The Massachusetts Higher Education and Knowledge Cluster

The Microeconomics of Competitiveness

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1. Executive Summary

The competitiveness of the United States has been driven, to a large extent, by its capacity for innovation and knowledge creation, in which higher education institutions play a critical role. This paper aims to better understand the development of Massachusetts' dense cluster of higher education and research institutions, identify the challenges it faces today, and provide recommendations that bolster its continued success in light of these challenges.

At the country level, the main drivers appear to be strong factor conditions in human and financial capital, sophisticated demand, stringent legal and regulatory frameworks that protect competition, and productive collaboration between industry, academia, and the public sector. Key challenges include ineffective access to elite institutions, weakening financial system, loosening regulatory and anti-trust standards, and deterioration in the quality of local suppliers.

At the state level, the main drivers appear to be a robust K-12 public school system, robust immigration of skilled workers, effective government policy in cluster formation and R&D growth, strong collaboration between the public sector and a high-tech private sector, and a sophisticated network of think tanks and IFCs. Key challenges include a difficult business environment, inadequate physical and communications infrastructure, shrinking size of largest clusters, declining entrepreneurial capacity, and mediocre undergraduate state aid.

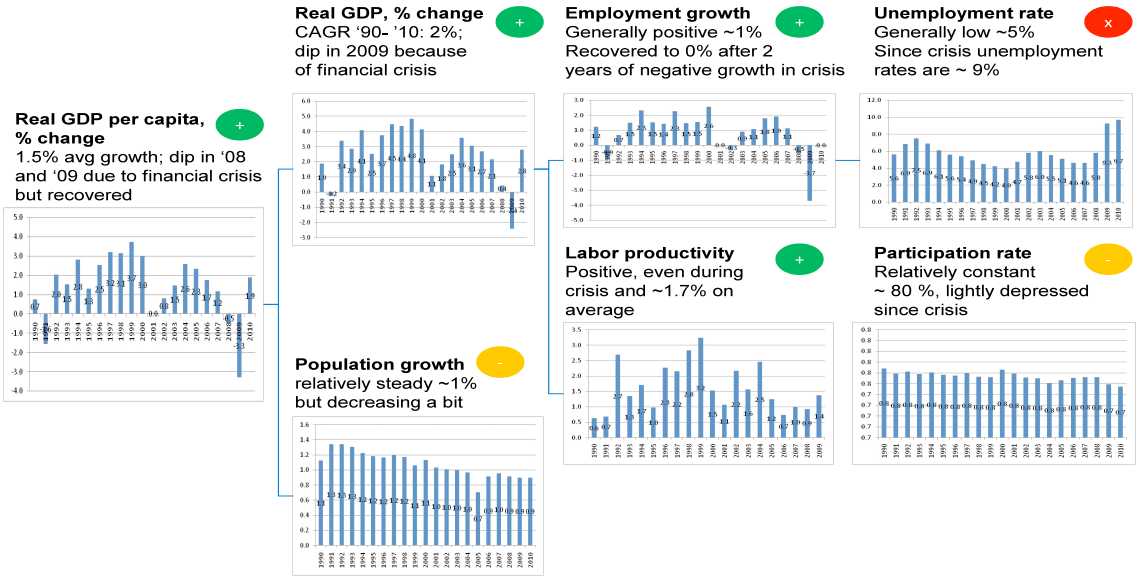
At the cluster level, main drivers are competitive primary/secondary education system given presence of charter and prep-schools, extensive private funding, sophisticated local demand, state legislation supporting R&D, intense competition between peer institutions, and collaborative private sector and IFCs. Issues include lack of public funding, shrinking local demand and burdensome regulation. Key cluster recommendations include removing labor restrictions, increase public funding for and engagement of public institutions, and strengthening the MTC.

2. U.S.A. Competitiveness Analysis

2.1. Overall Economic Performance

The U.S. economy, at $14.9 trillion nominal GDP (at PPP), accounts for 20% of the world's gross domestic product in 2010 (EIU, 2010). Real GDP has been growing at 2% CAGR and the "U.S. has accounted for…one-third of world economic growth" in the last 20 years (Porter, 2008). The recent financial crisis drove an economic contraction, but strong fundamentals have enabled real GDP to recover quickly. While unemployment remains high, general employment level has begun to grow and labor/total factor productivity remains positive (EIU, 2010).

Figure 1. *Drivers of U.S. GDP 2009-2010*

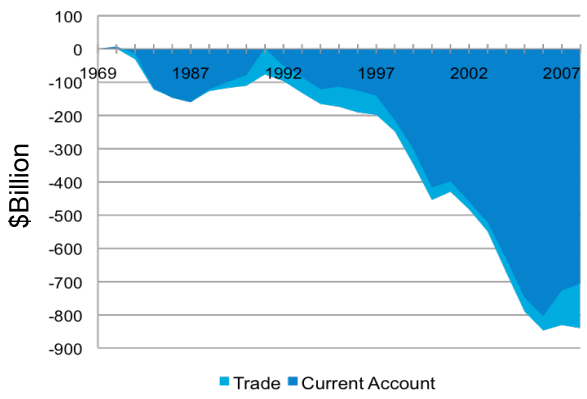


Source: EIU data, team analysis

Driven mostly by consumption (70%) as opposed to investment (15%), growth in U.S. GDP has been heavily dependent on private and public spending (EIU, 2010). Given a low national savings rate (2%), it is unsurprising the country suffered a twin deficit in 2009 (current account deficit 3% of GDP, fiscal deficit 10% of GDP) (BEA, 2010). The recent recession reduced the current account deficit from 5% of GDP in 2008, but foreign investment in U.S. assets, particularly in U.S. treasuries, continue to finance the nation's borrowing from abroad. Despite

the crisis, the U.S. dollar remains the world's reserve currency, held in mass quantities by various central banks, and historically, investment in U.S. assets have been driven by the country's high productivity, high innovation and technology adoption.

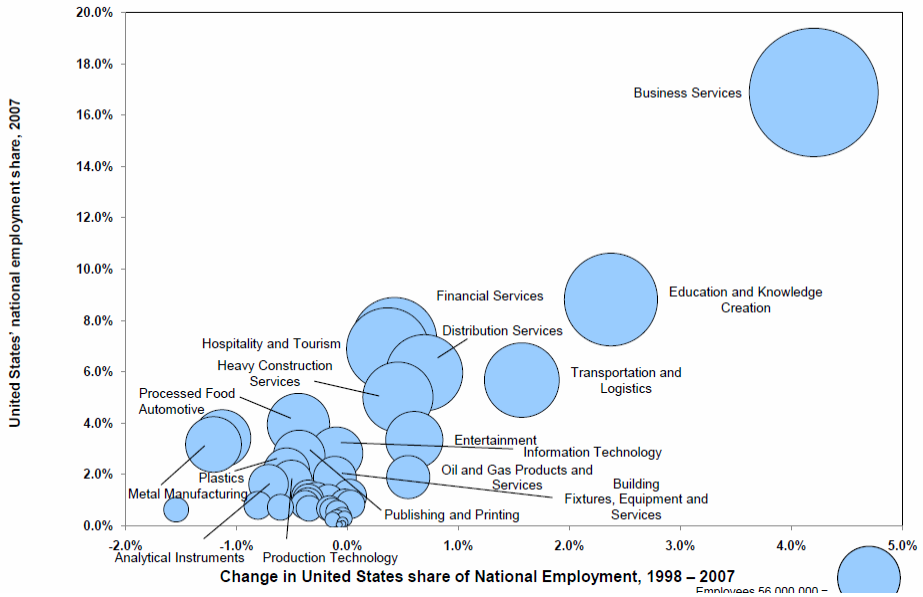
Figure 2. *U.S. trade balance and current account*



2.2. Composition of the Economy

In recent decades, the U.S. has shifted from a strong manufacturing economy to a service economy. 79.6% of real GDP is generated by services; industry only accounts for 19.2% of GDP and agriculture only 1.2% (EIU, 2010). Rapidly growing clusters (by employment) comprise service clusters such as business services, education and knowledge creation, financial services, and hospitality, tourism, and distribution services (ISC, 2010). Large clusters losing share of national employment comprise manufacturing industries such as processed food, automotive and metal (see below).

Figure 3. *Clusters in the U.S. economy*



Source: Cluster Mapping Project Data, ISC (2007).

2.3. U.S. Business Environment through the Lens of the National Diamond Analysis

The U.S. has one of the most competitive business environments in the world, driven by strong factor conditions, sophisticated demand, robust rules for competition, and an active and innovative private sector. However, each corner of the diamond is currently facing weaknesses.

