Globelics PhD School 2005

The Dynamics of Scientific Performance in Emerging Economies

Francisco Veloso

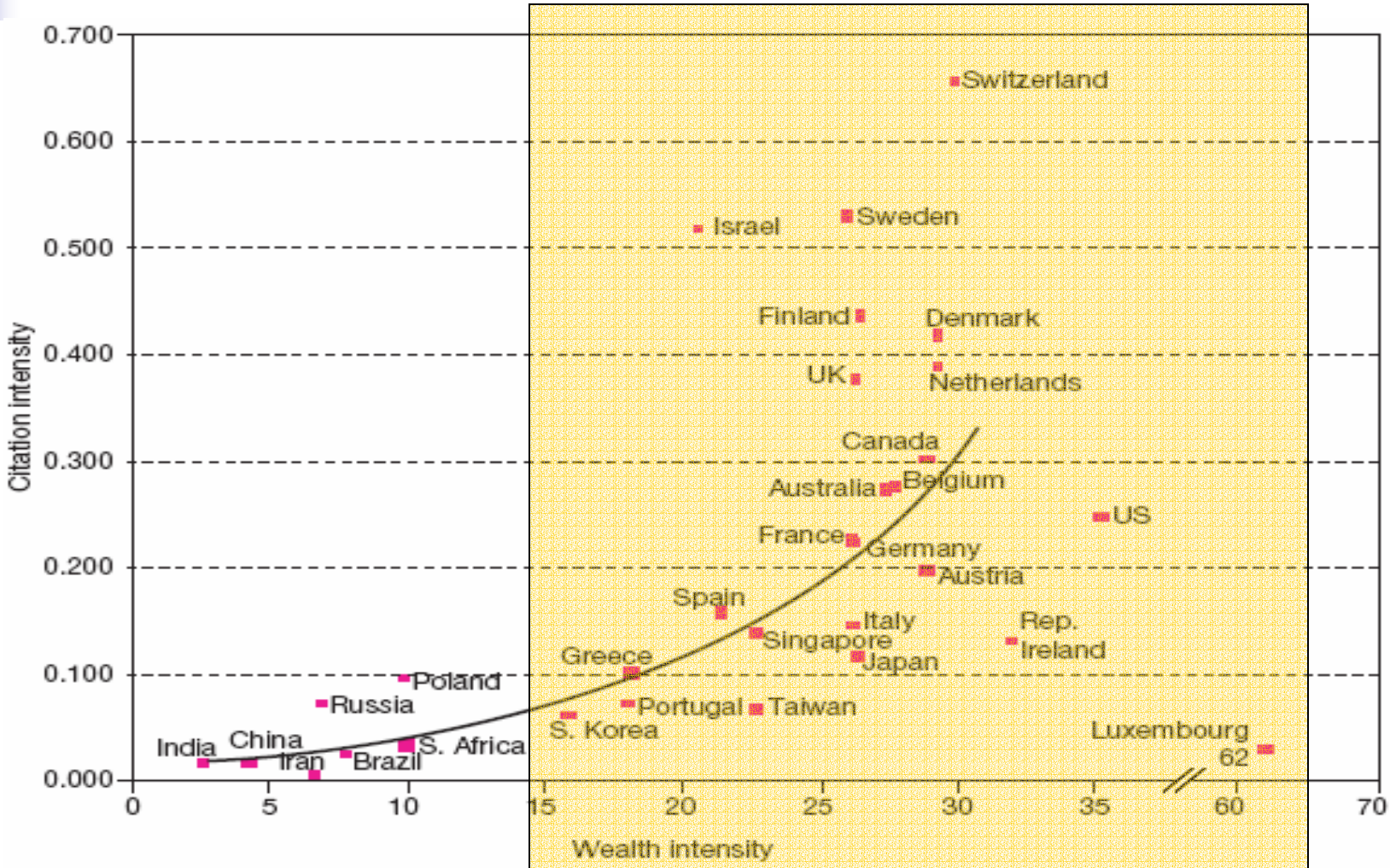
Carnegie Mellon University and Universidade Católica Portuguesa

