

Mobilizing Universities in Science, Technology & Innovation for Socio-Economic Transformation

Jose I. dos R. Furtado

Imperial College London

(National Symposium on Science, Technology & Innovation
for Socio-Economic Transformation, Mbarara University of
Science and Technology, Uganda; 13-15 September 2007)

*The great path has no gates,
Yet thousands of roads enter it.
When one passes through this gateless gate,
He walks freely between Heaven and Hell.*

**~ Zen koan in
'Gateless Gate' (Mumonkan, Wumenguan)**

Science, Technology & Innovation (STI) for Socio-Economic Transformation

- 1. What are the STI challenges for socio-economic transformation?**
- 2. How can universities capitalize on the Nature of STI for socio-economic transformation?**
- 3. How can Universities capitalize on their Roles for socio-economic transformation?**

1. STI Challenges for Socio-Economic Transformation

- 1.1 Technology innovations lead socio-economic transformations**
- 1.2 Military industries with subsidies & secrecy drive some strategic technology innovations**
- 1.3 Societies in any country are at different levels of socio-economic transformation / transition**
- 1.4 Societies use Innovations to enhance Socio-Economic competitiveness (Growth-Welfare dynamics) & diversity**
- 1.5 Four Kinds of Globalisation pose STI Challenges for Sustainability**
- 1.6-1.7 Universities Perform Three (3) Critical Entrepreneurial Roles in Knowledge Diversification and Economic Transformation**

1.1 Technology innovations lead Socio-economic transformations

- **Technology has always lead socio-economic transitions in different sectors at different time & spatial scales:**
 - **Resource-based industries:** e.g. Agriculture – meeting domestic needs & export demands
 - **Manufacturing industries:** e.g. Agriculture - ‘Downstream’ processing of produce for storage, handling, transport, trade & consumption
 - **Service industries:** e.g. Agriculture – use of ITC to access information about markets, production & processing methods, & natural hazards

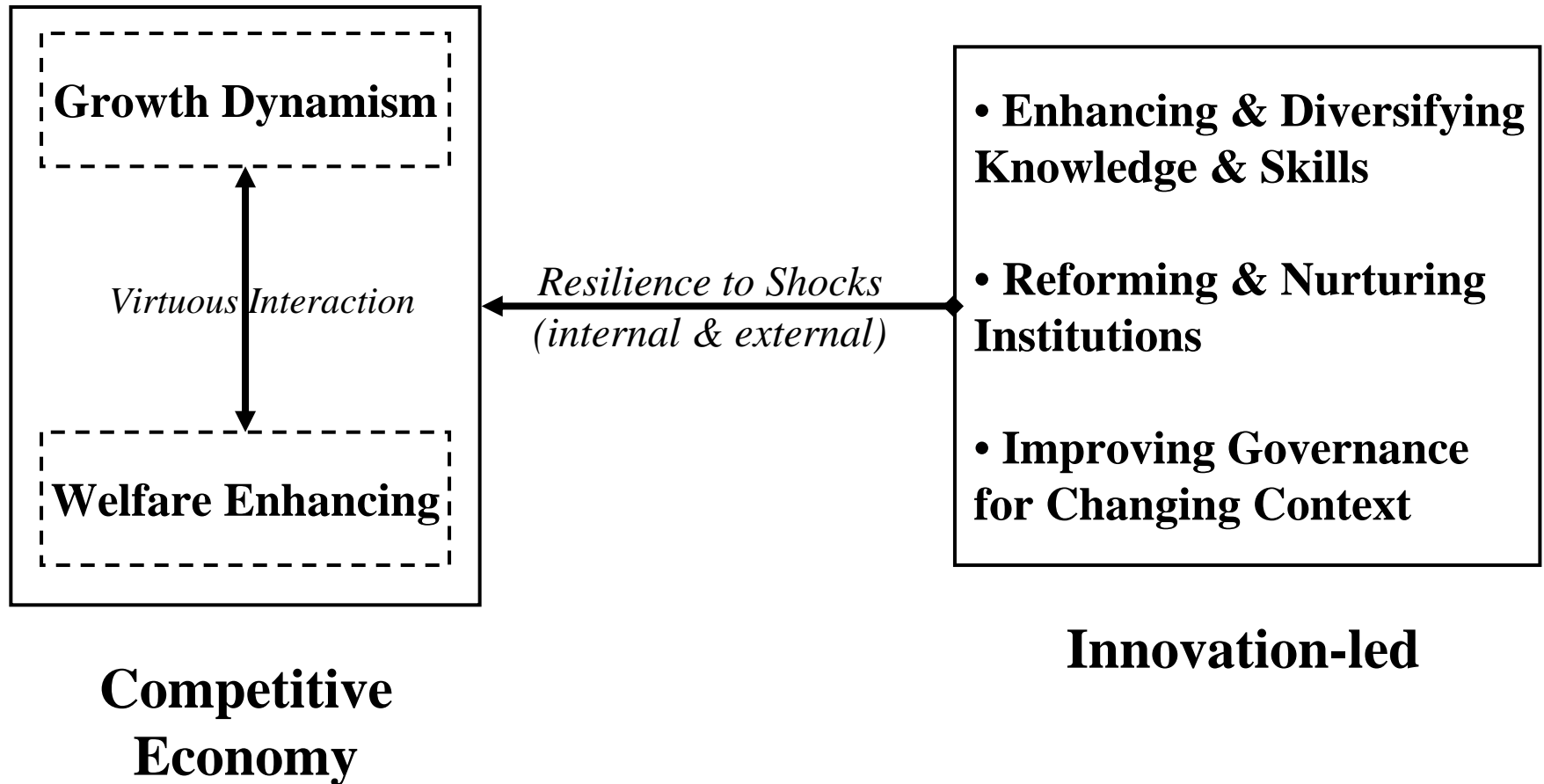
1.2 Military industries with subsidies drive some technology innovations

- **Military industries with subsidies & secrecy for strategic goods & services have driven some technology innovations:**
 - **Agriculture:** e.g. monoculture farming on steppe grasslands (Genghis Khan)
 - **Energy:** e.g. nuclear power (UK, Germany, USA)
 - **Minerals:** e.g. steel, new materials
 - **Manufacturing:** e.g. rapid transport
 - **Services:** e.g. Internet, laser technology, robotics

1.3 Societies in any country are at different levels of socio-economic transformation / transition

- **Different levels of transformation / transition:**
 - **Local:** e.g. Agriculture
 - **National:** e.g. Processing & Manufacturing
 - **Transnational:** e.g. Transport, Services
 - **Global:** e.g. Financial services, Trade
 - **Cosmic:** e.g. Space explorations, Zero-gravity innovations

1.4 Societies use Innovations to enhance Economic competitiveness (Growth-Welfare dynamics) & Socio-cultural diversity & resilience



