Commercializing University Innovations:

Pathways & Practices

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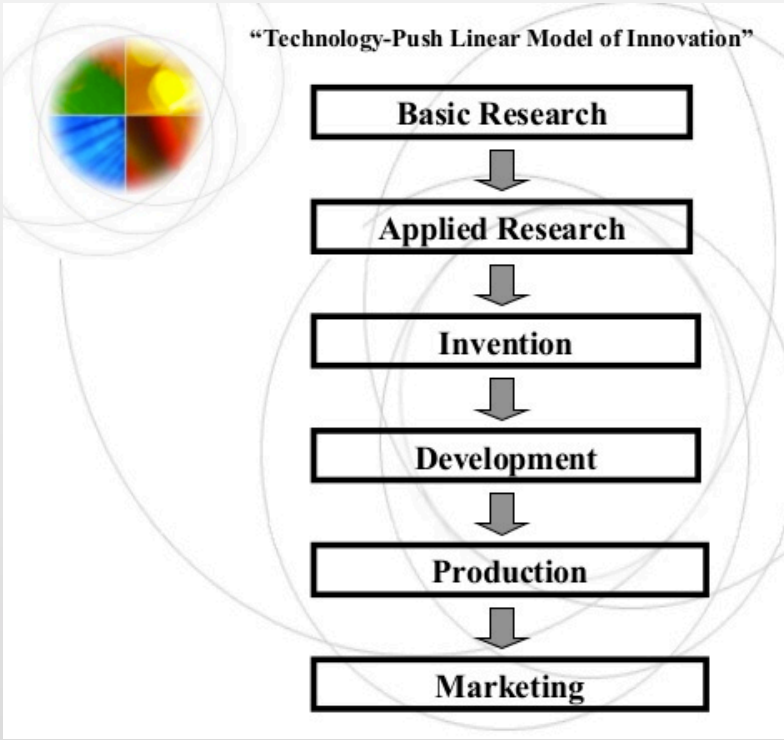
Agenda: *30 minute talk + 30 minute Q & A*

1. Framework for How Univ Innovations Get Commercialized
   - The 4Ms: ***Morphed***, ***Mined***, ***Milked*** & ***Marketed***
   - University startup ***spin-outs*** versus ***blast-outs***
2. Bifurcation of Activities that Drive & Support Commercialization
   - Systematic activities that have an ***asymptotic*** impact
   - Organic activities that have an ***exponential*** impact (and are cost-effective)
3. Value of Univ Local Innovation Ecosystems
   - Definition & segmentation
   - Strategic value to university
4. Framework & Strategy for Growing Univ Innovation Ecosystems
5. How Univ Ecosystems Scale Talent & Reach Supercritical Mass
6. Hy-LIE 10 Best Practices & 5 Predictions

Question: *How Do Univ Innovations Get Commercialized?*

- Conventional answer (in 2006) was linear
  (research=>invention=>license =>commercialize)
- What and/or who catalyzed the commercialization?
- How are universities involved in the process?
- How can universities increase startups?



Conventional Answer to
How Technology Developed at Universities
Gets Commercialized

Research: *Studied Over 50 Technologies*

- Institutions: UC Berkeley & Berkeley Lab
- Sectors: Information technology, life sciences, clean tech
- Scenarios: Success & failures
- Cases Studies:

  Amyris, Calimetrics, CaliSolar, CellASIC, Chiron, Ensighta Security (FireEye), Excellin, Fluxion Biosystems, GoodGuide, Harmonic Devices, Hybrid Wisdom Labs, Inktomi, Integrated Diag, IntelliOne, Kalinex, Lumiphore, Mercator Med, MicroClimates, MicroFluiDX, OnWafer, ON Diagnostics, PhotoSwitch Bioscience, Redwood Bioscience, Safely, SiClocks, TheraFuse, Urban Scan, Verimetra Med, Wireless Industrial Tech, Dust Networks, Iris AO, SiTime, NanoGripTech, Adura Tech, Aurora Biofuels, CommandCAD, Euclid Media, MediFuel, NanoRay, nanoPrint, Analog Devices, Nueprene (XL Tech), Google (streetscape), Honeywell, Intel, Berkeley Bionics, Arkal Medical, Cisco, ClimateCooler, FuelFX, Luminus Devices (laser lift-off), Honeywell, Microchip Biotech, Renovis, Sand9, Silicon Basis, Solexel, Vitesse, 3M

Results: *The 4Ms of Univ Innovation Commercialization*

- Identified 4 common patterns/pathways
- Developed strategies for optimizing the 4 pathways
- Strategies led (in part) to:
  - BerkeleyStartupCluster.com in 2009
  - QB3 East Bay Innovation Center in 2010
  - The Skydeck in 2011

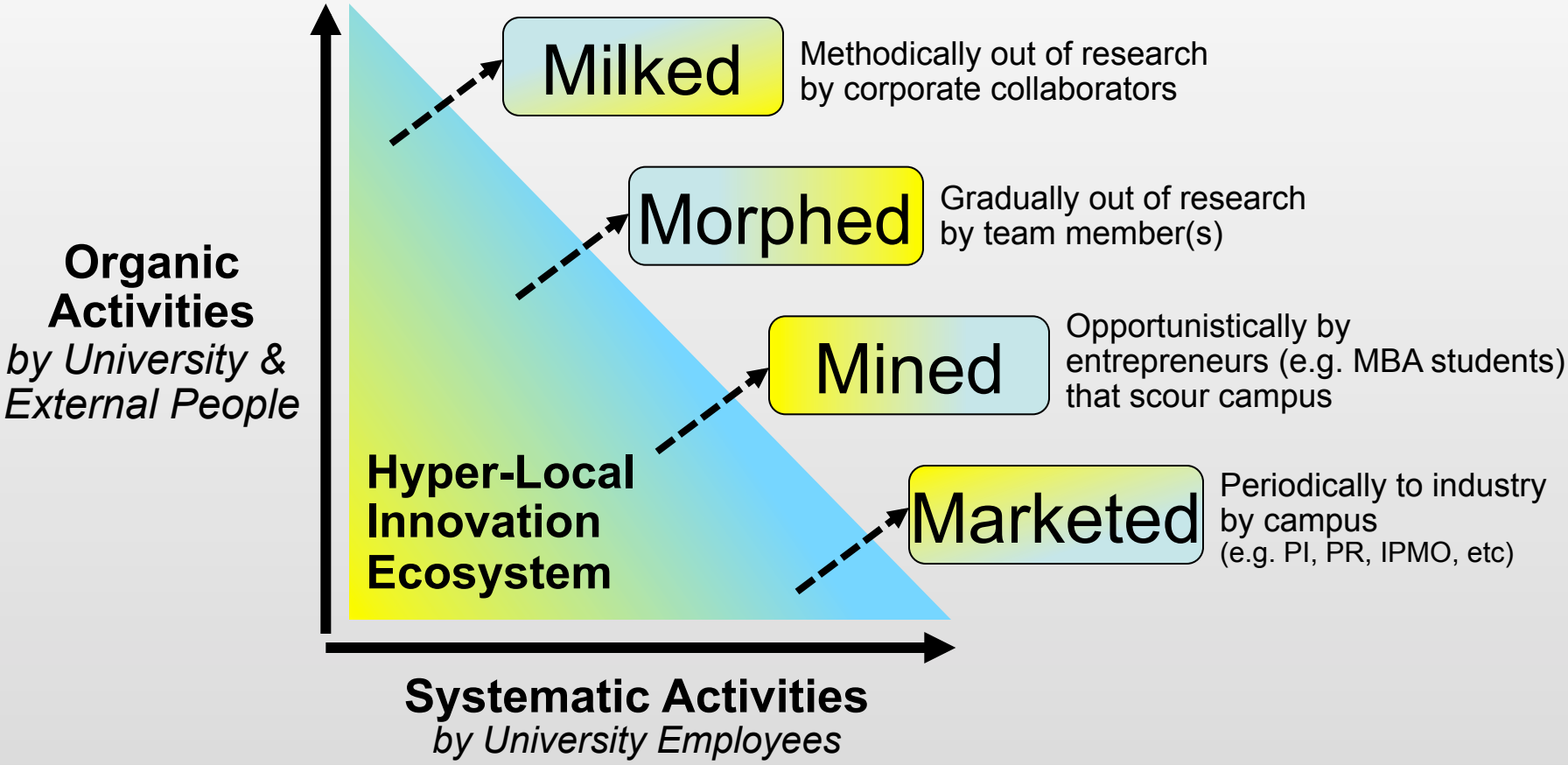
The 4Ms of Commercializing University Innovations

berkeley startup cluster

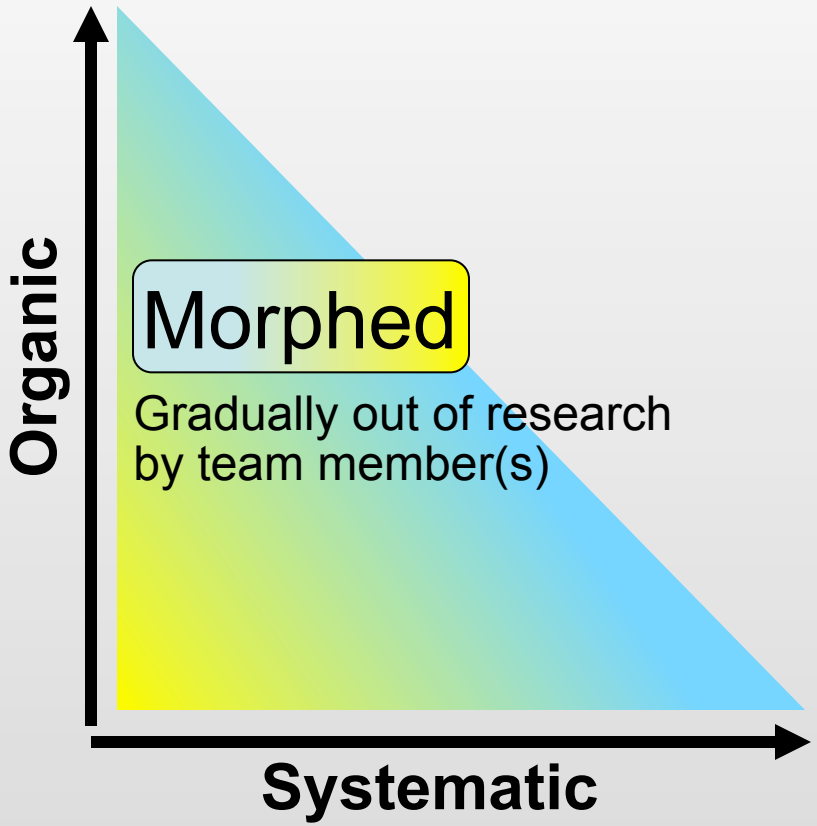
qb3 ucb·ucsc·ucsf

SkyDeck | Berkeley

4Ms Framework: *4 Pathways for Commercialization*

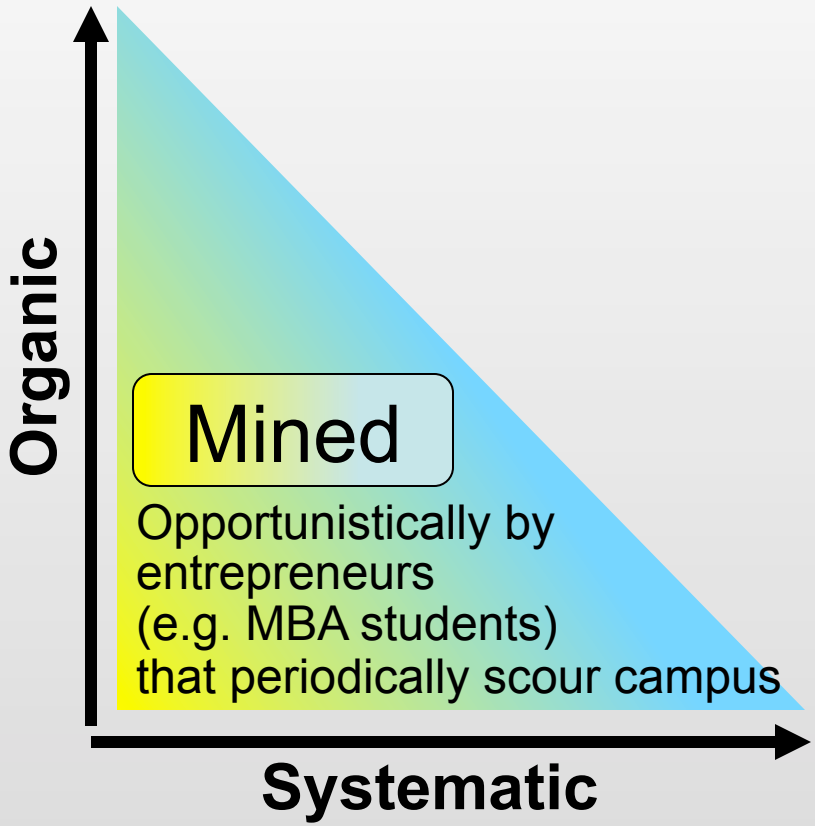


4Ms Framework: ***Morphed***, *Mined, Milked, Marketed*



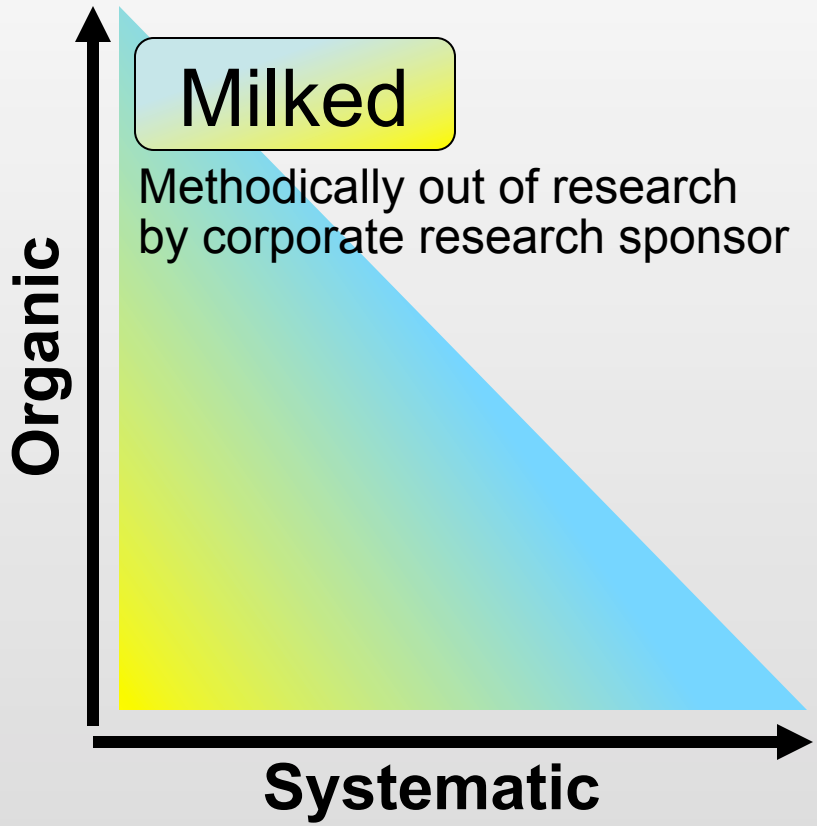
- Examples: Amyris, Calimetrics, CaliSolar, CellASIC, Chiron, Ensighta Security (FireEye), Excellin, Fluxion Biosystems, GoodGuide, Harmonic Devices, Hybrid Wisdom Labs, Indoor Reality, Inktomi, Integrated Diag, IntelliOne, Kalinex, Lumiphore, Mercator Med, MicroClimates, MicroFluiDX, OnWafer, ON Diagnostics, Persistent Efficiency, PhotoSwitch Bioscience, Redwood Bioscience, Safely, SiClocks, TheraFuse, Urban Scan, US Bionics, Verimetra Med, Wireless Industrial Tech, Dust Networks, Iris AO, SiTime, NanoGripTech
- Drivers:
  - Quantity & Quality of Research
  - Ecosystem: Spin-out vs Blast-out
- IP:
  - Some obtain exclusive license to improve biz plan & attract investors
  - Some ignore or abscond with IP

