UNIVERSITY OF KWAZULU-NATAL

TECHNISCHE UNIVERSITÄT CHEMNITZ

9. AAE Summer School:

“Innovation and Intercultural Management for Sustainable Development“

31st August – 11th September 2015

Chemnitz University of Technology

Chemnitz, Germany

The Role of Innovation, Technology and Entrepreneurship for Sustainable Development

Prof. Dr. Stefan Hüsig

Chair for Innovation Research and Technology Management

1st of September 2015

TU Chemnitz, ThW 7, K012

TECHNISCHE UNIVERSITÄT CHEMNITZ

Agenda

- Technology, Innovation and Sustainable Development in an International Context
- How are technology, entrepreneurship and innovation shaping the economic development at an international level between countries?
- How are different regions & countries developing their innovation systems? What supports innovation and technological development?
- Implications for Managers and Entrepreneurs: Disruptive & BOP Innovation
- How to enter existing and new & emerging markets with innovations?
- Which innovation strategies might be most promising for emerging countries and new firms?

TECHNISCHE UNIVERSITÄT CHEMNITZ

Sustainable Development: Background and Normative Orientation

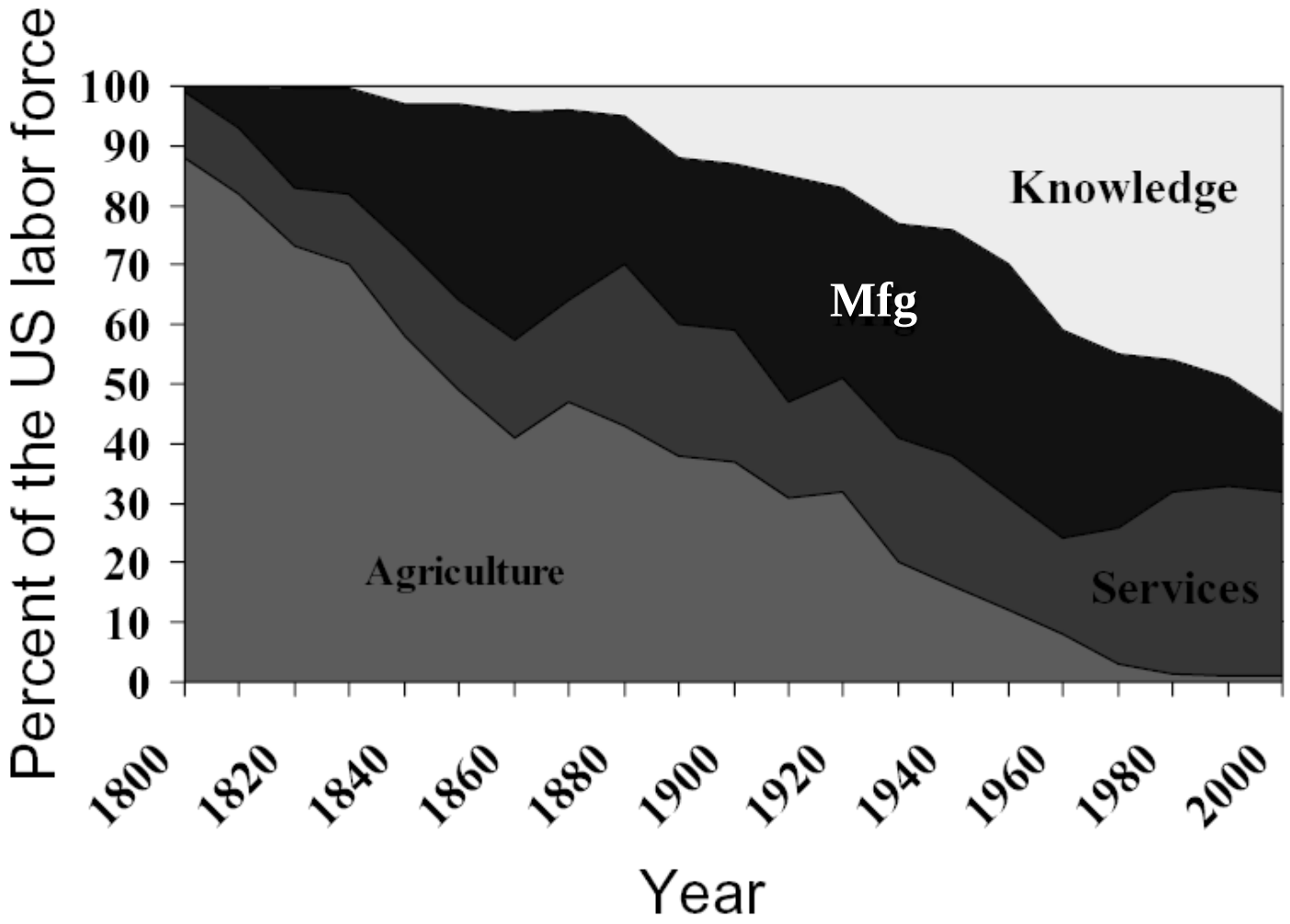
- „Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains two key concepts:
  - the concept of "**needs**", in particular the essential needs of the **world's poor**, to which overriding priority should be given; and
  - the idea of **limitations** imposed by **the state of technology** and **social organization** on the **environment's ability** to meet present and future needs.“

    1987 World Commission on Environment and Development (Brundtland Report.) „*Our Common Future*“

→ **Triple-Bottom-Line:** Economic growth, environmental protection, and social equality

What Would You Do in this Moment - 250 Years ago?

Why Technology Matters:
Sectoral Development in the USA in the Long Run



Technology Improves Productivity

$$\text{Productivity} = \frac{Outputs}{Inputs}$$

Inputs: *labor, materials, capital, …*

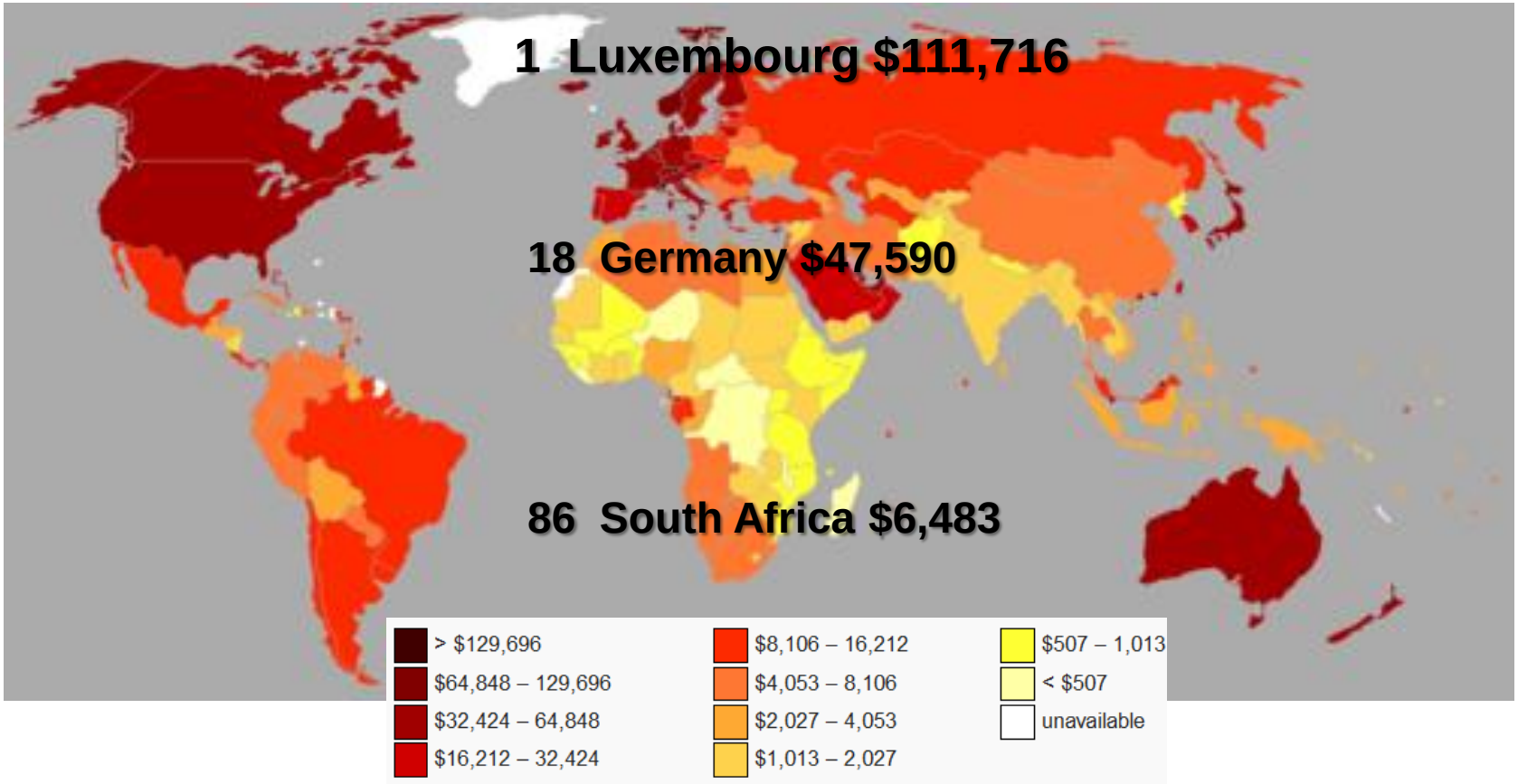
Outputs: *goods, services*

Productivity Improves Prosperity (c.p.)

Working hours to buy goods over time

	1900	2002
Bread	0.10	0.03
Milk	1.04	0.09
Car	1,726.84	727.84
House	13,814.76	7,300.09
Income	$ 687.00	$ 71,032.00

Global Prosperity 2014



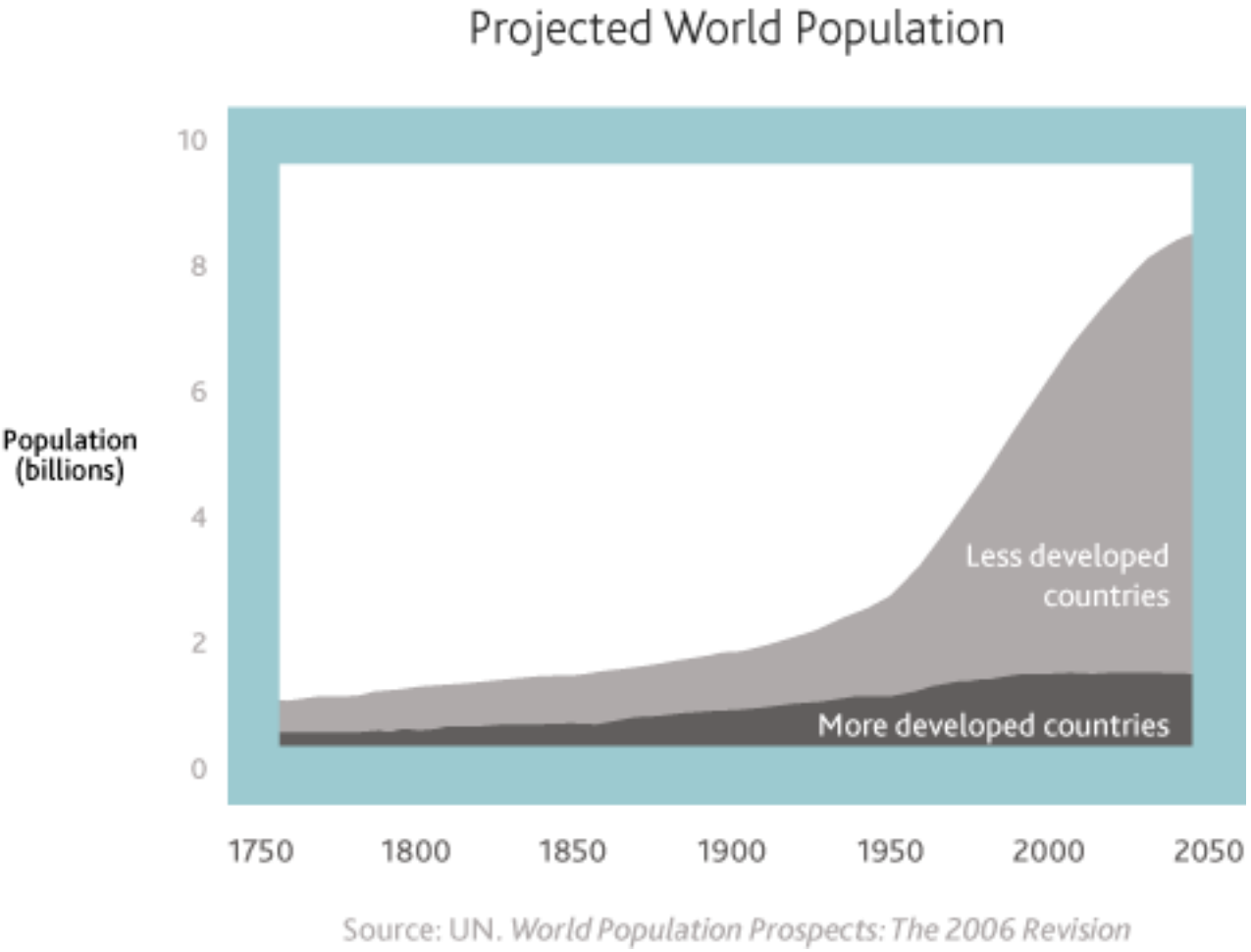
Countries by 2014 GDP (nominal/$) per capita (IMF+ WorldBank data).

https://en.wikipedia.org/wiki/List_of_countries_by_GDP_%28nominal%29_per_capita

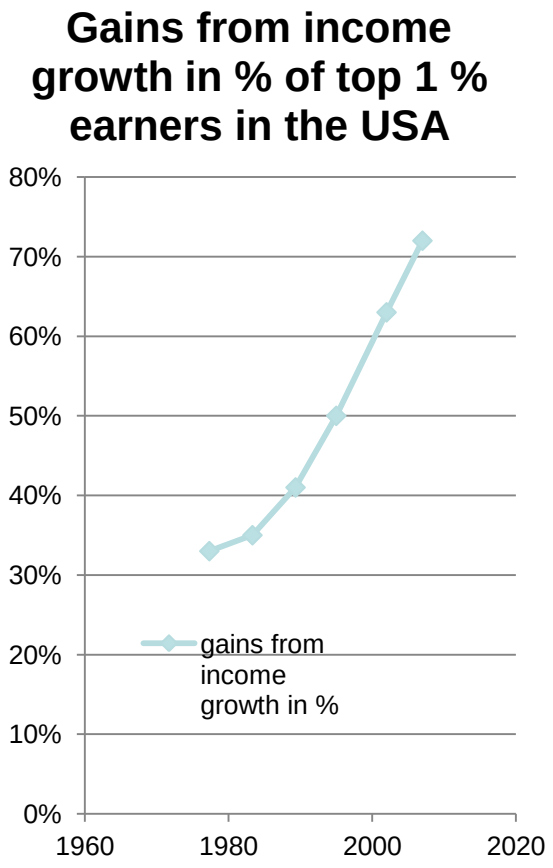
TECHNISCHE UNIVERSITÄT CHEMNITZ

Distribution Matters!

