical knowledge to innovate in health care applications, they are making significant strides and ratcheting up competitive pressures. As Brookings scholar Jonathan Rauch has written, "Health care is beginning to taste the disruptive culture of Silicon Valley, retailing, and many other American sectors."[27]

24. PriceWaterhouseCooper, "Top Health Industry Issues of 2014."

25. Ponemon Institute, "Fourth Annual Benchmark Study on Patient Privacy & Data Security" (2014).

26. Richard Waters, "Health Tech Start-ups Target Internet Talent," Financial Times, June 7, 2015.

27. Jonathan Rauch, "Disruptive Entrepreneurship Is Transforming U.S. Health Care" (Washington: Brookings institution, 2015).

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The information technology challenge and opportunity

Clearly, the landscape of health care is changing rapidly. Responding to market forces and public policy decisions, the industry is under tremendous pressure from payers, employers, and consumers to increase the efficiency and effectiveness of care. In achieving those goals, IT will play an increasingly important role—and Nashville now faces an opportunity to participate deeply.

To say IT has disrupted nearly every other sector of the economy is an understatement. Yet its most disruptive opportunities are yet to come in health care, a field that has lagged behind in adopting IT and data-driven innovation.[28] Providers, payers, and suppliers across the care continuum are ramping up investments in data, analytics, and IT and finding abundant opportunities to carve out value and increase quality and productivity throughout the system. At the same time, other regions—Silicon Valley, Pittsburgh, Austin, Indianapolis, among others—are amassing strong assets and talent in a space in which Nashville also has assets, and they are moving rapidly to establish footholds in health care.

Emerging opportunities in HIT cross three major segments:

- Information technology—reducing costs through automation, better quality control, and operational improvement. Even the relatively simple application of revenue management or workforce optimization software to medical billing and nurse scheduling holds the potential to save billions of dollars. In the near term, providers and payers will continue to invest in back-office solutions such as revenue cycle and risk management tools. Over the next five years, Nashville could strengthen its IT services capabilities and bolster the development of new offerings in this area with incumbent provider systems.

- Preventive care and wellness, along with personalized medicine and other advances such as genomic testing, represent a second opportunity for new IT applications to change consumer behaviors. IT innovation is also increasing competition in this incumbent-heavy sector through the development of new digital platforms, greater consumer choice, and the growing ability to shop, compare, and critique the quality of care online. Health care providers will

28. For a comprehensive review of the impact of IT on these industries and more see Robert Atkinson and Daniel Castro, "Digital Quality of Life: Understanding the Personal and Social Benefits of the Information Technology Revolution" (Washington: Information Technology and Innovation Foundation, 2008).

need to adapt to new delivery models and venues, including retail settings. Nashville has the opportunity to lead the next wave of change in these areas by strengthening its capabilities in platform-level software development in close collaboration with care providers.

- Finally, rapid advances in data analytics will allow patients and providers to better understand and predict the interplay among myriad diagnostic variables, with data collection, cognitive computing, and medical device technology anticipated to transform diagnostics and treatment. Within this expansive area, Nashville can build on its extensive networks of care providers and delivery systems, world-class research institutions, strong concentration of diagnostic laboratories, and other relevant areas to develop new capabilities in data-driven medicine and health management.

Health IT in Nashville

Macroeconomic and demographic forces are reshaping health care and dramatically widening the potential applications of IT within the sector. Going forward, the role of IT in health care will encompass not only hospital information systems and electronic health records, but also a broader set of solutions, from revenue management to care delivery and clinical process redesign. Each of these emergent applications represents a major opportunity for Nashville—if Nashville can align its assets and mitigate its deficits.

Defining HIT

It first bears asking, what is HIT and what does it look like in Nashville? To gauge Nashville's full potential in this emergent field one must look beyond traditional health care companies, given that those regions best poised to excel in the new HIT landscape will have strengths both in health care and fields auxiliary to health. For example, in addition to care providers and IT firms, management consultants, accounting firms, health care payers, and diagnostic laboratories all have the potential to be extremely active and vital players in the HIT economy.

The HIT sector will require capabilities in management, accounting, operations, clinical processes, and care delivery, as well as software development and IT services. Therefore, this analysis defines the HIT sector broadly (see box) as a collection of 13 HIT-related industries that house these capabilities.

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Defining and sizing the HIT sector's potential reach

Defining the HIT sector is a difficult task. A good sector definition should capture emerging applications of IT to health care, along with a web of firms often hailing from different industries. In actual fact, the scope of the HIT sector—the technologies and firms it encompasses—evolves as new applications of IT emerge.

Standard approaches to sector analysis do not work well for HIT. The potential universe of firms is too large for firm-by-firm analysis, and the North American Industry Classification System (NAICS), defined and updated by the federal government and typically used for sector analysis, does not capture more recent permutations and evolution in the use of IT within health care. For these reasons, Brookings' definition of the HIT sector intentionally errs on the side of breadth with the goal of encompassing the full universe of firms potentially engaged in this sector.

In this vein, the present definition covers 13 NAICS industries (see Table) concentrated around three key areas: (1) IT and software firms, (2) health care providers, and (3) business services. Close exam-ination of a sample of the largest employers in each of these areas indicated that the majority of these firms is involved in health care related activities.

| NAICS Code	Industries in Brookings' definition of the HIT sector
5112	Software publishers
5182	Digital transactions, data warehousing, and related services
5412	Accounting, tax preparation, and payroll services
5415	Computer systems design
6221	General medical and surgical hospitals
5614	Business support services
5191	Other information services
5241	Insurance carriers
5419	Other professional, scientific, and technical services
4242	Drugs and druggists' merchant wholesalers
6214	Outpatient care centers
5416	Management, scientific, and technical consulting services
6215	Medical and diagnostic laboratories

In any event, the present analysis places a broad swath of companies and functions in three-major HIT fields:

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- **Information technology and software**, including software design, data analytics, data management, and data warehousing;

- **Clinical and health care delivery**, including hospitals, outpatient care centers, and diagnostic labs;

- **Relevant business services**, ranging from professional services and accounting to insurance carriers.

Figure 4. Job growth in HIT
2010-2014
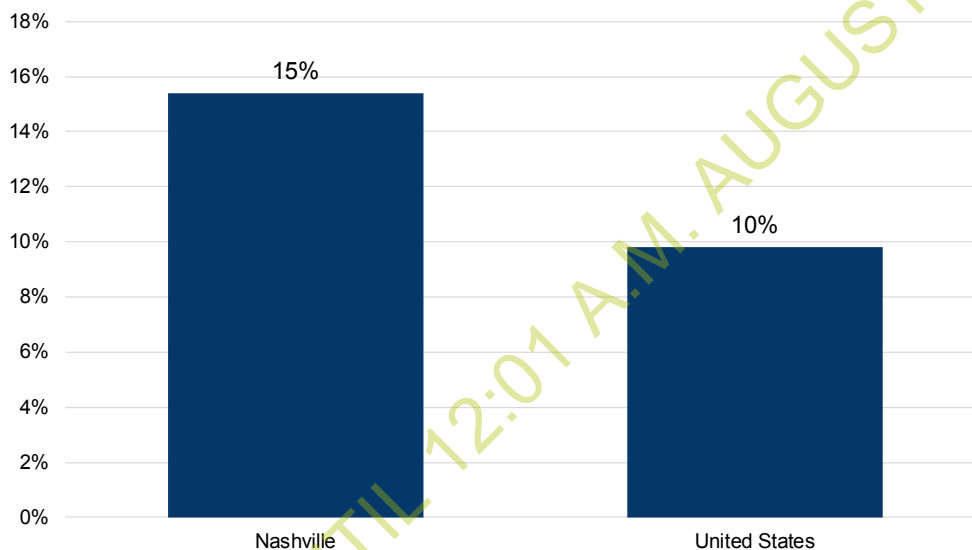
Source: Brookings's analysis of Moody's Analytics data.

Sizing the sector

Taken together, establishments in the 13 HIT-related industries account for as many as 106,000 jobs and nearly $12.6 billion in economic output for the Nashville metro area, encompassing more than 10 percent of both employment and gross metropolitan product (GMP) in the region.