1.5 Four Kinds of Globalisation pose STI Challenges for Sustainability

Globalisation: = Process where geographical constraints on social & cultural arrangements disappear, & people become increasingly aware of this recession (Malcolm Waters)

4 Types of Changes: Each → Controversy + *Counter-movement*

1. **Economic:** Global mobility of goods, services, capital, organizations & employment → *Protectionism*
2. **Political:** Global concern for international trade, security, wars, terrorism, climate change, epidemics, etc. → *Nationalism*
3. **Cultural:** Global access to / adoption of art forms, rituals, clothes, foods, styles, etc. from anywhere → *Traditionalism / Fundamentalism*
4. **Biological / Ecological:** Global gene piracy for use, access to ecosystems for ecotourism, health epidemics, species / resource depletions, climate change → *Native species protection*

1.6 Universities Perform Three (3) Critical Roles in Knowledge Diversification

University	Knowledge Diversification		
Roles (3)	Generate	Disseminate	Transfer
Functions	• <i>Research</i>	• <i>Education & Training</i>	• <i>Innovation</i>

1.7 Critical Entrepreneurial Roles of Universities in Economic Transformation

- **Generation:**
 - R&D → Creativity + Innovations
 - Critical evaluation of old knowledge & traditions
- **Dissemination / Transmission:**
 - Educate youth & professionals (e.g. courses)
 - Train technicians / Inform the public (e.g.
- **Transfer:**
 - Expert advise / Consultations
 - Technology imitation, adaptation & innovations

Repositories: e.g. Libraries, Databases, Patents, Museums

Science, Technology & Innovation (STI) for Socio-Economic Transformation

- 1. What are the STI challenges for socio-economic transformation?**
- 2. How can universities capitalize on the Nature of STI for socio-economic transformation?**
- 3. How can Universities capitalize on their Roles for socio-economic transformation?**

2. Capitalizing on the Nature of STI for Socio-economic Transformation

- 2.1 Human Resources:** Able & Capable Human
Individuals are the Central & Critical Resource for the Knowledge Enterprise
- 2.2 R&D Spectrum:** STI opportunities lie on a Research & Development (R&D) or Knowledge Continuum depending on staff competencies, resources & support
- 2.3 Market Demands:** Market ‘pull’ & Technology ‘push’ opportunities generate critical applications discoveries / innovations
- 2.4 Organization:** Entities generating Innovations interact & link more like a ‘Compost heap’ than a system

2. Capitalizing in the Nature of STI for Socio-economic Transformation (contd.)

2.5 Life cycles: Ideas & Innovations have their own Socio-Political Life-cycle

2.6 Open minds: Knowledge generation occurs in Open minds / 'environments' without Extremes (isms) / Obstacles

2.7 Pyramidal effort: Knowledge Hierarchy from Facts to Wisdom demands a pyramidal effort & capability

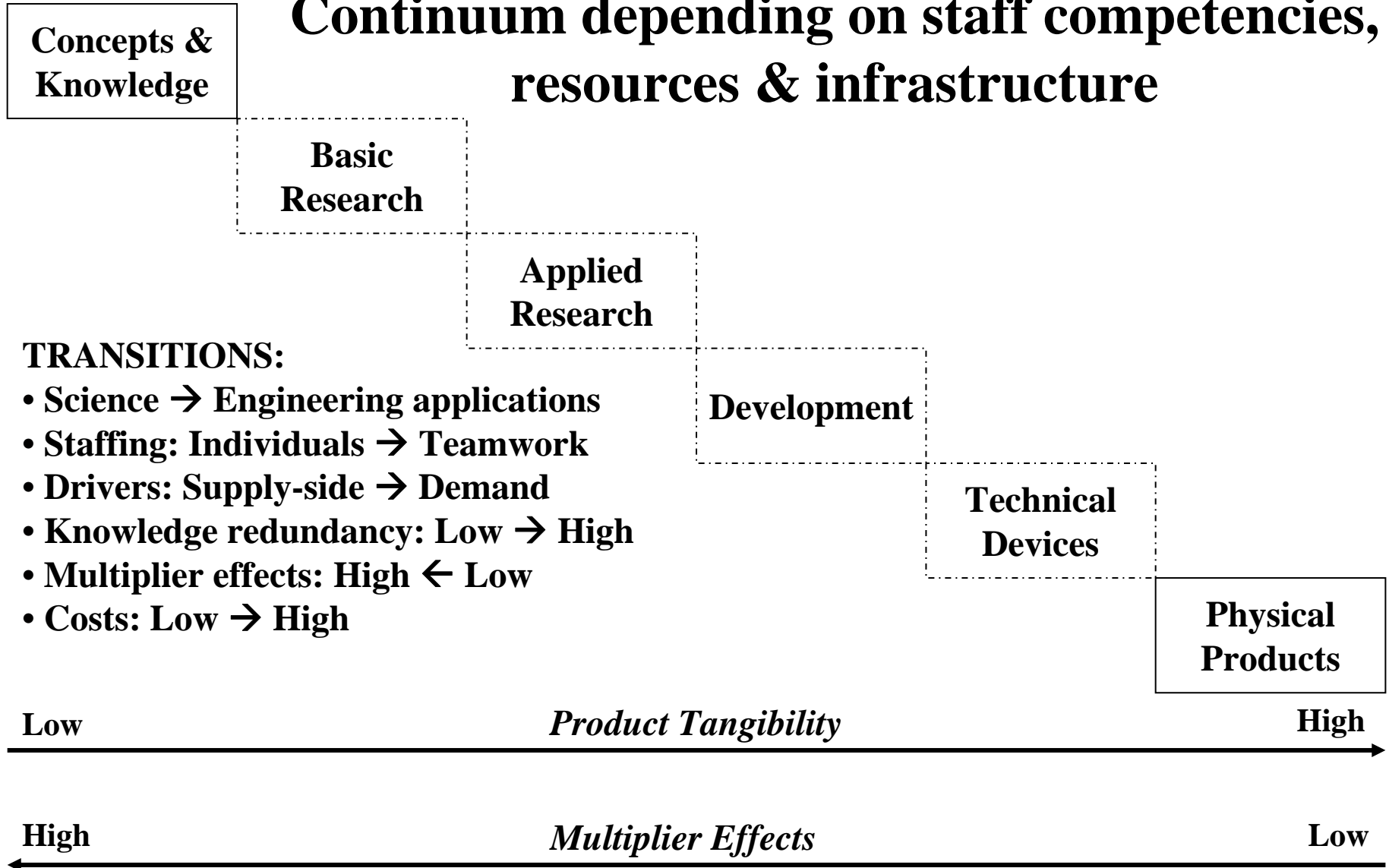
2.8 Conditions: Certain Organizational conditions favour Unpredictable creativity & innovation