Population Growth and Income & Wealth Inequality Accelerate

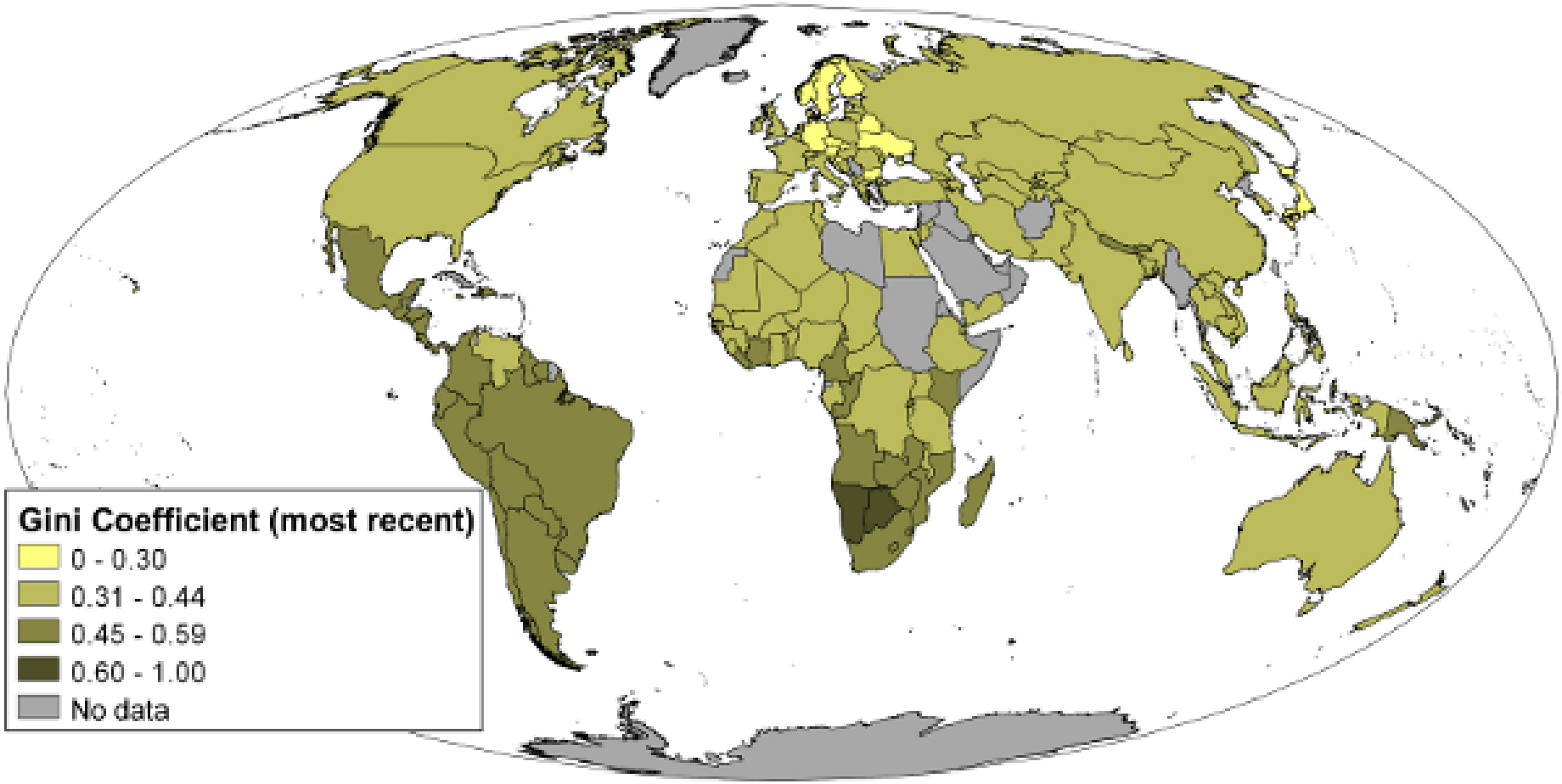


Source: UN. *World Population Prospects: The 2006 Revision*



TECHNISCHE UNIVERSITÄT CHEMNITZ

Global Economic Inequality within Society

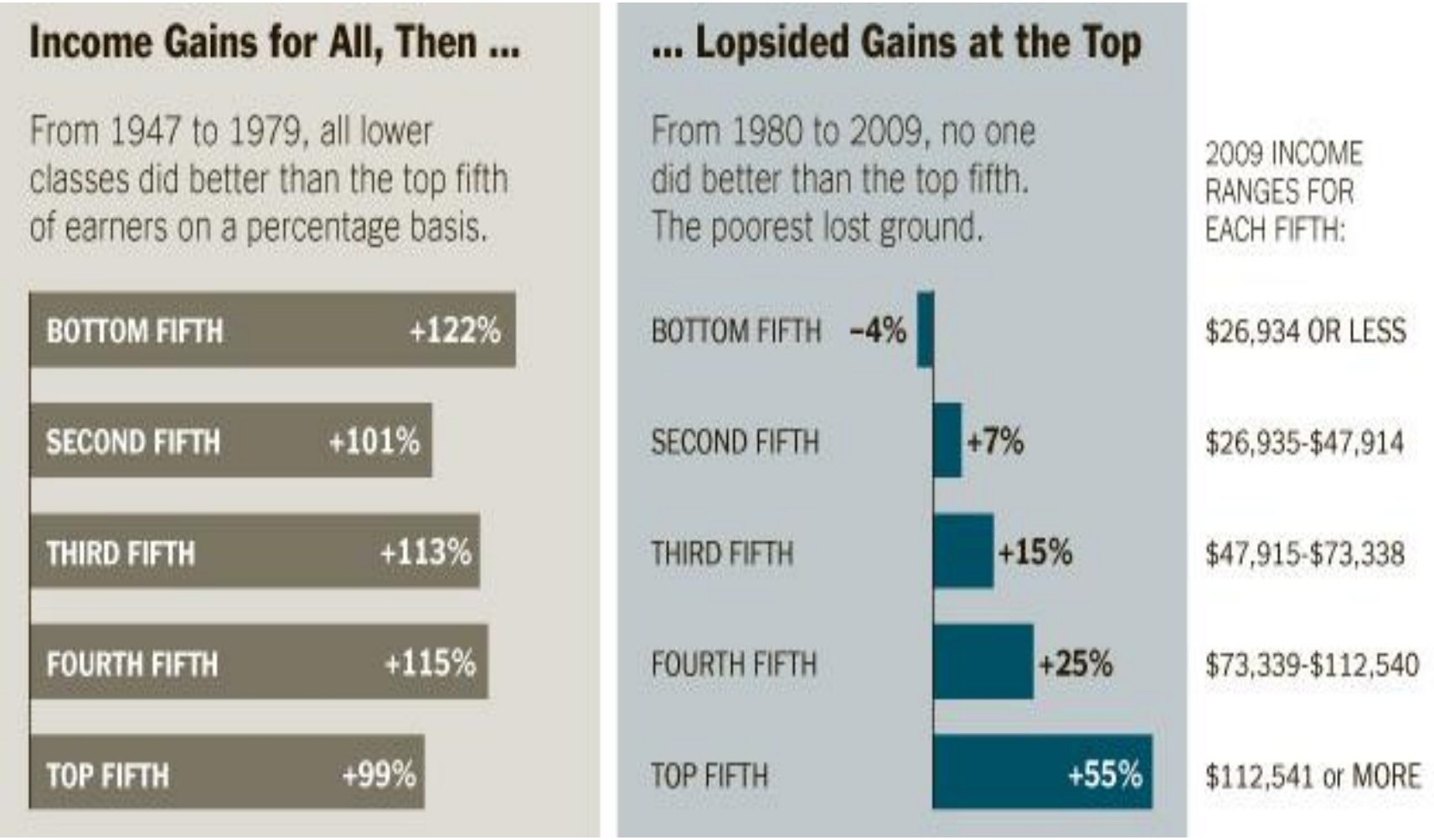


Gini Coefficients (most recent available).
data from United Nations Development Programme

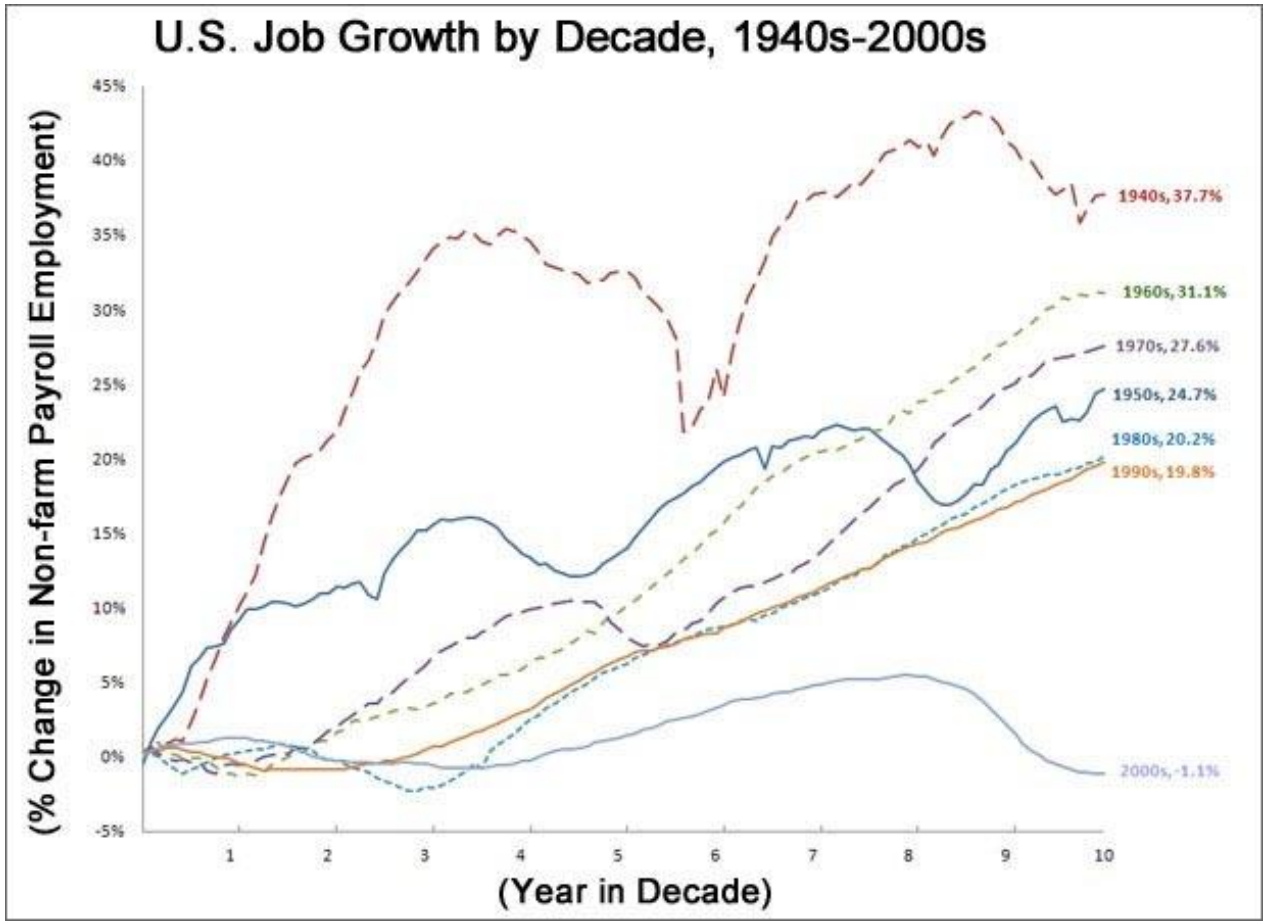
Productivity-Prosperity-Relationship Broken?