Nationally, the HIT sector has grown faster than the overall economy in the post-recession years (2010 to 2014), and also faster than the traditional health care sector. This trend is even more pronounced in Nashville, where HIT-sector employment rose 15 percent between 2010 and 2014—more than 5 percentage points faster than the equivalent growth

rate nationally (see Figure 4). Similarly, during that period, economic output (or GMP) in Nashville's HIT sector expanded by 27 percent, almost double the national rate.[29]

To benchmark this progress, a group of 10 peer metro areas was assembled and includes both potential competitors and recognized industry leaders (see map and Table 1).[30] Among these regions, Nashville ranks near the middle in HIT sector job growth, with a growth rate faster than in Birmingham, Kansas City, and Boston but slower than in technology powerhouses such as Austin, San Jose, and Raleigh.

Relative strength of Health IT Sector
Nashville and peer metros
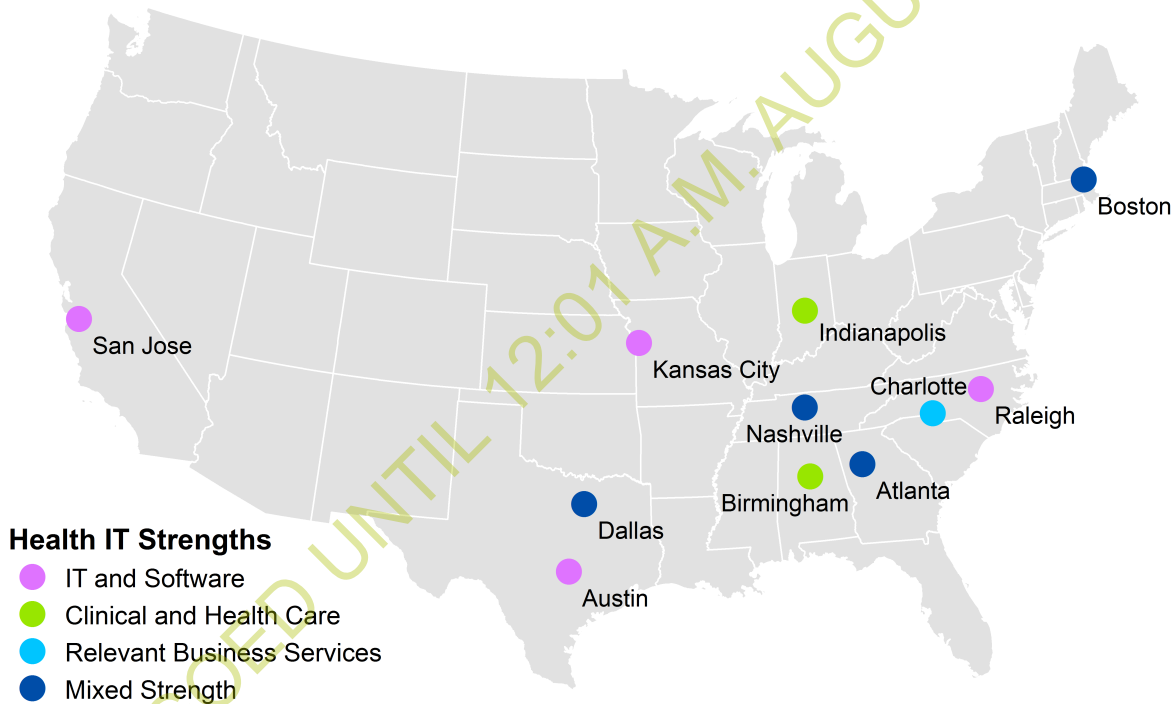
Source: Brookings analysis of Moody's Analytics data

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29. Although the HIT sector has experienced tremendous growth in Nashville, its manufacturing sector has grown even faster, given the post-recession growth of the automotive industry.

30. Brookings arrived at the list of 10 peer metro areas through a multipronged process involving interviews with local and national experts, and analysis of the size, expertise, and industry composition of each metro area's economy.

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**Table 1. HIT sector employment and growth in Nashville and peer metros**
2010-2014

Peer Metropolitan Areas	Total Jobs, 2014	HIT Sector Jobs, 2014	HIT Sector Job Growth, 2010-2014
Austin, Texas	790,800	73,870	39.6%
San Jose, Calif.	872,470	135,100	33.4%
Raleigh, N.C.	504,650	51,960	29.4%
Atlanta, Ga.	2,288,060	252,670	16.9%
Charlotte, S.C.	963,510	70,420	16.7%
Dallas, Texas	2,953,970	289,860	15.8%
Nashville, Tenn.	779,720	91,680	15.4%
Indianapolis, Ind.	919,710	92,300	10.5%
Boston, Mass.	2,423,700	330,530	10.4%
Kansas City, Mo.-Kan.	978,970	104,290	10%
Birmingham, Ala.	496,850	48,750	2.8%

Source: Brookings's analysis of Moody's Analytics data.

Breaking the Nashville HIT sector down

The pace of growth varies widely across the different segments of the HIT sector. From 2010 to 2014, employment in Nashville's **IT and software industries**—which include software publishers, digital transactions processing, and computer systems design services—grew by 37 percent. In relevant **business services industries**—which include consultancies, accounting firms, and insurance carriers—employment expanded by 25 percent. However, among **health care delivery industries**—including hospitals, clinics, and what can be referred to as "traditional" health care—jobs only grew by 2.4 percent (see Figure 5).

Figure 5. Job growth in Nashville's Health IT component industries
2010-2014
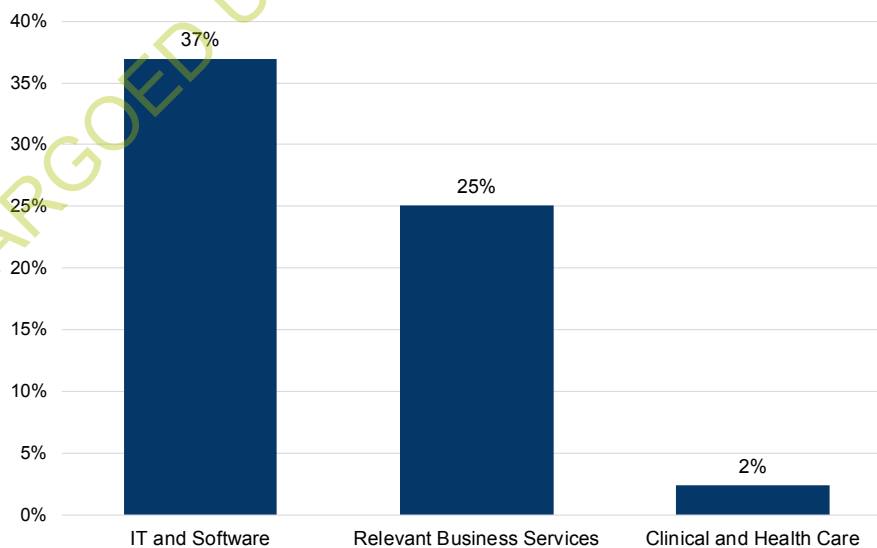
Source: Brookings analysis of Moody's Analytics data.

Percentage growth rates mask some of the trends underway in the region. Although the IT and software segment has achieved a rapid growth rate, its expansion occurred from a base of only 9,900 jobs, the smallest among any of the comparison metro areas with the exception of Birmingham. Within this segment, the software publishing industry is a case in point. It grew by more than one-third (35.6 percent) in Nashville between 2010 and 2014, but that expansion began from an extremely small base of 1,100 jobs.

The largest number of jobs within the IT and software segment falls under the computer systems design industry, which primarily consists of in-house IT departments in companies across all sectors of the economy (see Table 2). In Nashville, computer systems design jobs have seen the highest growth rate since the recession, a trend common to other peer metro areas as well.

The digital transactions (or data processing) industry is a potential area of specialization for Nashville. It employs twice the number of workers one would expect given Nashville's size, indicating high concentration in the region. The industry has experienced 9 percent annual growth since the end of the recession and includes firms such as Change Healthcare (formerly Emdeon).