4Ms Framework: *Morphed,* ***Mined****, Milked, Marketed*



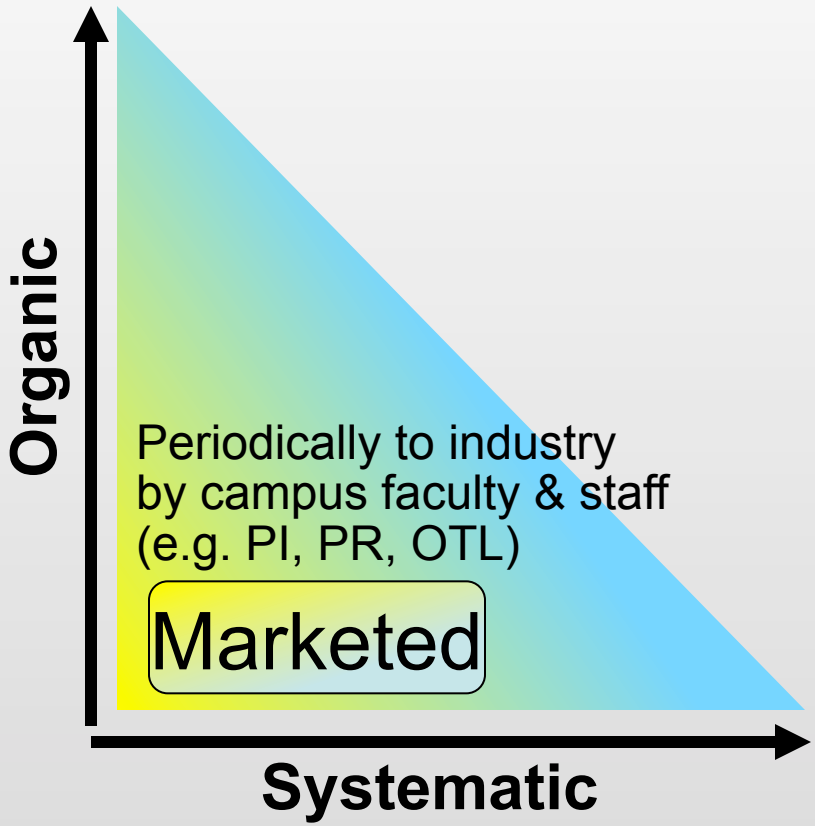
- Examples: Adura Tech (Acuity), Aurora Biofuels, CommandCAD, Euclid Media, MediFuel, NanoRay, nanoPrint
- Drivers:
  - Quantity & Quality of Research
  - MBAs, Biz plan comp, OTL mrktg
- IP:
  - Many obtain exclusive license to improve biz plan & attract investors
  - Some ignore or abscond with IP
- Comments:
  - Pathway with highest growth rate
  - Many campus EIRs are MBA students

4Ms Framework: *Morphed, Mined,* ***Milked****, Marketed*



- Examples (*that licensed IP*): Analog Devices, Nueprene (XL Tech), Google (streetscape), Honeywell, Intel, Berkeley Bionics (first morphed then milked)
- Drivers:
  - Great sponsored research with optimized terms (i.e. 1st access, NERF, open source, etc)
  - Off-campus corporate labs (i.e. BWRC, Intel, Cadence, Yahoo, Starkey, etc)
- IP:
  - Some jointly own IP
  - Some obtain a license to legally use IP or thwart competitors
  - Some ignore or abscond with IP (why license when get know-how)

4Ms Framework: *Morphed, Mined, Milked,* ***Marketed***



- Examples: Arkal Medical, Cisco, ClimateCooler, FuelFX, Luminus Devices (laser lift-off), Honeywell, Microchip Biotech, Renovis, Sand9, Silicon Basis, Solexel, Vitesse, 3M
- Drivers:
  - Quantity & Quality of Research
  - Marketing (i.e. IP Licensing offices, University PR programs, Faculty pubs & ppts, Patent pubs, etc)
- IP:
  - Most obtain exclusive license to stay legal, improve BP, attract investment, or thwart competitors
  - Some ignore IP or abscond with IP
- Comments: Didn't get *morphed*, *milked* or *mined* because tech or market too nascent when invented

4Ms Framework: *Partial List* of >100 Start-ups*

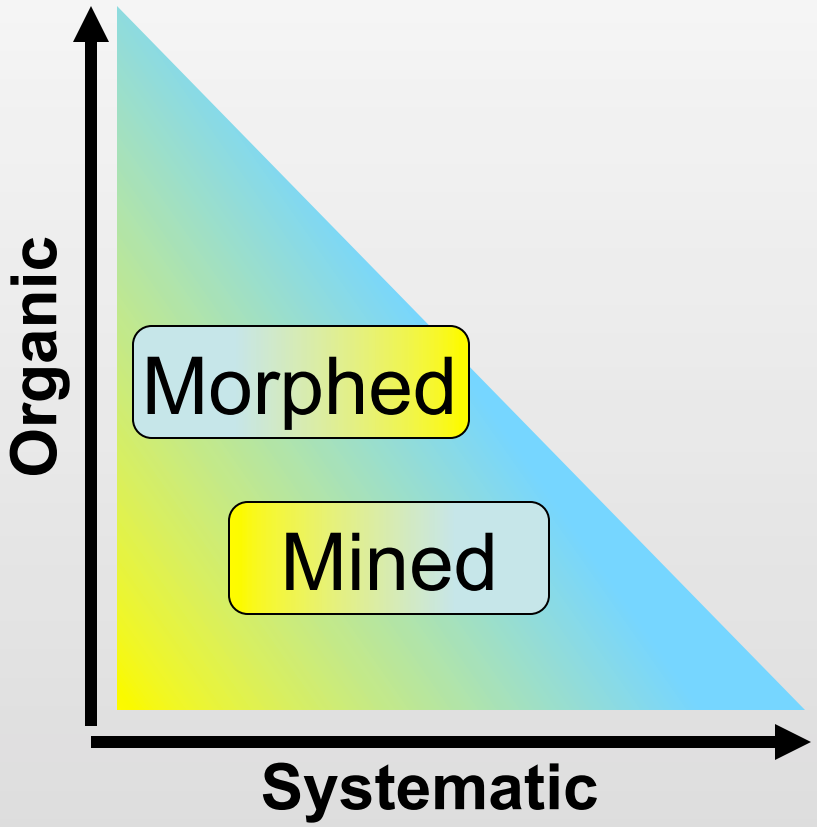
**This is a list of the over 100 start-ups that have leveraged UC Berkeley intellectual property rights (i.e. patentable inventions or copyrightable software) since about the mid 1990s.*

These start-ups have used UC Berkeley's intellectual property (IP) rights to strengthen their business plans and thereby improve their prospects for obtaining the venture capital or other funding needed to pursue the commercialization of Berkeley innovations.

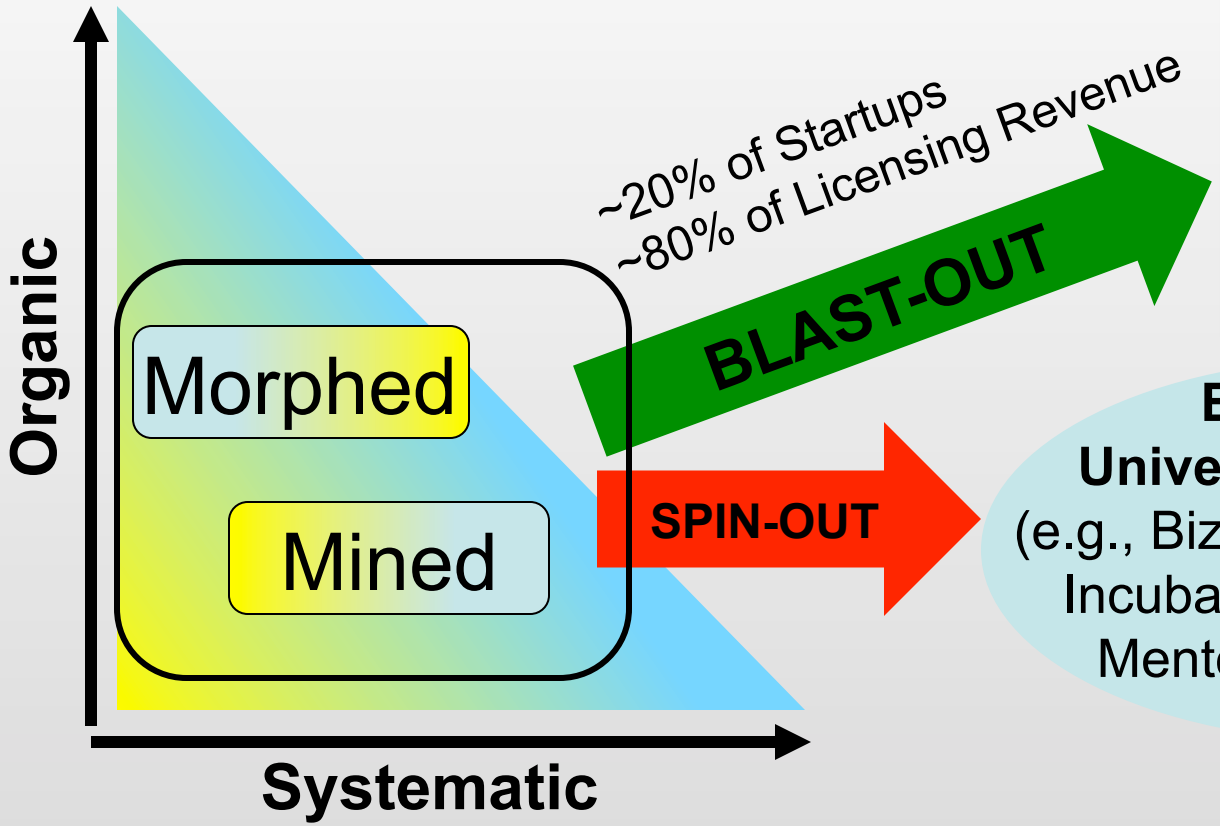
Note that this list does not include the numerous start-ups that have commercialized UC Berkeley innovations but did not leverage any UC Berkeley IP rights (because the innovations don't have associated IP rights – such as UNIX, SPICE, RAID, etc).

Acacia Biosciences
Adura Technologies
Alien Technologies
Ambrx
Amyris Biotechnologies
Arkal Medical
Aurora Biofuels
Bandwidth9
Berkeley Bionics
Berkeley Biosciences
Berkeley Madonna
Berkeley Microinstruments
BeThere
Biomanagement Group
Bioscale
BPS
Calimetrics
Calisolar
CellASIC
Ceres
Chiron
CNNSuperChip
Cognitive Wearable Technologies
Cooler
CommandCAD
Colusa Software
Cyberpac
Davis Allergy Research
Digital Mosaic Systems
Discera
DNA Sciences
Ecoprene
Euclid Media
EscharaX Medical
Excellin Life Sciences
Exelixis
Filgen Biosciences
FLX Micro
Fluxion Biosciences
Fuel FX
Genocea Biosciences
Gold Mountain Research
Goodguide
Harmonic Devices
Covarium/Heath Interactive
HFTA
iMedd
Inktomi
Integrated Diagnostics
IntelliOne
International Energy
InVino Sense
Iris Micromedical
Isatis
Joule Biotechnologies
Juvenon
Kaiwood Technologies
Kalinex
KineMed
Leucadia Technologies
Libraria
Light Stage
Lumiphore
Luminus Devices
Medifuel
Mendel Biotechnology
Mercator Medical
Microchip Biotechnology
Micro Climates / Aptility
MicroFab Biosystems
MicroReactor Systems
Mimesyn
Modulus Video
Molecular Dynamics
MOR Innovations
NanoGripTech
NanoNerve
NanoRay
NanoSys
NanoVasc
Neomorphic Software
nPrint
OmniOx
Oncobionic
ON Diagnostics
Onix Microsystems
OnWafer Technologies
Oswald Green
Photoswitch Biosciences
Preference Metrics
Protiveris
Q-Chem
Quadrant Imaging
Receptron
Redwood Biosciences
Renovis
RHA Technology
Rubicon Digital Mapping
Secured Streams
SenSys Networks
Silicon Basis
Silicon BioDevice
Silicon Clocks
Silicon Genesis
Similix
Solexel
Solidus Biosciences
SpectruMedix
Stressmarq Biosciences
Sunesis Pharmaceuticals
Symyx Technologies
Target Analytics
Thuris
TruVideo
Tularik
Two Blades (Foundation)
Urban Scan
Ventria Biosciences
Videnda
Vitapath Genetics
Wireless Industrial Tech
Xenometrix