…Not for All!


Income Gains for All, Then ...
From 1947 to 1979, all lower classes did better than the top fifth of earners on a percentage basis.
BOTTOM FIFTH +122%
SECOND FIFTH +101%
THIRD FIFTH +113%
FOURTH FIFTH +115%
TOP FIFTH +99%
... Lopsided Gains at the Top
From 1980 to 2009, no one did better than the top fifth. The poorest lost ground.
2009 INCOME RANGES FOR EACH FIFTH:
BOTTOM FIFTH -4%
$26,934 OR LESS
SECOND FIFTH +7%
$26,935-$47,914
THIRD FIFTH +15%
$47,915-$73,338
FOURTH FIFTH +25%
$73,339-$112,540
TOP FIFTH +55%
$112,541 or MORE

Is Technology to Blame Again?
Entering an Era of Digital Technological Unemployment?



http://www.heise.de/tr/artikel/Der-Wettlauf-mit-den-Maschinen-1370433.html

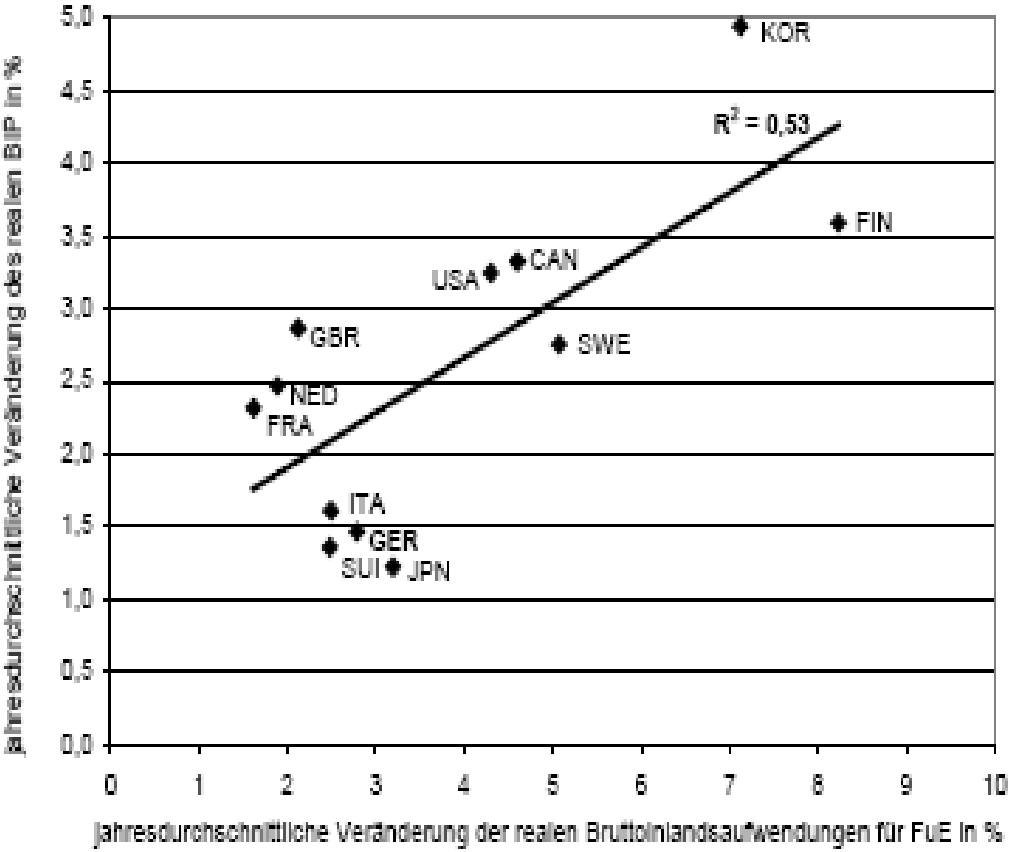


Erik Brynjolfsson und
Andrew McAfee (MIT)

Why National and Regional Innovation Capacity Differs?

R&D Investments in Improving Technology Foster GDP Growth

R&D and Growth in G12 1994-2004*

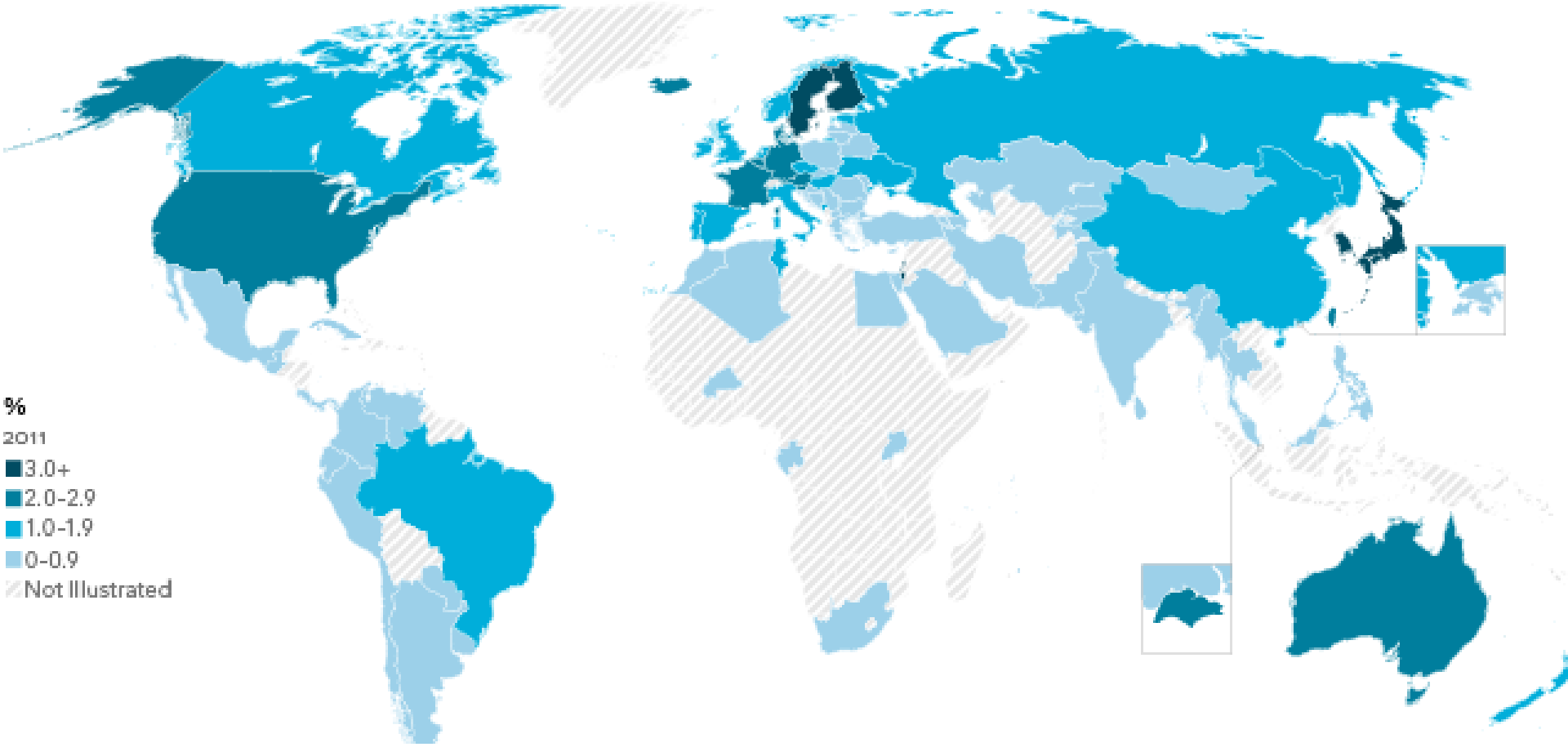


*) GBR, ITA, SWE 2003 statt 2004.

Quelle: OECD, Main Science and Technology Indicators (2006/1). - Berechnungen und Schätzungen des NIW.

TECHNISCHE UNIVERSITÄT CHEMNITZ

Global Research and Development Intensity 2011



Research and development (R&D) as a percentage of its total GDP (R&D intensity)

Euromonitor International (2012)

TECHNISCHE UNIVERSITÄT CHEMNITZ

Ranking G45: The Technological Capabilities of Nations (last available year for each indicator)

Country	Tech WEF	TechRead WEF	TechInnov WEF	GSII EUComm	KI WB	ArCo
Sweden	2	1	6	2	1	1
United States	1	8	3	7	6	5
Switzerland	8	5	2	3	12	3
Finland	3	12	4	1	3	2
Japan	4	17	1	4	13	8
Denmark	6	9	8	9	2	9
Netherlands	10	10	10	11	8	11
UK	16	6	11	12	9	13
Germany	17	18	5	8	14	12
Singapore	15	2	9	5	25	20
Canada	14	15	12	10	11	6
Israel	9	3	7	6	22	4
Iceland	7	4	18	15	4	14
Korea, Rep.	5	16	14	13	20	18
Norway	11	13	17	17	7	7
Australia	12	7	21	18	5	10
France	27	22	13	14	17	19

Daniele Archibugi et al, The technological capabilities of nations: The state of the art of synthetic indicators, Technological Forecasting & Social Change 76 (2009) 917–931

TECHNISCHE UNIVERSITÄT CHEMNITZ

Beyond R&D Investment: Systems of Innovation

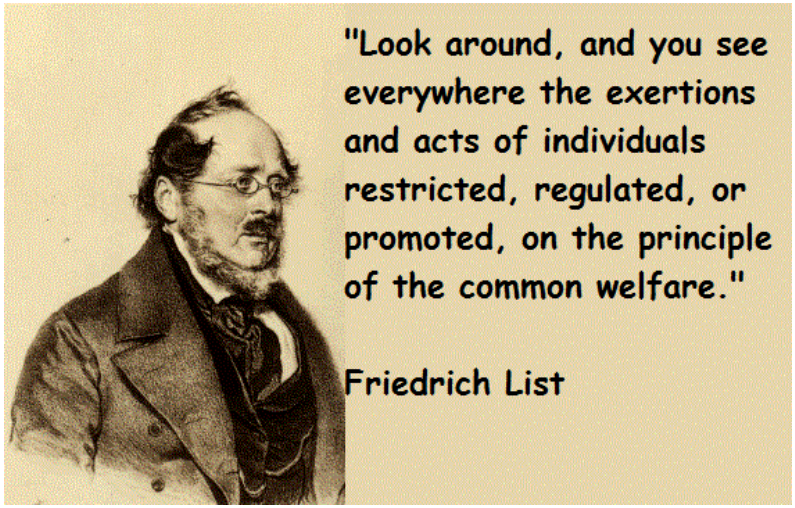
- New technologies are not isolated inventions. They involve a constellation of **inter-related technological, social and organizational innovations**.

– that **produce & direct technical change** in each **national/regional economy**

- **Theoretical approach** to explain innovation activities (Nelson, 1993; Edquist, 2005; Lundvall et al., 2002)
- „*The network of institutions in the public and private sectors whose activities and interactions initiate, import, and diffuse new technologies*“ (Freeman 1987)

Background: Systems of Innovation

- **Institutional** combined with **evolutionary** theories have led to the Innovation System (IS) approach:
- **Georg Friedrich List** (1789-1846)