In contrast to IT and software, companies in the relevant business services segment have grown from a much larger base of 37,600 jobs in 2010 to 47,000 jobs by 2014 (see Table 2). Within this segment, accounting, consulting, and drug wholesalers have seen the fastest growth. For example, accounting, a core part of payroll management within HIT and by far the largest business services industry with 11,600 jobs, achieved growth of 33.4 percent between 2010 and 2014. Consulting services also stands out for its even higher growth rate of 47.1 percent—although it started at a base with one-half as many jobs as in the accounting industry.

The segment of the HIT sector directly involved in clinical and health care delivery has grown much more slowly than the other segments. One reason is that much of the health care delivery segment consists of care providers that serve local patients. That is, they make up the nontraded part of the economy, where growth is generally linked to population growth.

On the other hand, some parts of Nashville's health care delivery segment, such as clinical and diagnostic labs, are export-oriented, selling goods and services to other

countries and regions within the United States. This industry has fared well; it experienced rapid growth of 48.6 percent between 2010 and 2014, driven by firms that provide services nationally, such as Aegis Labs (see Table 2). In Nashville, there are 2.2 times as many jobs in diagnostic labs as would be expected given the region's size, suggesting that much of this activity is serving markets and customers from beyond the region, and indicating another area of high concentration for Nashville.

Table 2. Employment, growth, and job growth; Nashville's HIT component industries
2010–2014

HIT Segment	NAICS Code	Industry	Jobs, 2014	Job Growth, 2010-2014	Location Quotient*
IT and software	5182	Digital transactions	3,540	9.0%	2.02
	5112	Software publishers	1,530	35.6%	0.78
	5415	Computer systems design	8,170	60.2%	0.73
	5191	Other information services	274	-30.1%	0.20
Relevant business services	5416	Professional services	7,040	47.1%	0.90
	5412	Accounting services	15,540	33.4%	2.57
	4242	Drugs merchant wholesalers	2,650	30.3%	2.15
	5419	Other professional services	4,200	25.4%	1.05
	5241	Insurance carriers	8,940	13.2%	1.09
	5614	Business support services	8,650	9.7%	1.58
Health care delivery	6221	General hospitals	36,250	-1.5%	1.28
	6214	Outpatient care centers	5,540	9.4%	1.25
	6215	Diagnostic laboratories	3,480	48.5%	2.21

Source: Brookings analysis of Moody's Analytics data.

*The location quotient is the ratio of an industry's share of total jobs in Nashville to that industry's share of total jobs nationwide. A location quotient substantially above 1 means an industry is particularly concentrated within the Nashville metro area.

In sum, the HIT sector makes up a substantial share of Nashville's economy and has been one of its core strengths. The sector helped the region grow rapidly after the recession and outperform the nation as a whole. Within the sector, however, trends diverge. Software jobs have grown rapidly but from a low base while relevant business services represent a much larger, and growing, portion of the economy. Finally, the more traditional health care industries within HIT have grown at a more moderate pace owing

largely to the nontraded elements of health care. HIT is changing the health care landscape, and Nashville's mix of HIT industries provides multiple opportunities for the region to thrive in this new environment.

Strengths and weaknesses in Nashville's HIT sector

The changes underway in the U.S. health care system are shifting the competitive landscape for regions, opening up new opportunities for some metro areas and undermining traditional strengths in others. The questions for Nashville leaders are what role will the region play in the rapidly evolving competition to establish a specialized hub for HIT, and what steps can the region take to bolster its HIT ecosystem to pursue that goal? This section assesses the vibrancy of the region's HIT sector on three key dimensions: innovation capacity, talent base, and ecosystem quality. It does so with an eye to identifying areas ripe for concerted investment by the region's civic, business, and political leadership.

The HIT innovation infrastructure is patchy

Creating new products, improving existing processes, and translating research into commercial activity happen differently in HIT than in other areas of health care. This reality introduces unique hurdles to establishing a dynamic HIT cluster. In the pharmaceutical or medical device industries, the commercialization of new technologies follows a linear path from research in universities and small biotechnology firms to acquisition by larger drug or device companies.[31] In these fields, time horizons are long, but the process of innovation is fairly regimented.

Innovation in HIT is far less predictable and more multimodal, occurring in universities, hospitals, and health care firms, among entrepreneurs, and at companies in adjacent sectors, such as those involved in business transactions. That wide variation means the level of network connectivity among many potential innovators is as important as the direct investments and sponsored activities of any firm or institution.

Direct investments matter, however, and by some measures Nashville excels on this front. Among the selected peer regions, only Boston and Austin have higher absolute

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31. Gary Pisano, The Business of Science: The Promise, the Reality, and the Future of Biotech (Cambridge: Harvard Business School Publishing, 2006).

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levels of university R&D. Nashville attracts higher R&D investments than peers such as Indianapolis, Dallas, and Charlotte.[32] Nashville receives more R&D funding per dollar of GMP from the U.S. Department of Health and Human Services than any of the peer metro areas, outperforming second-place Boston by more than one-third (see Figure 6). Nashville's concentration of research skews heavily toward health-related activities.

More than 80 percent of all university-based R&D in the region occurs at Vanderbilt University, which has a substantial research base primarily centered in medicine and biotechnology.[33] Vanderbilt conducts nationally notable work in precision medicine and has a strong health informatics department, both of which are relevant to HIT.

Figure 6. HHS R&D funding per $1,000 of GDP
2013

Source: Brookings's analysis of U.S. Department of Health and Human Services data.

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32. Brookings analysis of data from the Higher Education Research and Development Survey, National Science Foundation.

33. Ibid.

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Despite the area's undeniable strengths in health-related research, the impact of that research on the HIT economy is limited. Although Vanderbilt's work in precision medicine has clear links to HIT, much of its medical research occurs within its organic chemistry and life sciences departments, rather than in fields specifically related to information technology. Of technologies available to license from the university, according to the university's tech transfer website, only a handful of more than 350 are related to HIT.[34]

In addition, the level of engagement with the private sector at Nashville's research universities is comparatively low. In 2014, the private sector funded less than 2.5 percent of university R&D in the Nashville region—less than one-half the average among the top 100 metro areas nationally.[35] In recent years, Vanderbilt has made strides in engaging the private sector more, but in 2011 it ranked 89th among research universities in the country for patents generated per research dollar expended.[36] Meharry Medical College research is almost exclusively funded by the federal government and maintains a minimal technology transfer office. Several leaders in Nashville technology and venture capital firms interviewed for this report consistently noted challenges associated with commercializing HIT technologies emerging from Vanderbilt and other research institutions.

To be fair, nearly all academic medical centers have far to go in commercializing research and making technology transfer offices effective links to the business community. Yet, with its strong engineering and computer science programs, Nashville's research universities could be more powerfully engaged in HIT product development and innovation.

The lack of connectivity between the business and research community would make sense if the major health and diagnostic firms in the region were not investing in HIT, but that does not appear to be the case. Most of the major Nashville health care companies interviewed reported that one of their fastest growing areas of investment is software. For example, in a major health management company, IT and software investments have grown nearly four times faster than revenue for the last several years. Similarly,

34. The Center for Technology Transfer and Commercialization, "Technologies for Collaboration" (Nashville: Vanderbilt University, 2015). HIT patent and licensing applications are fewer at nearly all academic medical campuses. Nonetheless, Vanderbilt's significant R&D assets largely reside in medical devices and the life sciences.
35. Brookings analysis of data from the Higher Education Research and Development Survey, National Science Foundation.
36. Association of University Technology Managers, "2011 Technology Transfer Statistics" (2012).

firms in the broader HIT cluster—including diagnostic labs and IT firms—are expanding their digital capacities to capture new opportunities. Change Healthcare (formerly Emdeon), for example, recently acquired Altegra Health's cloud-based data and analytics platform to combine Altegra's risk-adjustment tools with its own revenue cycle management and payment solutions products.[37]