U.S. National Diamond

Factor Conditions

+ Strong research institutes and higher education
+ Abundant private capital availability
+ Numerous high-skilled workers; role of immigration
+ High private spending in education and R&D
- Decreasing participating in tertiary education
- Weak primary and secondary education system
- Recent weakness in financial system
- Increase in administrative and regulatory costs

Demand Conditions

+ Highly sophisticated and innovative companies
+ Large domestic market
+ Federal promotion of information, communication, technology (ICT)
- Decline in buyer sophistication
- Inefficient government spending
- Weakening regulatory standards

Context and Firm Rivalry

+ Historically strong legal and regulatory framework
+ Tradition of strong commitment to competition and free markets
+ Government agencies promoted technological advancement
+ Economic decentralization and regionalization
- Divisive political environment presenting obstacles to implementing needed change
- Loosening anti-trust standards

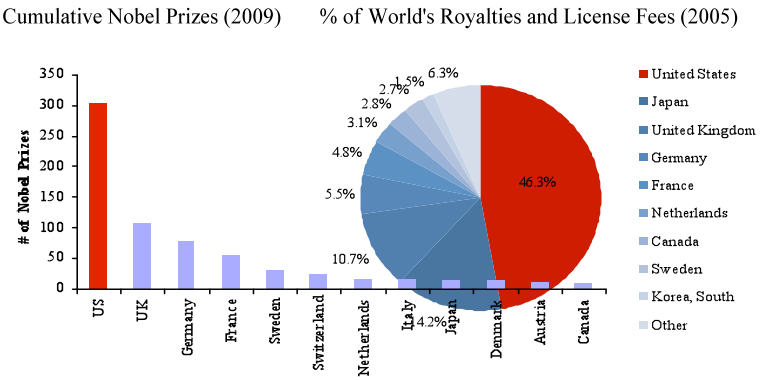
Related and Supporting Industries

+ Strong private spending in R&D by companies and through licensing of university research
+ Sophisticated network of collaboration between think tanks, research institutes, and higher education institutions
- Weakening cluster development
- Quality of local suppliers deteriorating

Factor Conditions. With world-class higher education, scientific research and management training institutions, deep venture capital and domestic credit availability, and "unparalleled environment for entrepreneurship and starting new companies" (Porter, 2008), the U.S. has produced more skilled labor and innovation than almost any other country in the last decade and has consistently placed in the top 5 in the Global Competitiveness Index (GCR, 2009).

Figure 4. *Competitive factor conditions and derived benefits in the U.S.*

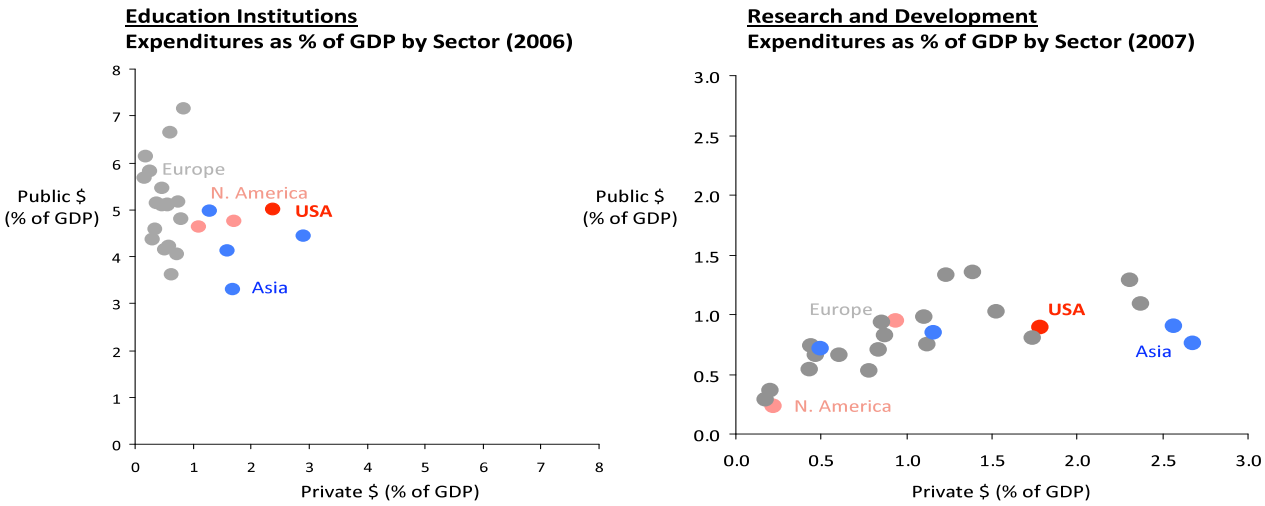
GCI Indicator	Avg Ranking (2001-2009)
Innovation/ Education	
Quality of scientific research institutions	1.3
Quality of management schools	2.0
University-industry research collaboration	2.2
Utility patents per million population	1.6
Capital	
Domestic credit to private sector	2.0
Venture capital availability	2.6
Administrative	
Ease of Starting New Business	4.4
Human	
(Low) Brain drain	1.1
Availability of scientists and engineers	7.0



Source: OECD, World Development Indicators, and GCR, 2009.

Moreover, private spending on education and R&D has been substantial as compared to the rest of the world (as a percentage of GDP) (see Figure 5), and the above figure shows that "the U.S. remains uniquely good at coaxing innovation out of its research and translating those innovations into commercial products" (Porter, 2008).

Figure 5. *Public and private spending (as % of GDP) on education and R&D*



Source: OECD, 2009.

Yet, many factor conditions are deteriorating. Despite having elite higher education institutions, U.S. student participation in tertiary education have been declining relative to other developed countries. While the postsecondary participation rate for those between 18 and 24 hovered around 35-38% in the U.S. during the last decade, comparable OECD countries have exceeded those rates, causing the U.S. to become one "of the few OECD nations in which the older generation has achieved higher tertiary education rates than the younger population" (Douglass, 2009). The primary and secondary education system in the U.S. is also weak, as the quality of primary education is ranked only 26 by GCI, and secondary enrollment ranked 36 by GCI. Moreover, 15-year-olds in the U.S. only exhibit mediocre performance when measured by international standards such as the PISA science or mathematics literacy scale (NSF, 2010). The

recent financial crisis has exacerbated and highlighted some fundamental weaknesses in the U.S. financial system, and the GCI downgraded U.S. ranking in soundness of banks, quality of securities regulation, and availability of equity and debt financing to 64, 51, 31, and 28 respectively. This decrease in financing availability is coupled with falling R&D spending (Porter 2008). Lastly, administrative costs (customs procedures and taxes) and regulatory burden have increased while conditions for starting a business have deteriorated.[1]

Demand Conditions. The World Economic Forum's report on competitiveness (GCR) ranks the U.S. 8th in business sophistication and 1st in domestic market size (GCR, 2009), both of which enables the U.S. to have highly favorable demand conditions. In addition, the federal government has successfully promoted information communication technologies (ICT) that have led to further market sophistication and size – the GCI ranks government procurement of advanced technology 2nd in the world (GCR, 2009)[2].

Yet, the same free-market system that enabled prolific innovation has also led to weaker regulatory standards. The GCI ranks the U.S. 19th in presence of demanding regulatory standards and 23rd in stringency of environmental standards. This lowers the pressure to continuously improve demand conditions and partially explains the lack of momentum in energy efficiency improvement and other critical changes that require public policy (Porter, 2008). Buyer sophistication has also declined – now ranked 15th in the world, sliding down 12 spots from 2004 (GCR, 2009). Penetration of key services such as mobile phone subscription, broadband subscription and Internet usage have lagged behind (69th, 16th and 13th respectively) (GCR, 2009) and government spending has not helped to improve these indicators. While U.S. government

[1] GCI for burden of customs procedures, tax payments for doing business, burden of government regulation, number of procedures required to start a business, and east of starting a business have fallen to 35, 21, 29, 21, and 8 respectively.

[2] The Global Competitiveness Index 2009 also ranks the U.S.A. 10th in government success in ICT promotion and 11th in laws related to ICT.

spending in advanced technologies continues to be one of the highest in the world, public spending overall has become highly inefficient and wasteful, ranking 68th in the world (World Economic Forum report) (GCR, 2009). This has only led to infrastructure bottlenecks and higher logistics costs for businesses (Porter, 2008) and has not particularly helped to drive discerning demand.

Context for Firm Strategy and Rivalry: U.S. has traditionally had a strong legal and regulatory framework with robust anti-trust and intellectual property laws, including the Sherman Antitrust Act of 1890, Clayton Act 1914, Robinson-Patman Act 1936 and the Celler-Kefauver Act 1950. This body of legislation underscores the U.S.'s belief in protecting free enterprise and maintaining a level playing field. As Michael Porter argues: "America has been the country with the strongest commitment to competition and free markets. This belief has driven the remarkable level of restructuring, renewal, and productivity growth in the U.S." (Porter, 2008). The U.S. government also established the Defense Advanced Research Projects Agency (DARPA) in 1958, which led to the creation of the Internet and other technological advancements[3]. In the past fifteen years, at an above-G7 average of R&D spending (U.S.: 2.7% of GDP, G7 average: 2.2% of GDP), the U.S. has accounted for 40% of the R&D spending growth in OECD countries (OECD, 2009). Another feature of U.S. competitiveness has been its economic decentralization and regionalization. While the federal government provided the legal and regulatory backbone, most of the growth has been driven by competition and increased productivity within states and economic regions specializing in different clusters and industries (Porter, 2008). In addition to competition, these regions also collaborated in promoting interstate flow of labor, capital, goods, and services with inventions such as the electronic toll-collection

[3] For a detailed historical overview of DARPA and its role in the U.S. technological advancement, please see: http://www.darpa.mil/.

system, E-ZPass, which is used along the east coast of the U.S.[4]

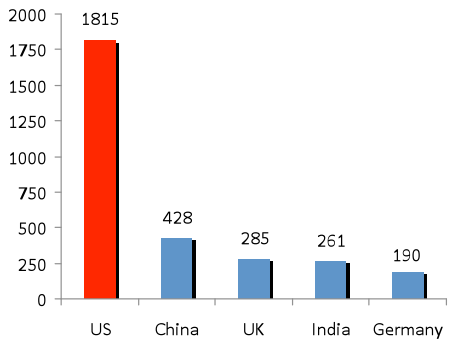
However, the recent economic crisis coupled with an increasingly divisive political environment has led to a rise in protectionism (Buy American Clause, Recovery Act, 2009), regulatory burden, and a loosening of anti-trust enforcement as mergers between large players have been allowed to take place (Porter, 2008). Political stalemate has come to obstruct financial reform and needed changes in energy and environmental policy (EIU, 2008), and contributed to a lack of strategic planning by the federal government (Porter, 2008).