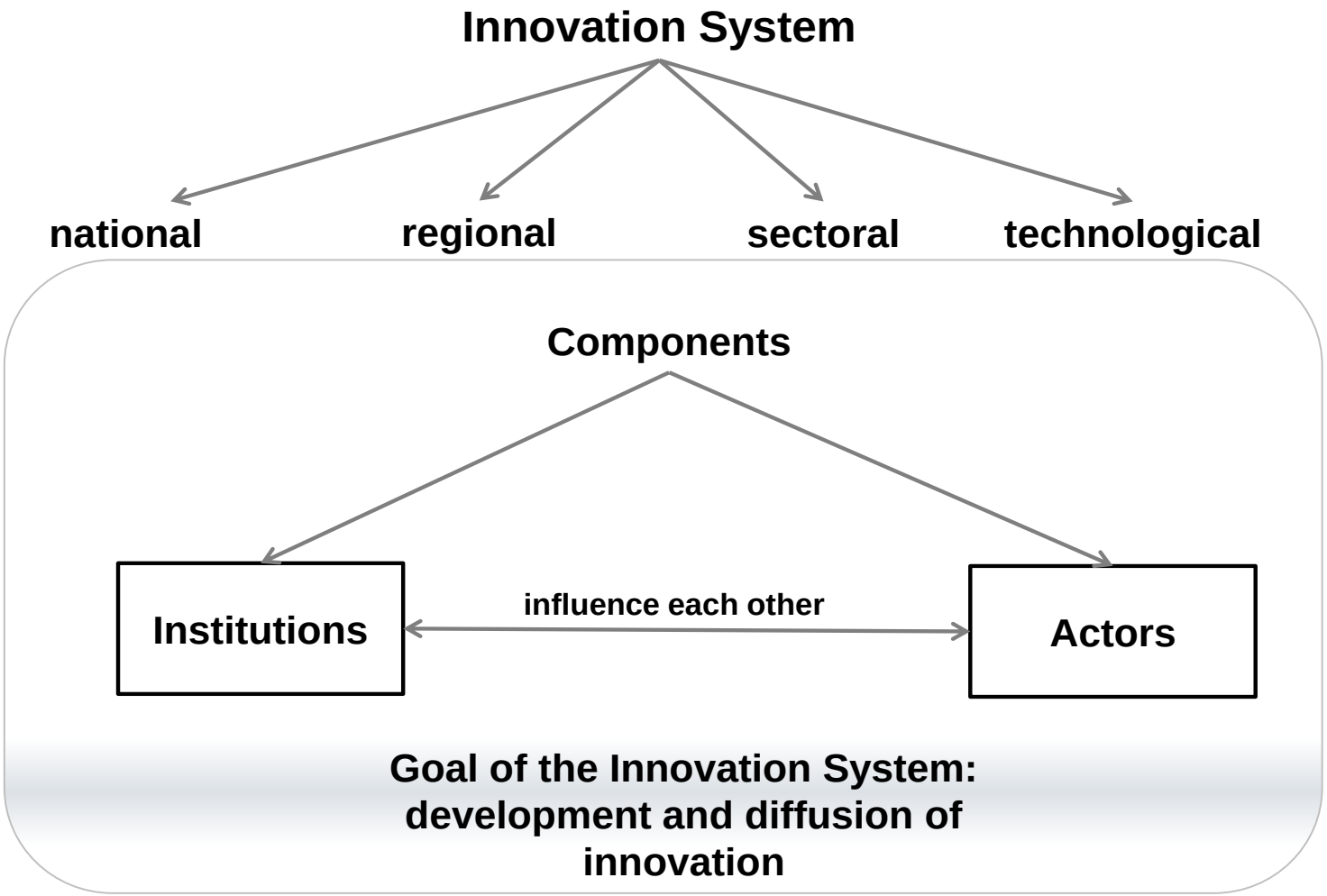


German-American economist who developed the "National System" or the “National System of Innovation”.



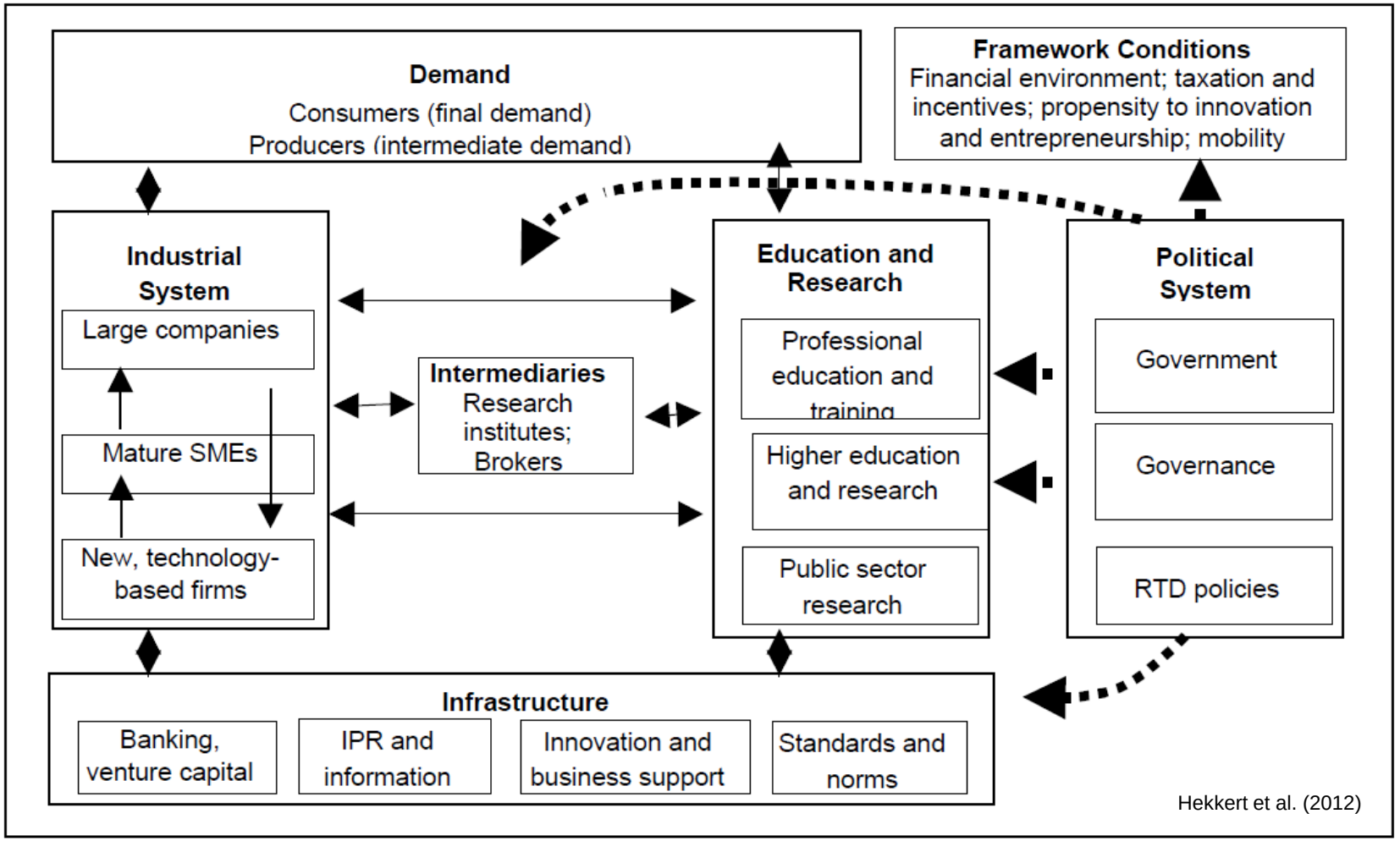
- **Christopher Freeman**
  (1921-2010 Neo-Schumpeterian economist)

Innovation System Types



TECHNISCHE UNIVERSITÄT CHEMNITZ

Structure of a Technological Innovation System (TIS)



Hekkert et al. (2012)

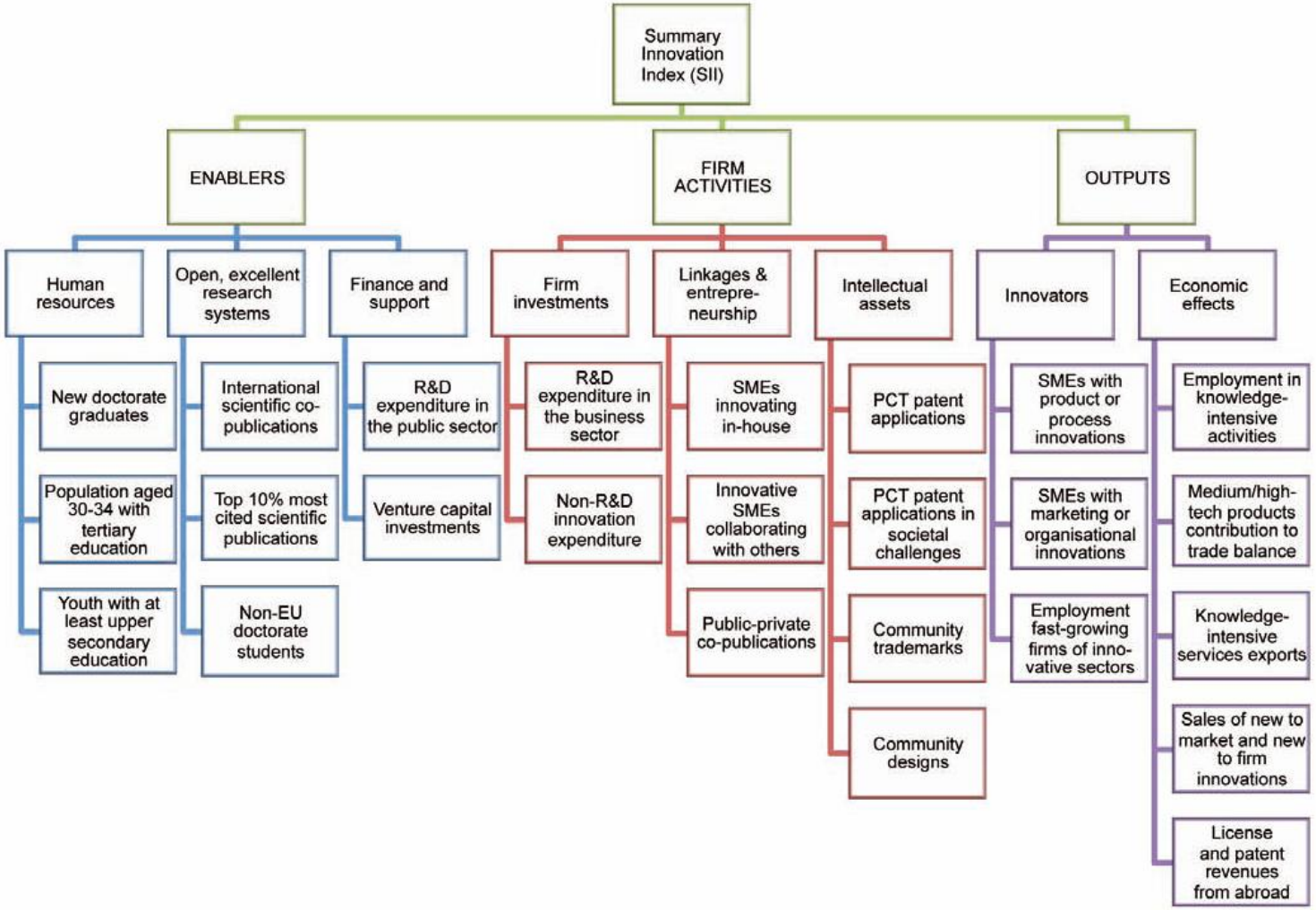
TECHNISCHE UNIVERSITÄT CHEMNITZ

Functions of TIS
(Hekkert et al. 2007)

- Key activities in innovation systems, and to describe and explain shifts in technology specific IS:
- Function 1: Entrepreneurial activities
- Function 2: Knowledge development
- Function 3: Knowledge diffusion through networks
- Function 4: Guidance of the search (Option selection)
- Function 5: Market formation
- Function 6: Resources mobilization
- Function 7: Creation of legitimacy/counteract resistance to change