2.1 Able & Capable Human Individuals are the Central & Critical Resource for the Knowledge Enterprise

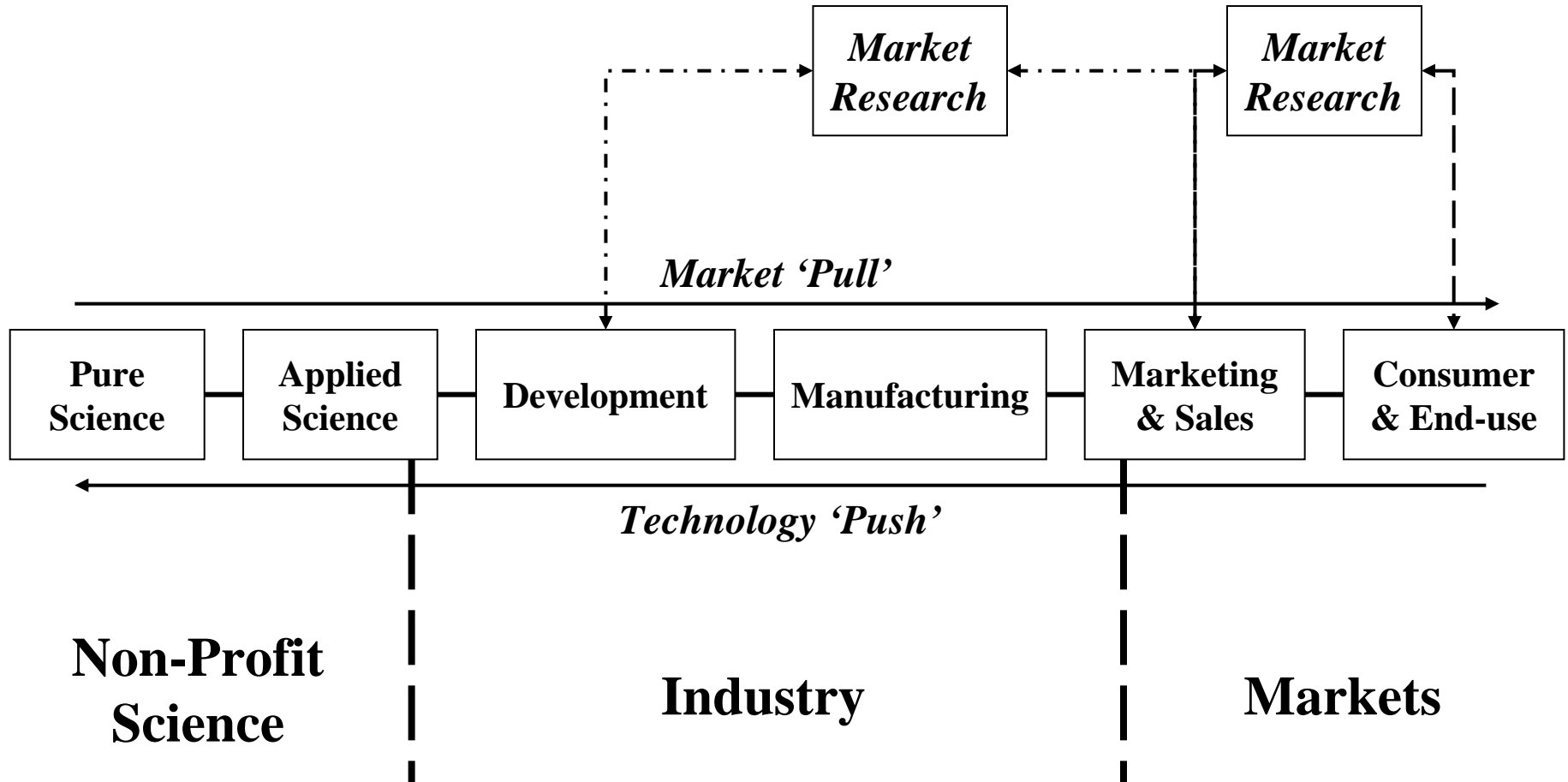
With respect to:

- → Promoting Scientific research & Technological development (R&D)
- → Fostering Creativity & Innovations
- → Nurturing & Educating about the S&T enterprise & Innovations at Universities
- → Catalysing Socio-Economic transitions & transformations

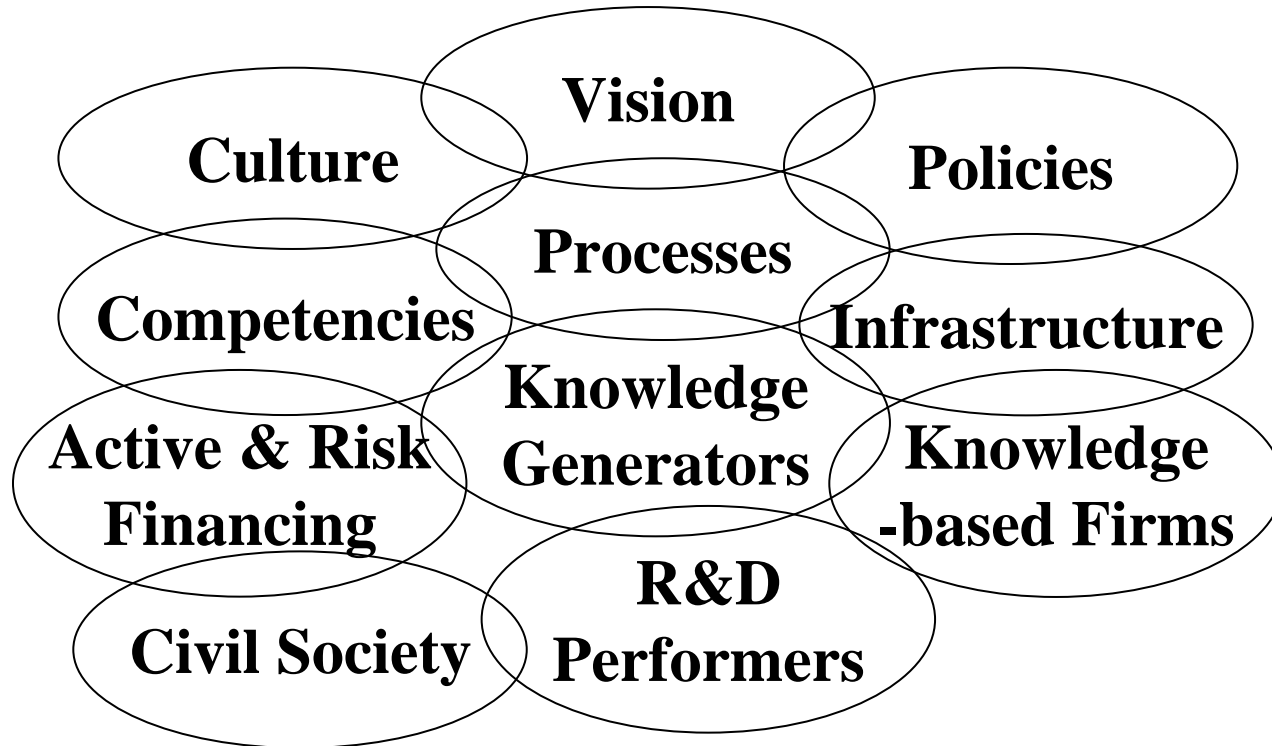
2.2 STI opportunities lie along a Research & Development (R&D) or Knowledge Continuum depending on staff competencies, resources & infrastructure