Related and Supporting Industries. R&D spending by the private sector is a principal driver of innovation in the U.S. In 2006, 10 out of the leading 25 global corporations in R&D spending were U.S.-based – accounting for 41% of the top 25's total expenses (NSF, 2010). These companies have enabled the U.S. to enjoy one of the world's highest levels of R&D activity.

Figure 6. *R&D activities by country*

	Billion current PPP $	% Financed by		Performed by			Total Researchers (FTE)
		Ind.	Gov't	Ind.	Higher Ed.	Gov't	
United States	$398	67%	27%	73%	13%	11%	1,425,550
Japan	$148	78%	16%	78%	13%	8%	709,974
China	102	70	25	72	9	19	1,423,381
Germany	72	68	28	70	16	14	290,853
France	43	51	39	63	20	16	215,755
United Kingdom	41	47	30	64	25	8	261,406
Canada	25	48	33	54	35	10	139,011
Australia	15	58	37	58	25	14	87,140
OECD	$890	64%	28%	70%	17%	11%	4,072,240
EU 27	264	55	34	63	23	13	1,448,354

Figure 7. *Think tanks by country*



The private sector also funds research by purchasing licenses from universities: higher education institutions in the U.S. derived $2.1 billion in licensing income in 2007 (AUTM, 2009). The U.S. also possesses a sophisticated network of think tank and research institutes that facilitates

[4] E-ZPass is a multi-state, multi-city, cooperation in the U.S. east coast that aims to ease congestion, improve transportation, and promote economic growth through standardization and digitalization of electronic toll system. For more information, please see Interagency Group's homepage at: http://www.e-zpassiag.com/.

collaboration between academia, government, and the private sector. Moreover, the country is home to the world's largest number of think tanks, far ahead of China and the U.K. (see Figure 7). These research and policy centers are also some of the world's most influential: 16 out of the top 25 think tanks in the world are based in the U.S. (McGann, 2010).

Unfortunately, the U.S. has seen its leadership position in GCI in certain related and supporting industry categories erode substantially in 2008. For example, it no longer leads the world in the "extent of collaboration in cluster" (down 9 ranks), the "state of cluster development" (down 6 ranks), or in the "local availability of specialized research and training services" (down 7 ranks). Other worrisome indicators include the "quality of local supplier" (down to 14th globally from 5th), confirming an overall loss of competitiveness.

2.4. Recommendations for the U.S. President

As Michael Porter succinctly summarized, "America needs an economic strategy" (Porter, 2008). The following macro policy recommendations focus on creating a sustainable environment for long term growth while the micro policy suggestions focus on creating a strategy around the country's competitive advantage: innovation creation.

Macro Policies. Washington is not ascribing to the "Washington Consensus" as the U.S. suffers from both external and internal imbalance.

- To address external imbalances, U.S. needs to promote domestic savings (through mandatory savings or tax schemes) and incentivize investments by ensuring access to long-term credit.
- To address internal imbalances, the U.S. needs to curb public spending, potentially through reforming its social welfare systems (by engaging the private sector). Inefficient spending may also be reduced by improving the effectiveness of the political system, promoting strategic thinking at the federal level and delegating responsibilities to regional state actors. For

example, the President can invite governors to submit state-specific 5-year strategic plans for increased industry/cluster collaboration, soliciting inputs from regional chambers of commerce and other institutions for collaboration.

Micro Policies. Policies aimed at improving human capital, financial access, and decreasing administrative burden help to improve the business environment for innovation.

- U.S. needs to increase participation in tertiary institutions. Department of Education can conduct a national campaign on the value of higher education for employment[5] and improve public funding or fellowships to improve access to these institutions.
- U.S. should also improve primary and secondary education systems via increased spending and by promoting competition between schools via private and charter systems.
- U.S. should ensure its immigration policy remains conducive to attracting highly educated foreigners to study, work, and stay in the country.
- The federal government needs to reverse the trend of decreased spending in R&D.
- U.S. needs to set regulations that ensure strong capital flow to small and medium enterprises during tight credit conditions, and only increase financial regulation where appropriate.
- Federal government needs to reduce distortionary taxes and subsidies and open its borders to flows in goods, capital, and information/technology.[6] It should also streamline and simplify corporate taxes, and reduce administrative and procedural costs in starting a business to ensure the country's competitive advantage in entrepreneurial activities is protected.

[5] Recent studies by the Bureau of Labor Statistics demonstrate there is clear correlation between lower education level and higher unemployment rate (BLS, 2010)

[6] Currently, the US ranks 46 in GCI on "restrictions on capital flows" and 40 in "prevalence of trade barriers".

3. Massachusetts Competitiveness Analysis

3.1. Overall Economic Performance

With a population of over 6.5 million, Massachusetts is one of the most competitive states in the U.S. Its economy is dominated by intensive knowledge-based clusters, which suffered a relatively lower toll from the financial crisis than other sectors (Massachusetts Technology Collaborative, 2010). Primary and secondary education is relatively well funded (public expenditures as percentage of GDP of 3.54% vs. 3.48% national average), public school teachers enjoy higher annual salaries ($58,624 vs. $50,816 national average), and high school students tend to perform better (51% of 8th graders are proficient in mathematics vs. 31% national average) (National Science Foundation, 2007). Massachusetts is a world leader in R&D: in 2007, federally funded R&D amounted to $6.7 billion while industry invested another $13.2 billion.[7] Massachusetts is home to renowned universities such as Harvard or MIT, and its residents have the highest educational attainment in the country with 36% of adults between age 24 and 65 holding a bachelor's degree compared to a 26% national average (U.S. Census Bureau). The rate of unemployment in the state remains high (9.3% in 2009 vs. 9.7% national average), but has more to do with the current recession than deficient structural conditions. In 2008, Massachusetts' performance in attracting and retaining population was the best in a decade (Massachusetts Technology Collaborative, 2009). Potential challenges to the state's competitiveness include new business formation capacity post-financial crisis and the relative lack of interest expressed by high school seniors for science, technology, engineering and math (STEM) careers.

[7] Testament to the state's attractiveness, many prominent innovation-intensive multinational businesses continue to locate their R&D facilities in Massachusetts: for instance, the Novartis Institutes for Biomedical Research (biopharmaceutical, Swiss), the Schlumberger-Doll Research Center (oilfield services, Dutch), the Nokia Research Center (telecomm, Finnish), and a branch of Vestas Technology R&D Americas (renewable energy, Danish).

Economic Performance

Gross State Product (GSP) per capita, 2009
- MA: $56,169 (rank 7)
- US: $46,588
- MA % above US: 20.6%

Growth in GSP per Capita, annual rate, 1998-2008:
- MA: 2.28% (rank 7)
- US: 1.50%

Employment, 2007:
- MA: 3,073,941 (rank 13)
- % of US: 2.55%

Employment growth, annual rate, 1998-2007:
- MA: 0.55% (rank 44)
- US: 1.22%

Average wage, 2007:
- MA: $51,151 (rank 4)
- US: $41,680
- MA % above US: 22.7%

Wage growth, annual rate, 1998-2007:
- MA: 3.92% (rank 6)
- US: 3.49%

Share of Employment in Traded Clusters, 2007:
- MA: 31.3% (rank 6)
- US: 27.4%

Change in share of Employment in Traded Clusters, 1998-2007:
- MA: -3.16% (rank 40)
- US: -2.14%

Innovation Indicators

R&D performed as share of GSP, 2007:
- MA: 7.0% (rank 2)
- US: 2.6%

Patents per 10,000 employees, 2008
- MA: 11.44 (rank 6)
- US: 6.43

Growth in total patents, annual rate, 1998-2008:
- MA: 0.30% (rank 13)
- US: -0.39%

Traded establishment formation, annual rate, 1998-2007:
- MA: 0.63% (rank 49)
- US: 2.11%