4Ms Framework: *University Startups*



University Startups: *Spin-outs vs Blast-outs*



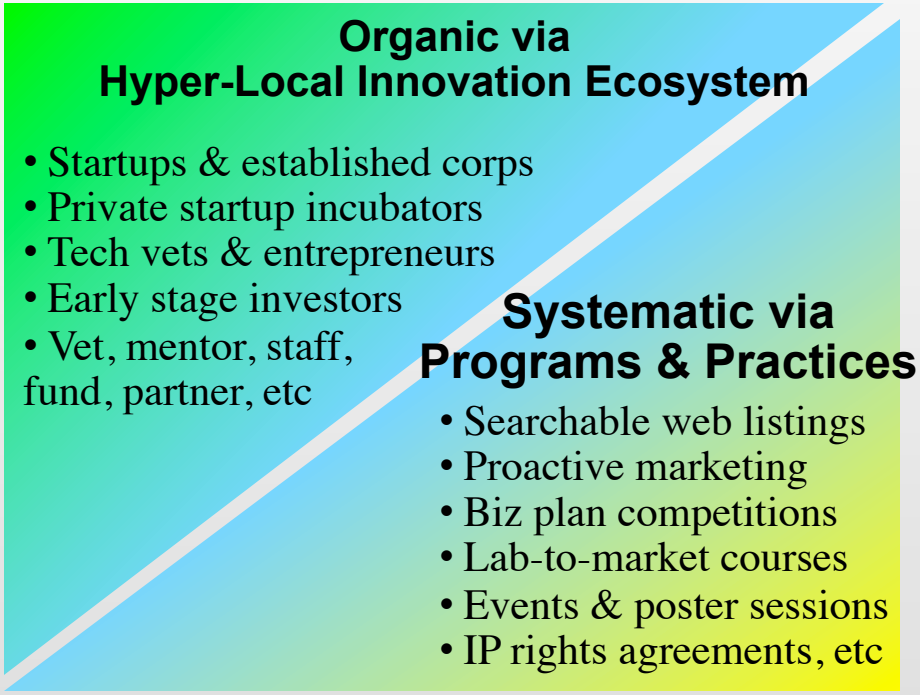
Examples: Amyris, CaliSolar, Chiron, Ensighta Security, GoodGuide, Inktomi, IntelliOne, Mercator Med, OnWafer, ON Diagnostics, Safely, TriFacta, Dust Networks

Benefit from University Resources
(e.g., Biz Plan Competitions, Incubators/Accelerators, Mentor Networks, etc)

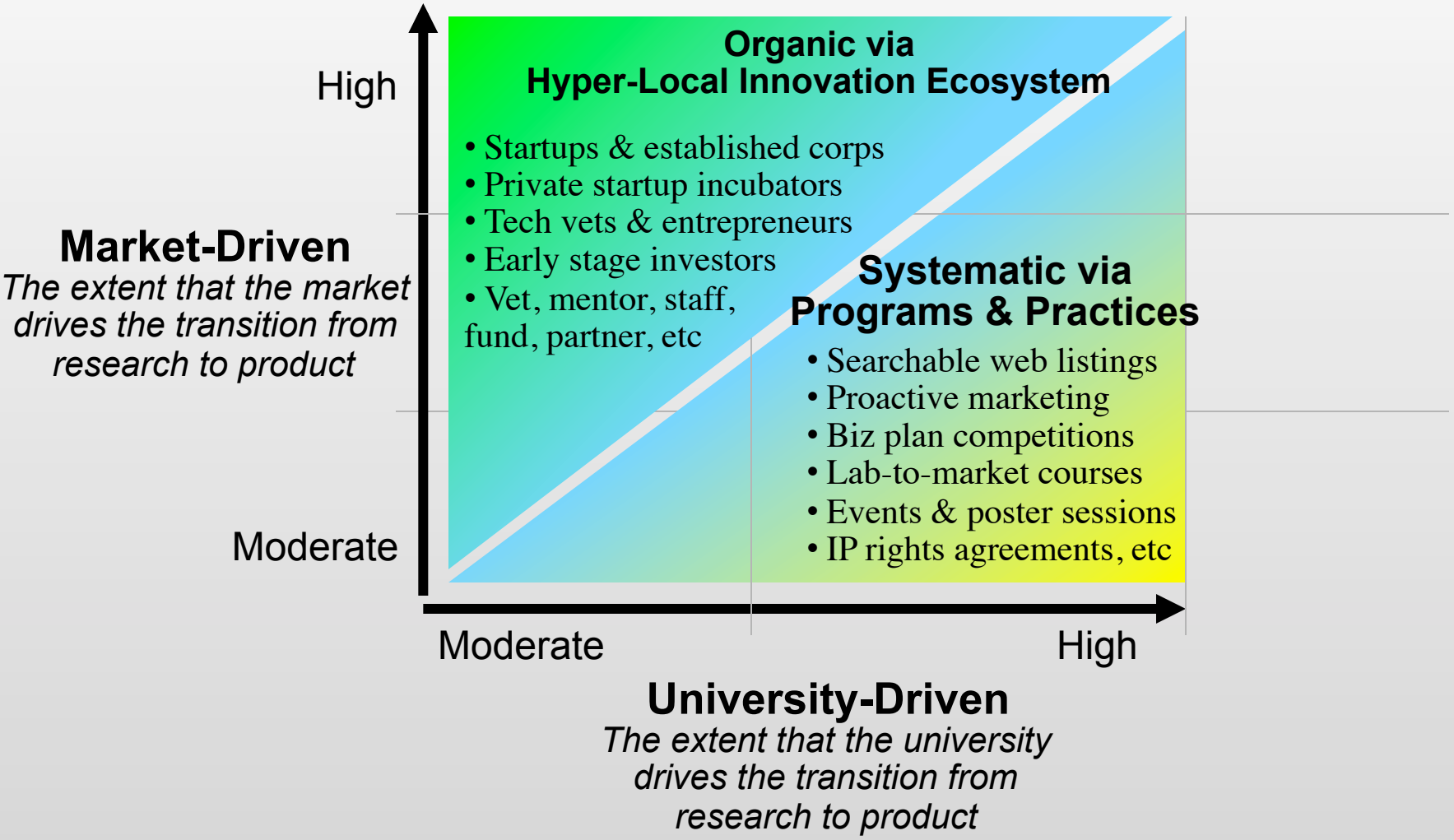
Research: *What Campus Activities Drive the 4Ms ?*

Pathways (4Ms)	Activities, Catalysts, Programs, Initiatives	Recent Progressive Approaches	Offices	Ideas & Comments
Morphed	•Entrepreneurship classes •On-campus Incubators •Entrepreneurial Admissions •Entrepreneurial Culture	•On-campus incubators co-located with special lab facilities	•CET (CoE) •Haas (MOT, Lester) •OTL	•SBIR/STTR help center •Berkeley Startup Cluster
Mined	•Entrepreneurial MBA Program (EIRs) •Biz Plan & Tech Competitions •Research-to-Market Courses (C2M) •Seminars & Poster Sessions (YAPS) •Haas Speaker Series & VC Office Hours •Haas Bancroft Incubator	•Cleantech-2-Market Course	•Haas (Lester) •OTL •CoE •CITRIS •QB3 •Student Clubs (BERC)	•Berkeley Startup Cluster •Berkeley Center for Growth Companies
Milked	•Institutional response to RFPs •Opportunistic PIs •Sponsored Research Agreements •Visiting Industrial Fellows •Faculty Consulting & Student Hiring	•Research-Oriented Approach to Managing IP rights (e.g. NERFs, BIP, SRA IP grants, etc)	•VCRO •IPIRA (IAO & OTL) •CoE •CITRIS •QB3	•Adjacent R&D Office Parks/Buildings •Research Enterprise Marketing
Marketed	•Newsletters & Press Releases •Searchable Web Listings •Serial Entrepreneur & VC Discussions •Scholarly Publications & Presentations	•	•CoE •OTL •NewsCenter	•EBGC Customer Cred Program •EBGC Cluster Clubs •Email Mrktg

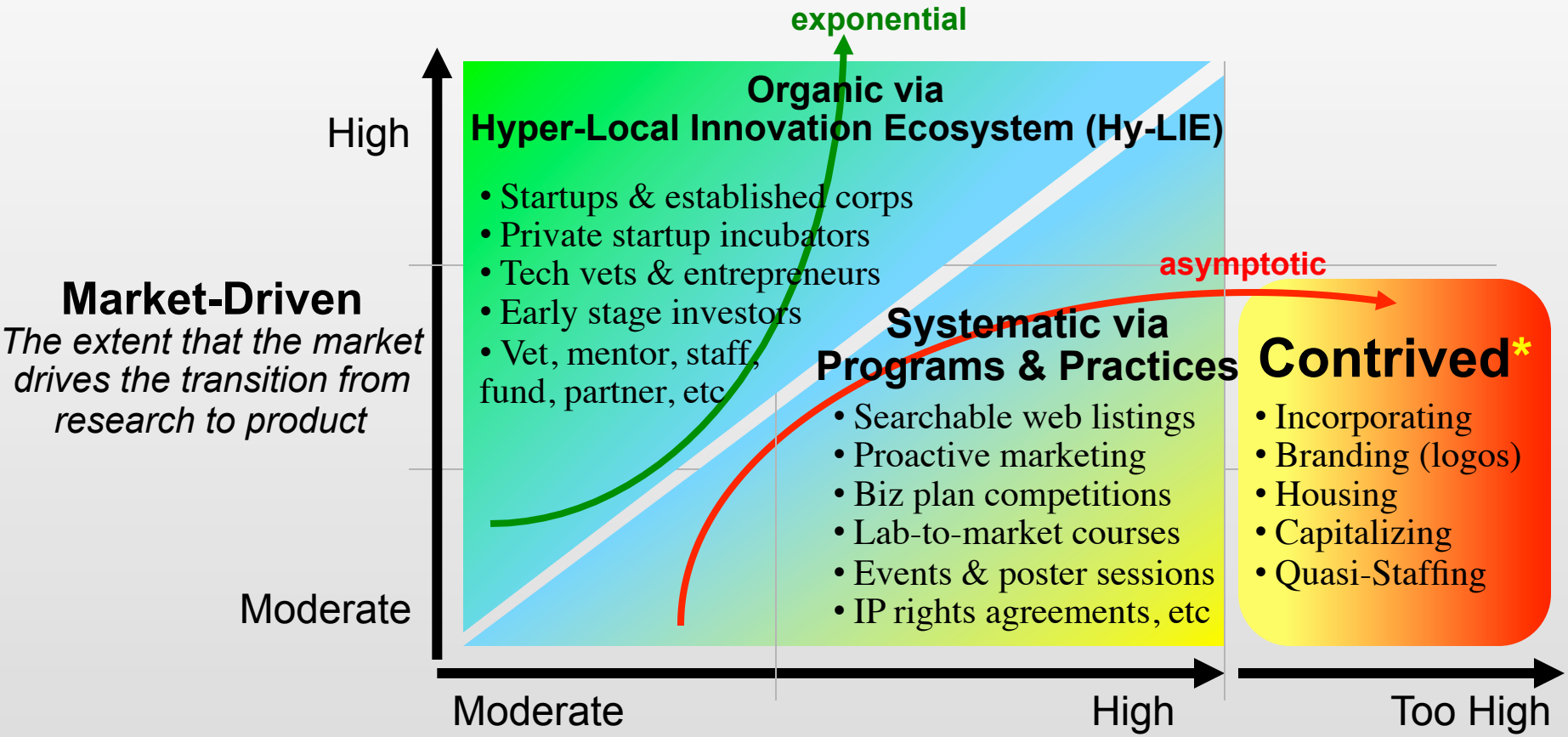
Bifurcate Campus Activities: *Systematic & Organic*



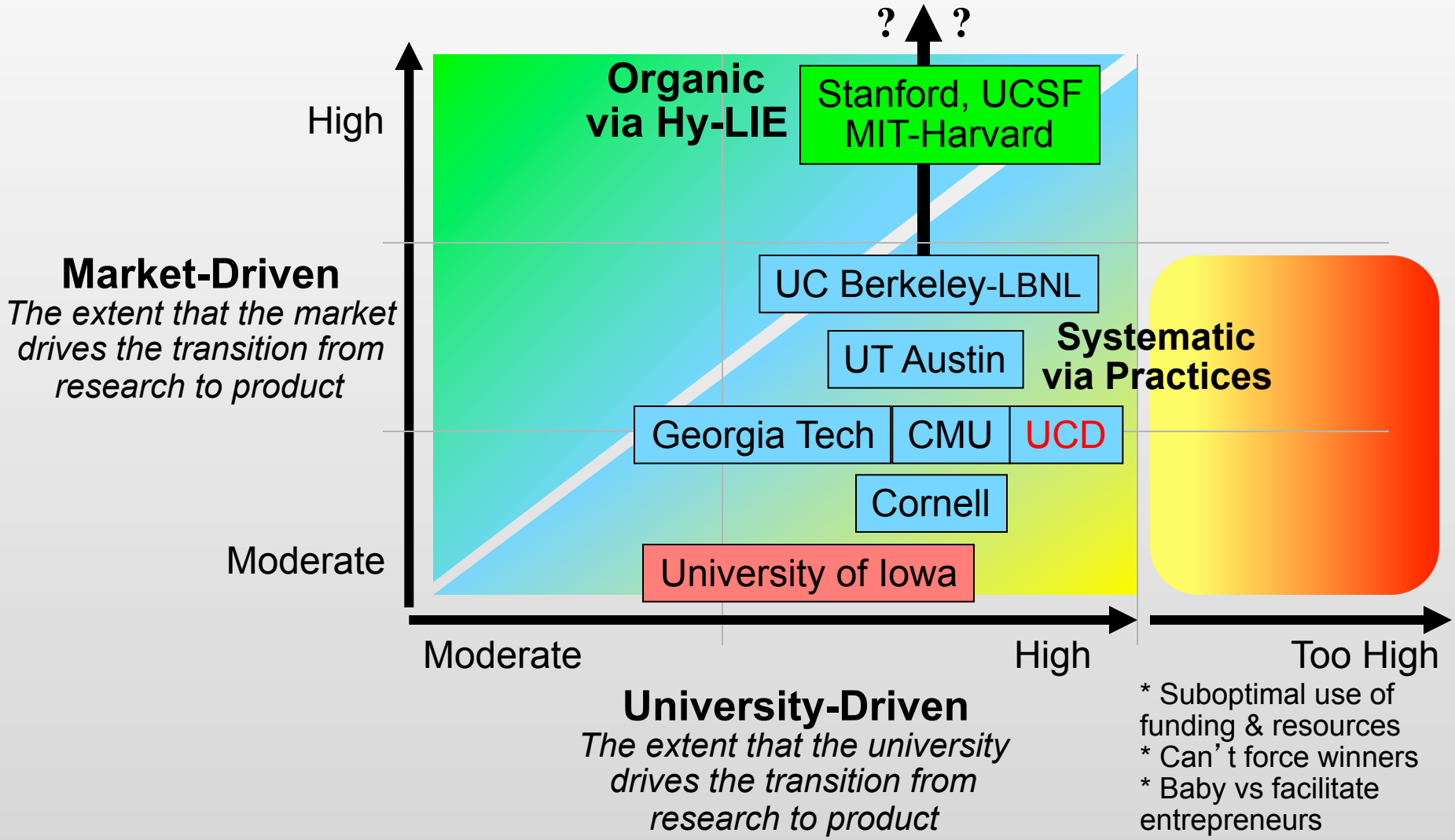
Bifurcate Campus Activities: *Systematic & Organic*