2.3 Market 'pull' & Technology 'push' opportunities generate critical applications discoveries / innovations

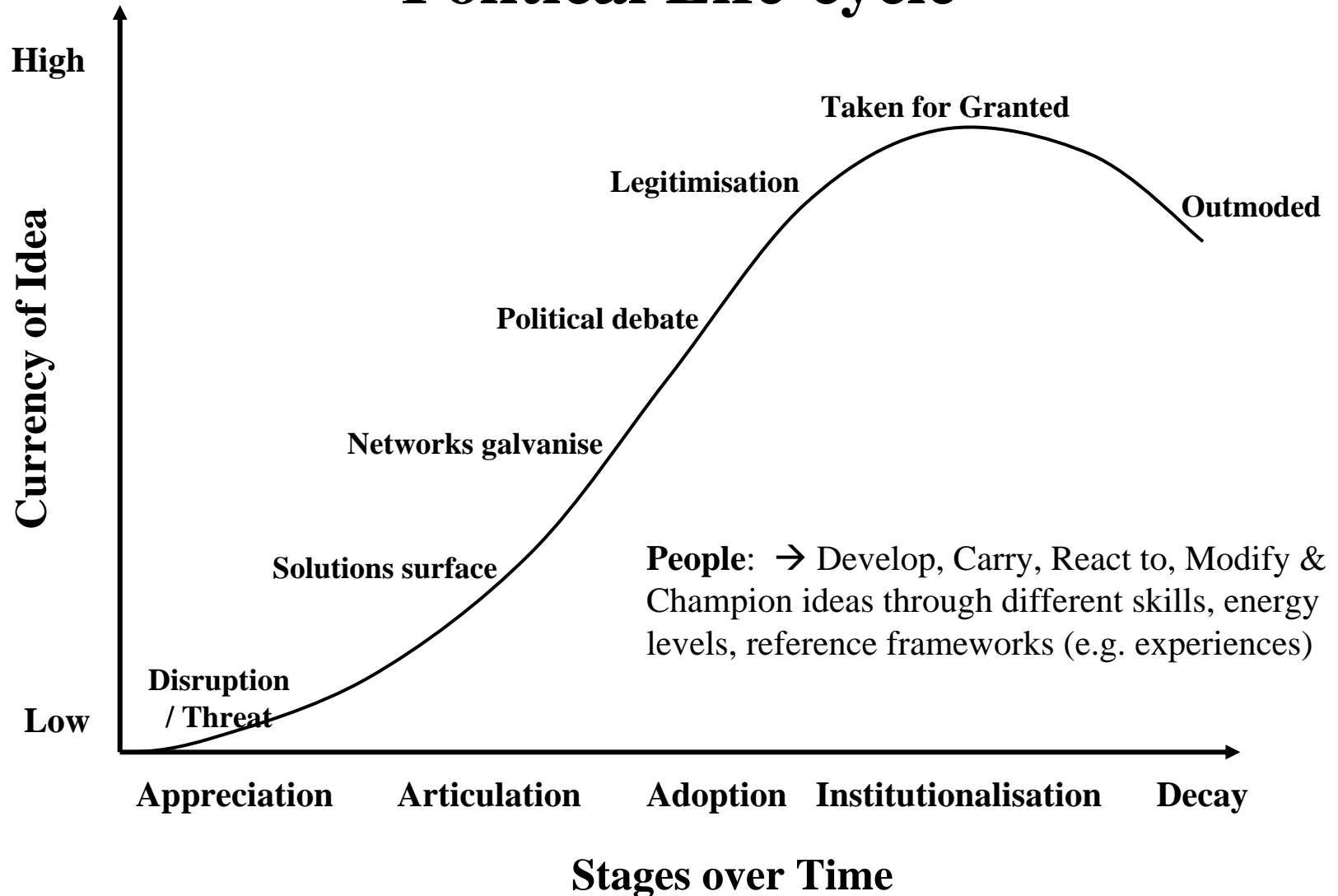


2.4 Entities generating Innovations interact & link more like a ‘Compost heap’ than a system

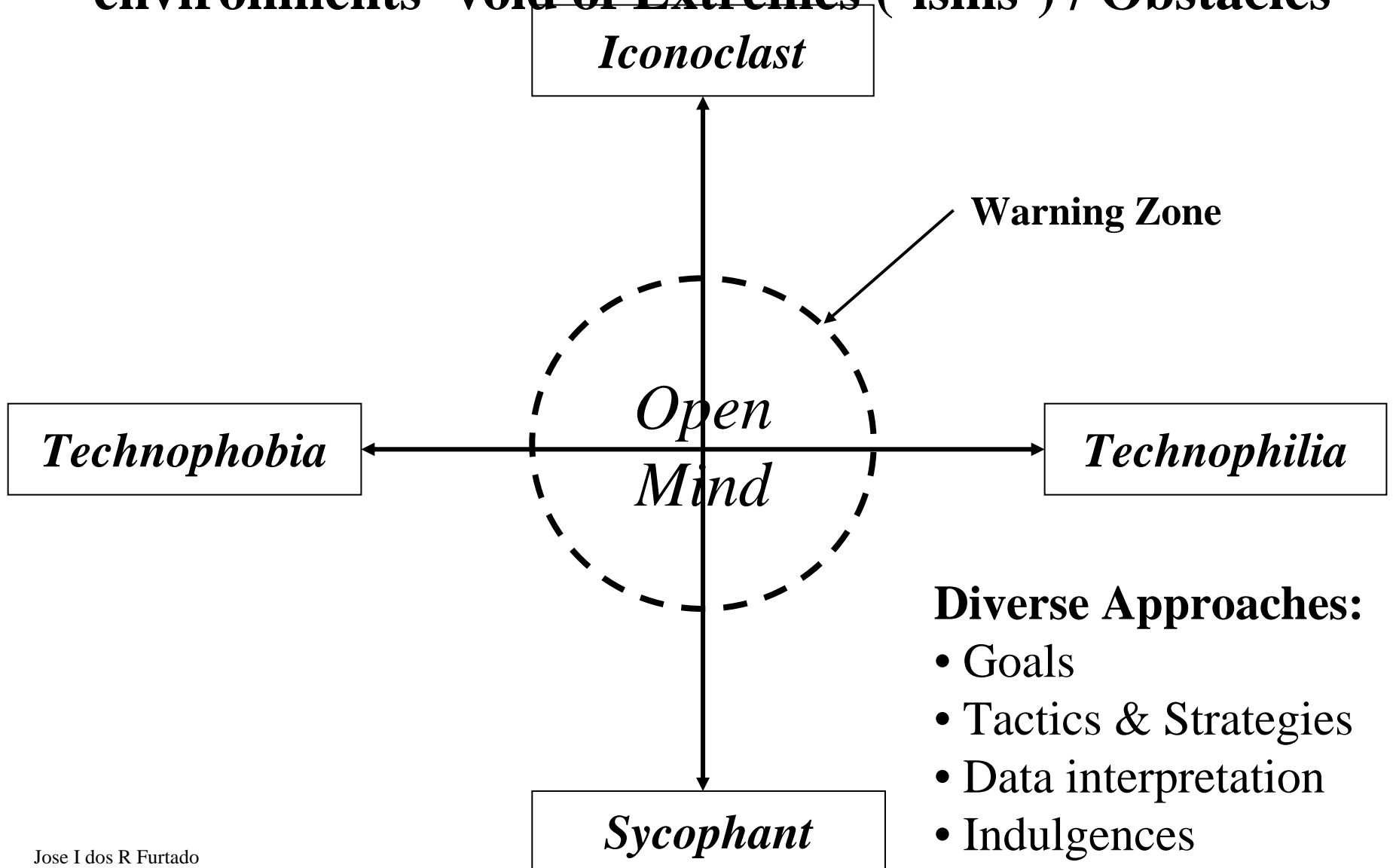


More like a Compost Heap than a Discrete System

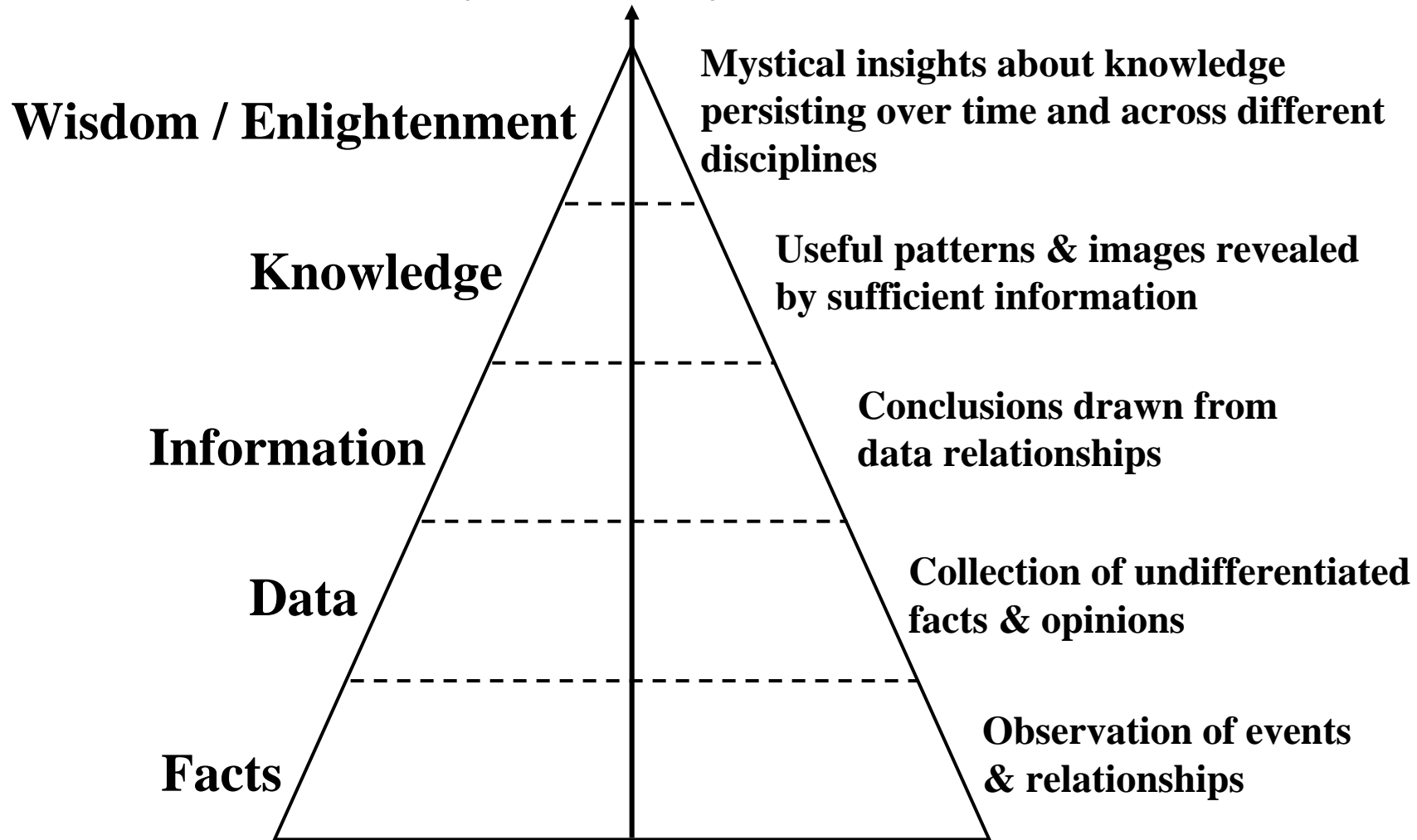
2.5 Ideas & Innovations have their own Socio-Political Life-cycle



2.6 Knowledge Generation occurs in Open 'environments' void of Extremes ('isms') / Obstacles



**“Parables”, “Fables”
Myths, Poetry, Art**



2.7 Knowledge Hierarchy from Facts to Wisdom demands a pyramidal effort & capability

2.8 Certain Organizational Conditions favour Unpredictable Creativity & Innovation

Great discoveries / innovations = Unpredictable

Favourable: (+)

- Organizational **autonomy**
- Organizational **flexibility**
- Optimal **skills diversity**
- **Open** communication
- Social **integration**
- **Leadership** to understand & integrate R&D
- **Talented** individuals
- **Time + Money**

Unfavourable: (-)

- Differentiation
- Hierarchical authority
- Bureaucratic controls
- Centralized coordination (budgets, programmes, staffing, standards, etc.)
- Hyper-diversity in skills
- Mimicry / Plagiarism
- Lack of commitment

Science, Technology & Innovation (STI) for Socio-Economic Transformation

- 1. What are the STI challenges for socio-economic transformation?**
- 2. How can universities capitalize on the Nature of STI for socio-economic transformation?**
- 3. How can Universities capitalize on their Roles for socio-economic transformation?**