Demographic Profile

Population, 2009
- MA: 6,593,587
- % of US: 2.15%

Population, percent change, 2000-2009:
- MA: 3.9%
- US: 9.1%

Labor force participation, 2007:
- MA: 66.9% (rank 38)
- US: 66.0%

Labor force growth, annual rate, 1999-2009:
- MA: 0.4%
- US: 1.1%

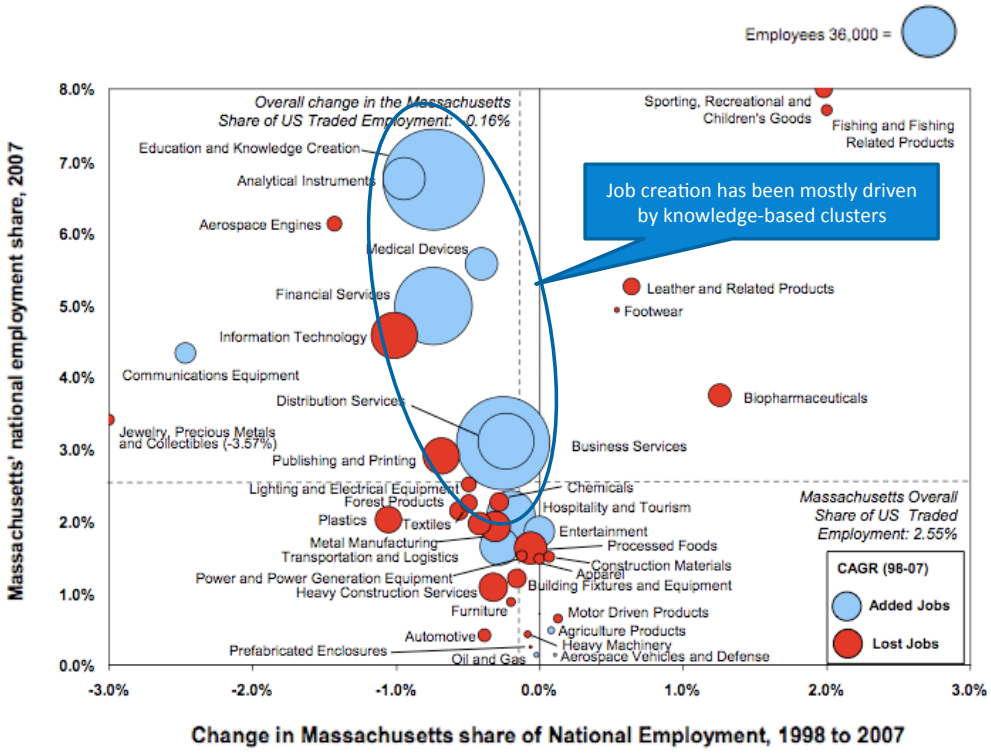
Source: Institute of Strategy and Competitiveness; U.S. Bureau of Labor Statistics; and U.S. Census Bureau.
Note: Ranks are among the 50 U.S. states plus the District of Columbia. Growth calculated using compound annual growth rates. Gross state product figures in 2000-chained U.S. dollars.

3.2. Composition of the Economy

The Massachusetts economy is dependent on industries that require a highly educated workforce and a strong capacity for technology adoption. Dominant clusters include: education and knowledge creation (employing 196,193 people), financial services (119,654), business services (171,292), information technology (42,655) and biomarphaceuticals (10,338) (ISC, 2007).

MA and its Competitiveness: Composition of Economy

MA highly dependent on education and knowledge creation



Source: Cluster Mapping Project Data, Institute of Strategy and Competitiveness (2007).

Traded clusters represent 31.1% of the state's employment and enjoy high average wages ($71,616) (ISC, 2007). Competitive industries drive demand for Massachusetts' local clusters such as commercial services, hospitality, real estate, or food/beverage processing (accounting for 68.7% of the state's employment, for average wages of $41,821).

3.3. Business Environment

Compared to other states, Massachusetts underperforms in the quality of its overall business environment and ranks #37 in Forbes' index of doing business in the U.S. (Forbes, 2007). The state ranks #33 in the "economic climate" category, due to a difficult regulatory and tort climate, weak incentives, inadequate transportation infrastructure, and mediocre bond ratings.

Massachusetts performs very poorly in the "cost of doing business" category (#49), which highlights prohibitive tax rates as well as high labor and energy costs.

3.4. State Diamond Analysis

Factor Conditions

+ Strong stock of human capital
+ Robust primary and secondary public school system
+ High quality immigration patterns
- Private sector wage inflationary trends
- Weak physical and communications infrastructure

Demand Conditions

+ Sizeable, wealthy local population
+ Presence of sophisticated and innovative institutions and industries
+ Healthy government support in cluster formation
- Shrinking size of largest clusters
- Declining entrepreneurial capacity

Context and Firm Rivalry

+ High-tech and knowledge-intensive economy
+ Innovation-prone environment with numerous highly ranked universities
+ Permanent tax credits for R&D spending
+ Strong knowledge protection laws
- High labor costs, living costs, and corporate tax levels
- Heavy regulatory environment

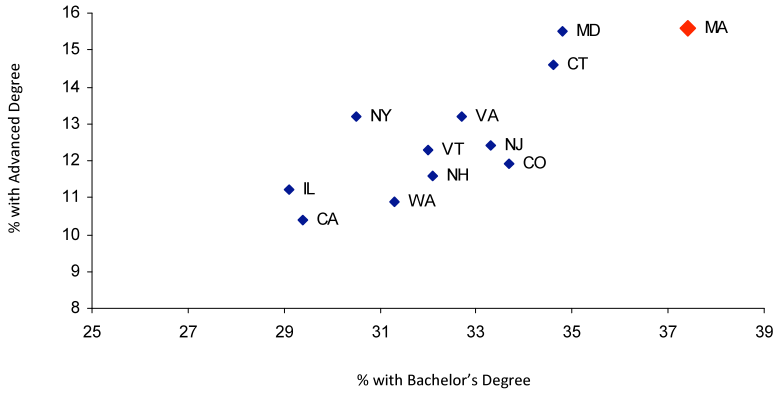
Related and Supporting Industries

+ Private sector as real partner in R&D effort
+ Strong and sophisticated network of think tank
+ Existence of IFCs with clear mandate and momentum
- Relatively low level of postsecondary state aid

Factor Conditions. Massachusetts has a particularly strong stock of human capital. According to the State New Economy Index,[8] the state ranks first in the nation in workforce education and number of scientists and engineers, and possesses significantly higher labor productivity than most other states (Porter, 2010). In fact, Massachusetts enjoys the highest concentration of postsecondary degrees in the U.S. as shown in Figure 8.

Figure 8 *Percent of state population with bachelor's and advanced degrees*

Source: U.S. Census Bureau, 2004.



[8] The State New Economy Index, as defined by Kauffman's Information Technology & Innovation Foundation, aims to measure indicators that enable the structure of the state economy to more closely "match the ideal structure of the New Economy" – one that is "knowledge-dependent", "global", "entrepreneurial", "rooted in information technologies", and "driven by innovation" (Kauffman 2008).

In addition to substantial immigration of "knowledge workers" into the state (Kauffman, 2008), Massachusetts' own primary and secondary public school system also provides reasonably strong candidates, scoring in the top three in reading, math, and science as 8th graders, and then 7th in the nation in percent of students taking Advanced Placement exams at the high school level (NSF, 2007). Yet, this labor does not come cheap as the state also has one of the highest average private sector wages that continues to grow at a more rapid pace than many other states (Porter, 2010). As discussed more extensively in the cluster section, the state also hosts numerous higher education institutions, research institutions, and companies with world-class R&D. However, Massachusetts suffers from weak physical and communications infrastructure, despite its leading position in innovation. Having the third highest percentage of "functionally obsolete or structurally deficient" bridges (51%) in the country (U.S. Department of Transportation, 2004), the state continues to suffer from a weak transportation infrastructure despite heavy spending. According to the State New Economy Index, it moreover ranks a mediocre 23rd in Internet users as a share of population and technology in schools.

Demand Conditions. Massachusetts' economic position in the U.S. creates a foundation for ideal demand conditions. With an average wage of $51,151, it ranks 4th among all states in the country (ISC, 2010). Combined with a sizeable population of 6.5 million (15th among states), Massachusetts is a prized market for both start-ups and established companies. Furthermore, healthy state financial performance has led to stable growth in GDP of 2.28% from 1998 to 2008, the 7th highest in the country (ISC, 2010), which ensures long-term stable demand. Massachusetts' competitive edge in innovation also stems from the presence of research driven institutions and inter-linked industries that play a crucial role in setting demand conditions. Ranking 4th in terms of share of cluster national employment (ISC, 2007), research organizations

in Massachusetts allow for early innovation as in the case of Harvard or MIT (Porter, 2008). The presence of inter-linked industries also drives the scale and sophistication of demand within clusters. Several clusters effectively intersect in various ways such as in medical schools (knowledge and health), medical software (health and IT), and medical consulting or telemedicine (knowledge, health and IT) (Porter, 2008). Lastly, the government of Massachusetts has played a role in stimulating the formation of industries both through stimulating public demand and setting standards (e.g., mandatory minimum healthcare insurance) as well as facilitating the dialogue among private sector groups (e.g., the Governor's Council on Economic Growth and Technology) (Porter, 2008). Despite these strengths, the state faces critical issues such as the decline in size of its biggest clusters. Between 1998 and 2007, the overall change in the Massachusetts share of U.S. traded employment was -0.16% with IT at -1.01%, education and knowledge creation at -0.74%, financial services at -0.74% and business services -0.25% (ISC, 2010). Lower economic activity in these clusters impacts all other inter-linked industries as they drive demand down the value chain. This problem is compounded by the state's slower rate of new-venture creation. From 1998 to 2007, the annual rate of traded establishment formation in Massachusetts was 0.63% (ranked 49th) compared to the U.S. average of 2.11% (ISC, 2010).

Context and Firm Rivalry. The Information Technology and Innovation Foundation (ITIF) ranks state economies in their competitiveness along an index focusing on knowledge jobs, globalization, economic dynamism, digital economy, and innovation capacity. Massachusetts leads the nation in three of those indicators and remains in the top five in all others (ITIF, 2008). In 2007, the state ranked 3rd in "Total R&D performance", 5th in "Industry R&D", and 1st in the "Research and development" which measures "the ability to attract various types of federal, industry, and academic funding" (ASTRA and Milken Institute, 2008). A critical driver of

innovation in Massachusetts is the state's policy of permanent tax credits for R&D expenses (cf. Chapter 63 of Massachusetts Laws. Finally, the state's mandatory health care coverage for all citizens reduces costs, improves personal security, and strengthens the overall wellbeing of the workforce (Health Connector, 2010).