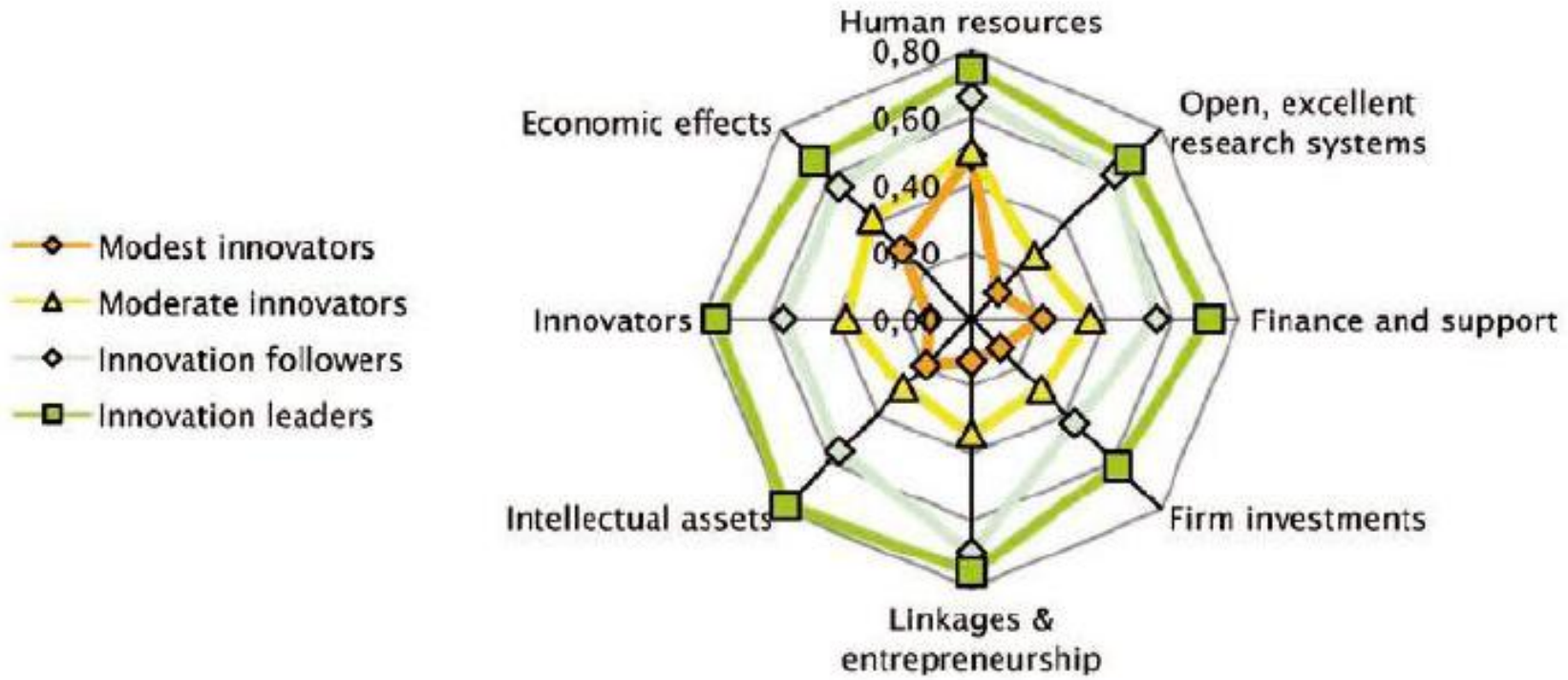
TECHNISCHE UNIVERSITÄT CHEMNITZ

Measurement Framework of the Innovation Union Scoreboard 2014



TECHNISCHE UNIVERSITÄT CHEMNITZ

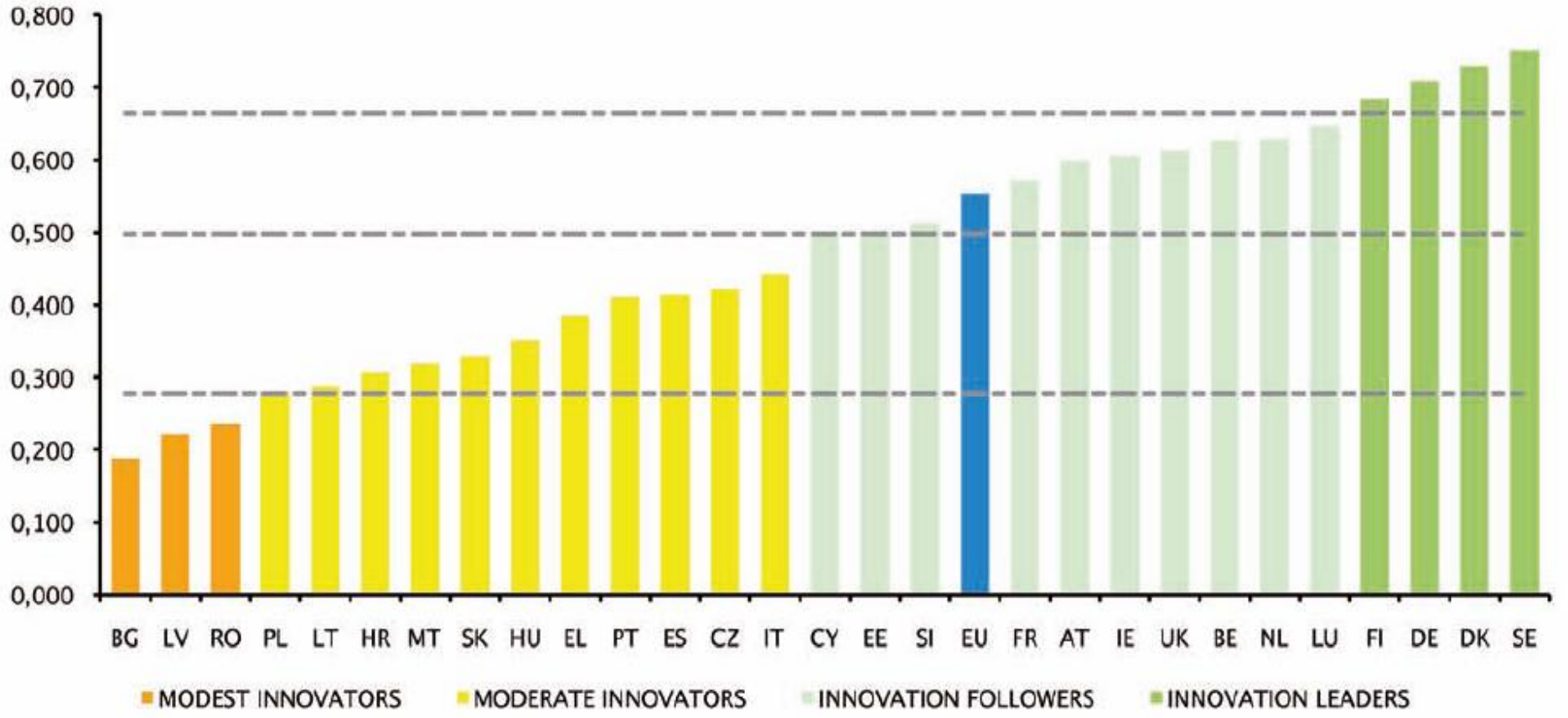
Country Groups Innovation Performance per Dimension



Quelle: EU (2014): Innovation Union Scoreboard 2014.

TECHNISCHE UNIVERSITÄT CHEMNITZ

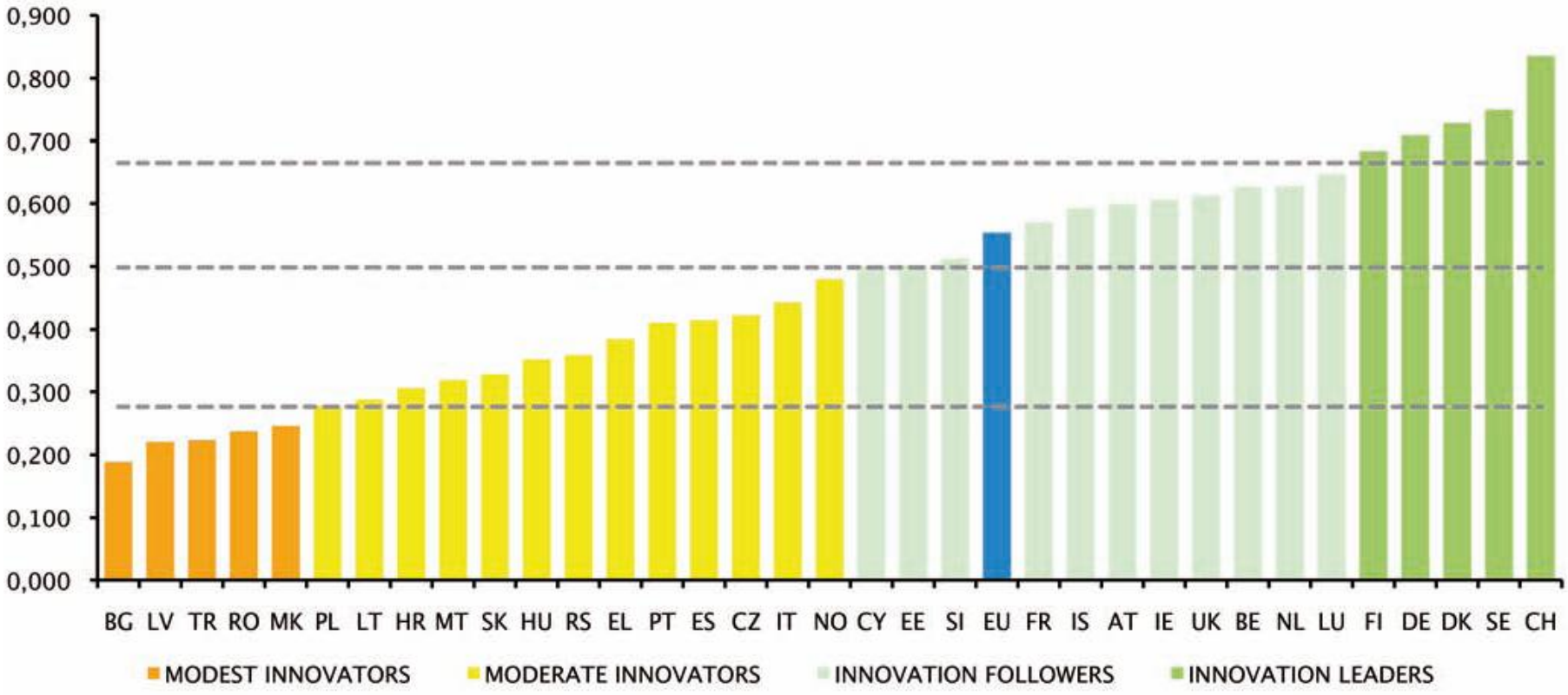
EU Member States' Innovation Performance



Innovation Union Scoreboard 2014

TECHNISCHE UNIVERSITÄT CHEMNITZ

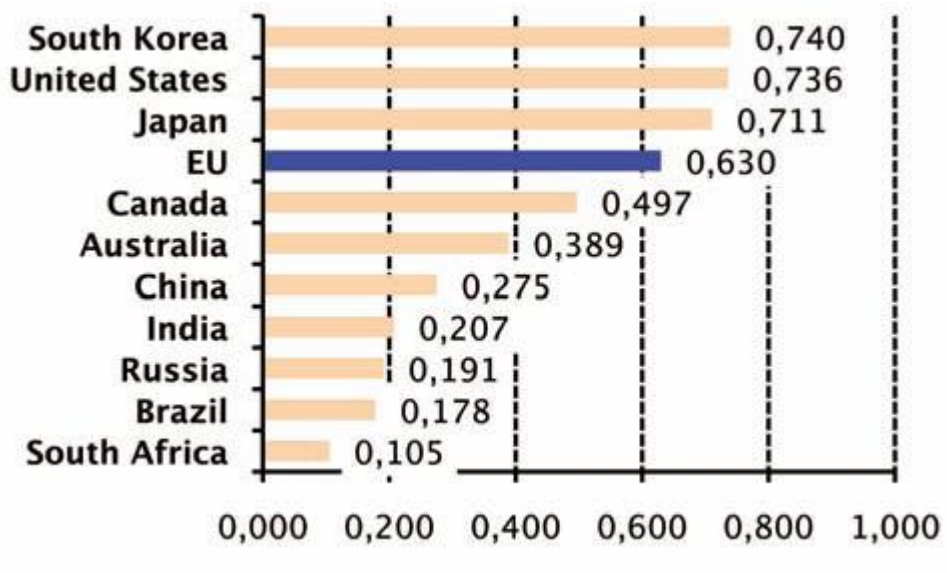
Innovation Performance in Europe

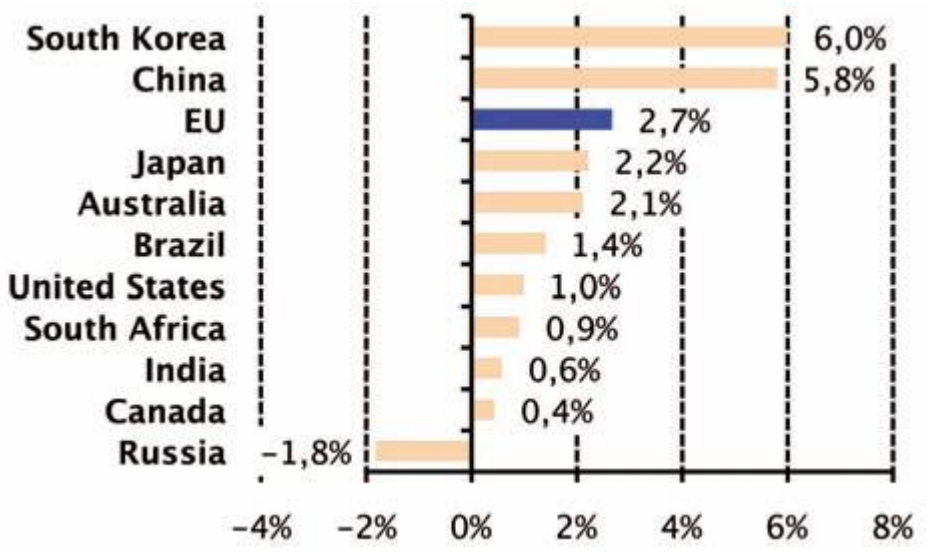


Innovation Union Scoreboard 2014

TECHNISCHE UNIVERSITÄT CHEMNITZ

Global Innovation Performance & Groth Rates





Innovation Union Scoreboard 2014

Why Should Managers Care?