3. Capitalizing on the Roles of Universities for Socio-Economic Transformation

3.1 Roles: Universities perform Three (3) Roles in Diversifying Knowledge:

- Generation / Dissemination / Transfer

3.2 Strategies: Universities realise these Roles through several Opportunistic strategies

3.3 Partnerships: Strategic STI Partnerships enable:

- Research & Innovation
- Education & Training
- Policy & Governance

3. Capitalizing on the Roles of Universities for Socio-Economic Transformation (cont)

3.4 Wealth: Universities create Societal Wealth through Strategic Enterprises

3.5 Approaches: East-West Mental & Behavioural Approaches towards Knowledge Generation

3.6 Short-cuts: Short-cuts for LDC Universities to undertake World-class R&D

3.7 Economy characteristics: Knowledge Economy & Learning Characteristics

3.1 Universities Perform 3 Entrepreneurial Roles Diversifying Knowledge: Generate, Disseminate & Transfer

University	Knowledge Diversification		
Roles (3)	Generate	Disseminate	Transfer
Functions	• <i>Research</i>	• <i>Education & Training</i>	• <i>Innovation</i>

3.2 Universities realise these Roles through several Opportunistic strategies

- A. Enterprising individuals** → Value-added, Critical teams, Entrepreneurship, & Recognition
- B. Defining priorities based on economic geography** → Successful partnerships, Catalytic role, Research orientation
- C. Investments & Privatisation** → Entrepreneurship
- D. Strengthening S&T infrastructure** → R&D
- E. Addressing 3 Globalisation challenges** → Entrepreneurial businesses, 'Brain drain', 'Wandering scholars'
- F. Mixing Strategies** → Diversification & Consolidation of Knowledge Competencies

3.2 (A) Human Capital

A. **Attract / Select / Retain capable & enterprising individuals to lead R&D in specific areas:**

- → **Value-added** in knowledge
- → **Critical teams** with complementary skills for technology adaptations & innovations
- → **Entrepreneurship** based on organizational independence & flexibility
- → **International recognition** through R&D cooperation
- → **International standards** through independent external evaluation

3.2 (B) Economic Geography

B. Focus on economic geography of region to define R&D priorities:

- → **Successful partnerships** by strong links with the economy:
 - University-Industry / University-Government / University-Society / University-Government-Industry
- → **‘Catalytic / Engaging role’** with society → Changing its role as an ‘Ivory Tower’
- → **Research-oriented universities** emergence →
 - New ideas / technology → Attractive R&D ‘environment’
 - Create spin-offs industries → Researchers / Population

3.2 (C) Investments

C. Invest in universities to transform them into more ‘private’ Higher educational enterprises accessible to all:

- **R&D financing = High in OECD economies** compared to Developing economies with their constraints: (a) Resource allocations, (b) Resource competition, (c) External evaluation, (d) Institution quality & Research teams
- **Investments in Higher Education = High in OECD economies** [US\$10-25k/student] compared to Developing economies with their constraints: (a) Funding, (b) External evaluation, (c) Teaching quality, (d) Staffing numbers, (e) Researchers

3.2 (D) Infrastructure

D. Strengthen S&T infrastructure for R&D:

- **Development assistance grants**
- **R&D partnerships** that promote & support: e.g.
 - Financing partnership arrangements
 - Industry parks & incubators
 - Formal inter-University linkages
 - University-Industry collaboration
 - University-Civil society linkages
 - University-Government partnerships

3.2 (E) Globalisation Challenges

E. Address three (3) Globalisation challenges facing Universities:

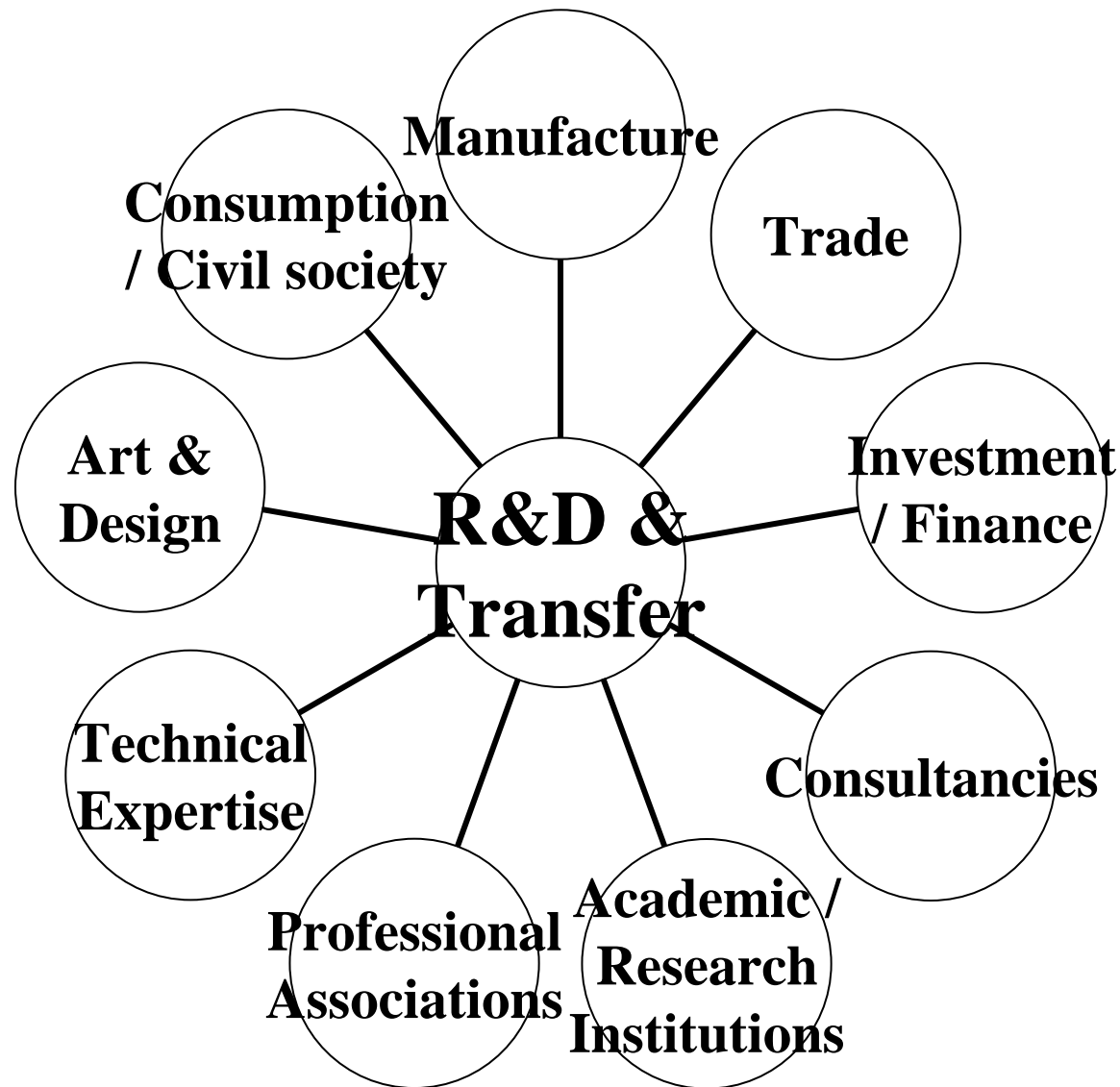
- Global nature of S&T / R&D → **Transnational ‘Entrepreneurial business’**
- Global mobility of Academics (Supply) → **‘Brain Drain’**
- Global mobility of Students (Demand) → **‘Wandering scholars’**