with

Claudia Gonzalez and Leonardo Reyes

Carnegie Mellon University

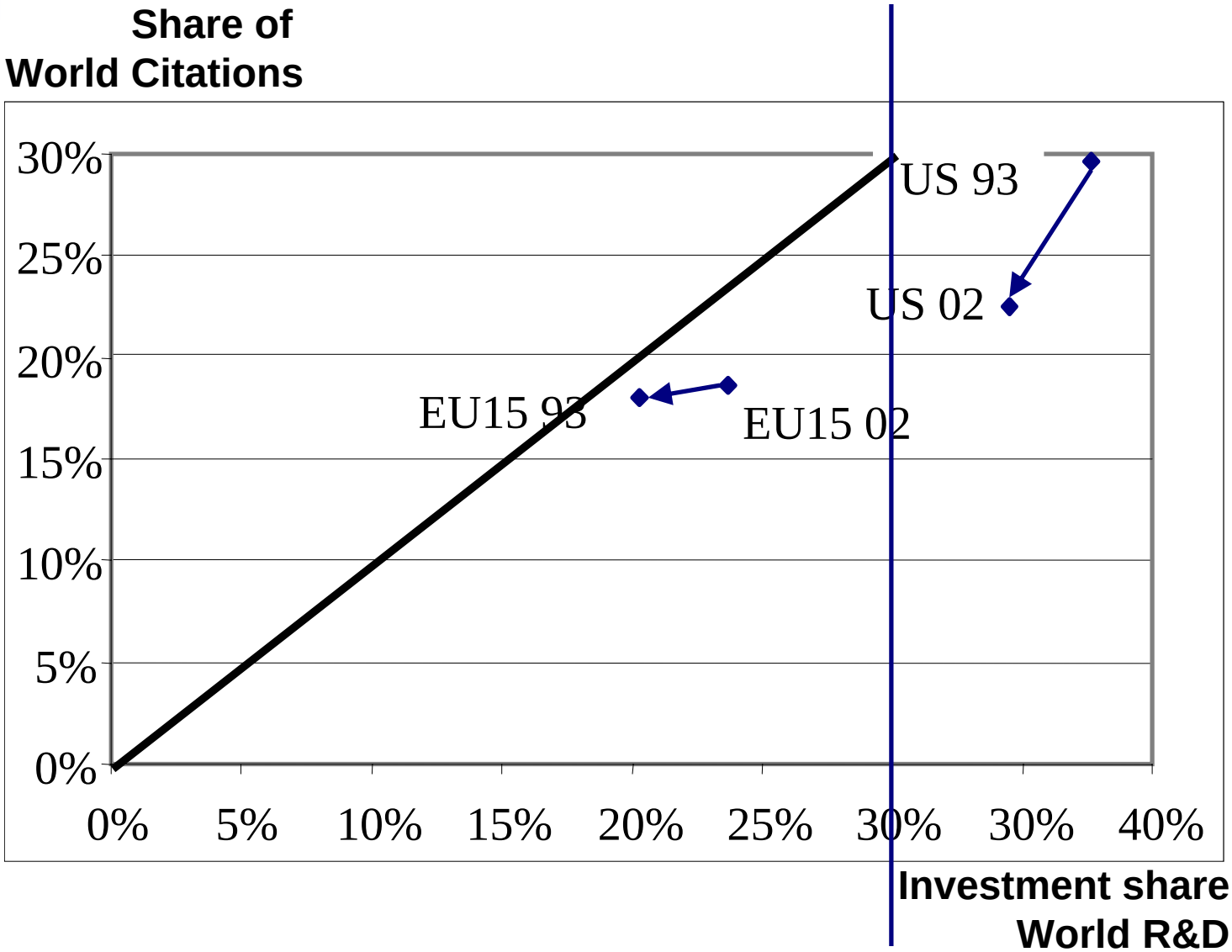