Industry & Firm Level Evidence: R&D Investments and Performance (I)

- Series of studies conducted by the National Bureau of Economic Research in the USA at Harvard University (1998 by Zvi Griliches)
- Industries: Chemicals, Metals, Electric Equipment, Autos, Aircraft
- Results
  - 1957 to 1963: rate of return to R&D of 27%
  - 1966 to 1977
    - R&D increases productivity
    - Private R&D more effective than government R&D
    - Basic research more effective than applied
  - Similar results for Japanese companies
  - Patent data from 1950 to 1985
    - R&D leads to more patents

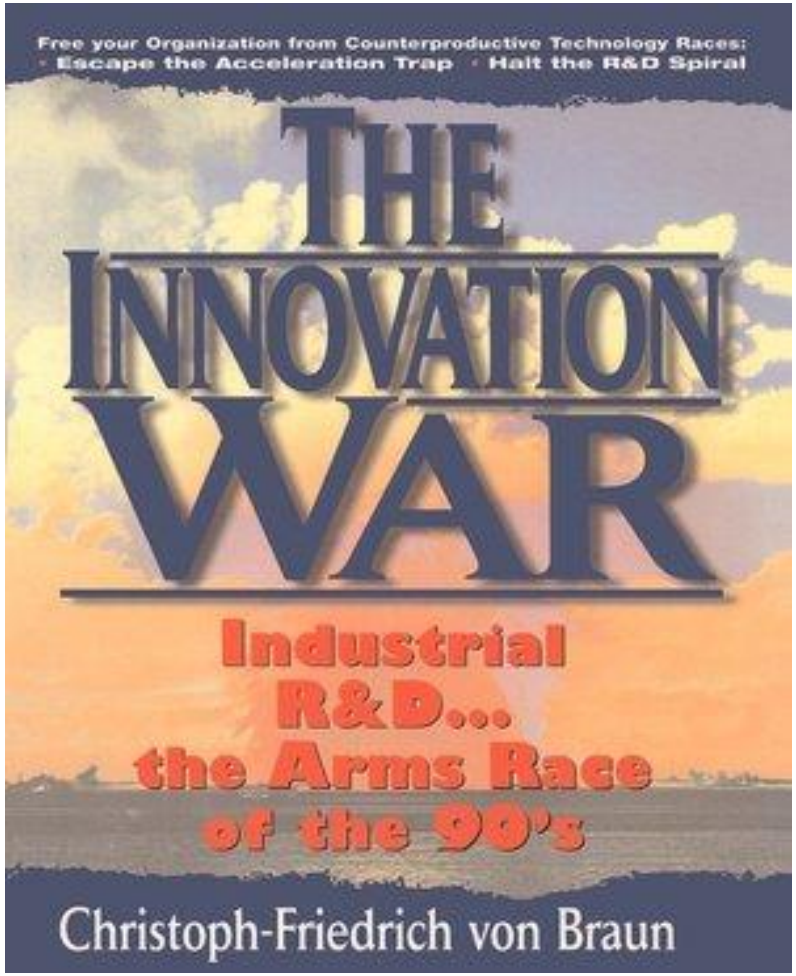
Industry & Firm Level Evidence: R&D Investments and Performance (II)

Overall result of 30 Years Research:

Higher investments in R&D lead to higher performance in innovation output (e.g. patents, new products) and to higher economic success

TECHNISCHE UNIVERSITÄT CHEMNITZ

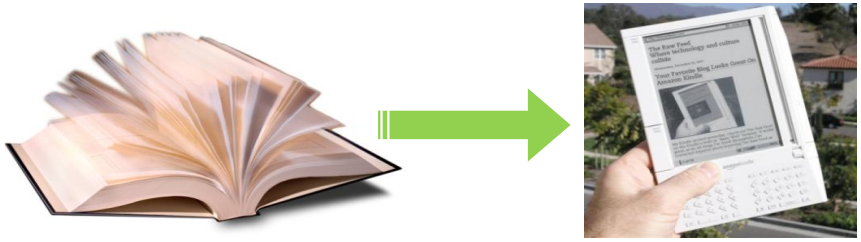
Competition by Innovation „The Innovation War“



Technology and Firm Change







TECHNISCHE UNIVERSITÄT CHEMNITZ

Results of the Digitalisation in the German Photofinishing Industry

Kodak	→	Photofinishing closed
Agfa Photo	→	Bankruptcy
Konica Minolta	→	Photo activities given up
Spector	→	Financial losses
V-Dia	→	Bankruptcy
Südcolor	→	Bankruptcy
Shutterfly	→	Financial losses
Photoways	→	No Profits known

Schumpeter´s „Creative Destruction“

- „in capitalist reality as distinguished from its textbook picture, it is not (perfect) competition which counts, but the competition from
- the new commodity,
- the new technology,
- the new source of supply,
- the new type of organization…
- competition which commands a decisive cost or quality advantage and which strikes not at the margins of profits and the outputs of existing firms but at their very lives….”



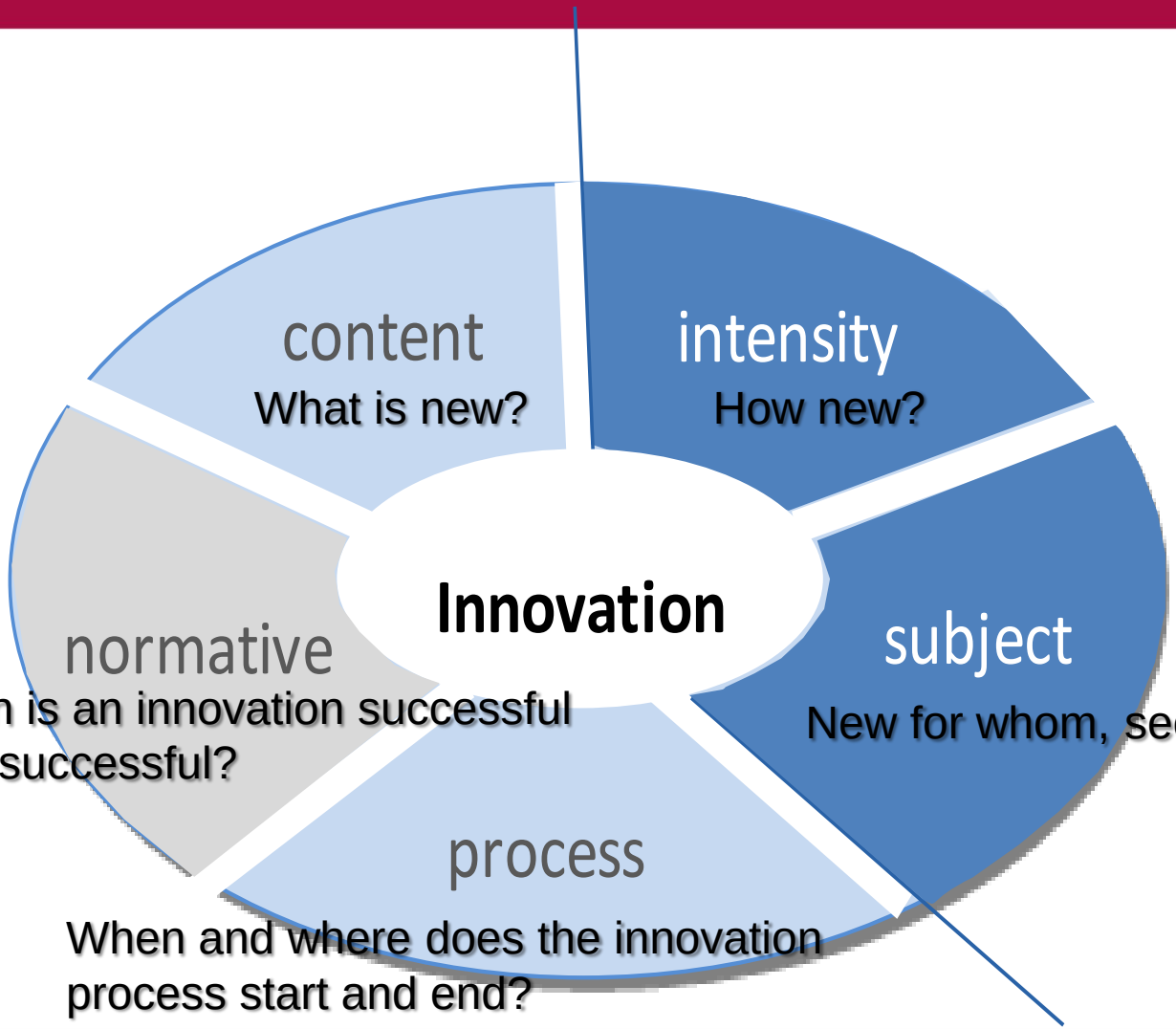
Joseph Schumpeter (1883-1950)

TECHNISCHE UNIVERSITÄT CHEMNITZ

Basic Concepts: Technology & Innovation

- **Technology** is the knowledge, embodied in products and processes, and also the knowledge to create, to produce, and to replicate these products and processes.
- **Innovation** is generally understood as the *successful introduction* of a new thing or method. It is the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services (Luecke / Katz)
- Innovation = Invention + Commercialization/Application + Diffusion

Concept and Dimensions of Innovation and Innovativeness



Types of Innovation

- Technological Innovation
  → Products, Processes
- Service Innovation
- Organizational Innovation
  → Structures, Routines, Systems
- Market/Strategic Innovation
  → Business models, rules of the game,…
- Social Innovation
  → Politics, life styles,…
- System Innovation
  → Inter-organizational Systems, Standards/Networks

Modes of Innovation

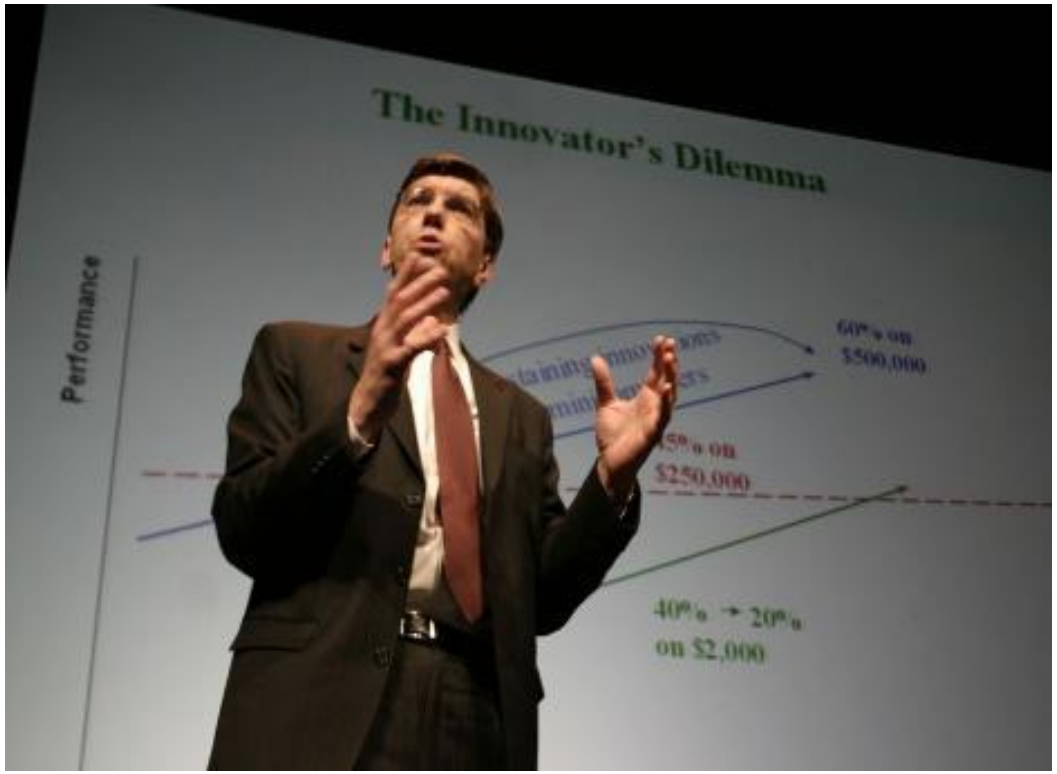
Generation	Designation
First Generation (1950s-1960s)	Technology Push
Second Generation (1960s-1970s)	Market Pull (Demand Pull)
Third Generation (1970s)	Interactive (Coupling)
Fourth Generation (1980s)	Integrated Business Processes
Fifth Generation (1990s)	Systems Integration and Networking (Fully Integrated)
Sixth Generation? (2000s)	Open Innovation?

Rothwell, 1992. Joe Tidd, John Bessant and Keith Pavitt, 2005
J. Niosi. Fourth Generation R&D: *From Linear Models to Flexible Innovation*. Journal of Business Research 45 (1999) 111.

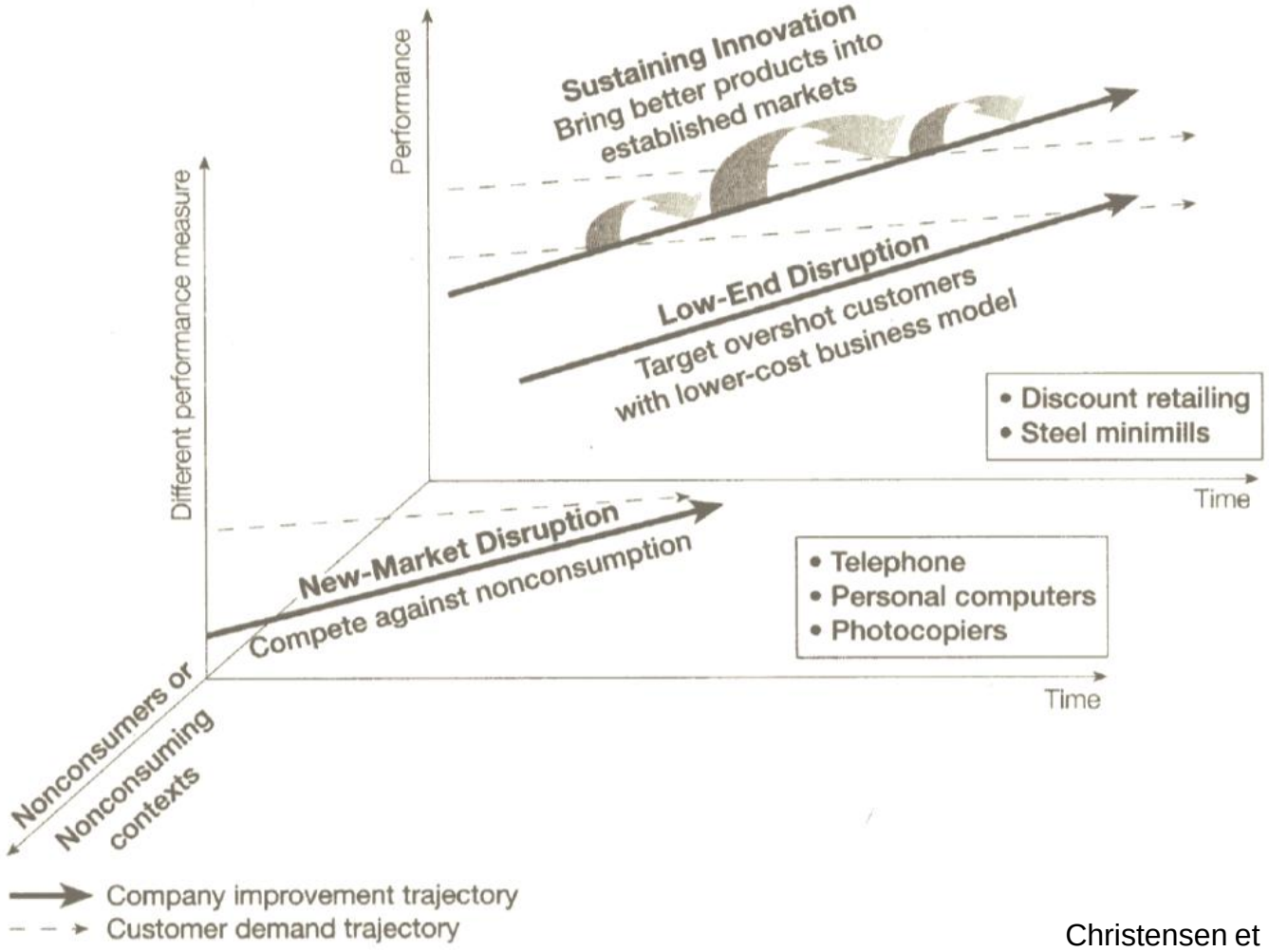
How to Enter Existing and New & Emerging Markets with Innovations?