Systematic v Organic: *Impact - Asymptotic v Exponential*



Systematic v Organic: *Comparing Position & Potential*



Hyper-Local Innovation Ecosystem (Hy-LIE): *Definition*

University Hyper-Local Innovation Ecosystem:

Cluster of R&D-oriented entities readily accessible to the campus – including small & large corps, tech vets, entrepreneurs & early stage investors as well as related supply chains & service providers

Hyper Local: Convenient: walk, bike, shuttle or short drive (with easy parking)

Local: Less than 30 minutes drive + easy parking

Metro: About 30-60 minutes + - commuter traffic

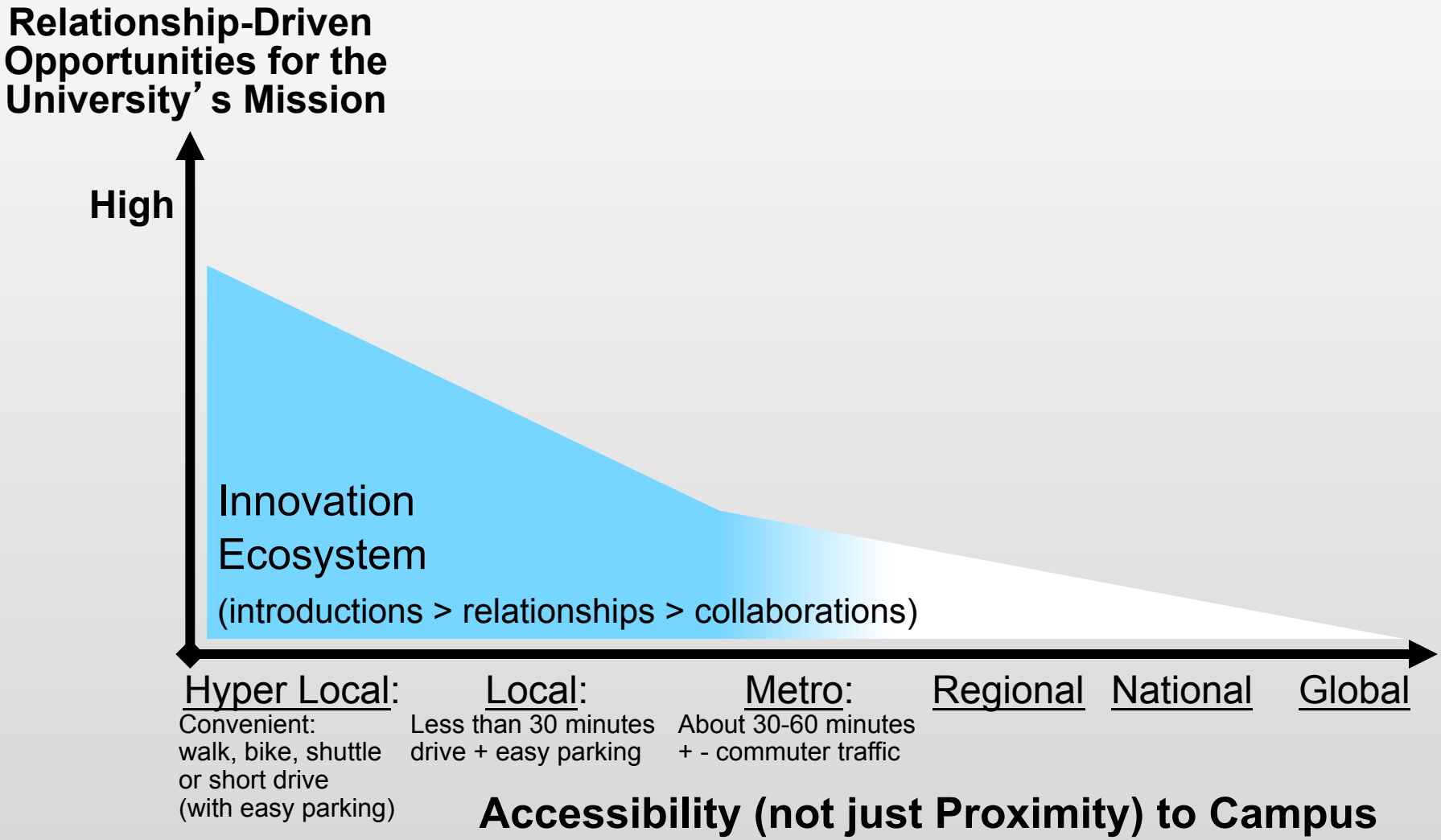
Regional

National

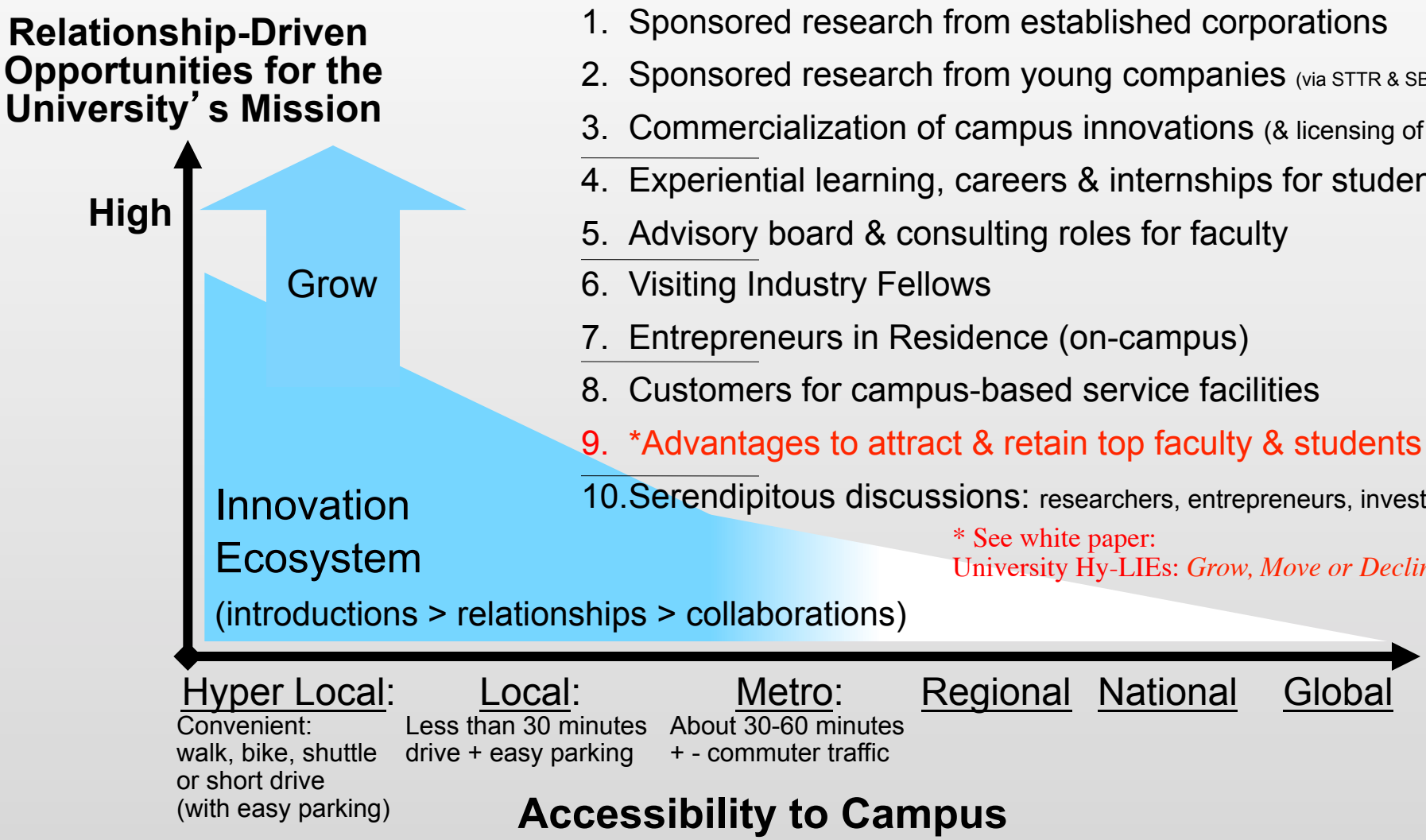
Global

Accessibility (not just Proximity) to Campus

Hy-LIE: *Strategic Value to University*



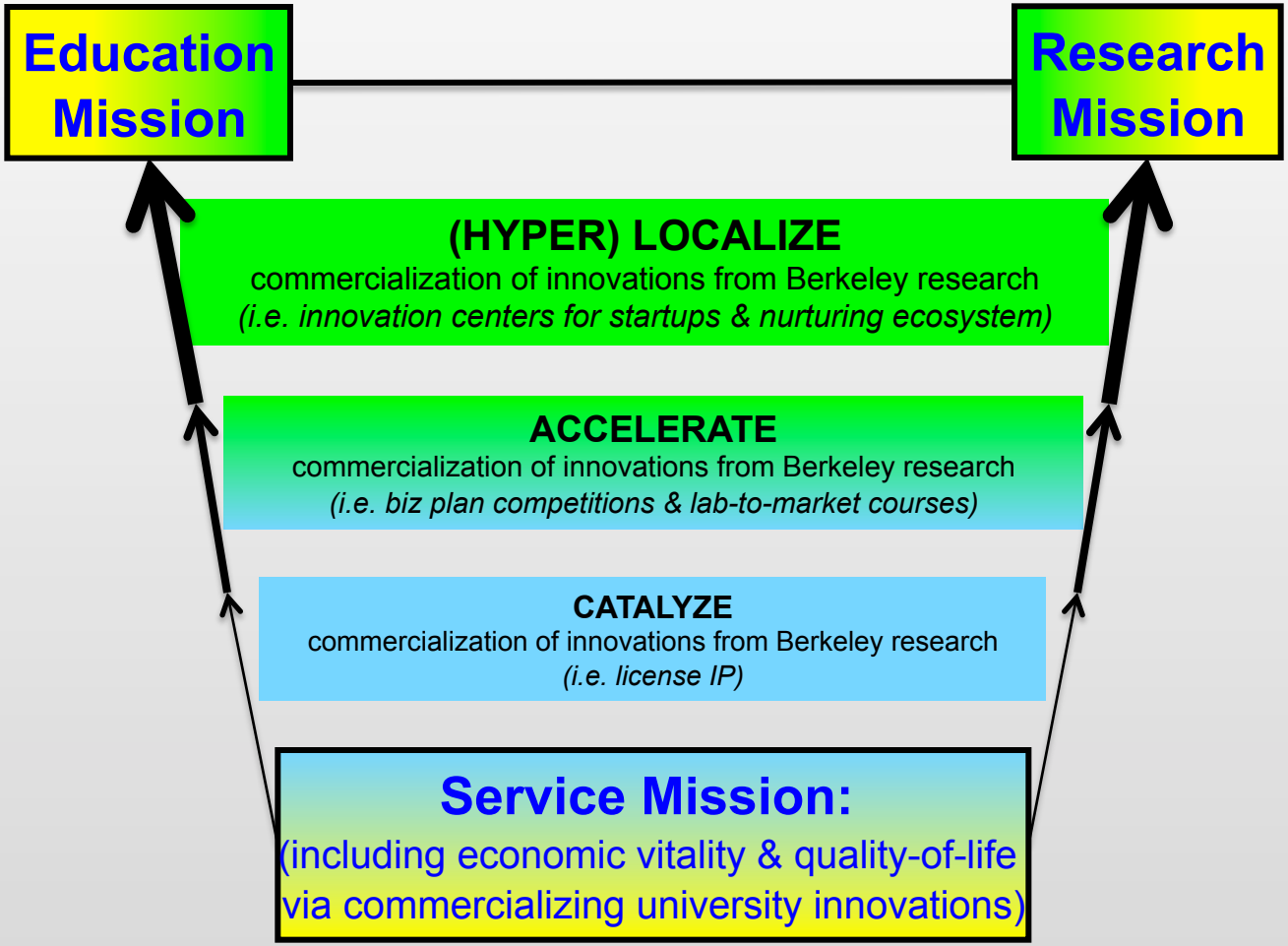
Hy-LIE: *Bolster Research, Education & Tech Xfer*



1. Sponsored research from established corporations
2. Sponsored research from young companies (via STTR & SBIR)
3. Commercialization of campus innovations (& licensing of IP)
4. Experiential learning, careers & internships for students
5. Advisory board & consulting roles for faculty
6. Visiting Industry Fellows
7. Entrepreneurs in Residence (on-campus)
8. Customers for campus-based service facilities
9. *Advantages to attract & retain top faculty & students
10. Serendipitous discussions: researchers, entrepreneurs, investors

* See white paper:
University Hy-LIEs: *Grow, Move or Decline*

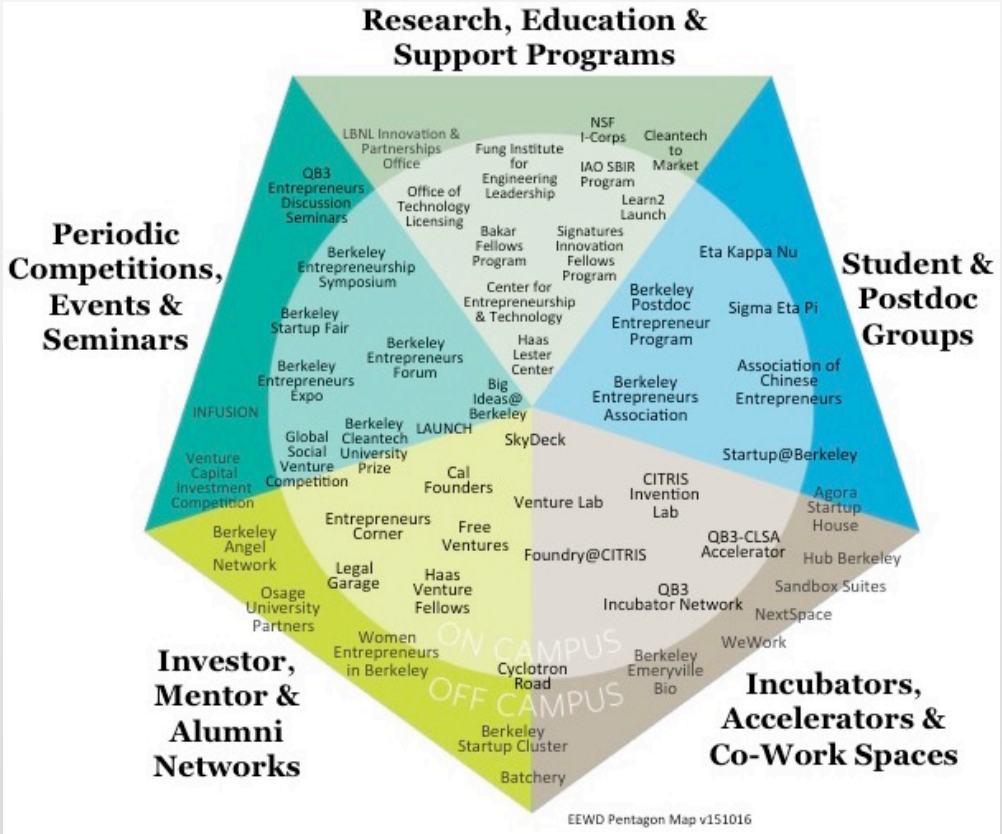
Hy-LIE: *Third Level of Ecosystem Development*



UC Berkeley Analysis: *Background*

- In 2015, UCB VCRO convened monthly meetings of campus innovation ecosystem
  - What are UCB ecosystem's strengths & weaknesses?
  - What are other university ecosystems doing well?
  - How can UCB improve?
  - Is UCB ecosystem too disorganized?
  - Is UCB TTO (IPIRA) doing enough?
- Carol & I made some strategic observations
  - Some are slightly controversial or somewhat non-intuitive
  - So, did research to assess observations & articulated observations in a paper

UC Berkeley Innovation Ecosystem



Is this Good?
Can it be Better?