3.2 (F) Use a mix of Strategies to Diversify & Consolidate Knowledge Competencies

Examples of Strategic approaches:

- **‘Gambling’ strategy:** → staff undertake R&D initiatives emerging in their area of expertise
- **‘Banking’ strategy:** → staff collaborate to consolidate R&D thrust areas based on competencies, critical mass & comparative advantage
- **‘Parasitic’ strategy:** → staff ‘free ride’ on innovations elsewhere to explore applications
- **‘Predation’ strategy:** → institution secures patents / staff / investments to build critical mass for technology applications & innovations

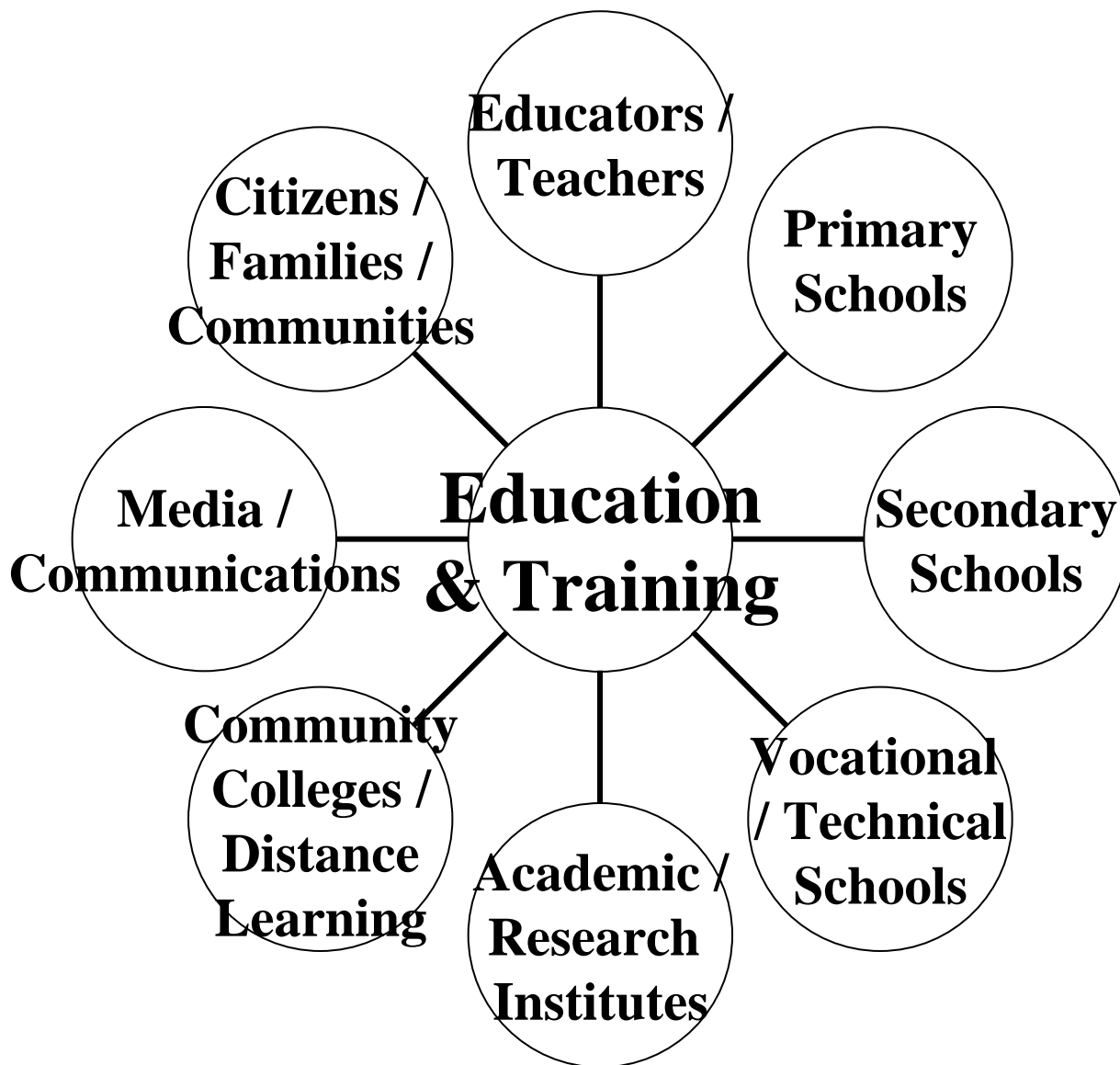
3.3 STI Partnerships (A) Research & Innovation



Some Examples

- **University-Industry:** e.g. Soil testing for construction, Soil analysis for agriculture
- **University-Government:** e.g. Advising on metrology & standards for quality control (Pollution standards)
- **University-Society:** e.g. Nature conservation surveys & education (Malayan Nature Society)
- **University-University:** e.g. Flowering biology of timber & fruit trees (U Malaya-U Aberdeen), Comparative productivity of natural & managed ecosystems (IBP - U Malaya with British & Japanese universities, & Royal Society & Japan Science Council funds)
- **University-Industry-Civil society:** e.g. Screening medicinal plants for pharmaceuticals (NIH-based)

3.3 STI Partnerships (B) Education & Training



Some Examples

- **Graduate manpower:** e.g. New courses for changing demands (MSc in Environmental Technology & Policy)
- **Researchers:** e.g. Attracting graduate students to industry-oriented problems (Industry waste recycling)
- **Technicians:** e.g. Overseeing technician training (City & Guilds exams)
- **Professional education:** e.g. Refresher courses for professionals (General medical practitioners)
- **Adult education:** e.g. Adult education courses (Open University, Distance learning)
- **Public awareness:** e.g. Media briefings (BBC), Public lectures / demonstrations / exhibitions (Royal Institution)