The Innovator´s Dilemma:
When New Technologies Cause Great Firms to Fail

- Clayton M. Christensen
- Harvard Business School - 1997

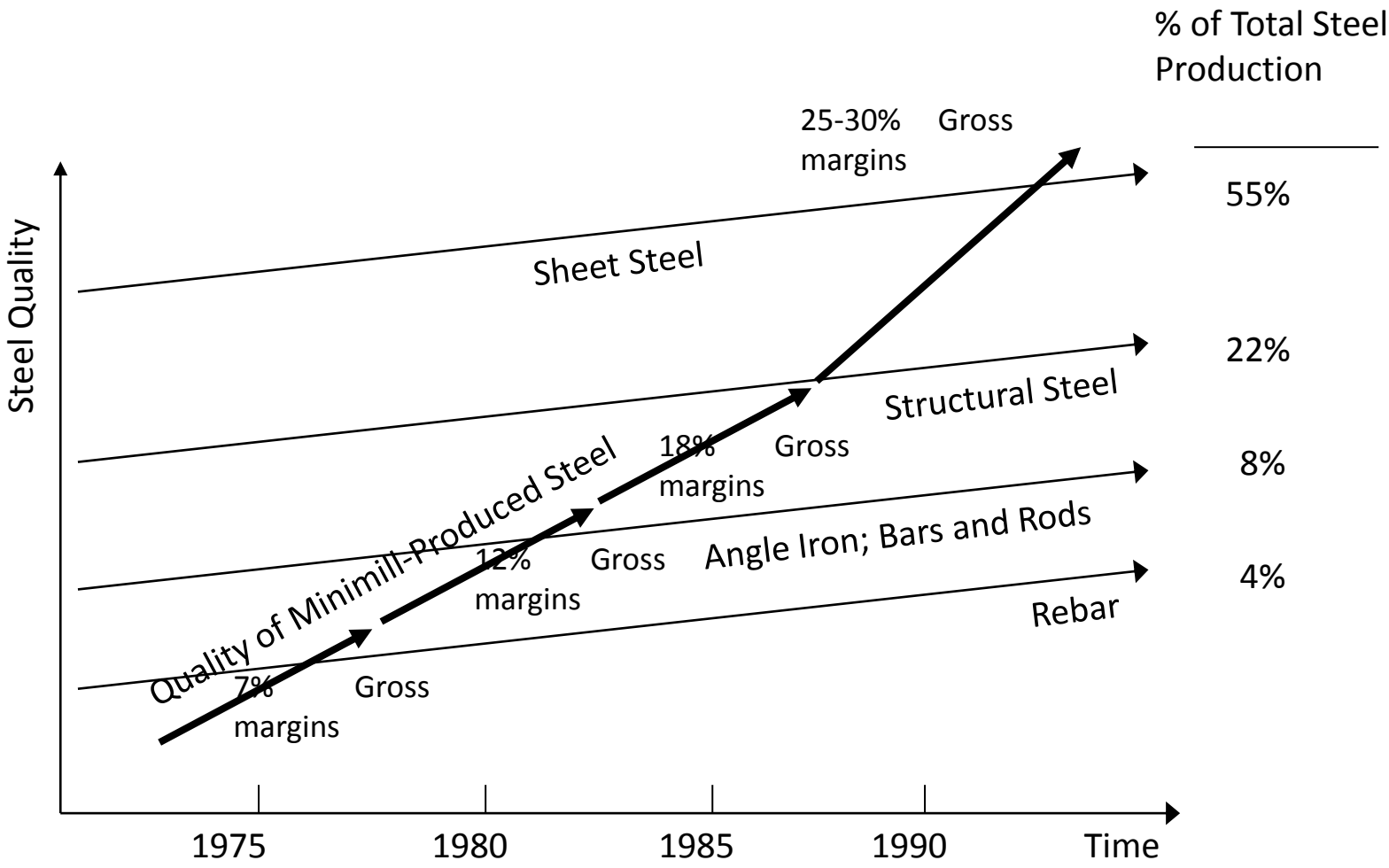


The Disruptive Innovation Theory



Christensen et al. (2004)

Low End Disruption Example: The Up-Market Migration of Steel Minimills



Source: American Iron and Steel Institute; interviews with company executives. Note that the tonnage percentages do not sum to 100% because there are other specialty categories of steel.

TECHNISCHE UNIVERSITÄT CHEMNITZ

Identifying Asymmetries of Motivation and Skills

What to Look For	Definition	Signals
Asymmetric motivation	Firm does something that another firm does not want to do (provides shield protecting from response)	• Size of market relative to firm size • Target customers • Business model in market relative to existing business models
Asymmetric skills	Firm does something another firm is incapable of doing (provides sword to use during attack)	• Mismatch between processes required for success and established processes

TECHNISCHE UNIVERSITÄT CHEMNITZ

Three Approaches to Creating New-Growth Businesses (I)

Dimension	Sustaining Innovations	Low-End Disruptions	New-Market Disruptions
Targeted performance of the product or service	Performance improvement *in attributes most valued by the industry's most demanding customers*. These improvements may be incremental or breakthrough in character.	Performance that is good enough along the traditional metrics of performance at the low end of the mainstream market.	Lower performance in "traditional" attributes, but *improved performance in new attributes – typically simplicity and convenience.*

TECHNISCHE UNIVERSITÄT CHEMNITZ

Three Approaches to Creating New-Growth Businesses (II)

Dimension	Sustaining Innovations	Low-End Disruptions	New-Market Disruptions
Targeted customers or market application	The *most attractive (i.e., profitable) customers* in the mainstream markets who are willing to pay for improved performance.	*Overserved customers* in the low end of the mainstream market.	Targets *non-consumption:* customers who historically lacked the money or skill to buy and use the product.

TECHNISCHE UNIVERSITÄT CHEMNITZ

Three Approaches to Creating New-Growth Businesses (III)

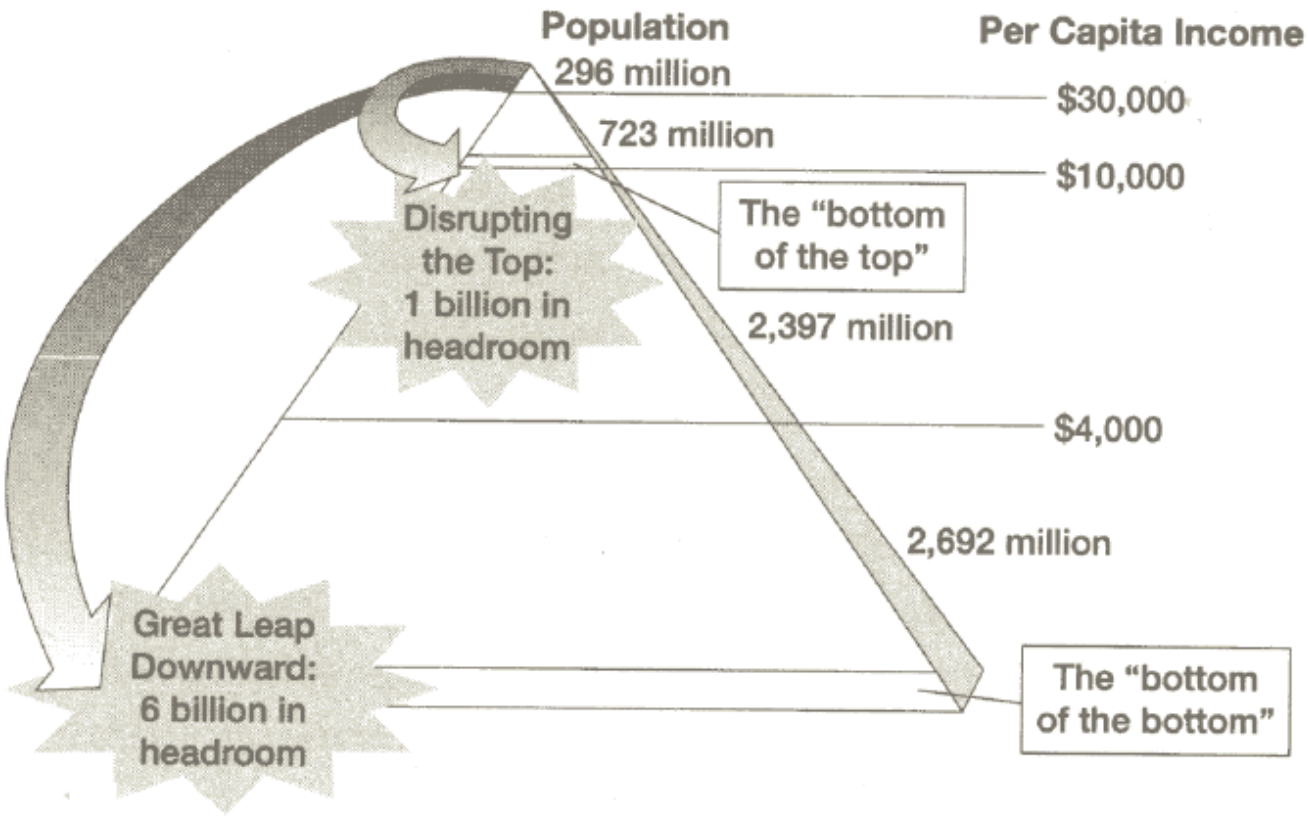
Dimension	Sustaining Innovations	Low-End Disruptions	New-Market Disruptions
Impact on the required business model (processes and cost structure)	Improves or maintains profit margins by exploiting the *existing processes and cost structure* and making better use of current competitive advantages.	Utilizes a *new operating or financial approach or both* – a different combination of lower gross profit margins and higher asset utilization that can earn attractive returns at the discount prices required to win business at the low end of the market.	Business model must make money at lower price per unit sold, and at unit production volumes that initially will be small. Gross margin dollars per unit sold will be significantly lower.

Which Innovation Strategies Might be most Promising for Emerging Countries and New Firms?

Disruption Opportunities at the Bottom of the Pyramid & Emerging Markets

What does Low End mean?

Future Growth Opportunities are at the Bottom of the Pyramid (BOP)



Source: Author analysis, World Bank; per capita income based on purchasing power parities.