Research: *Approach*

- Forbes ranked
  "America's Most Entrepreneurial Universities"
- Researched correlation
  between Forbes ranking &:
  - Human talent
  - Ecosystem structure
  (- Leadership by TTO vs Academic Units)
- People talent (2)
  based on:
  - ARWU (Shanghai) ranking of
  engineering programs
  - US News ranking of
  MBA programs
- Ecosystem structure (3)
  based on
  web searches using
  key words such as "entrepreneurship" and "startups"

Research: *Data in Paper*

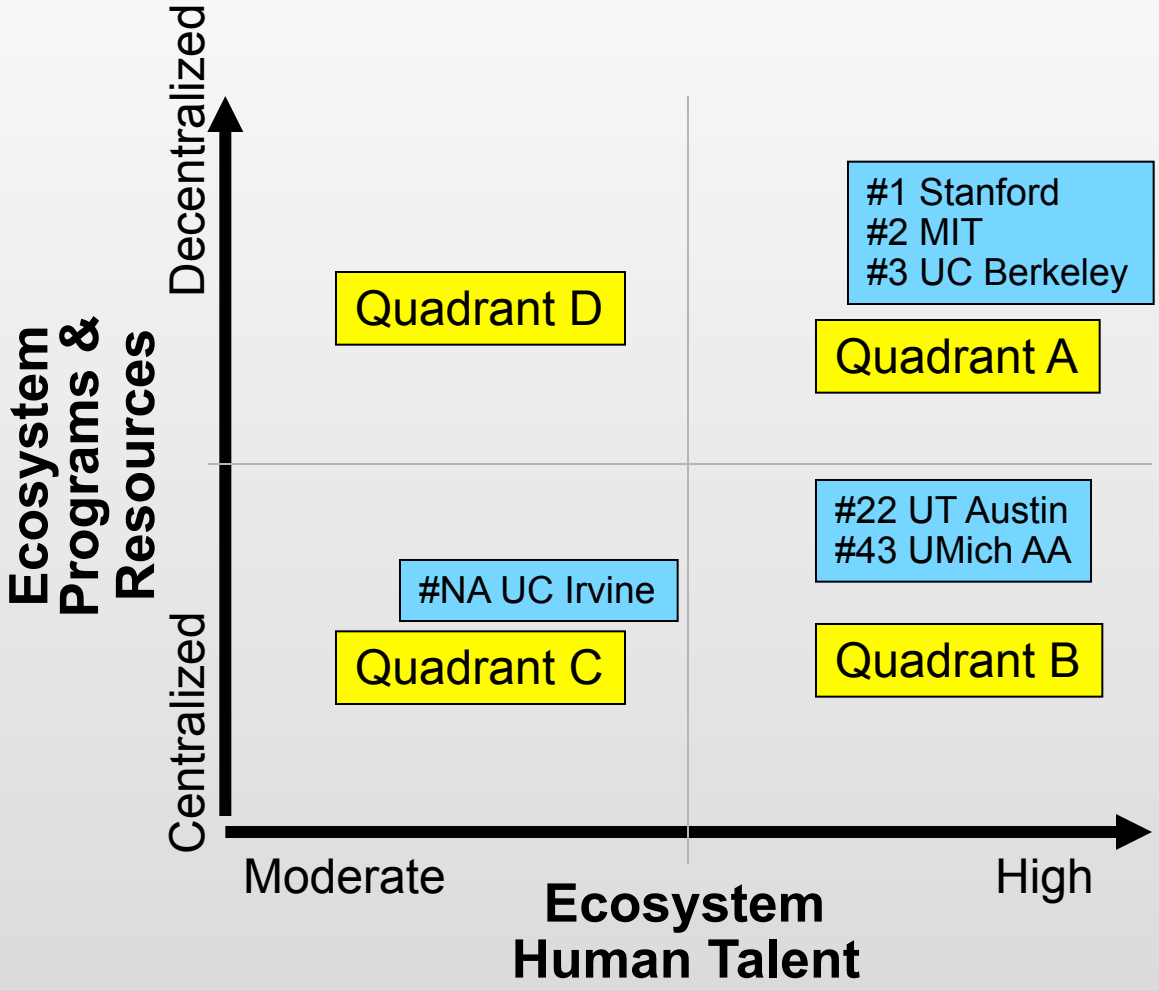
- Stanford
  - Engineering #2
  - MBA #2
  - Entrepreneurship #1
- MIT
  - Engineering #1
  - MBA #5
  - Entrepreneurship #2
- UC Berkeley
  - Engineering #3
  - MBA #7
  - Entrepreneurship #3
- UT Austin
  - Engineering #5
  - MBA #17
  - Entrepreneurship #22
- UMich AA
  - Engineering #8
  - MBA #11
  - Entrepreneurship #43
- UC Irvine
  - Engineering #51
  - MBA #53
  - Entrepreneurship #not in ranking

Research: *Data Additions*

- Cal Tech
  - Engineering #20
  - MBA #NA
  - Entrepreneurship #6
  - Org
- Columbia
  - Engineering #76-100
  - MBA #10
  - Entrepreneurship #NR
  - Org
- Duke
  - Engineering #51-75
  - MBA #12
  - Entrepreneurship #NR
  - Org
- Harvard
  - Engineering #25
  - MBA #1
  - Entrepreneurship #25
  - Org
- Hopkins
  - Engineering #76-100
  - MBA #NA
  - Entrepreneurship #NR
  - Org
- Penn
  - Engineering #76-100
  - MBA #4
  - Entrepreneurship #39
  - Org
- UCSB
  - Engineering #17
  - MBA #NR
  - Entrepreneurship #21
  - Org
- UCSD
  - Engineering #14
  - MBA #77
  - Entrepreneurship #48
  - Org
- UFL
  - Engineering #101-150
  - MBA #37
  - Entrepreneurship #NR
  - Org
- UI
  - Engineering #4
  - MBA #39
  - Entrepreneurship #NR
  - Org
- UW
  - Engineering #32
  - MBA #27
  - Entrepreneurship #45
  - Org
- Yale
  - Engineering #NR
  - MBA #8
  - Entrepreneurship #11
  - Org

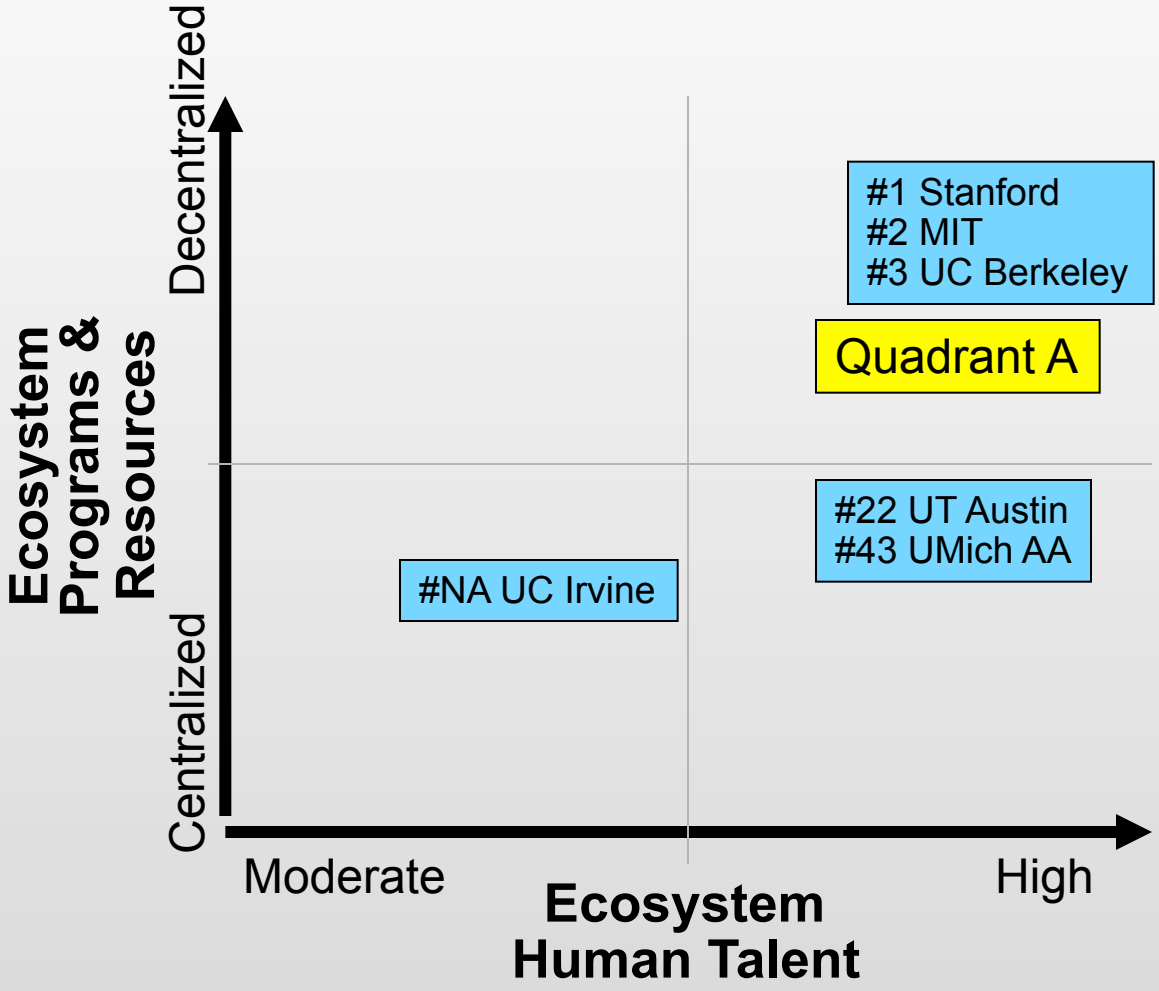
Research: *Framework*

- Simplified model
- 2 axis & 4 quadrant
- No university had weak talent
- Decentralized doesn't mean no coordination



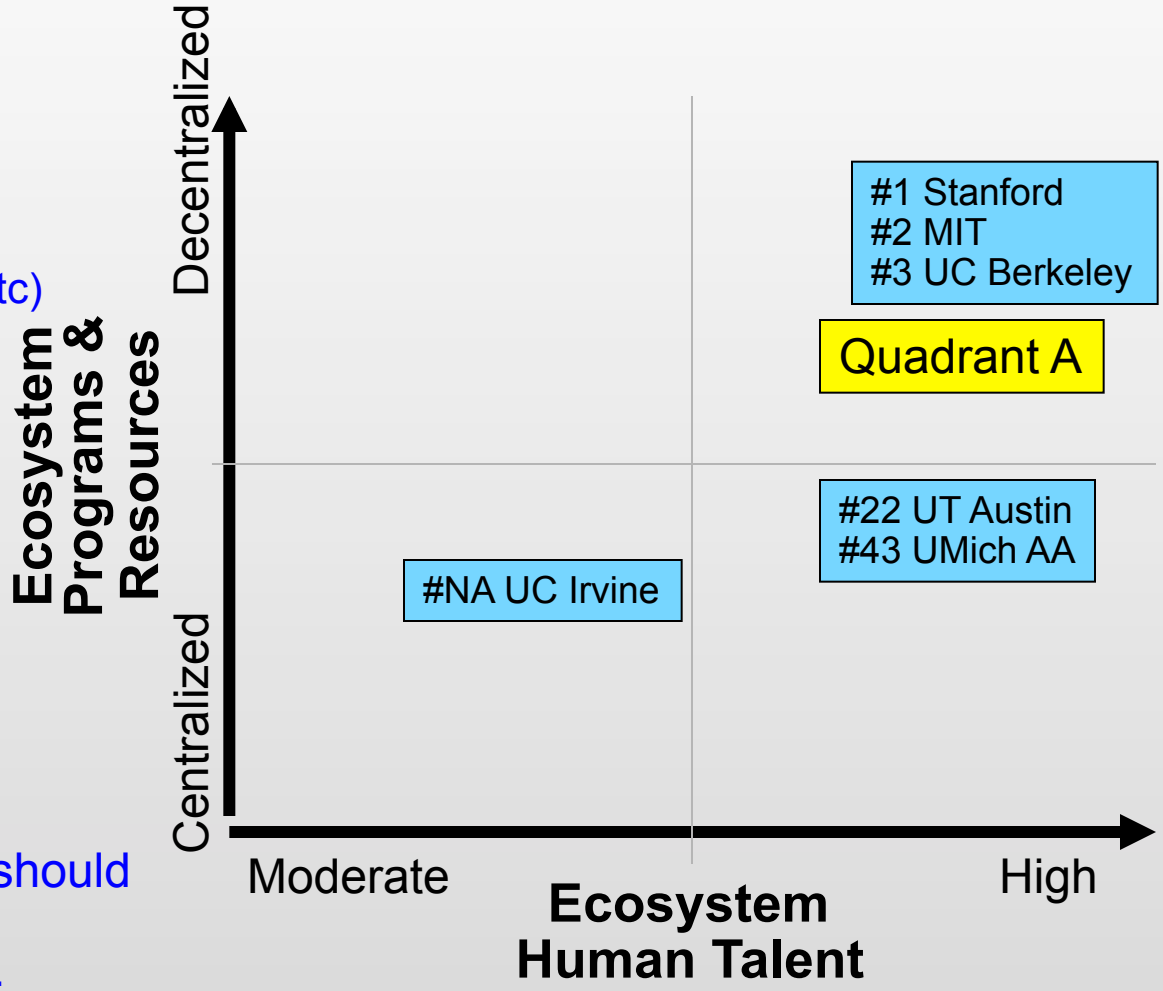
Finding 1 of 4: *Ecosystem Structure*

- Correlation: Top UIEs have strong talent & decentralized structure
- Value of decentralization not intuitive because it has trade-offs
  - Cost inefficiencies
  - Confusion (mitigated by web & concierge)
- Why decentralized is optimal?
  - Autonomy
  - Dynamism
  - Expertise
  - Private Sector