The state's business environment nevertheless remains challenging and costly, due to cumbersome regulations and labor costs that are higher than the U.S. average by 10% and exceed labor productivity (Commonwealth Corporation, 2006). According to Forbes, Massachusetts ranks #37 in the U.S. for "doing business". In the "economic climate" category, which measures regulatory environment, tort climate, incentives, transportation, and bond ratings, the state ranks #33. In the "costs of doing business" category, which measures cost of labor and energy, as well as tax levels, the state ranks #49 (Forbes, 2007).

Related and Supporting Industries. A major force behind Massachusetts' global leadership in R&D is first the supportive nature and research-focus of its private sector, which acts as a real partner in pushing innovation. Massachusetts effectively ranks first in the U.S. in terms of business-performed R&D as a percentage of private-industry output (6.1% compared to 2.2% national average (NSF, 2007). A second comparative strength is the presence of a strong network of think tanks and related research institutes, which act as ideas generators and disseminators for the benefit of the broader economy. The state ranks second in the U.S. for the total number of think tanks after Washington, D.C.

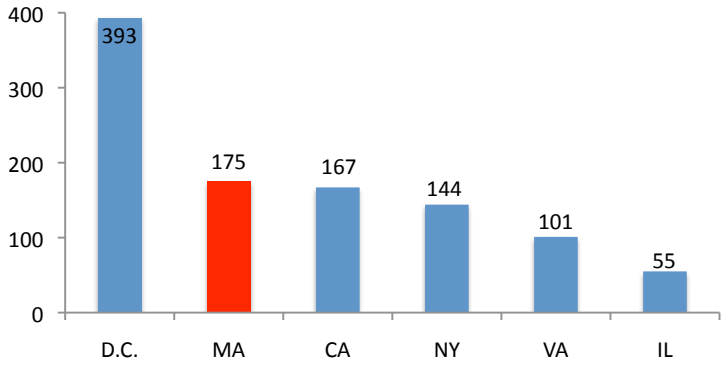


Figure 9 *Number of think tanks by state (McGann, 2010)*

But since most D.C.-based centers focus on politics or public policy, Massachusetts effectively leads the country in science and technology-oriented research centers. A third strength is the existence of sophisticated institutes for collaboration such as the Massachusetts Technology Collaborative that serve as catalyst to growing knowledge- and technology-based industries. A potential threat to Massachusetts' competitiveness remains the relatively low level of state support for undergraduate education, which undermines the expansion of the talent pool. Massachusetts indeed only belongs to the second quartile of states ($1,192-$660) in terms of annual public expenditures on student aid per full-time undergraduate student (NSF, 2007).

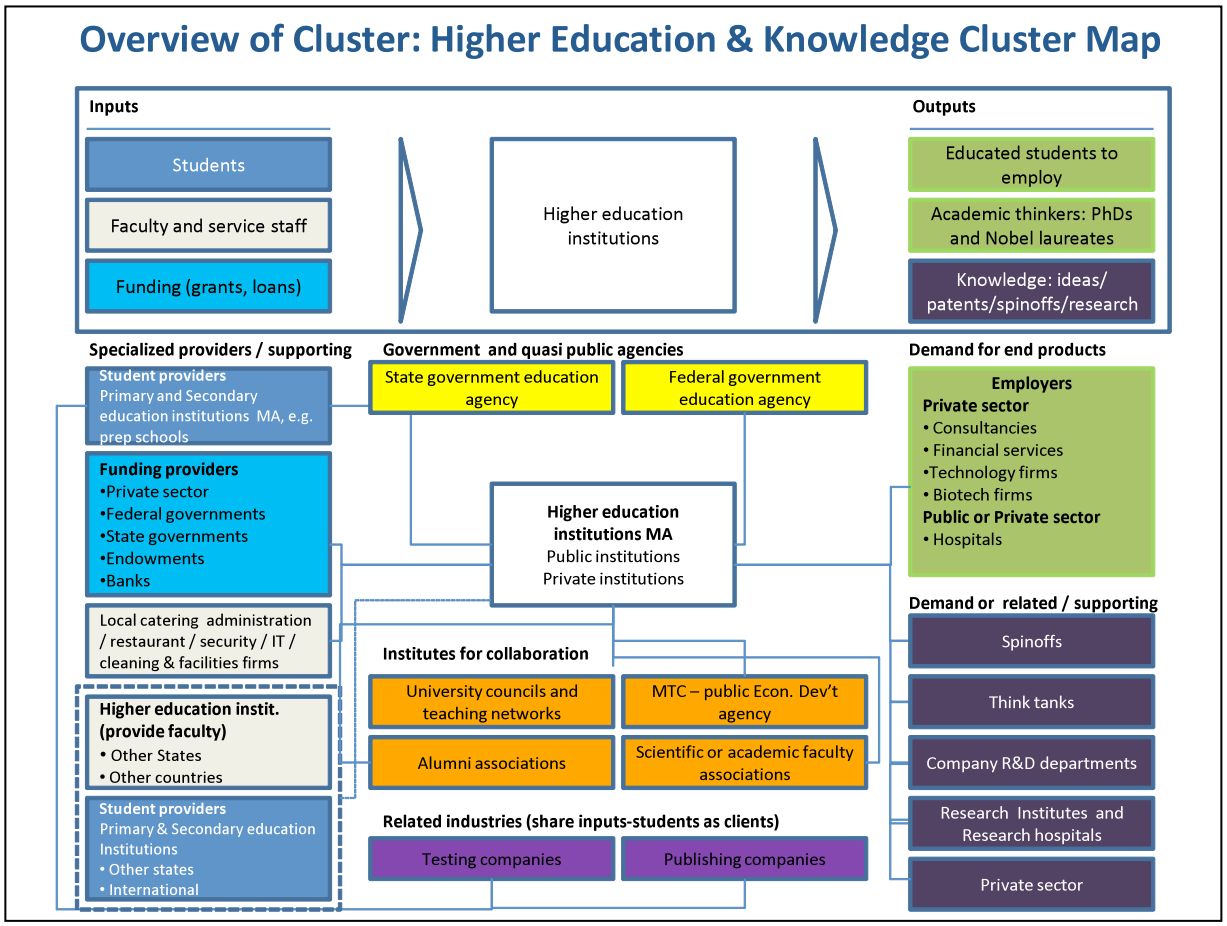
3.5. Recommendations

Below is a set of recommendations for the Governor of Massachusetts to improve the competitiveness of the state based on the challenges it currently faces:

Challenges	**Recommendations**
Cluster concentration and dependence	• Similar to medical devices strategy, enhance diversification by strengthening clusters such as IT, communications equipment, leather, or advanced instruments
New business formation post financial crisis	• Lower corporate taxes to better compete with other states • Simplify and streamline business registration procedures
Inadequate and aging infrastructure	• Invest on information and communications infrastructure, with a specific focus on access to technology for public school system • Invest on physical infrastructure in order to ensure the safety and convenience of the state's residents and business interests
Retaining talent	• Invoke the argument of national and regional competitiveness to lobby the President for more flexible federal visa policies
Competition for venture capital investments	• Loosen restrictions on "non-compete" agreements to align with regulation in California and better compete for funding
Lack of interest for STEM in high school	• Institutionalize current pilot scholarship program for "out of field" math and science teachers • Introduce state financial support (scholarships, grants, loans) tied to undergraduate studies in STEM • Give political teeth to the "STEM Educational Advisory Council" (created in October 2009)

4. Massachusetts Higher Education and Knowledge Cluster Competitiveness Analysis

4.1. Cluster Definition, Map and Development



The education cluster is an unconventional cluster and therefore needs some clarification. As can be seen in the graph above, we define students, faculty, service staff and funding as inputs to higher education institutions. These inputs are provided by specialized providers and/or supporting industries (NB: the colors of supporting and demand industries correspond with input and output categories.) Students are provided by primary and secondary educational institutions in MA and outside the state (dotted lines). Next to high schools, Massachusetts is home to a number of elite prep-schools. Funding is provided by grants of the federal and state government, by University endowments and by the private sector. Furthermore banks play a key role in

providing loans to students. Other higher institutions in other states and countries can be considered to provide an inflow of faculty to universities in Massachusetts. Service staff can be considered another input into the higher education institutions. Universities typically hire catering or restaurant services, security services and cleaning or facilities services.

Outputs of the cluster are graduating students and ideas / knowledge / research or marketable knowledge like patents and spin offs. The private sector can fulfill two roles: it can drive demand for the end product or it can function as a supporting or related industry. We consider the private sector to be a demand factor when it is seeking to employ educated students, PhDs or faculty or, when it buys university created knowledge (licenses). It is considered to be a supporting or related industry when it is collaborating with universities on research or when it pays for R&D.