Figure 7. Number of patents in IT methods for management
2008-2012
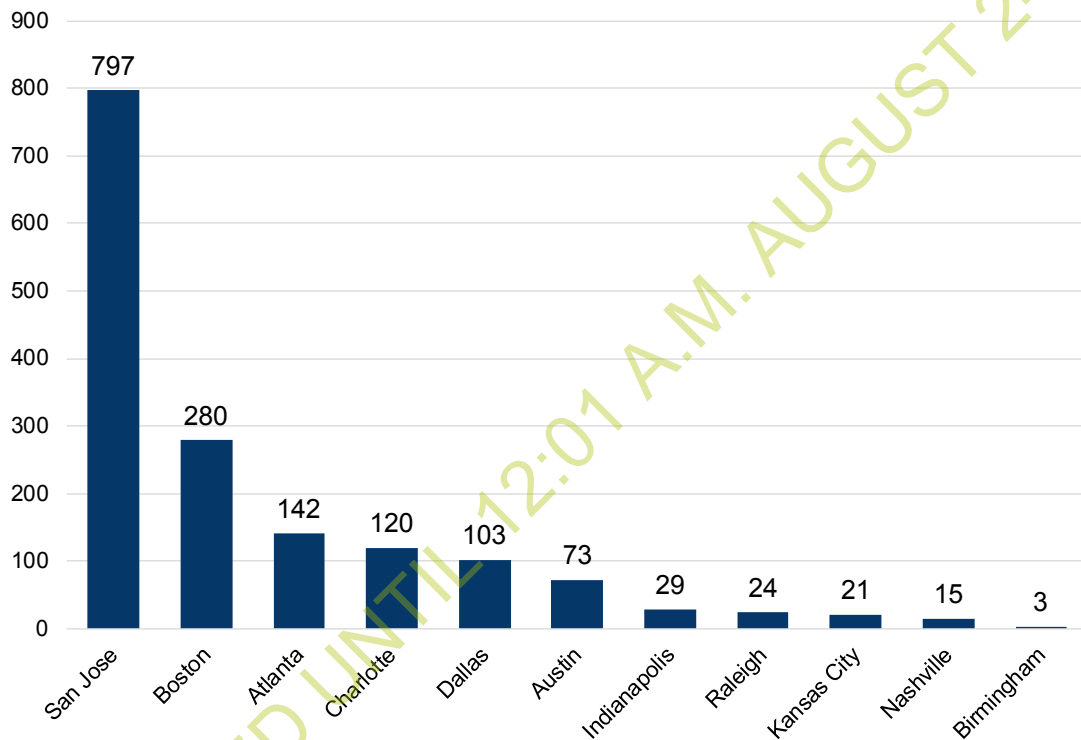
Source: Brookings's analysis of OECD RegPat database.

Patent filings whose reported invention dates fall between 2008 and 2012. Patents after 2012 are excluded because data are not reliably complete given the time lag between invention and patent filing. A five-year interval is used to account for year-to-year fluctuations in inventions.

Despite evidence that major firms are investing in IT and related capacities, the spillover effects into the larger business ecosystem are more limited. Innovation investments to the region's software and Software-as-a-Service (SaaS) sectors remain thin. Patents

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37. Emil Kubis, "Emdeon Buys Health Care Analytics Company for $910," Nashville Post, July 6, 2015.

issued for medical technologies in Nashville are roughly similar to those granted to inventors in other focus regions, but this innovation has not led to new inventions specifically in software. As Figure 7shows, the region ranks behind all but Birmingham in patents filed for "IT methods for management."[38] Although it is true that many health care companies rely on trade secrets, not patents, to protect internal intellectual property in their software systems, that fact simply explains the overall low levels of patenting in IT, not Nashville's comparatively low level amid its peer regions. The reality is that limited patenting in digital technologies points to a weakness in software development, a key driver of innovation in the HIT sector.

Figure 8. Information technology export royalties
2014, $Millions
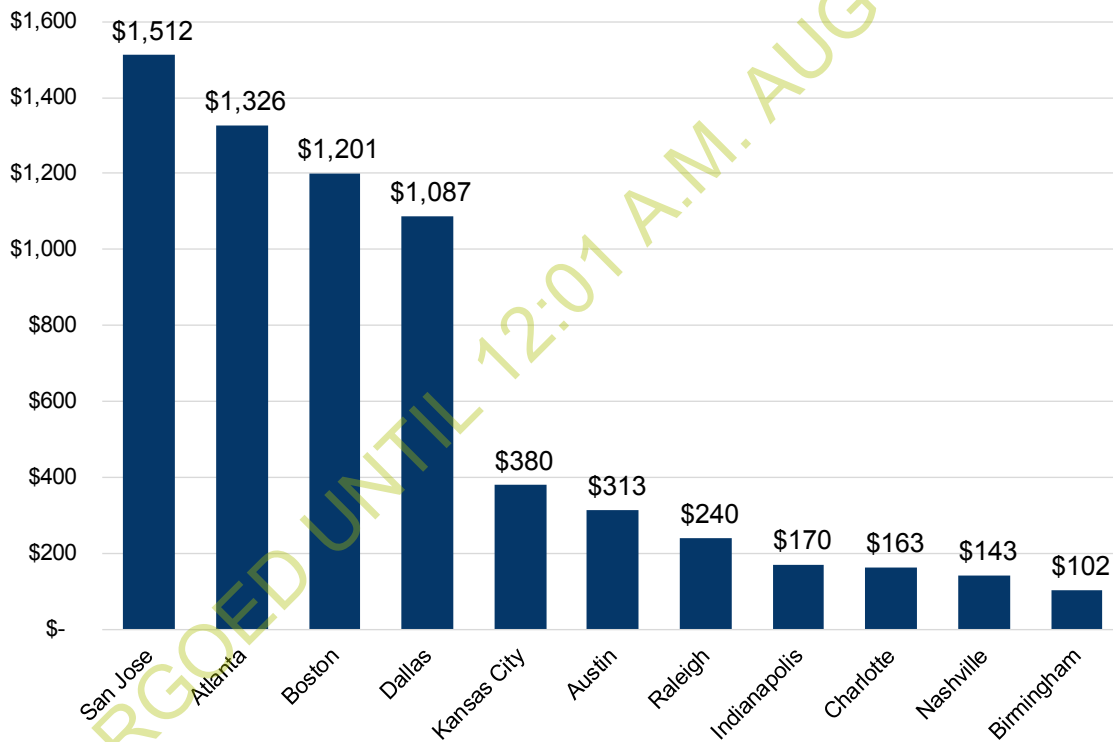
Source: Brookings "Export Monitor 2015."

The region's weakness in software is also apparent in its high-value exports that are a product of technology development. Nashville leads its peer regions in the exports of

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38. Brookings's analysis of Organization for Economic Co-operation and Development REGPAT data, 2015.

accounting and auditing services, and in particular medical services, where Nashville exports at least 50 percent more than would be expected given the region's size.[39] Yet it ranks below all other peer metro areas for exports in both information services and information technology royalties (see Figure 8).

One potential explanation for the paucity of digital patenting, licensing, and software exports is that much of the IT used by major health care companies in Nashville is designed, patented, and purchased from software vendors outside the region. As one Nashville-based software company put it, "There are situations where the best IT solution could exist in small Nashville companies, but because the large health care firms react to active marketing—which is outside the budgets of small companies—it's extremely hard to get on the radars of companies right here in Nashville." In this respect it is unrealistic to argue that some of the country's largest health care management firms should only purchase from local vendors. Still, fostering higher levels of interaction and greater synergy across these organizational boundaries could open new avenues for economic development in the region.

New forms of partnership between software and health care firms of all sizes represent a potential approach to enriching the region's innovation ecosystem. For example, allowing access to noncommercial clinical data or tackling regional health analytic challenges—even approaching these issues from a corporate social responsibility perspective—could lead to important knowledge-sharing between larger firms and the nascent software sector, while protecting firms' proprietary interests.

Skills and workforce demand

The HIT sector encompasses a range of skill sets and occupations, from revenue cycle and accounting specialists supporting digital transactions, to medical technologists and diagnosticians integrating medical devices into digital systems, to software developers pursuing new back-office solutions and mobile apps geared to consumers.

Each metropolitan area developing HIT capabilities faces unique workforce dynamics. Silicon Valley clearly leads the nation in the size and level of talent available for software development. Nashville, by contrast, has unique strengths as a result of the large

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39. Brookings Institution, "Export Monitor 2015" (2015).

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numbers of senior executives experienced in all aspects of health care management. However, the region needs to complement its unparalleled expertise in health care functions and business management with critical digital competencies.