Christensen et al. (2004)

Low End Car from India: Tata Nano (1700-2160 Euro)

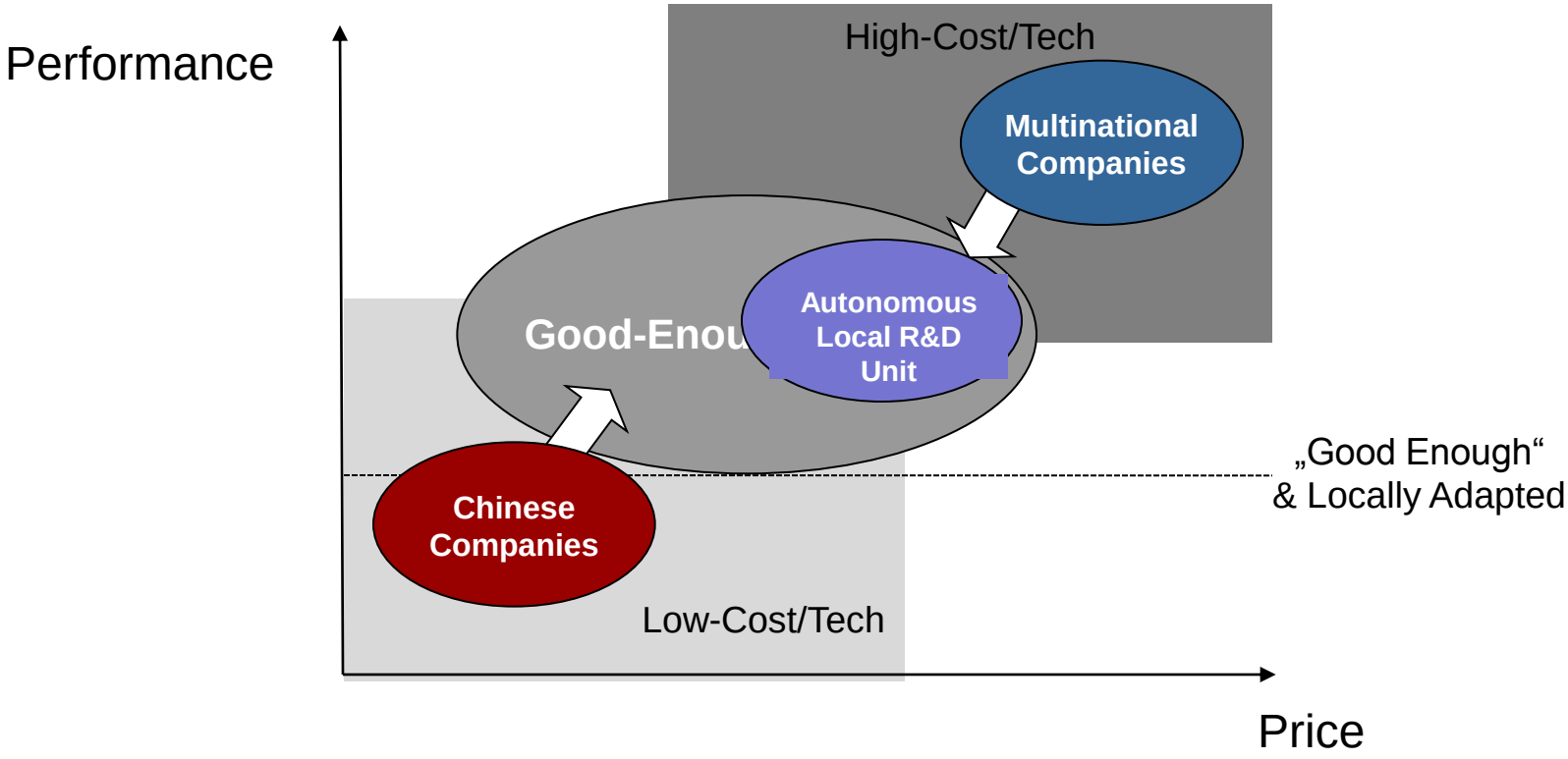


TECHNISCHE UNIVERSITÄT CHEMNITZ

MNC Challenges in the Case of Emerging Markets ?

- MNC struggle to succeed, because they tend to **miss market requirements** and customer needs by offering **over-engineered products**
- MNC suffer of **higher costs** due to **highly featured products and global overheads** and **weak local distribution and service networks**
- MNC increasingly face **competition from local competitors**
  - E.g. in the Chinese market as well as their home-markets
  - e.g. Huawei in telecommunications, Haier in household appliances
- Selling **home-developed products with minor adjustments** does not lead to significant and long-term value creation
- **MNCs must often "unlearn"** much of what has made them successful in developed markets to successfully develop far less expensive products that meet the needs of consumers in Emerging Markets

Example: The Good-Enough Market is Served by Chinese as well as MNCs



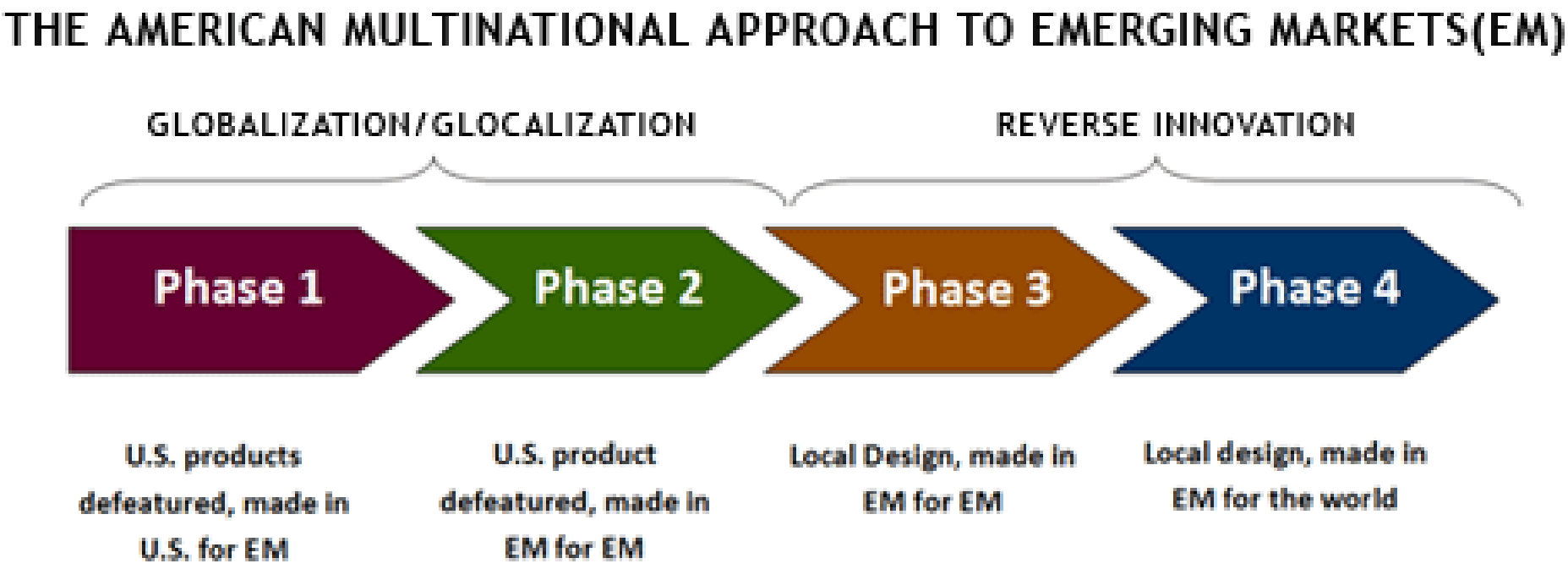
Example: Siemens Medical Solution

Med Somatom Spirit



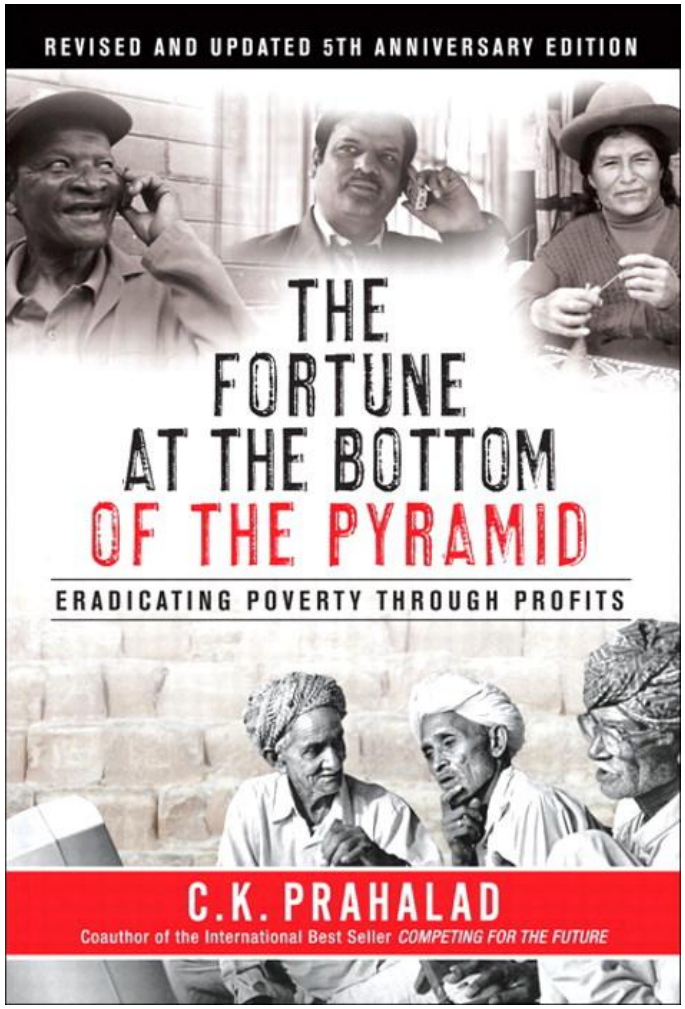

REVERSE
Vijay Govindarajan
Chris Trimble
INNOVATION
CREATE FAR FROM HOME, WIN EVERYWHERE
Foreword by
Indra K. Nooyi
CHAIRMAN AND CEO, PEPSICO INC.
HARVARD BUSINESS REVIEW PRESS
REVERSE

Path to Reverse Innovation



- Example RI: GE is now selling an ultra-portable electrocardiograph machine in the U.S. at an 80% markdown for similar products. The machine was originally built by GE Healthcare for doctors in India and China.

BOP-Innovation
A Market-based Approach to Fight Poverty





TECHNISCHE UNIVERSITÄT CHEMNITZ

The „High-Cost Economy“ of the Poor

- Mumbai: Dharavi – Slum vs. Warden Road – UpperClass Area

Cost	Dharavi	Warden Road	Poverty premium
credit (annual interest)	600%–1,000%	12%–18%	53X
municipal-grade water (per cubic meter)	$1.12	$0.03	37X
phone call (per minute)	$0.04–$0.05	$0.025	1.8X
diarrhea medication	$20	$2	10X
rice (per kilogram)	$0.28	$0.24	1.2X

Prahalad and Hammond (2002)

TECHNISCHE UNIVERSITÄT CHEMNITZ

BOP Innovation Examples & Mechanisms

- Microcredits (40-70% p.a.), e.g. Grameen Bank (Bangladesh) vs. loan sharks (up to 2000% p.a.)
  - + crowd-funding: KivaZip.org facilitates loans at 0% directly to entrepreneurs via mobile payments and PayPal
- Grameen Telecom‘s Village phone vs. expensive individual phone

→Business model innovation

→lowering operating & investment costs

→Pooling of demand

→Use of (mobile) technologies to bridge infrastructure problems

TECHNISCHE UNIVERSITÄT CHEMNITZ

4As for BOP Innovation (Prahalad 2012)

1. **Awareness**: Creating an awareness of the product and service such that the BOP consumers and producers know what is available and on offer, and how to use it
2. **Access:** Enabling access such that even consumers in remote locations are able to get access to the products/service
3. **Affordable**: Ensuring that the product or service is *affordable* and *world-class quality* (not luxury) at prices that are 1/50 or better
4. **Availability**: To build trust and a loyal base at the BOP, we have to ensure an uninterrupted supply of products and services.

TECHNISCHE UNIVERSITÄT CHEMNITZ

MNC Perception vs. Reality of BOP-Markets

View of large firms towards BOP markets	BOP market reality
Have no purchasing power and do not presenta a viable market	BOP consitutes a large market about 4 billion people
Are not brand concious	Are in the developing world where there are 400 cities with population more than 1 milllion of which 30% are poor
Are hard to reach	Willing to pay premium for access to goods and services
Are unable to use and are not interested in advanced technologies	Are highly brand and value concious
	Have sopisticated technology inclination

Areas for Innovation of MNCs

New Strategies for the Bottom of the Pyramid

Price Performance	Views of Quality
• Product development • Manufacturing • Distribution	• New delivery formats • Creation of robust products for harsh conditions (heat, dust, etc.)
Sustainability	**Profitability**
• Reduction in resource intensity • Recyclability • Renewable energy	• Investment intensity • Margins • Volume

TECHNISCHE UNIVERSITÄT CHEMNITZ

References

- Christensen, M. C.; Raynor, M. E. (2003): The Innovator's Solution: Creating and Sustaining Successful Growth, 1. Auflage, Havard Buisness School Press, Boston, Massachusetts
- Immelt, J. R,; Govindarajan, V.; Trimble, C. (2009): How GE Is Disrupting Itself, in: Havard Business Review, Oktober 2009, S. 1-11
- Johnson, M. W. et al. (2008). Reinventing Your Business Model. Harvard Business Review, dec, 1-11
- Kim, C. W., and Mauborgne, R. (2005). Blue Ocean Strategy. How to Create Uncontested Market Space and Make the Competition Irrelevant. Boston, MA: Harvard Business School Press.
- Osterwalder, A.; Pigneur, Y. (2010). Business Model Generation. Hoboken, NJ: John Wiley & Sons.
- Prahalad, C. K. und Hammond, A. (2002). Serving the World's Poor, Profitably, Harvard Business Review 80(9), pp.48–58.
- Prahalad, C.K. (2010): The Fortune at the Bottom of the Pyramid, Wharton School Publishing, New Jersey.
- Schanz, C.; Huesig, S.; Dowling, M. und Gerybadze, A. (2011): Low cost–high tech' innovations for China: why setting up a separate R&D unit is not always the best approach, R&D Management, 41, 3.
- Vijay Govindarajan und Chris Trimble (2012): Reverse Innovation, Harvard Business School Publishing, Boston.