Our previous section already described the large variety of clusters driving demand in MA. We think that the higher education cluster within Massachusetts, which is specifically concentrated in the cities of Boston and Cambridge, shows a few unique characteristics that explain its unique competitive position. First, with respect to the business services demand / supporting or related industry cluster, it is interesting to note that Massachusetts can be considered the cradle for strategy consulting businesses. Many top consultancies like Monitor Company (founded in Cambridge in 1983 by Harvard affiliates such as Michael Porter (Monitor, 2010)), the Boston Consulting Group (founded in Boston in 1963, by HBS Alumni (BCG, 2010)), and Bain & Company (founded in Boston in 1973 by Bill Bain and 5 other BCG partners (Ormiston, 1990)) were started in Boston or Cambridge by alumni or professors of elite higher education institutions. They still have their global headquarters in Boston or Cambridge. While the firm McKinsey was founded outside of MA in 1926, it was also significantly developed by an HBS alum, Marvin Bower (McKinsey, 2010).

A second unique characteristic for the Massachusetts cluster is that there is a large number of non-profit research institutes and (teaching) hospitals, which are both collaborating with universities and which are contracting students, PhD's and/or professors for consulting services (see Figure 10; MTC, 2010). Especially in the medical field, hospitals also collaborate with each other in specific medical research, treatments and education. The Harvard University plays an important role in facilitating collaboration between several hospitals in the field of medical education (See Figure 11; HMS, 2010).

Figure 10: *MA research institutions* ***Figure 11:*** *Hospitals part of Harvard teaching network*

Hospitals & nonprofit research institutes	Universities
Beth Israel Deaconess Medical Center	Tufts University
Brigham & Women's Hospital	Univ. of Massachusetts
CBR Institute for Biomedical Research	Northeastern University
Children's Hospital Boston	Harvard University
Dana-Farber Cancer Institute	MIT
New England Medical Center	Boston U./ Boston Medical Ctr.
St. Elizabeth's Medical Center of Boston	
Massachusetts General Hospital	
Schepens Eye Research Institute	
Tufts Medical Center	
Woods Hole Oceanographic Institution	

Offering Institutions

- Beth Israel Deaconess Medical Center
- Brigham and Women's Hospital
- Cambridge Health Alliance
- The CBR Institute for Biomedical Research
- Children's Hospital Boston
- Dana-Farber Cancer Institute
- Harvard Pilgrim Health Care
- Joslin Diabetes Center
- Judge Baker Children's Center
- Massachusetts Eye and Ear Infirmary
- Massachusetts General Hospital
- Massachusetts Mental Health Center
- McLean Hospital
- Mount Auburn Hospital
- Schepens Eye Research Institute
- Spaulding Rehabilitation Hospital
- VA Boston Healthcare System

A third unique characteristic of the Massachusetts cluster is the presence of the IFC and quasi-public agency, the Massachusetts Technology Collaborative (MTC). The MTC is an agency that pursues federal funding to support economic development in Massachusetts. While many US states have state agencies for education, the MTC is unique in that it brings together leaders from government, industry, universities, trade associations, and non-profit organizations to strengthen the knowledge economy in Massachusetts, develops a strategy and monitors the status of the knowledge economy (MTC, 2010). A promising initiative that contributes to competitiveness is the historic collaboration between leading research universities, corporations, and state government to establish a Green High Performance Computing Center in Holyoke. This initiative has the potential to catalyze a revival of that city's economy and increase state competitiveness (MCT, 2010).

In terms of cluster development, MA and in particular Boston have a first mover advantage in comparison with other states in the U.S. in terms of higher education. Both the 1st Latin grammar school of the US and the 1st U.S. higher education institute, Harvard University, were founded near Boston. Massachusetts, where public school attendance became mandatory starting in the 1800s, has traditionally led by raising standards with respect to education (cf. Massachusetts Acts of 1642 and 1647 introducing the New England Primer).

Overall Cluster Performance

When comparing the education cluster in Massachusetts with other states and other countries we see that it has a unique position in many key performance criteria. First, R&D investment as a percentage of GDP is higher in Massachusetts than in the U.S. in general or in other innovative country (cf. Figures 12 and 13). However, other countries are rapidly catching up. The first follower seems to be South Korea, where R&D intensity of the economy is growing faster than in Massachusetts (MCT, 2010).

Figure 12

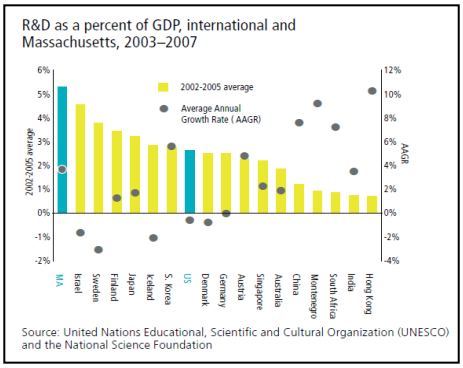
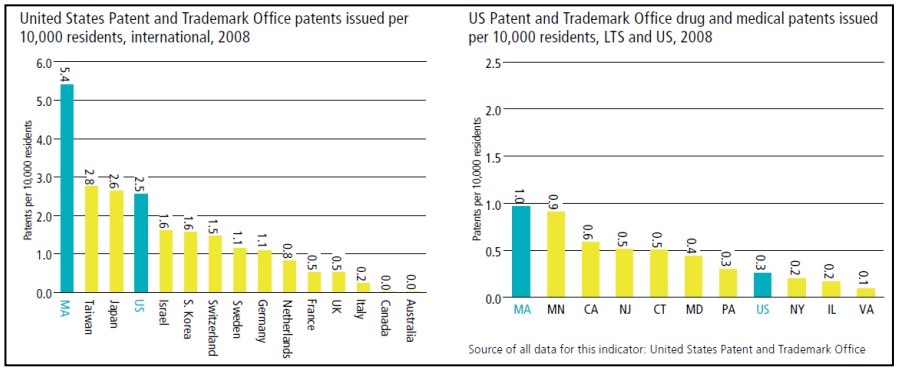


Figure 13



Massachusetts also seems to be leading in terms of innovation activity and resulting patents filed when looking at patents per capita, both within the US as in comparison with other countries. Patenting in MA remained constant in 2007-2008 while it declined in the US overall. Massachusetts seems to have a core competence in drugs and medical patents, which seems

logical given the presence of many leading medical institutions. In 2008, Massachusetts led in drugs and medical patents per capita and trailed only California in computer and communications patents per capita. It therefore seems important for Massachusetts to maintain an attractive place for medical institutions in order to maintain this core competence (MCT, 2010). Third, universities, hospitals and research institutions in MA seem to be very good at commercializing their knowledge since they led in the number of licenses and options executed in 2007 within the US. A key leader in technology licensing is the MGH, which tripled its licensing revenues to 346 million in 2006 vis-à-vis 2005. MGH represents 60 percent of the revenues that were received by hospitals and non-profit research institutes in the US. This is due to the arthritis drug Enbrel (MCT, 2010). The fact that MA institutions perform so well on license income is promising since this means that the perceived market value of their IP is high and that they can reinvest revenues in new R&D to sustain their performance.

Figure 14

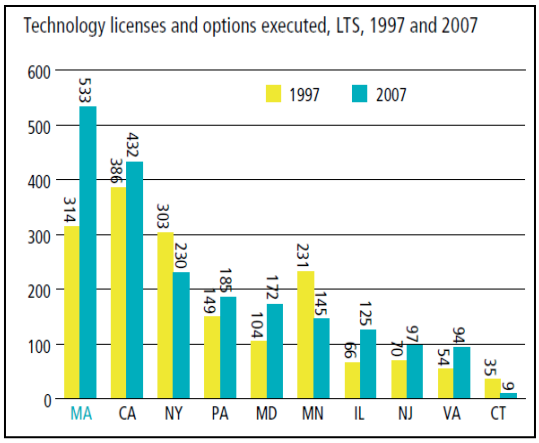
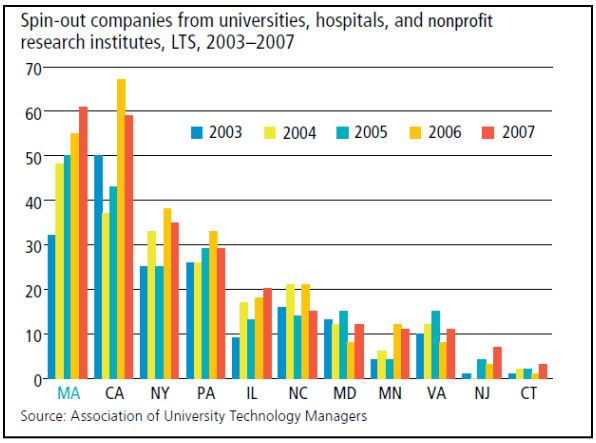


Figure 15



Fourth, spinouts help us understand how good Massachusetts is in commercializing emerging technologies through new business formation as the number of spinout companies from universities, teaching hospitals and research institutes serve as a proxy for entrepreneurship

within these institutes. Compared to California, Massachusetts is clearly lagging behind. It is however a strong performer in comparison with other states.