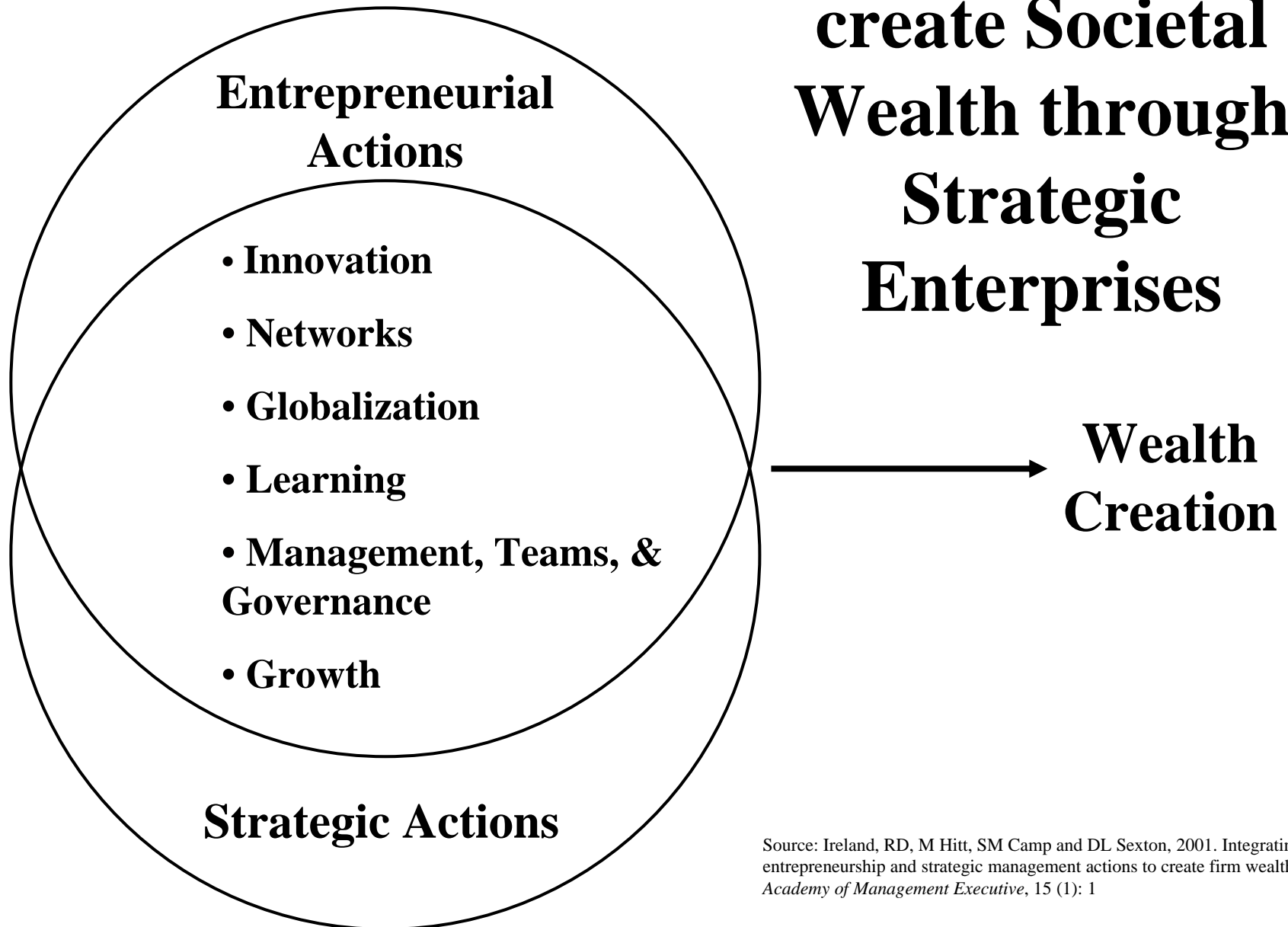
3.3 STI Partnerships (C) Policy & Governance



Some Examples

- **Policy-makers:** e.g. Training / Briefing on:
 - Topical issues (Workshops / Consultations)
 - Problem areas (Field visits / Study tours)
 - Legislative issues (Expert advice / consultations)
- **Decision-makers:** e.g. Training / Briefing on:
 - Topical issues (Workshops / Consultations)
 - Problem areas (Field visits / Study tours)
 - Managerial issues (Expert advice / consultations)
- **Judiciary:** Training / Briefing on:
 - Topical issues (Expert advice / consultations)
- **Media:** Training / Briefing on:
 - Topical issues (Workshops / Consultations)
 - Problem areas (Field visits / Study tours)
 - Investigative issues (Expert advice / consultations)

3.4 Universities create Societal Wealth through Strategic Enterprises



Source: Ireland, RD, M Hitt, SM Camp and DL Sexton, 2001. Integrating entrepreneurship and strategic management actions to create firm wealth. *Academy of Management Executive*, 15 (1): 1

3.5 East-West Mental & Behavioural Approaches towards Knowledge Generation

<u>Approaches</u> Features	<i>Western</i> ‘Distancing’	<i>Eastern</i> ‘Immersion’
Focus (cf. Nisbett)	<ul style="list-style-type: none"> • On objects as such 	<ul style="list-style-type: none"> • On objects in context
S&T	<ul style="list-style-type: none"> • Separation of Science from Technology 	<ul style="list-style-type: none"> • Integration of Science with Technology
State & Society	<ul style="list-style-type: none"> • Separation of State from Society 	<ul style="list-style-type: none"> • Integration of State with Society
Addressing Unknown	<ul style="list-style-type: none"> • Individualistic exploration 	<ul style="list-style-type: none"> • Collective adoption

3.6 Short-cuts for LDC Universities to undertake World-class R&D

- 1. Human capital + Independence + Flexibility:** → Entrepreneurship + Value-added
- 2. Choice & Freedom:** → Mobility for students + staff
- 3. Economy – R&D links:** → R&D priorities + Success
- 4. R&D Harmonization:** → Critical mass / networks
- 5. International cooperation:** → Attract expertise, investments & recognition
- 6. S&T Infrastructure:** ← Development assistance
- 7. Talent + Resources + R&D + ‘Market’ demands:**
→ Discovery + Innovations + Inventions → Economic growth & transformations
- 8. Emergent Research Universities:** → New ideas, Create spin-offs, Create attractive R&D environment

3.7 Knowledge Economy & Learning Characteristics

1. **Inherent polarization** → Diversification of knowledge & learning
2. **Competitiveness** → Constantly emerging & diversifying
 - Learning-based >> Knowledge-based
 - Learning capability → Success of people, firms & regions
3. **Economic transformation:** = Very rapid
 - Shorter product life-cycles
 - Shorter life-time for competencies → Constant training & retraining

Role of Universities

The role of a university is to be a “place of light, of liberty, and of learning”

~ Benjamin Disraeli