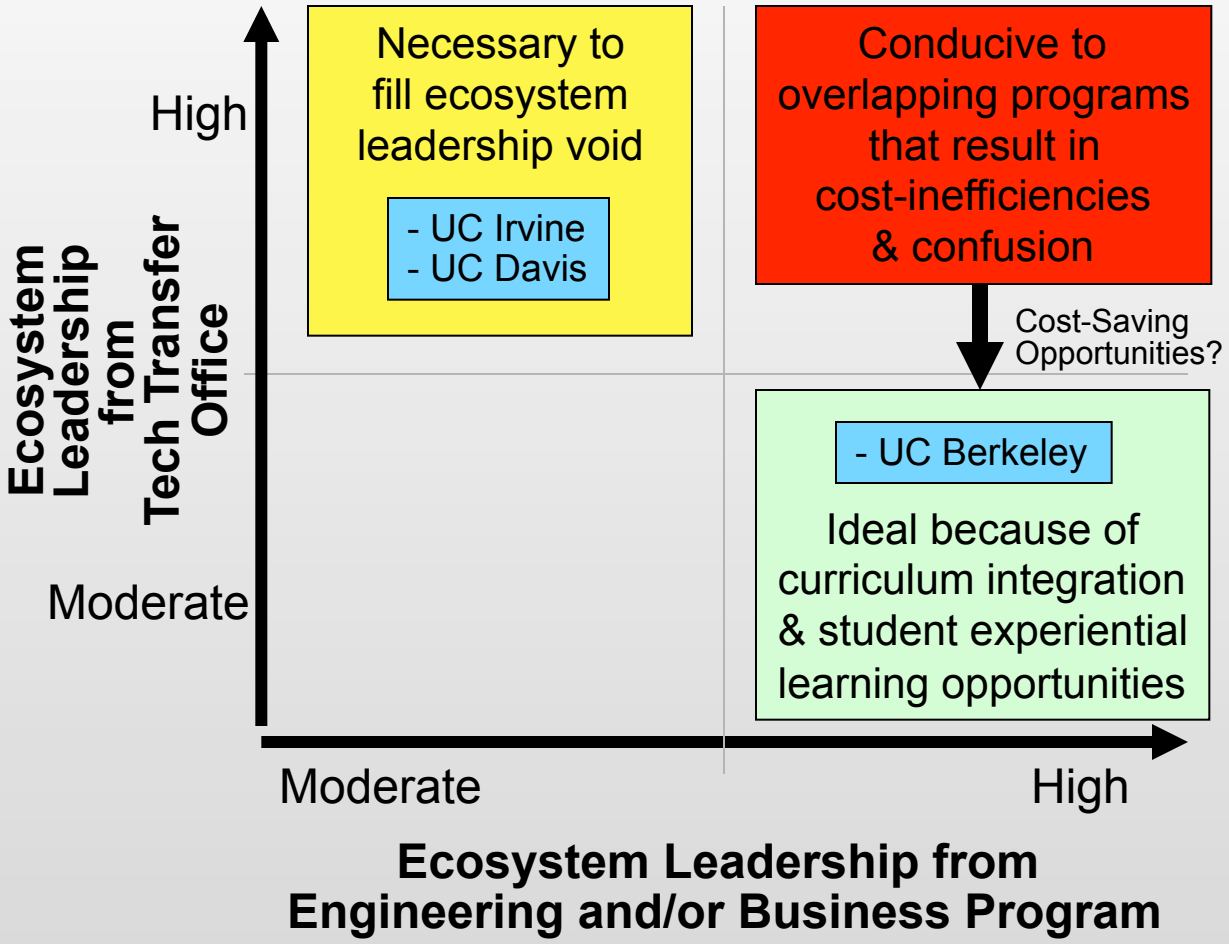


Finding 2 of 4: *Ecosystem Leadership*

- Correlation:
  Top UIEs led by academic units, not VCRO / TTO
  (competitions, accelerators mentor/investor networks, etc)
- In comparison to TTO, academic units better at
  - Integrating UIE with student curriculum that maximizes experiential learning
  - Integrating UIE with alumni network
- If academic units don't step-up, then TTO should
- Explains difference between VCRO / TTO at:
  - UC Berkeley, MIT, Stanford
  - UC Davis (#51, #48, NR) & UC Irvine

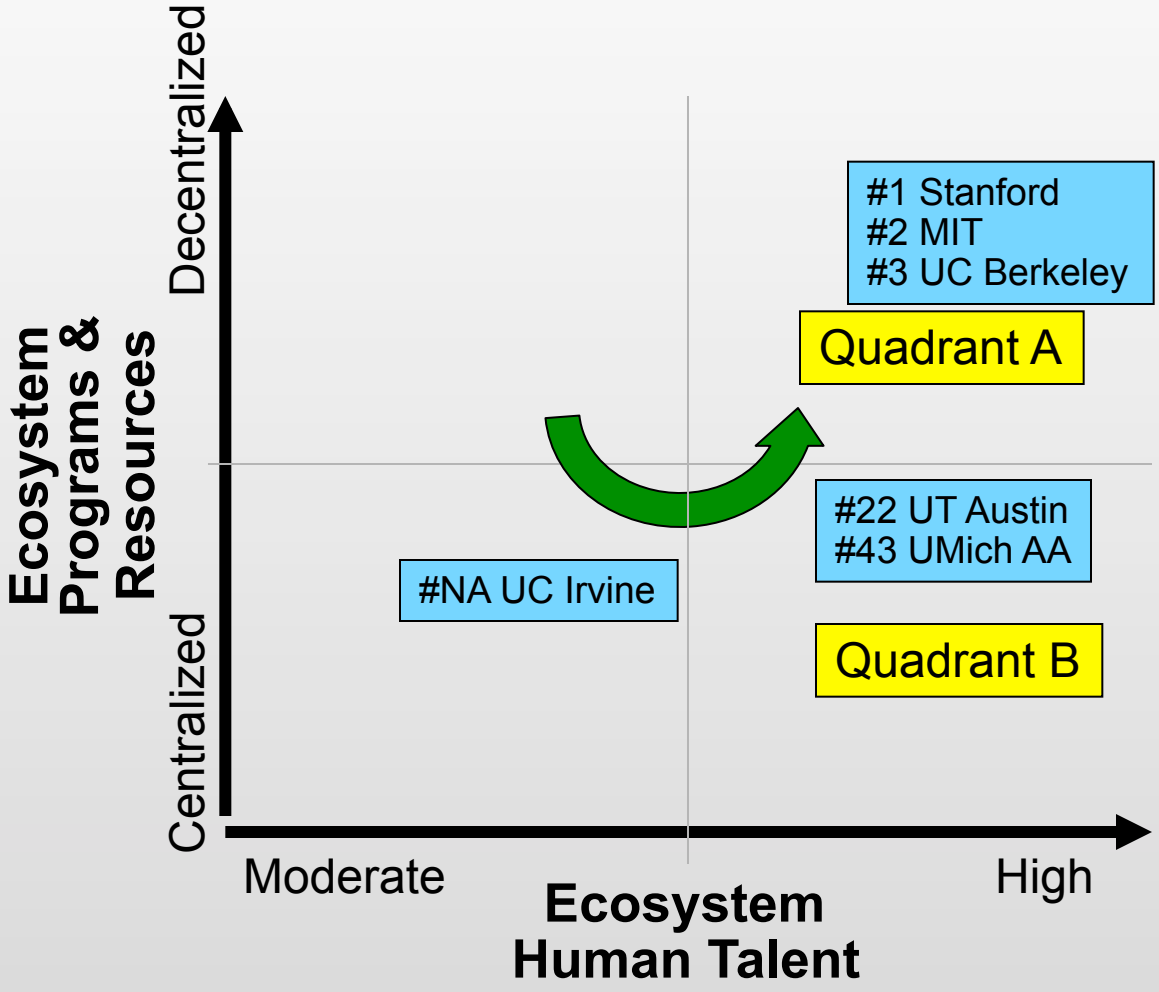


Finding 2: *Academic Units vs Tech Xfer Office*



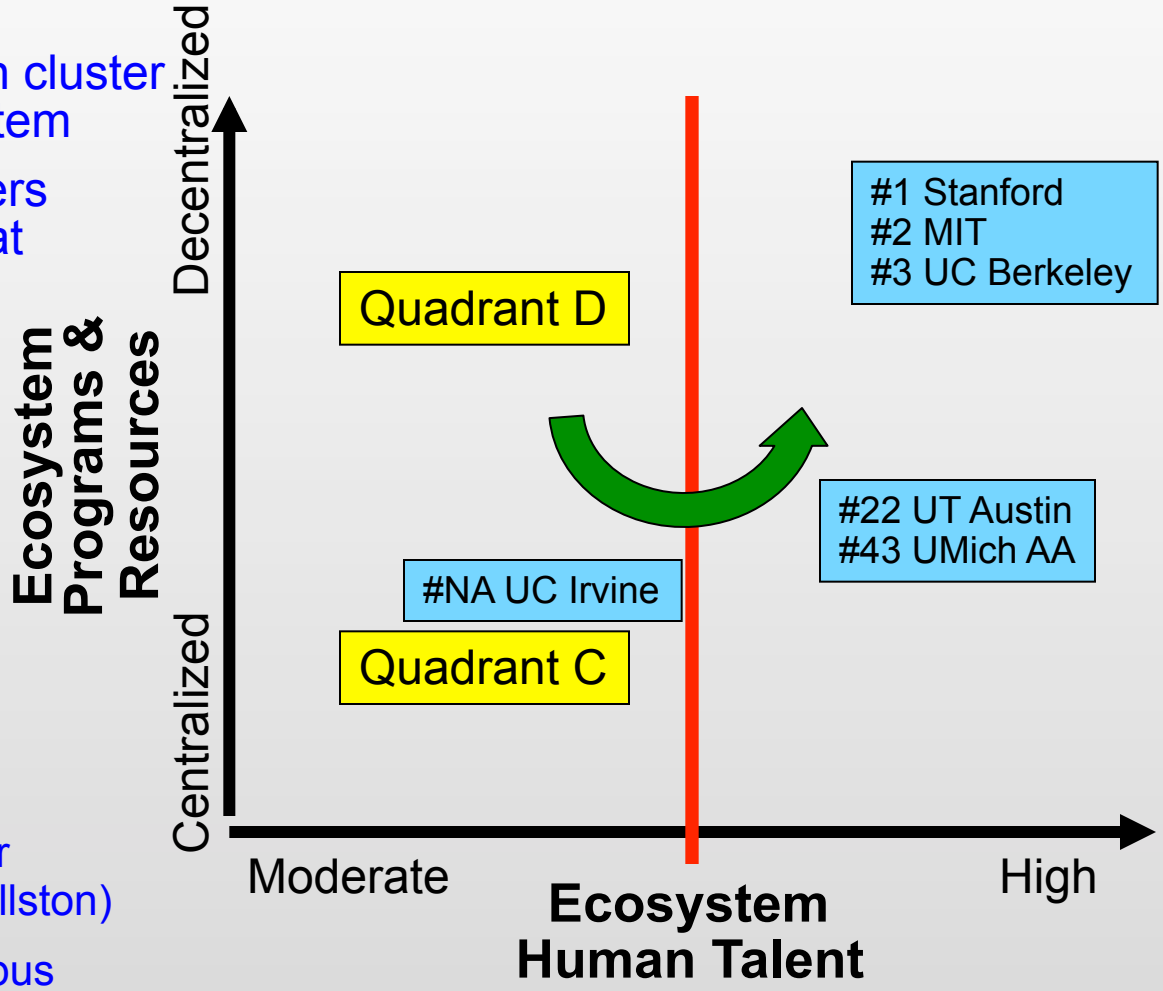
Finding 3 of 4: *Ecosystem Supply-Demand*

- Dispel myth that most universities have RCT that's sitting-on-shelf (due to onerous TTOs & risk-averse VCs)
- In robust UIEs demand for RCT exceeds supply of RCT
  - Tech not proven
  - Market too nascent
- Strategy
  - More applied research & proof-of-concept funding
  - More lab-to-market courses (Cleantech to Market)



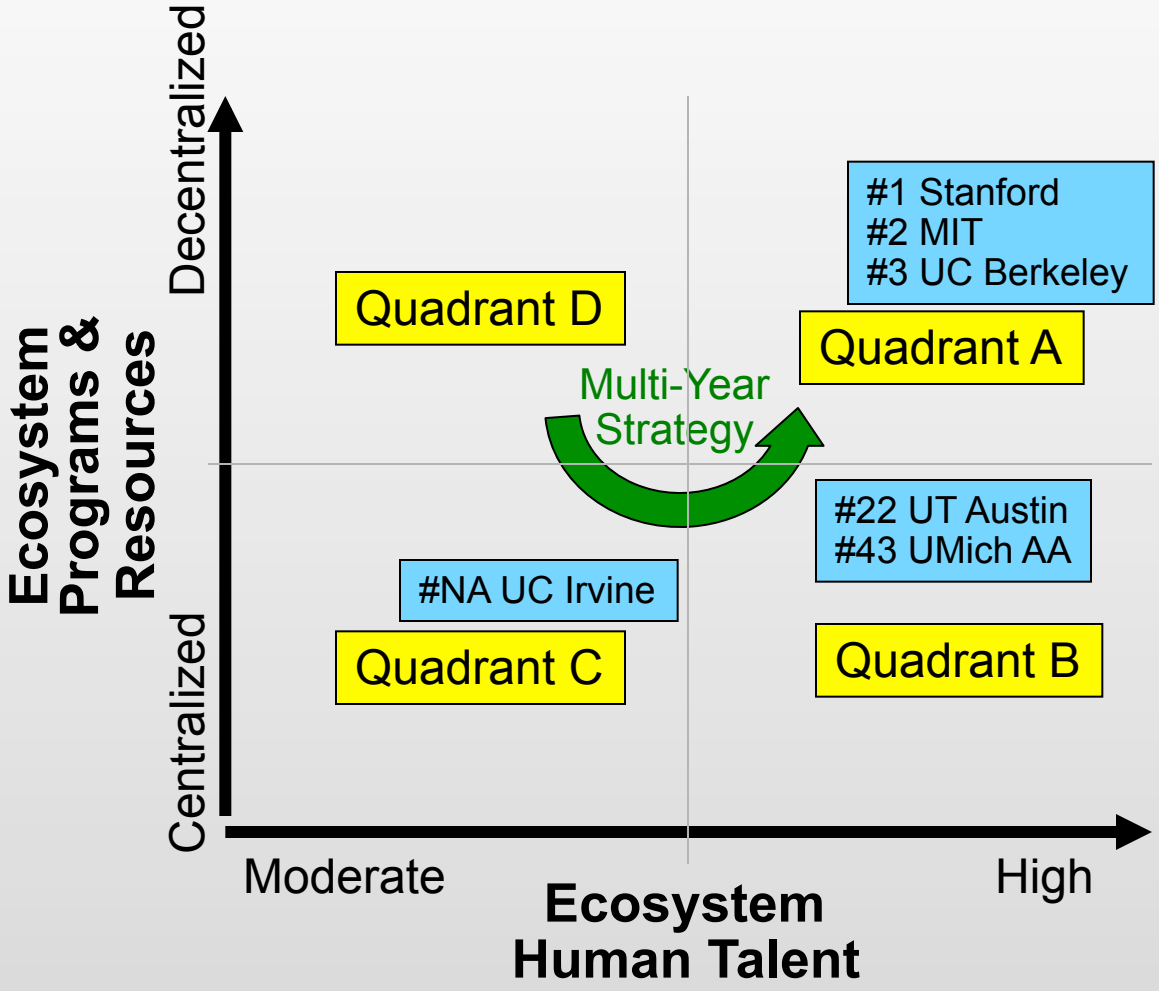
Finding 4 of 4: *Ecosystem Innovation-Drain*