In 2011, in this vein, the Nashville Health Care Council, Chamber of Commerce, Technology Council, and KPMG published "Strategies to Address the Health Care Information Technology Workforce Shortage," which found that, "A unique skill-set is necessary in order to be an effective HIT employee, including a blend of technical know-how and functional expertise within clinical practices, operational process, or both. For example, an effective HIT workforce would have experience in both database design as well as hospital care pathways, in project management as well as hospital operations, or even software development/design and payer/provider reimbursement structures."[40] Given this perspective, the study determined that 80 percent of firms surveyed in the region faced an inadequate supply of talent. Brookings's analysis broadly corroborates these findings, revealing both areas of strength and weakness across different segments of Nashville's HIT talent pool.

Since the recession, wages in the Nashville HIT sector have grown 4.9 percent after adjusting for inflation, compared with a decline of 0.2 percent for the region as a whole, indicating a tightening HIT labor market.[41] The most significant local wage increases have occurred in software publishing and data processing, whose wages increased by 72.7 percent and 25.9 percent, respectively, indicating strong market demand for talent in these fields. Nationally, wages in these fields increased only 5.3 percent and 3.2 percent, respectively, during the same period. Today, Nashville's HIT-related software industries pay an average of $98,700 annually—twice the average wage for the Nashville economy as a whole.

The region also has clear strengths in health care management, diagnostic, and clinical knowledge. Nashville ranks second only to Birmingham among peer regions in the number of workers in occupations categorized as "high value" to the diagnostic labs industry.[42] Birmingham is a national center for pathology laboratories, which explains its

40. KPMG, "Strategies to Address the Health Care Information Technology Workforce Shortage."

41. Brookings analysis of Moody's Analytics data.

42. We define occupations of "high value" to HIT industries as those that are both particularly concentrated in these industries and at the same time account for a significant share of industry jobs. Throughout, we define occupations as "high value" when they make up at least one of 100 jobs in the industry and are at least five times as concentrated within the HIT industry as in the overall economy.

position, but the number of workers of high value to diagnostic labs in Nashville exceeds those in other regions that are also noted centers for lab-related industries, including Boston and Indianapolis.

What is encouraging is the high-skilled nature of the region's prominent occupations. More than in any peer region, Nashville's mix of workers in medical and diagnostic fields skews toward occupations with higher STEM (science, technology, engineering, and math) skills.[43] Nashville leads comparable metro areas in the STEM-intensive occupations of clinical laboratory technologists, laboratory technicians, and medical and health service managers. These occupations are important to the region's overall ecosystem because they support technology applications and development related to health care. In 2014, STEM occupations paid an average of $65,770 annually, which is 50 percent higher than the average wage in Nashville for all occupations.

The region also has a large share of occupations in fields related to medical records and health information technicians, which are considered low-skilled positions but are rapidly becoming essential to HIT. A decade ago, health information technicians primarily performed data entry functions. Today, with the right industry credentials, these workers maintain electronic health records, update software, and oversee coding for reimbursement billing.

Nashville also leads its peers in occupations that are important to digital transactions in fields such as accounting and payroll management, with nearly 10,000 workers in these occupations. Workers in these fields are skilled in understanding reimbursements and complex payments, a skill that is increasingly necessary as payments and reimbursements grow more complex. That only major national IT centers such as Boston and San Jose have a larger workforce than Nashville in payroll and accounting activities further suggests Nashville's competitiveness in a critical dimension of HIT. As a leader in a Nashville-based digital reimbursement company put it, "Health IT is about understanding the complex world of payments as much as anything else."

Software skills, by contrast, appear less available. Even though IT workers are well compensated in Nashville, the region has relatively few of these workers compared with other regions. With only 36 skilled workers in software fields per 1,000 workers in its workforce, Nashville ranks second to the bottom among peer metro areas in its overall capacity for this work.

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43. For more on measuring STEM skills, see Jonathan Rothwell, "The Hidden STEM Economy" (Washington: Brookings Institution, 2013).

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Software application developers, network architects, programmers, and computer system analysts are among the fields with least representation in the Nashville work-force—and all are high-skilled jobs critical to the development of HIT products and services. Workers in these fields often focus on identifying and solving market and management issues. Those are bodies of work that generate high rates of entrepreneurship and emerge from companies with large numbers of these occupations.

Table 3. Employment comparisons in high value digital industries

Occupations of High Value to IT and Software Industries	Jobs per 1000 Workers		Nashville as Share of Peer Average
	Nashville	**Average across Peers**	
Software developers, systems software	1.50	7.00	21%
Software developers, applications	3.20	10.4	30%
Computer network architects	0.80	1.70	48%
Web developers	0.70	1.30	51%
Database administrators	0.60	1.30	52%
Computer programmers	2.00	3.60	56%
Network and computer systems administrators	2.30	4.00	58%
Computer occupations	1.10	1.70	63%
Computer systems analysts	4.70	6.80	70%
Computer user support specialists	4.40	6.30	70%
Computer and information systems managers	3.30	4.50	74%
Computer network support specialists	1.60	2.10	75%
Sales representatives, services	6.10	7.40	82%
Sales representatives, wholesale, technical products	4.00	4.00	101%

Source: Brookings's analysis of Occupational Employment Statistics data, Bureau of Labor Statistics.

The software sector in Nashville is nascent, which explains the low numbers in many of these areas. However, even after controlling for the size of the relevant industries, Nashville's workforce has significantly fewer IT workers in HIT-related endeavors than peer regions (see Table 3). In fact, Nashville has 4,100 fewer IT workers than would be expected given the size of the region's IT and software industries, which also rank among the smallest across the peer metro areas.

The low number of IT workers is somewhat surprising given that 11 colleges and universities in the region offer degree or certificate programs related to computer and information science, including Vanderbilt, Meharry Medical College, and Middle Tennessee State University. The latter three all have IT programs associated with their

medical schools. Across the metro area, the number of graduates in computer-related fields nearly doubled between 2010 and 2013 albeit from a low base.[44]

Lipscomb University responded to increased health industry demands for IT security analysts by creating the region's first undergraduate major in Information Security,[45] and Belmont University partnered with Tennessee Health Information Management System Society—the state association for HIT industries—to create the HIT Accelerator Program, developing its curriculum jointly with local industry to meet the changing requirements of HIT jobs in Middle Tennessee.[46]

Although important, these programs are small and not producing the number of graduates needed, and most are operating as pilot programs rather than as full-scale, comprehensive programs. With the exception of the Accelerator, too few of Nashville's HIT programs have developed strong ties or working partnerships with regional employers that lead to apprenticeship programs, internships, and joint industry–university programming.

Consistent with the findings of the 2011 HIT workforce study and the 2015 report by the Nashville Chamber of Commerce, the present analysis concludes that the region's pipeline of HIT workers is far too small to meet the growing sector's needs.[47] Across the metro area, only 1.8 percent of all students graduated with degrees or certificates, at any level, in computer and information sciences in 2013.[48]

A more thorough analysis shows that the skill portfolio of Nashville's HIT workforce is highly uneven. The region has an overabundance of workers in health management, diagnostics, and support services occupations and significantly fewer in IT. If unaddressed, the lack of software talent in the Nashville region represents a fundamental constraint on its future economic growth trajectory.

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44. Brookings's analysis of Integrated Postsecondary Education Data System (IPEDS) data.
45. For more information, see Lipscomb University's course guide for the Information Security major: www.lipscomb.edu/technology/information-security-undergraduate.
46. For more information on the HIT Accelerator Program, see http://tnhimss.org/hit-accelerator-program/.
47. "Strengthening the Middle Tennessee Region 2020: Building a Vital Workforce to Sustain Economic Growth and Expand Opportunity" (Nashville: Nashville Chamber of Commerce, 2015).
48. Brookings's analysis of Integrated Postsecondary Education Data System (IPEDS) data.