Wealth and Scientific Productivity

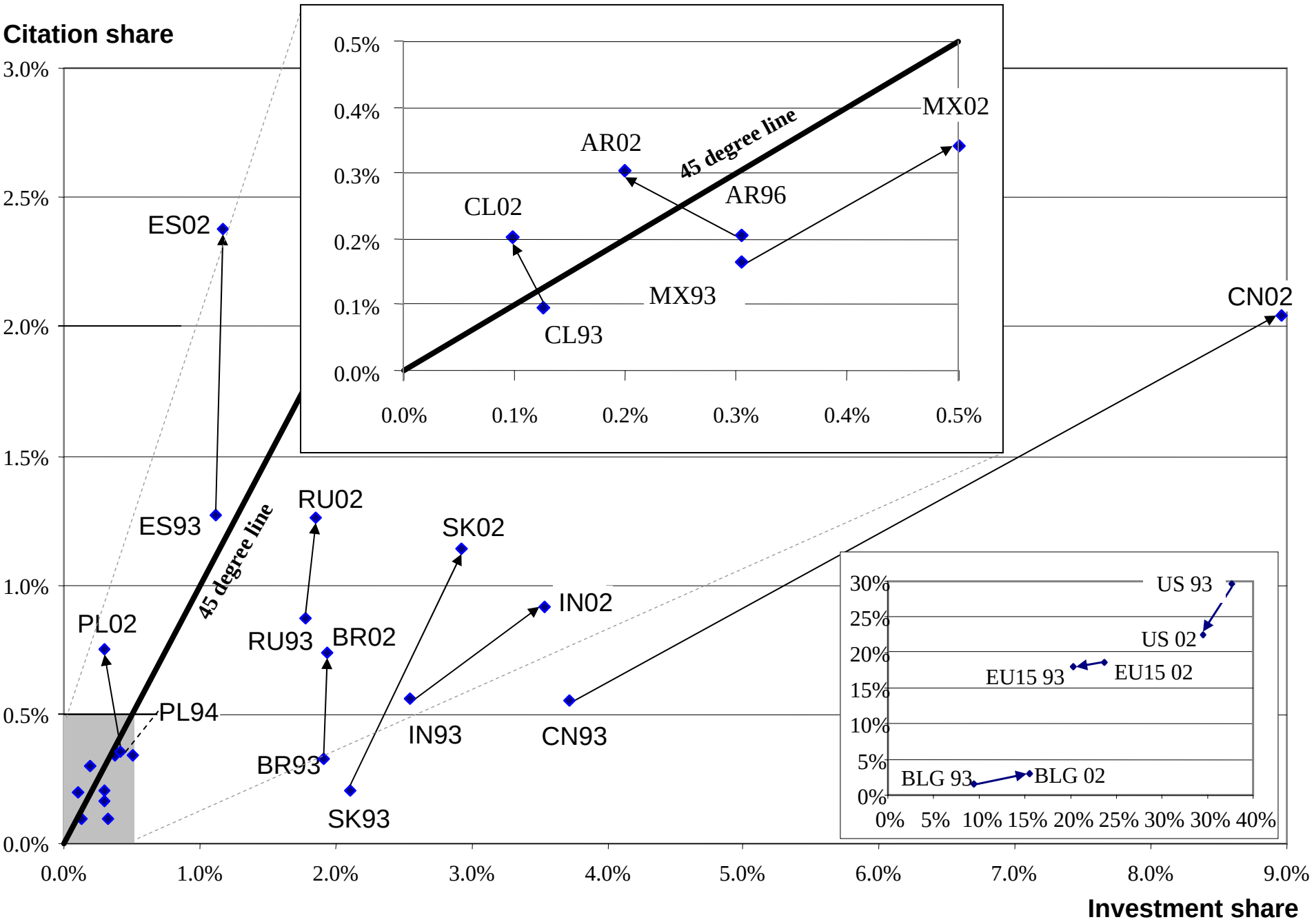


Typical Focus of International Studies

Source: King, 2004