- Correlation:
  Growth of UCB local tech cluster & growth of UCB ecosystem
- UIEs not near tech clusters incur innovation-drain that impedes achieving critical-mass of talent for robust UIE
  - Graduates & spinouts exit UIE
  - Brown (#7), Princeton (#8), Dartmouth (#9), Yale (#11), Penn (#39)
- Strategies
  - Grow a local tech cluster (UCB, UCLA, Harvard Allston)
  - Establish a branch campus in an existing tech cluster (Cornell, Wharton, CMU, UCD Business School)



Research: *Ecosystem Development Strategies*

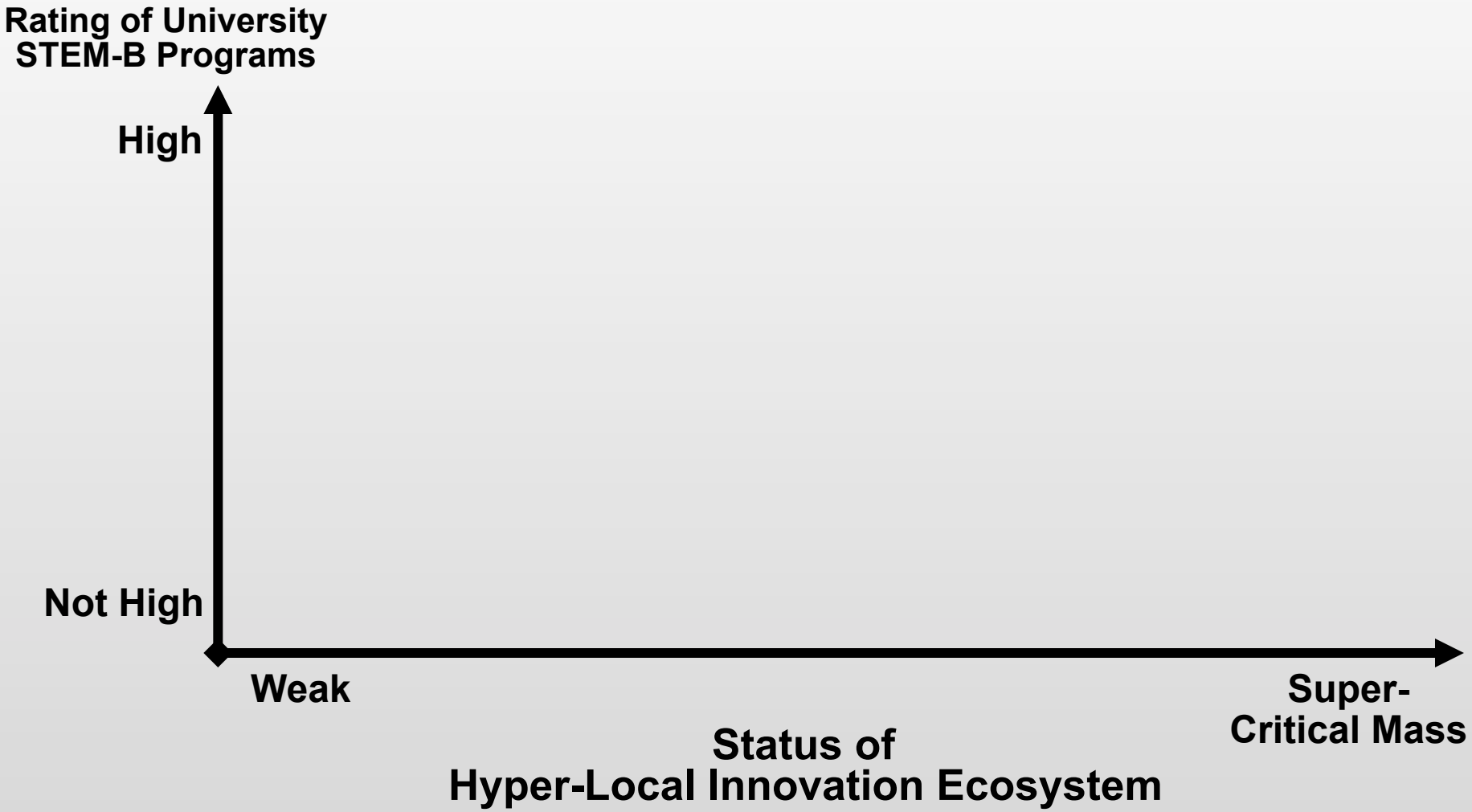
- Quadrant A:
  - Minimize confusion via website & concierge
  - Minimize TTO overlap with academic units
  - Stay dynamic
- Quadrant B
  - Facilitate multiple initiatives
- Quadrant C
  - Local tech cluster?
  - Attract & retain talent via flagship programs & admissions
- Quadrant D
  - Local tech cluster?
  - Consolidate activities
  - Create flagship program
  - Attract & retain talent



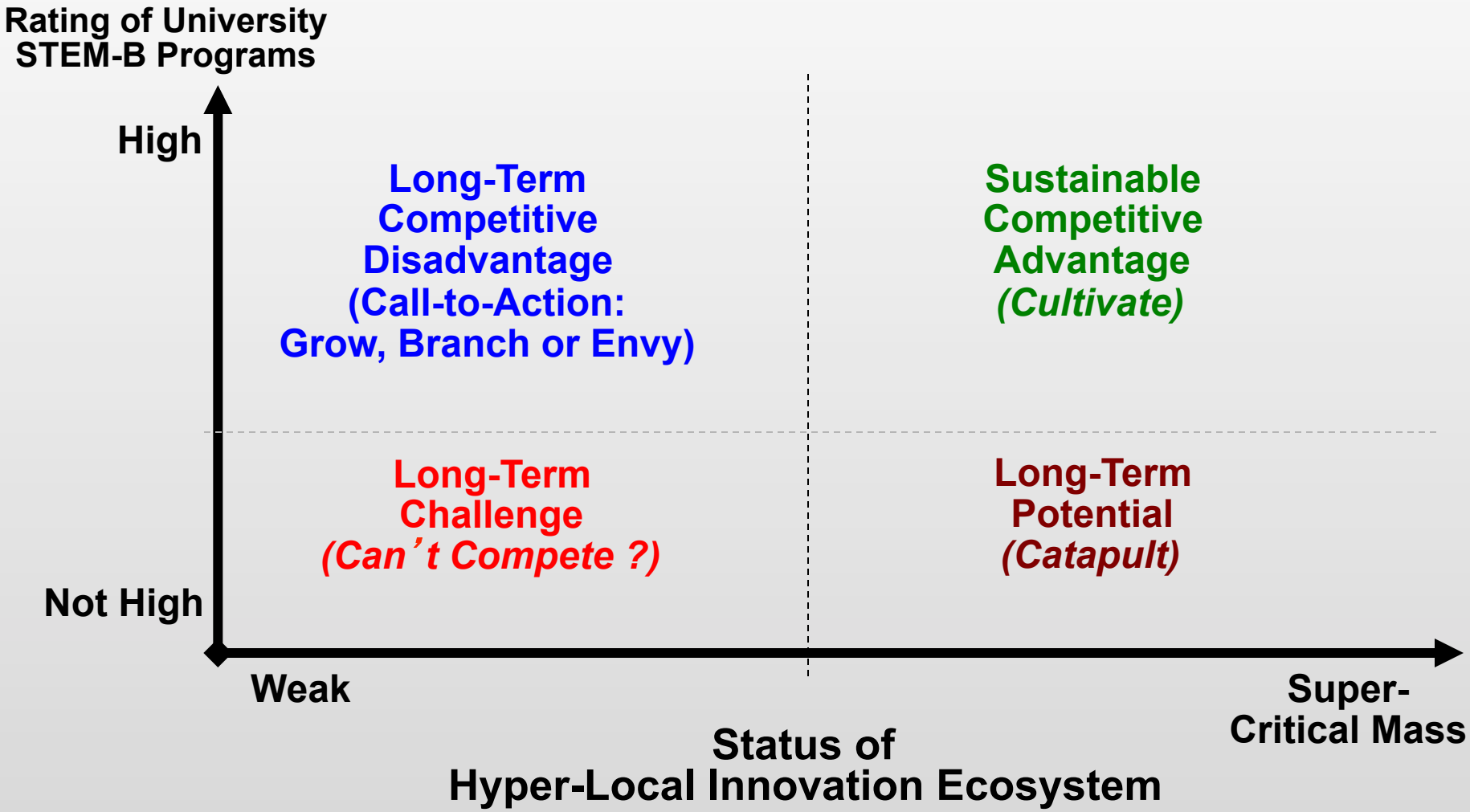
University Innovation Ecosystem: *Human Talent*

- Quality, quantity & variety of human talent is key
- How do top univ ecosystems reach supercritical mass?
- Two paradigms for how students interact with campus:
  - ***Waypoint campus***: matriculate, contribute, graduate & disperse
  - ***Vortex campus***: matriculate, contribute, graduate & stay
    - Contribute to campus ecosystem throughout career
    - Discussing, hiring, mentoring, investing, licensing, researching, teaching, donating
    - Annual incoming students + grads remaining = supercritical mass
    - Eventually ecosystem attracts talent that is not affiliated with univ
    - Super University Metro Area I&E Ecosytem (SUMIEE):
      - MIT, Harvard, Cambridge & Boston
      - Stanford & Silicon Valley
      - UC San Francisco & upper San Francisco peninsula
      - UC Berkeley, Lawrence Berkeley National Lab & East Bay

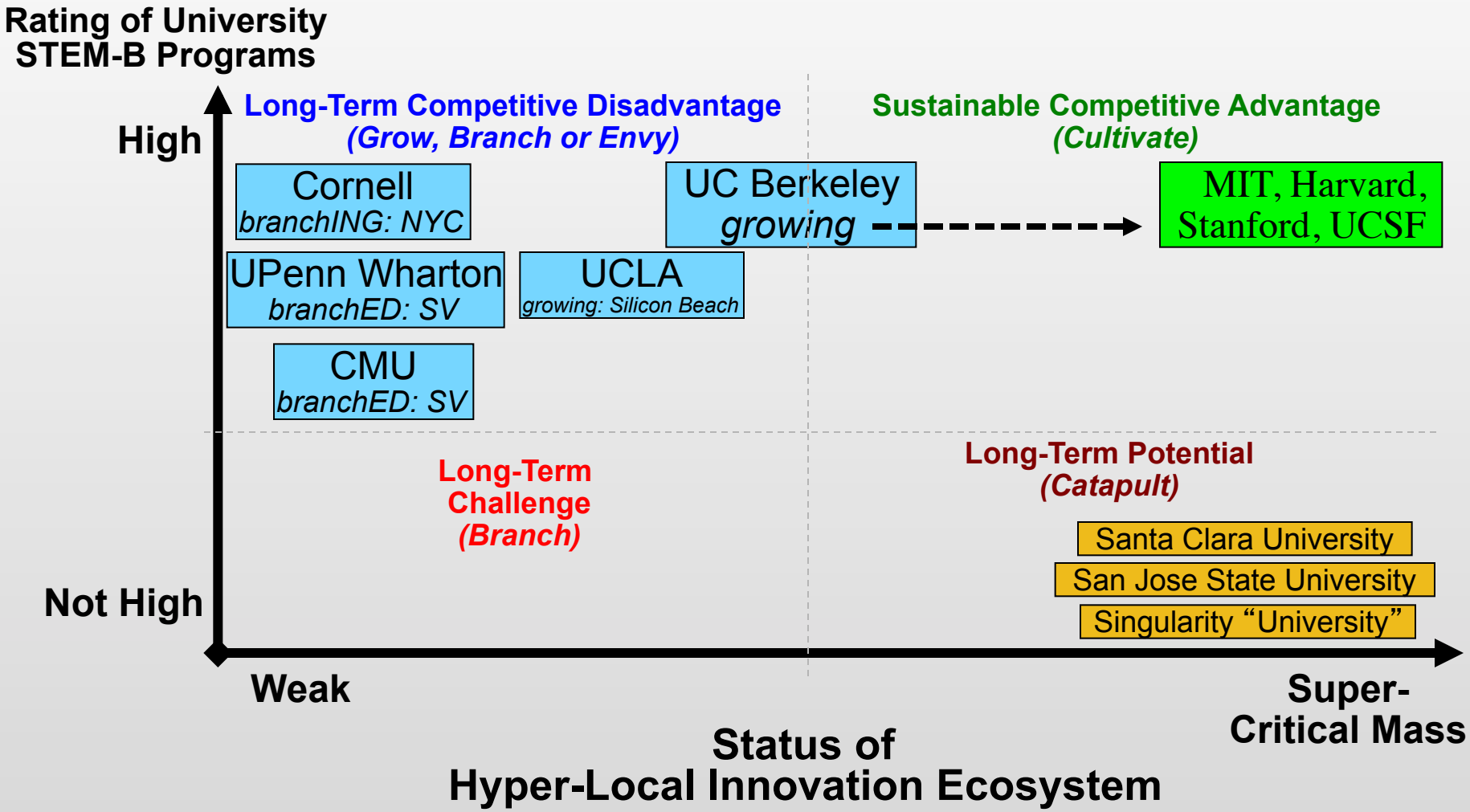
Strategy: *Hy-LIE Effect on STEM-B Programs*