Nashville's IT ecosystem is underdeveloped

Regional clusters or "ecosystems" of related firms, institutions, and other actors play a pivotal role in enabling and enhancing innovation and entrepreneurship in advanced industries.[49] In a healthy economic ecosystem, firms in a wide variety of related industries engage with one another to generate new expertise and capabilities. "Thick" labor markets provide ample talent for firms and opportunities for skilled workers. Entrepreneurs find access to capital and other supports for firm growth. Digital and physical infrastructure connect people, ideas, and firms across the region. In such an ecosystem, the quality and density of connections between actors matter enormously, as firms, institutions, workers, and entrepreneurs constantly link up to marshal distributed resources in a process of recombinant innovation. This is particularly true in the HIT sector, where innovation emanates from a wide variety of actors.

However, the vibrancy and connectedness of Nashville's HIT ecosystem appears thin and inconsistent. In advanced industries, to begin with, the rate of new firm formation is usually a leading indicator of the health of the regional ecosystem. It is those firms that take new ideas to market. Larger, more established firms often bring new technologies to scale, but economic research suggests that starts-ups and entrepreneurs are key to developing blue-sky technologies for commercialization.[50]

Particularly in technology industries, growing an entrepreneurial base requires access to capital. Traditional private equity continues to be the go-to source for firms in most industries, but for IT companies, access to venture funds and angel investors is usually more important. This is particularly true in the HIT sector because early adopters—the first tier of customers for HIT innovation—tend to be very large organizations, such as insurance carriers, hospital systems, or the government. These initial clients mean that companies must attain minimum scale and a proven track record before making their first sale, and thus require capital.

Based on the total value of venture capital deals, Nashville rates only average among its peer metro areas, with the number of deals ranking far ahead of Birmingham, Charlotte,

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49. For a review of recent research on clusters and ecosystems, see Mark Muro and Bruce Katz, "The New 'Cluster Moment': How Regional Innovation Clusters Can Foster the Next Economy" (Washington: Brookings Institution, 2010).
50. Jason Wiens and Chris Jackson, "The Importance of Young Firms for Economic Growth" (Kansas City: Kauffman Foundation, 2015).

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and Kansas City but far behind global leaders such as San Francisco and Boston. San Francisco has 67 times the level of venture capital funding as Nashville, although the vast majority of its deals are in the life sciences, consumer internet, and medical devices sectors. In this context, Nashville ranks just 52nd for overall venture capital per worker.[51]

Looking only at venture capital for HIT, however, Nashville is strong, ranking 11th among the largest metro areas in the nation. Between 2005 and 2015, for example, more than one-quarter of all venture capital available in Nashville funded HIT companies—a higher share than in any other peer region (see Figure 9). Helpful here is that that a number of local funds specialize in health care, including Medicare Investment Funds, Gen Cap America, Council Capital, and others.

What is even more telling is how many of the region's venture firms were started by investors with connections to large health care management companies, including HCA,

Figure 9. Digital health as share of total venture capital

2009-2014
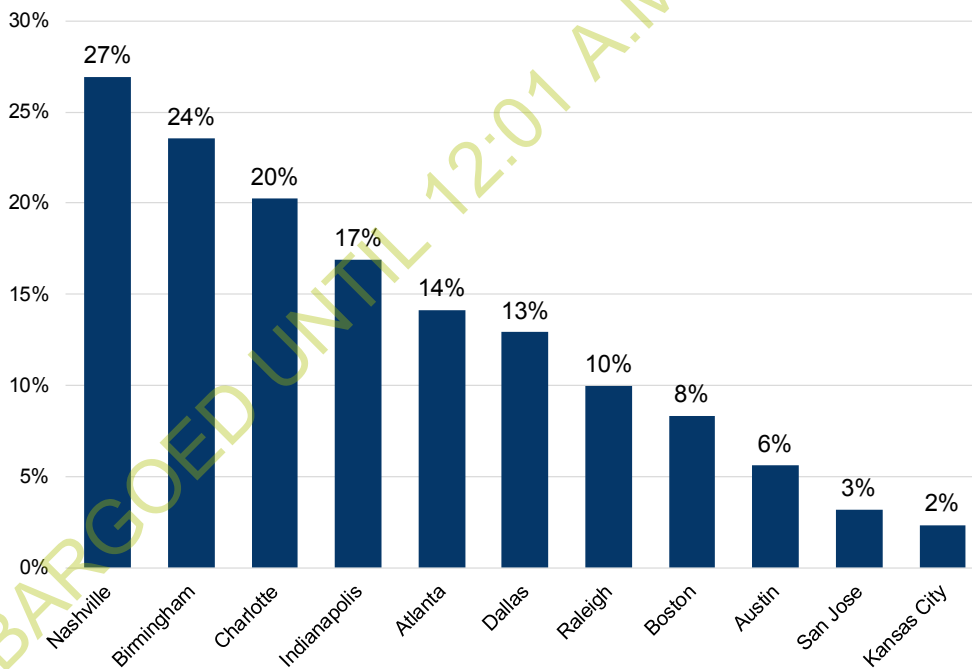
Source: Brookings's analysis of PitchBook data.

51. Ian Hathaway and Jonathan Rothwell, "A Cure for Health Care Inefficiency? The Value and Geography of Venture Capital in the Digital Health Sector" (Washington: Brookings Institution, 2015). Hathaway and Rothwell define "digital health" as "the application of information technologies to health care." For analytical purposes, we consider their definition a useful proxy for the part of the HIT sector that benefits most from venture capital investments.

Community Health Systems, and LifePoint.[52] Clearly, the venture capital community in Nashville deeply understands health care management.

Although impressive, the amount of venture funding in Nashville's health care ecosystem obscures a number of problems young technology companies in the region face. Other metro areas, including San Francisco, Boston, and Austin, have more total venture funding in HIT, and these regions are beginning to leverage their substantial software ecosystems (including capital, firms, and talent) to challenge Nashville's leadership in health care management. In addition, access to later and larger B-round funding in Nashville remains limited, with a number of local leaders expressing concern that "it is increasingly difficult even for companies that are growing after their first deal of $1–2 million to get that next deal for $20–30 million."
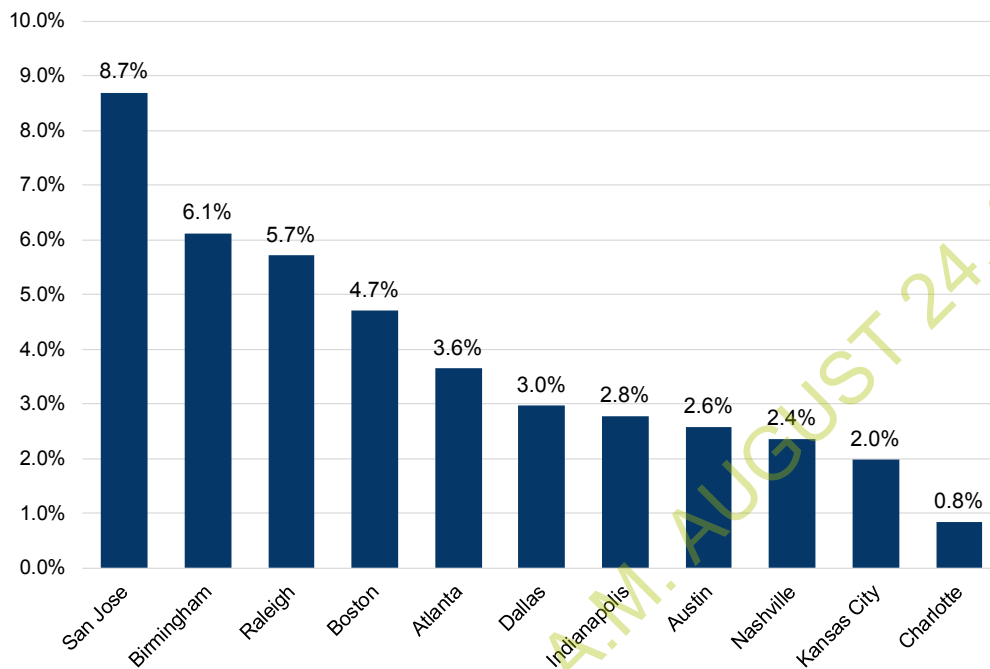
Access to capital is only one hurdle young companies poised for growth confront. Accessing market knowledge from larger companies is another critical issue for entre-preneurs. Economic research shows that cities with highly innovative industries create close links between larger and smaller companies because firms of different sizes play different roles in the innovation process.[53] Large companies often house much of the industry knowledge needed for new solutions, but they also usually have tightly controlled product lines. On the other hand, small firms lack the market intelligence to know exactly what solutions can be monetized, but they are more than willing to test new products in the marketplace, then sell to or be acquired by larger companies. Obviously, larger firms would prefer to skip the "middle man" and take the innovation process in-house. But in reality they often do not have the risk tolerance or corporate governance suited to design, test, and market new products, making the interplay between large and small firms essential to developing a robust ecosystem for innovation.[54]

52. See the Nashville Health Care Council's Industry Family Tree, which lists more than 500 com-panies: http://healthcarecouncil.com/nashville-health-care-industry/family-tree/.