Figure 16

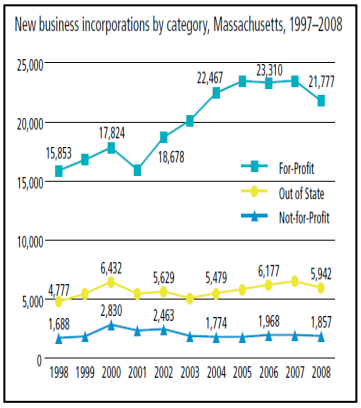


Figure 17 Number of international students per market

Host Market	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
United States	490,933	514,723	547,867	582,996	586,323	572,509	565,039	564,766	582,984	623,805
YoY growth	-	*4.8%*	*6.4%*	*6.4%*	*0.6%*	*-2.4%*	*-1.3%*	*0.0%*	*3.2%*	*7.0%*
IS per capita	*0.18%*	*0.18%*	*0.19%*	*0.20%*	*0.20%*	*0.20%*	*0.19%*	*0.19%*	*0.19%*	*0.21%*
Canada	97,336	114,098	136,732	150,541	159,711	164,838	167,162	170,146	176,077	178,227
YoY growth	-	*17.2%*	*19.8%*	*10.1%*	*6.1%*	*3.2%*	*1.4%*	*1.8%*	*3.5%*	*1.2%*
IS per capita	*0.32%*	*0.37%*	*0.44%*	*0.48%*	*0.50%*	*0.51%*	*0.52%*	*0.52%*	*0.53%*	*0.54%*
United Kingdom	232,540	222,936	225,722	227,273	255,233	300,056	318,399	330,078	351,470	389,330
YoY growth	-	*-4.1%*	*1.2%*	*0.7%*	*12.3%*	*17.6%*	*6.1%*	*3.7%*	*6.5%*	*10.8%*
IS per capita	*0.39%*	*0.37%*	*0.38%*	*0.38%*	*0.42%*	*0.50%*	*0.53%*	*0.54%*	*0.58%*	*0.64%*
Australia	117,485	105,764	120,987	179,619	188,160	166,954	177,034	184,710	211,526	223,508
YoY growth	-	*-10.0%*	*14.4%*	*48.5%*	*4.8%*	*-11.3%*	*6.0%*	*4.3%*	*14.5%*	*5.7%*
IS per capita	*0.62%*	*0.56%*	*0.63%*	*0.92%*	*0.95%*	*0.83%*	*0.88%*	*0.90%*	*1.02%*	*1.06%*
Japan	56,552	59,691	63,637	74,892	86,505	117,903	125,917	130,124	125,877	123,829
YoY growth	-	*5.6%*	*6.6%*	*17.7%*	*15.5%*	*36.3%*	*6.8%*	*3.3%*	*-3.3%*	*-1.6%*
IS per capita	*0.04%*	*0.05%*	*0.05%*	*0.06%*	*0.07%*	*0.09%*	*0.10%*	*0.10%*	*0.10%*	*0.10%*

Sources: MTC (2010); IIE, UNESCO-UIS, and Canadian ministry of citizenship and immigration.

Finally, Massachusetts is doing a fair job at attracting international students and thereby guaranteeing an inflow of talent to its knowledge economy, but Canada, the UK and Australia are all doing better on a per capita basis. Visa restrictions and higher costs of education in MA certainly account for such a situation.

4.2. Cluster Diamond Analysis

Massachusetts Diamond: Competitiveness of Cluster

Factor Conditions
- **Human Capital**:
  - +Primary & secondary education fairly strong because of charter and prep schools
  - - Limited capacity to attract more international students
- **Financial Capital**:
  - +Strong supply of private capital to its elite private education institutions
  - + Stable government loans for students
  - - Public funding low in comparison with other countries

Demand Conditions
- **Large and Sophisticated demand:**
  - + Presence of sophisticated local demand, especially in high tech and medical industries
  - + Access to national and foreign demand
  - + Strong demand for knowledge of research institutions and hospitals reflected in increased licensing revenues, especially at MGH
- **Limited job creation**
  - - Shrinking size local clusters that traditionally demand highly educated workforce

Context and Firm Rivalry
- **First mover advantage (+)**
- **Legislation:**
  - +Enabler of R&D, leading to great performers
  - - Restrictive immigration laws and cost of education in MA limit inflow of foreign students in comparison with other countries
- **Competition and collaboration:** Highly ranked universities and institutions ave created both a collaborative and competitive environment in research, teaching, and other forms of knowledge creation

Related and Supporting Industries
- **Vigorous business environment**
  - +Large and relatively innovative high-tech sector
  - +Strong levels of private-sector R&D but lagging Korea
  - +Great capital availability, especially in high-tech
- +**Collaborative competition:** intense cooperation among peer institutions
- **+Presence of functioning IFC :**that coordinates cooperation to improve business environment and drives economic development strategy
- +/-Strong performance on spin offs but lagging California

Source: team analysis

Factor Conditions. To a certain extent, the necessary human capital for Massachusetts's knowledge cluster has been touched on earlier – including its reasonably strong public school system, as compared to other states, and its highly educated workforce, from which one can choose knowledgeable professionals for both the higher education institutions at the center of the cluster and the science and technology research institutions and companies related to and supporting the cluster. A contributing factor to the state's strength in secondary school performance may be the presence of charter schools in the state, driven by the state's Education Reform Act of 1993. Under this act, "the new charter school has the freedom to organize around a core mission, curriculum, theme, or teaching method" and is "allowed to control its own budget and hire (and fire) teachers and staff" (Massachusetts Department of Education). This restraint on the part of the state government enables these charter schools to manage for performance, and provide competition to the public schools. Furthermore, charter school performance is reinforced by the fact that they can lose their charter if they don't "demonstrate good results within five years". MA is also home to three of the top thirteen elite prep schools according to Forbes (Jones, 2009), from which talent comes around the country and the world to gain access to Massachusetts' world-class higher education.

Besides human capital, MA also possesses financial capital for its higher education institutions, though it seems to be weighted on the private side. Compared to other states, postsecondary institutions in MA are predominantly private, non-profit institutions, and thus dependent upon private funding. Given this, it is not surprising that MA has the highest number of institutions that belong to the 50 biggest endowment schools list in the nation. However, where the private sector has succeeded the public sector has fallen short. MA spending per capita on primary and secondary education ranks a reasonable, though not stellar #7 in the nation

(NCES, 2007), and this inhibits the state's ability to provide access to students of all backgrounds and ensure an important pipeline of talent. However, internationally it lags behind many developed economies in terms of both public spending and growth of spending, which can worsen the MA position in the longer term.

On a national level, the US government has played an important role in providing student loans, as it has historically guaranteed the default risk of these loans for the private lenders (Moss, 2010). In the recently passed Health Care and Education Reconciliation Act of 2010, the government essentially eliminated the private lenders' intermediary role and proceeded to provide direct funding to the students. Given the current difficulties faced by the financial system, this may provide more stable funding to students in the near term, though the ability of the government to sustain these loans in the long term given its own budgetary constraints remains to be seen.

Figure 18

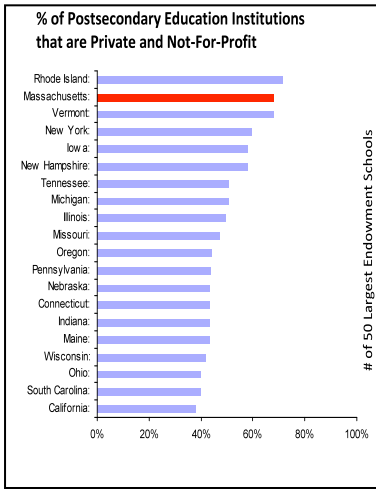


Figure 19

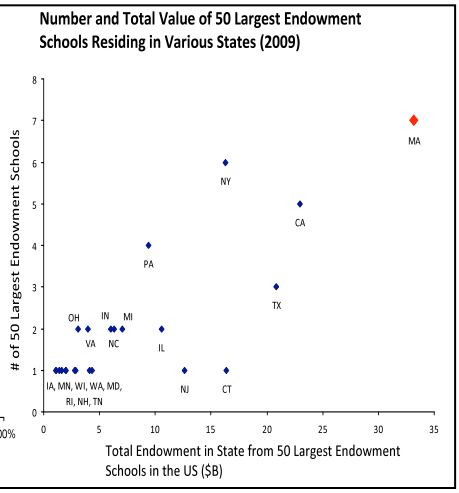
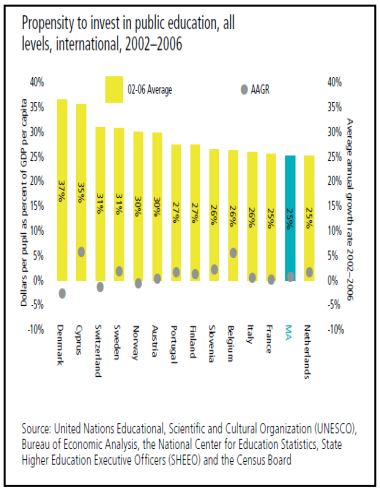


Figure 20



Demand Conditions. Massachusetts's economic composition provides a large and sophisticated demand for highly educated talent. Massachusetts' leading employers include the following traded clusters: Education and Knowledge Creation, Business Services and Financial

Services which are ranked 4th, 12th and 6th in terms of share of national employment; while the leading local cluster is Health Services which is ranked 11th (ISC, 2010). These large clusters employ the highest percentage of employees with top education attainment (i.e., bachelors degree and above) compared to other industries, resulting in Massachusetts having the highest percentage of postsecondary degrees within a state population. Furthermore, the Massachusetts Higher Education and Knowledge Cluster has the ability to tap national and foreign demand for talent with many national and global companies typically recruiting employees from Massachusetts educational institutions.