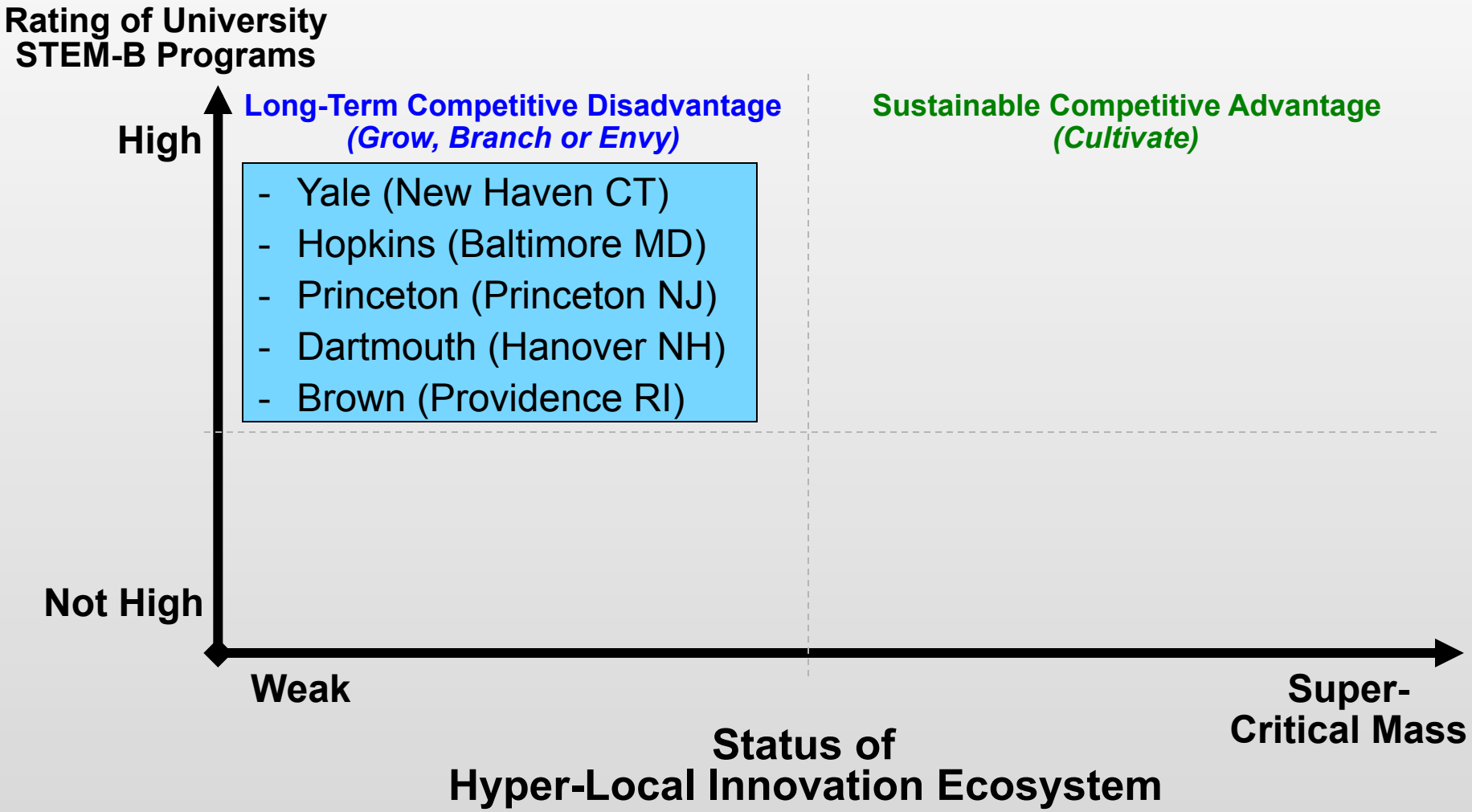
Strategy: *Hy-LIE vs STEM-B Segmentation*



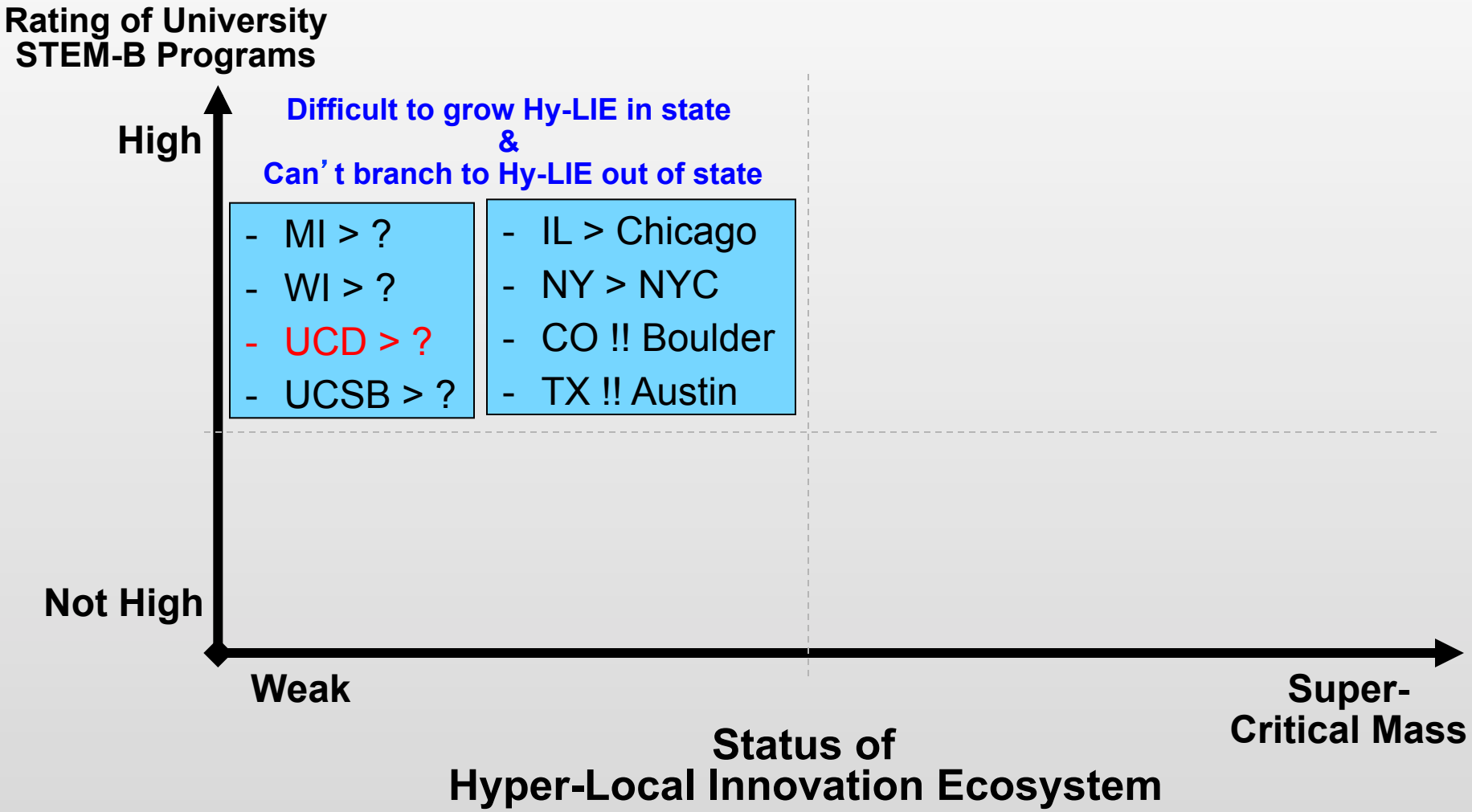
Strategy: *Grow, Branch or Envy (Die)*



Strategy: *Univ Ratings Based on Many Factors*



Strategy: *Dilemma for Some Public Univs*



Hy-LIE: *10 Best Practices to Foster University Hy-LIEs*

1. Students & Faculty: Entrepreneur-oriented MBA & tech management programs – from admissions, to curriculum, to culture
2. Mixers: MBA, engineering & applied sciences events: yet-another-poster session (YAPS), seminar series, etc – even across nearby institutions (i.e. UCB & LBNL)
3. Competitions: startups, tech innovations, big ideas (no more business plan competitions)
4. Research-to-Market Courses: Project-based classes with interdisciplinary teams that research market opportunities for selected tech (i.e. UCB's Cleantech-to-Market course)
5. University startup accelerators (i.e. Skydeck & Foundry) & idea incubators
6. Office park(s) for mature corps to leverage university & act as an anchor for startups
7. IP Management with an "impact-oriented approach to IP" (not just $)
8. University resources (not just IP rights): students as workforce; faculty as advisors; alumni as mentors; the university as an early (beta) customer to help establish a startup's credibility in its market
9. Startup service packages (with local biz): legal, finance, SBIR, etc
10. Partnering: university, local biz & gov (i.e. BerkeleyStartupCluster.net)

- ❑ Not: University funding of startups (that circumvents organic vetting process, & is different from proof-of-concept (POC) funding)

Hy-LIE: *5 Predictions on Hy-LIE Impact*

1. Research universities will have a campus startup accelerator (just as they have libraries, sports stadiums, fitness centers & student centers)

   1b. Many universities with accelerators will establish "University Startup Accelerator Stock Equity (U-SASE) programs to monetize the support provided to startups

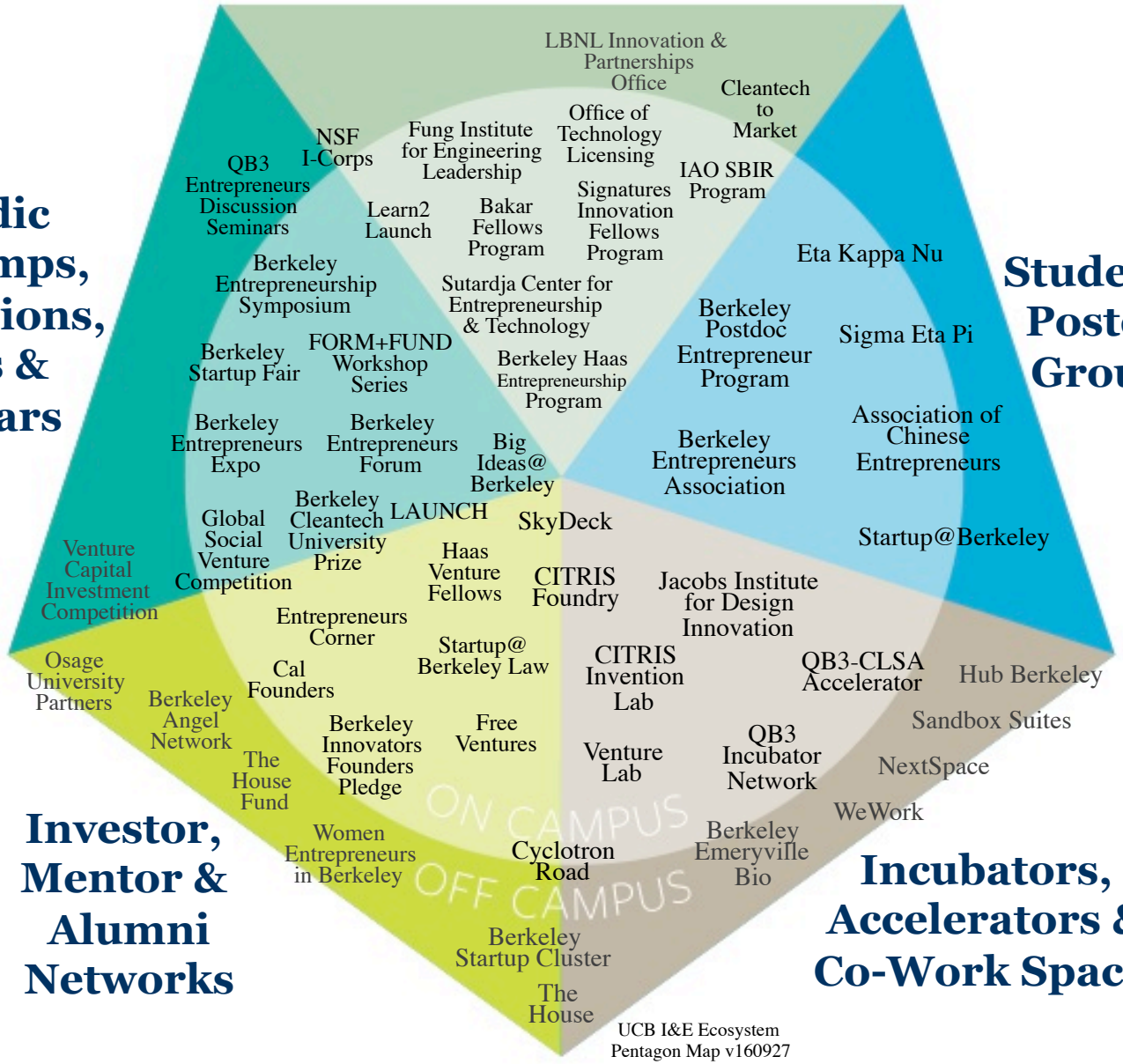
2. Many research universities will have campuses located in 1 or more leading Hy-LIEs (analogous to how many US corporations became multinational entities)
3. Many research universities will have economic development collaborations with their local governments (many already do)
4. Many research universities will have an employee responsible for local innovation ecosystem development
5. Hy-LIE attributes will become a new metric by which to evaluate & rank research university excellence (this will be problematic for some public universities that can't grow or branch)

Agenda: *Q & A*

Research, Education & Support Programs

Periodic Boot Camps, Competitions, Events & Seminars

Student & Postdoc Groups



UCB I&E Ecosystem
Pentagon Map v160927

Investor, Mentor & Alumni Networks

Incubators, Accelerators & Co-Work Spaces

Bio: *Commercializing Leading-Edge Technology*

1. Engineering undergraduate degree
2. Systems Engineer @ HP (back when most admired company)
3. MBA degree
4. Sun Microsystems Inc (product manager)
5. Mips Computer Systems Inc (product line manager)
6. Silicon Graphics Inc (product family of servers, $100M revenue)
7. Netpulse Networks Inc (co-founder, $10M+ in venture funding)
8. Peak Democracy Inc (co-founder, bootstrapped lean startup)
9. UC Berkeley

Bio: *UC Berkeley Research, Concepts & Initiatives*