53. John Hagedoorn and Nadine Roijakkers, "Small Entrepreneurial Firms and Large Companies in Inter-Firm R&D Networks: The International Biotechnology Industry." In M.A. Hitt and others eds., Strategic Entrepreneurship (Cambridge, MA: Blackwell, 2002).

54. Ibid.

Figure 10. Share of software firms with more than 250 workers
2014

San Jose 8.7%
Birmingham 6.1%
Raleigh 5.7%
Boston 4.7%
Atlanta 3.6%
Dallas 3.0%
Indianapolis 2.8%
Austin 2.6%
Nashville 2.4%
Kansas City 2.0%
Charlotte 0.8%

Source: Brookings's analysis of U.S. Census, "County Business Patterns: Metropolitan Areas, 2014" data.

In that context, the lack of routinized, robust connections between small firms in Nashville's software sector and larger firms in the health care sector represents a critical missed opportunity to build competitive advantage in new areas.

The city has numerous organizations that facilitate firm-to-firm exchanges within the HIT sector, including the Health Care Council, the Technology Council, the Tennessee Health Information Management Systems Society (HIMSS), the Chamber of Commerce, and the Entrepreneur Center. But more could be done to ensure that small firms have access to the wealth of health care knowledge in Nashville. The Pittsburgh Life Sciences Greenhouse (PLGS), for example, supports young HIT firms by connecting IT entrepreneurs in the region to top executives with clinical knowledge. The program was developed through an association with the University of Pittsburgh Medical Center.[55] Drawing on networks from the university's executive training programs, PLSG leverages one of the largest nonprofit health care systems in the country to support the development of HIT companies in the region. The model has been highly successful. With

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55. For more information on the Pittsburgh Life Sciences Greenhouse, see www.plsg.com/.

$20 million invested, PLSG has leveraged more than $1 billion in additional capital into western Pennsylvania firms and regions.

The decision to headquarter the Center for Medical Interoperability in Nashville presents an opportunity to facilitate access to health care knowledge among small and large firms alike. The center, a well-funded nonprofit membership organization, is a partnership between several of Nashville's most prominent health care firms and national industry leaders to collectively solve technical challenges in integrating health information systems and medical devices.[56] "Health care technology needs an innovation hub, and we are focused on creating the platform infrastructure for that," said Kerry McDermott, vice president for public policy and communications at the center. "Once you have the infrastructure, innovation will follow."

One structural barrier to collaboration and exchange among firms may be the mismatch in firm size, given that the region's software companies tend to be smaller than those in peer regions while its health care management firms tend to be larger. Only 2 percent of the region's software companies employ more than 250 people (see Figure 10), a lower percentage than any peer region except Kansas City and Charlotte. Because they have industry knowledge, larger software companies often serve as validators for small firms and "get them in the door" to larger firms.[57] Leaders such as Change Healthcare are serving this purpose, but the lack of a critical mass of established software companies puts the region at a disadvantage. The solution may not be to attract large IT companies, but to do more with those that are present and develop explicit strategies to connect small IT and large health care providers in Nashville.

In a roundtable discussion among leaders in IT startups conducted as part of the research for this paper, participants noted that major health care companies in the region

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56. For more information on the Center for Medical Interoperability, see http://medicalinteroperability.org/.

57. For example, Colibrium Partners—a small customer relationship management (CRM) company for health insurance plans in Bellevue, WA—won a Public Sector Health award from Microsoft in 2012. The next year Providence Health Plans, the largest provider-sponsored insurer in the Northwest, hired Colibrium to operate its CRM system for its 400,000 members, including Oregon's Public Exchange. Given Microsoft's reputation in HIT, awarding Colibrium served as a signal to Providence Health that the company's product would work. For more information, see Colibrium, "Providence Health Plans Select Tuo Products for Their Private Exchange – with Public Exchange Integration" (April 29, 2013). Available at www.colibrium.com/news/providence-health-plans-select-tuo-products-for-their-private-exchange-with-public-exchange-integration/.

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have not sponsored or actively supported software user groups or informal gatherings of programmers who come together to advance their skills and experiment with new solutions. Major industries in other regions have found ways to leverage such groups and "hackathons" to work on real-world problems while also protecting proprietary data. Intuit, the Silicon Valley software company, for example, created "sandboxes" to grant entrepreneurs access to selected market data outside the company firewall for problem-solving and experimentation.

In sum, Nashville has many of the right assets to develop a strong HIT ecosystem in which young firms grow, incumbent firms spin off new products, and each has access to talent and capital. Yet despite the impressiveness of Nashville's health care "family tree" and the unusually high number of firms that have spun off from its extensive health care cluster, as well as its strong base of HIT-focused venture capital, the major components of its ecosystem are not as robustly linked as those in other regions with more deliberate strategies to strengthen innovation in HIT.

Looking ahead

To seize the HIT opportunities before it and mitigate key deficits, the Nashville region should move to grow its health care cluster and commit to leadership in HIT innovation.

Nashville's strengths in health care and related industries are numerous and well known, but changes underway in the health care system are making the sector more competitive and opening the way for new firms and regions to develop competitive strengths.

Every point along the value chain in health care is ripe for disruption by insurgents. Given all its assets and competitive advantages, Nashville should approach the new era of health care bullishly, but without a deliberate strategy and concerted effort by its civic-, public-, and private-sector leadership to address its shortcomings, the region could miss the opportunity to fully leverage its potential as a national hub for innovation in health care.

In particular, among its greatest challenges, the software sector in Nashville is too small, lacking in skilled professionals and not deeply connected to the well of knowledge and expertise related to health care management that has driven much economic development in Middle Tennessee for several decades.

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A carefully crafted strategy should address the region's innovation, talent, and ecosystem challenges and include themes such as the following:

Expand the region's innovation infrastructure

To bolster and widen the region's innovation infrastructure, Nashville's corporate, industry, and university leaders should:

- **Create simple and standardized technology transfer contracts** with Vanderbilt University that any member of the Nashville Health Care Council or other key industry associations could employ for HIT-related commercialization, including technology licensing and research sponsorship[58]

- **Establish an "export" program to support young software firms in selling their products outside the region**, much as the state and region support companies in other traded industries in expanding into new markets and increasing exports

- **Form a consortium of IT firms with the goal of forging closer business ties with health care firms**, including those involved in the diagnostic labs and relevant business services industries, leveraging the region's networks of firms to enrich its HIT ecosystem

- **Institute a cross-industry working group for health care data with a mission similar to the Pittsburgh Health Data Alliance** (see box) and the University of Pennsylvania's M-Health Platform, which approach HIT problems from the perspective of multiple stakeholders[59]

- **Leverage the Center for Medical Interoperability** as an anchor for innovation

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58. Calcharge, a battery industry association in California, has created a standardized cooperative research and development (CRADA) agreement for any contract with Berkeley National Laboratory and its members. See "CalCharge and Berkeley Lab Sign Groundbreaking CRADA," Energy Technology Areas, September 2013.

59. For more information on the Pittsburgh Health Data Alliance, see http://healthdataalliance.com/.

Strengthening the innovation ecosystem: The Pittsburgh Health Data Alliance

Using data to improve health care delivery requires interdisciplinary coordination. No entity alone can fully leverage the massive amounts of data generated in digital health records, care provisions, and prescriptions. To address this need for coordination, the University of Pennsylvania Hospital System (UPMC), Carnegie Mellon University (CMU), and the University of Pittsburgh jointly created the Pittsburgh Health Data Alliance. The University of Pennsylvania Hospital System is sponsoring the project for six years during which the Center for Machine Learning and Health at CMU and the Center for Commercial Applications of Healthcare Data at the University of Pittsburgh will collaborate with care providers to develop new approaches to delivering care on the basis o fdata-driven solutions.