While Massachusetts currently has ideal demand conditions in terms of size and sophistication, recent employment trends have shown a decline in Massachusetts' ability to attract as many jobs that demand highly educated talent. Massachusetts' share in national employment across the mentioned key clusters—Education and Knowledge Creation, Business Services, Financial Services and Health Services is shrinking while their national clusters are continuing to grow (ISC, 2010). In Business Services (i.e., management consulting, computer programming and professional organizations and services), for example, Massachusetts' share of national employment declined by 0.25% from 1998 to 2007 with California and Texas being the top states in job creation in the national cluster (ISC, 2010). An important factor in this trend is the continuous increase in Massachusetts wages relative to other states, which potentially makes it less attractive. MA has the second highest average state wage for business services at $80,493, while California and Texas garner much lower wages ranking 7th and 10th respectively.

Context and Firm Rivalry. Massachusetts has long been recognized as a major center for higher education and knowledge creation. The State was the first in the thirteen original colonies to pass legislation in the 1640s that introduced compulsory elementary education for

Massachusetts's residents. This traditional commitment to developing education and the Boston's role as a magnet for early immigrants contributed to large establishment of institutions and universities throughout the next two centuries in Massachusetts.

More broadly, U.S. federal government helped create a highly deregulated education system whereby universities would compete for talent and federal resources. The Federal government did this through a series of legislative landmarks such as The Morrill Land Act of 1862, Higher Education Act of 1965, and Immigration Act of 1990. Each of these legislations contributed to creating the context and conditions for universities to thrive. Today U.S. is widely recognized as being home to the best universities, which has made the country a magnet for attracting students from around the world. Collaboration in research and teaching has further cemented cluster's position as a frontier place for knowledge creation, innovation, and research.

Despite these advantages, however, both Massachusetts and the cluster of higher education today face many challenges. At the local level, the state's business environment is laden with overburden regulation and costly labor issues, which makes it difficult for businesses to locate here and reap the benefits of the educated workforce and world-class institutions. Restrictions in immigration laws at the federal level coupled with increasing costs in attending higher education will also have a negative impact in sustained competitiveness of the cluster.

Related and Supporting Industries. The first comparative strength of the cluster is the size and vigor of its high-tech private sector, which acts as a real partner to institutions of higher learning by providing licensing revenue, direct financial support (e.g. "research contracts", participation in research consortia), or investing in university-based start-ups. In 2006, Massachusetts led the country with 16.3% of state employment in the high-tech sector (National Science Foundation, 2010) as well as corporate R&D spending in the state being highly geared

towards high-tech (cf. Figure 21). Furthermore, the cluster enjoys great capital availability – especially in high-tech (cf. Figure 22).

Figure 21 *Business R&D by sector*

2007 Ranking	State	Business-performed R&D ($bn)	Chemicals	Computer and electronic products	Computer-related services	R&D services	Motor vehicles	Companies with 5–499 employees
1	California	$64.2	13.9%	33.0%	14.6%	9.5%	NA	20.2%
2	Massachusetts	19.5	17.4	44.6	5.5	9.9	0.0%	18.5
3	New Jersey	17.9	63.1	6.3	5.2	8.0	0.1	13.4
4	Michigan	15.7	6.7	1.3	1.9	2.8	74.8	8.5
5	Texas	13.9	5.6	32.3	17.8	7.4	0.4	18.6
6	Washington	12.7	5.2	5.3	2.6	6.5	0.4	12.3
7	Illinois	11.4	25.2	32.7	4.3	2.4	1.8	14.1
8	New York	10.9	30.1	7.8	15.6	4.1	3.0	22.7
9	Pennsylvania	10.4	55.0	7.3	6.2	5.2	0.8	17.5
10	Connecticut	9.4	59.0	2.3	2.5	3.2	0.2	8.2
	United States	**$269.3**	**20.6%**	**21.8%**	**5.4%**	**8.4%**	**6.0%**	**18.7%**

Source: NSF, 2007.

Figure 22 VC disbursed per $1,000 of GDP

2008 Ranking	State	Venture capital / $1,000 GDP 1998	2003	2008
1	Massachusetts	8.5%	9.3%	8.2%
2	California	7.3	6.1	7.7
3	Colorado	5.1	3.4	3.3
4	New Hampshire	4.7	3.2	3.0
5	Washington	3.8	1.9	3.0
6	Minnesota	2.2	1.1	1.9
7	Utah	1.9	1.4	1.8
8	Maryland	2.0	1.6	1.7
9	Vermont	0.1	0.3	1.7
10	New Jersey	1.5	2.3	1.5
	United States	2.4%	1.8%	2.0%

Second, the cluster enjoys a very strong culture of collaboration among peer institutions. This environment leads to "positive sum" competition in which different institutions of higher learning act as supporting industries to one another. Prevalent modes of cooperation include: co-funding of research (e.g. joint grants), qualitative collaboration at the student and faculty levels (e.g. joint seminars, data sharing), joint faculty appointments, reciprocal access to infrastructure and resources (e.g. libraries, various facilities, faculty), cross-registration, or joint-degree programs agreements. The Harvard-MIT partnership best captures such "collaborative competition" through its strong institutional ties: among others, the *Harvard-MIT Division of Health Sciences and Technology*, the *Broad Institute of MIT and Harvard*, the *MIT-Harvard Center for Ultracold Atoms*, and the *Harvard-MIT Data Center*.

A third comparative strength of the cluster is the close proximity of a large number of top consulting firms. These operate as supporting industries to the cluster in that they can provide concomitant or future employment opportunities to faculty members and tertiary students, thereby increasing the cluster's attractiveness. Consulting firms also enhance the cluster's competitiveness by collaborating in, and sometimes even initiating, research projects with institutions of higher learning. First-class consultancies based in the Boston area include: *Boston*

Consulting Group, *Bain & Co.*, *Monitor*, *Symmetrix*, *GeoPartners Research*, *LEK/Alcar Consulting Group*, *Linkage*, *Mercer Management Consulting*, and *Vertex Partners*.

A potential threat to the cluster's competitiveness lies in the fact that intense collaboration mostly takes place at the private level, leaving public institutions behind. Most of the "collaborative competition" indeed occurs among the elite galaxy of Harvard, MIT, Tufts, Wellesley and to some extent BU and BC, excluding the bulk of the overall student population. The private-public divide also transpires in terms of capital availability. While Harvard and MIT respectively reported endowments in excess of $36.9 billion and $10.1 billion at the end of the 2008 fiscal year, the University of Massachusetts reported $350 million (cf. individual university website). Though the financial crisis severely hit elite institutions (Harvard lost $8 billion between 2008 and 2009), public institutions likely will continue to struggle accessing capital in the future. A final potential threat to the cluster is its relative lack of think tanks and related centers of collaboration focusing specifically on high-tech, despite the vibrant local environment.

4.3. Recommendations

1. **Increase attractiveness of business environment, especially for medical and high tech sectors** – The cluster seems to be leading in knowledge creation in both the high tech and the medical sector. The state government should therefore make sure that the business environment for these specific companies remains conducive. It should make the process to license, patent and spin out a business as easy and fast as possible and should engage in a discussion with business to find out how to do that. Furthermore it should invest in necessary IT infrastructure to keep Massachusetts more attractive than competitive places like California. The MA state government should also reduce its regulatory burden and liberalize its labor restrictions. Some of these restrictions have contributed, in part, to rising wages, which has made important consumers of talent, services companies, less willing to locate in MA. This is dangerous for ensuring strong demand conditions, and the state needs to find the political will to tackle unions and other inflexible labor measures head-on. Finally, it should make business taxation and regulation more competitive to retain talent;

2. **Ensure a sufficient number of students is educated in the fields of engineering, IT and health sciences to give businesses a rationale to stay in MA and ensure that educational**

programs meet business needs – As can be seen in the part on demand and an estimation of the MTA, approximately six percent of jobs today in Massachusetts are in engineering, computer, or information science professions (MTA, 2010). This is above ten percent and growing for health or biological science professions. Nearly all of these jobs require a postsecondary degree in the field. Universities should work together to attract students in these fields through joint marketing campaigns and potentially jointly offered programs. They could distinguish their programs to be well fitted to requirements of the businesses in the field by proactively engaging in a dialogue with businesses to shape the academic programs and prevent overshooting demand;

3. **Increase ease of immigration for higher education and reevaluate cost of education to maintain international competitiveness** – While the cluster is good at attracting its portion of international students it is lagging behind countries like Australia and the UK. In order to remain attractive to international students universities should look into ways to reduce the cost of education and should proactively attract foreign talent through outreach initiatives. Furthermore, the federal government and the state government must make it easier to (temporarily) immigrate for foreign skilled persons for the reason of following higher education;

4. **Guarantee sufficient funding to public educational institutions** – The MA state government needs to increase its spending on public education institutions. While the private institutions receive substantial funding from endowments and other private, though non-profit entities, the public higher education institutions and primary/secondary institutions do not receive enough state support;

5. **MTC should maintain coordinating role, keep a coherent strategy and monitor progress against targets set** – The MTC should continue to engage all stakeholders in aligning with an overall economic development strategy for the MA knowledge industry and should keep monitoring process against that strategy. Furthermore it needs to ensure that the private sector (and private education institutions) continues to engage and collaborate with the state's public institutions to ensure overall growth. As the quality of the private institutions have excelled those of the public, it has become more imperative that they continue to engage with the public schools and government agencies in research and other activities to ensure the entire cluster does not split apart. A last thing it should do is coordinate large investments in projects that improve the overall ease of doing business in Massachusetts;

6. **Increased collaboration between firms and think tanks** – The high-tech and medical institutions should fund think tanks or collaboration centers with a specific focus on high-tech and biotech research.

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