Specifically, the alliance will focus on five areas: data analytics; personalized medicine and disease modeling; privacy, security, and compliance when using big data; data-driven patient and provider education and training; and a new general framework for the use of big data in health care.

Linking specific areas of academic strength at CMU and the University of Pittsburgh with the clinical expertise and market demand from western Pennsylvania's largest hospital system can potentially help the region emerge as a commercial testbed for best practices in using big data to drive change in health care, and, simultaneously, expand the commercial pathways for academic computer science to affect health care and delivery.

Source: The Pittsburgh Health Data Alliance, healthdataalliance.com.

Build the HIT skills base

Industry should also work with the state and other actors to deepen the region's pool of software and other digital talent. Relevant action steps include:

- **Expand the accelerator program at Belmont University** operated in conjunction with Tennessee HIMSS and take its approach to scale through similar partnerships with other institutions[60]

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60. As its website describes, LaunchCode is a nonprofit job placement, training, and mentorship program that recognizes that given the speed at which software changes, traditional college degrees may be both insufficient and unnecessary. With the right training and mentorship, many people without such degrees, they argue, can meet the needs of the majority of companies. The program partners with companies to develop entry points into apprenticeships and jobs, for people willing to learn specific industry-required software skills, regardless of their formal education. The health care sector, with its highly specific needs, could be an ideal place to build a LauchCode model. For more information about LaunchCode, see www.launchcode.org/about/.

- **Expand nontraditional approaches to training in IT and coding**, with accelerated job placements in health care companies, by bringing more programs such as LaunchCode to Nashville

Building the HIT skills base: The AHIMA Foundation's Health Information Management Apprenticeship Program

Employers, professional associations, and charitable foundations across the country recognize the need to address skill shortages in the emerging HIT landscape. They are organizing cross-sector partnerships to standardize credentials and job descriptions, creating new entry points with intensive, short-term training and credentials, and defining new career pathways.

One example is the American Health Information Management Association Foundation's apprenticeship initiative, "Managing the Talent Pipeline in Health Information." The program connects employers with workers seeking to break into the HIT industry. The AHIMA Foundation provides a set of national guidelines for conducting apprenticeships. The guidelines, certified by the U.S. Department of Labor, remove much of the uncertainty in setting up and participating in apprenticeships for employers and workers alike. The guidelines define wage schedules, hours and content of instruction, and even the ratio of apprentices to mentors.

The foundation has identified four positions with detailed job descriptions, required competencies, training components, and certifications. The positions include hospital coders, clinical documentation improvement specialists, Health Information Management (HIM) business analysts, and HIM data analysts, with others to be added in future.

The common theme uniting these roles is the increasing need to transform health care data drawn from different information systems into meaningful insights for clinical and business management and decisionmaking.

The AHIMA Foundation has received a $4.9 million grant from the U.S. Department of Labor to launch the apprenticeship program, with the goal of reaching 1,200 recent college graduates and workers. Employers from several states, including Tennessee, Arizona, California, and North Carolina, have committed to sponsoring the initial round of apprentices.

Source: The AHIMA Foundation, http://www.ahimafoundation.org/prodev/Registered_Apprenticeship.aspx

- **Design a mentoring program to provide HIT experience to students in a variety of clinical settings** through rotations in different firms, following the standards under American Health Information Management Association Foundation's mentor program (see box)

- **Establish Nashville as a center for sub-baccalaureate degrees and HIT credentials** through the Tennessee Promise program

Deepen the HIT ecosystem

Building a nationally significant HIT cluster will also require fostering the emergence of a vibrant technical and business community of related firms, institutions, and other actors that will help spur innovation, entrepreneurship, and growth. Industry, industry associations, and other leadership groups should foster this community through steps like the following:

- **Launch a professional CEO network that brings global management talent to Nashville** to help young IT companies attract capital, find customers at large health care firms, and grow

- **Sponsor coding user groups and integrate them into major health care firms**, adapting the model of Honeywell's EMEA user group[61]

- **Institute a HIT data-discovery challenge** in which major firms allow access to nonproprietary data and sponsor competitions to develop new software applications, similar to the Illinois Corporate Startup Challenge[62]

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61. Honeywell sponsored a group, including an annual conference, for those who use their industrial technologies. The company also runs student competitions within the user group and is developing Demo Centers around the world for business users. See https://www.honeywellprocess.com/en-US/online_campaigns/hug/Pages/emea/index-emea.html.

62. According to its website, "The Illinois Corporate-Startup Challenge creates a bridge between the major corporations that serve as the backbone to Illinois' economy and the startup businesses that will power it through the 21st century. Launched in 2013, the program assembles a class of Fortune 1000 corporations on a semiannual basis and pairs them with startup companies that address their innovation needs through a highly curated matchmaking process." See http://www.illinoisinnovation.com/corporate-startup-challenge.

- **Strengthen the link between entrepreneurs and incumbent firms by,** for example, expanding the Jumpstart Foundry and the Entrepreneur Center's Project Health Care or developing new initiatives similar to DreamIT Health[63]

- **Develop a brand and marketing strategy and campaign** to establish Nashville as a national center for HIT and recruit new talent to the region

Improving health delivery across the city: The Heath Care Innovation Collaborative

In 2015, the Philadelphia CEO Council for Growth established the Health Care Innovation Collaborative, which brings together some of the city's largest public and private leaders among universities, payers, providers, and technologists. The founding members include Ben Franklin Technology Partners of Southeastern Pennsylvania, Children's Hospital of Philadelphia, Comcast, Drexel University, Independence Blue Cross, Safeguard Scientifics, Thomas Jefferson University and Jefferson Health, and University of Pennsylvania Health System. The collaborative was born of the council's Health Care Innovation Task Force, co-chaired by John Fry, president of Drexel University and Daniel J. Hilferty, president and CEO of Independence Blue Cross.

The collaborative aims to be a national model for entrepreneurs and large health care and technology companies. For example, the collaborative recently released a call for innovation in treating chronic diseases, which account for 86 percent of America's health care costs. The goal is to create an avenue that gives small technology and innovative health care companies access to larger firms in the sector. According to Stephen Klasko, president and CEO of Thomas Jefferson University and Jefferson Health, "The Health Care Innovation Collaborative will allow us to work with innovators and entrepreneurs to pilot new ideas that could make a real difference in how we deliver care."

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63. According to its website, DreamIT Health is ranked as one of the top 10 business accelerators in the world by Forbes. It partners with John Hopkins University, Children's Hospital of Philadelphia, Penn Medicine, and Blue Cross Blue Shield to "work with health care startups that can help meet institutional needs." The firms undergo an "intensive startup and health care curriculum taught by subject matter experts and active early-stage investors, and enjoy access to executives, systems, and data from leading industry players." See http://dreamit.com/.

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Conclusion

In Nashville, major anchor institutions have built and spun off a rich array of firms across all aspects of the health care sector, creating a deep bench of industry knowledge, technical expertise, and capital for the next generation of health care innovators. Going forward, software and data analytics will play a major role in health care innovation, which for Nashville will either open the way to new competitive advantages and opportunities for growth or relegate it to a lost opportunity.

By adopting a strategy to shape and strengthen its ecosystem for HIT, the region can establish itself at the forefront of the next generation of health care innovation, creating economic value and jobs in Nashville while improving the quality of life for millions of Americans. ■

Appendix: Data sources

Economic indicators

- Job, output and wage data: Moody's Analytics

Innovation

- University R&D spending: National Science Foundation; National Institutes of Health

- Patents: OECD RegPat database

- Export royalties: Brookings Export Monitor 2015

Workforce

- Occupations and workforce: Occupational Employment Statistics, Bureau of Labor Statistics

- Degree completions: IPEDS, National Center for Education Statistics

Ecosystem

- Venture capital: PitchBook data

- Establishment size: County Business Patterns, Census Bureau

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