Inputs and Outputs of R&D

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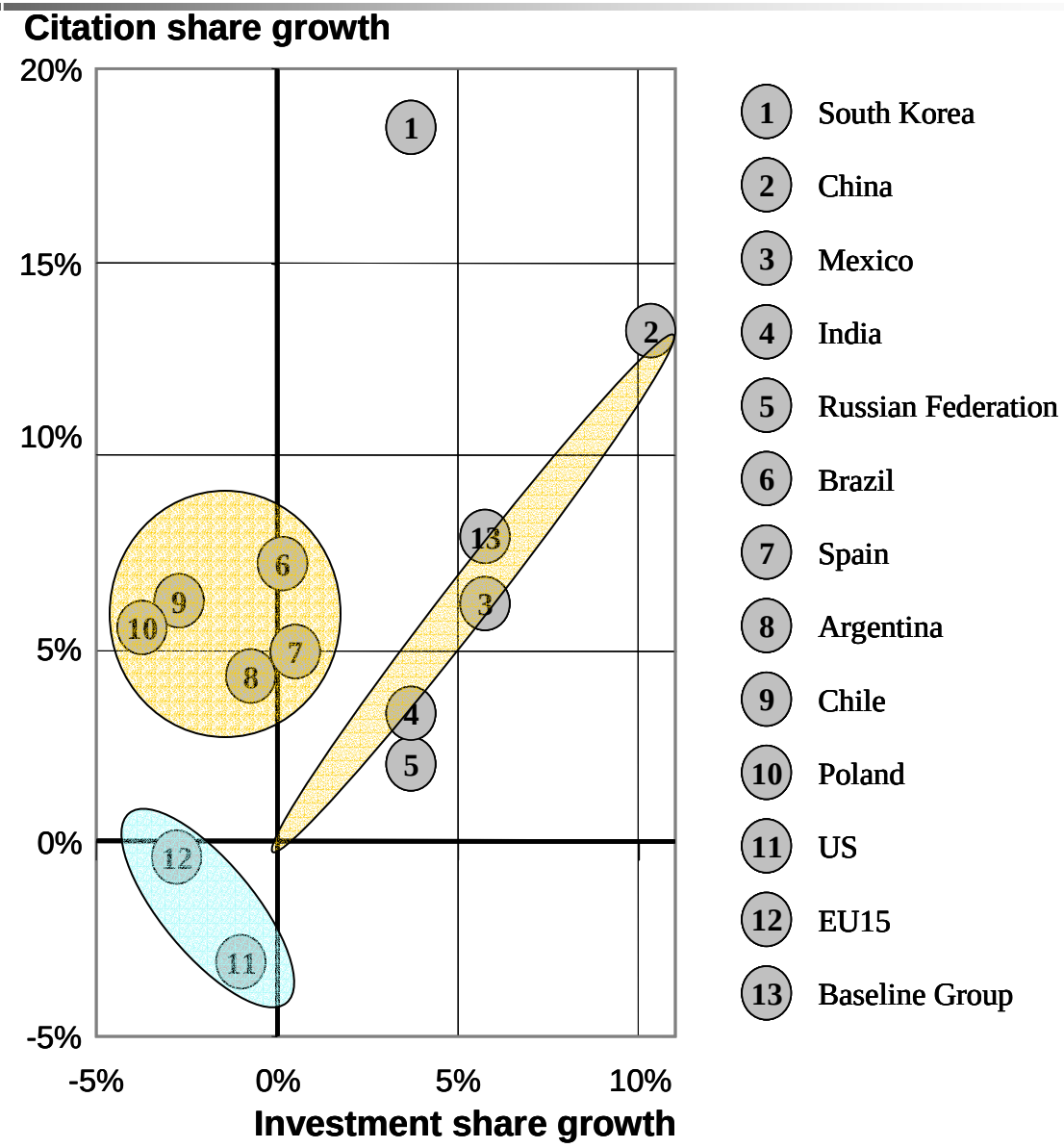
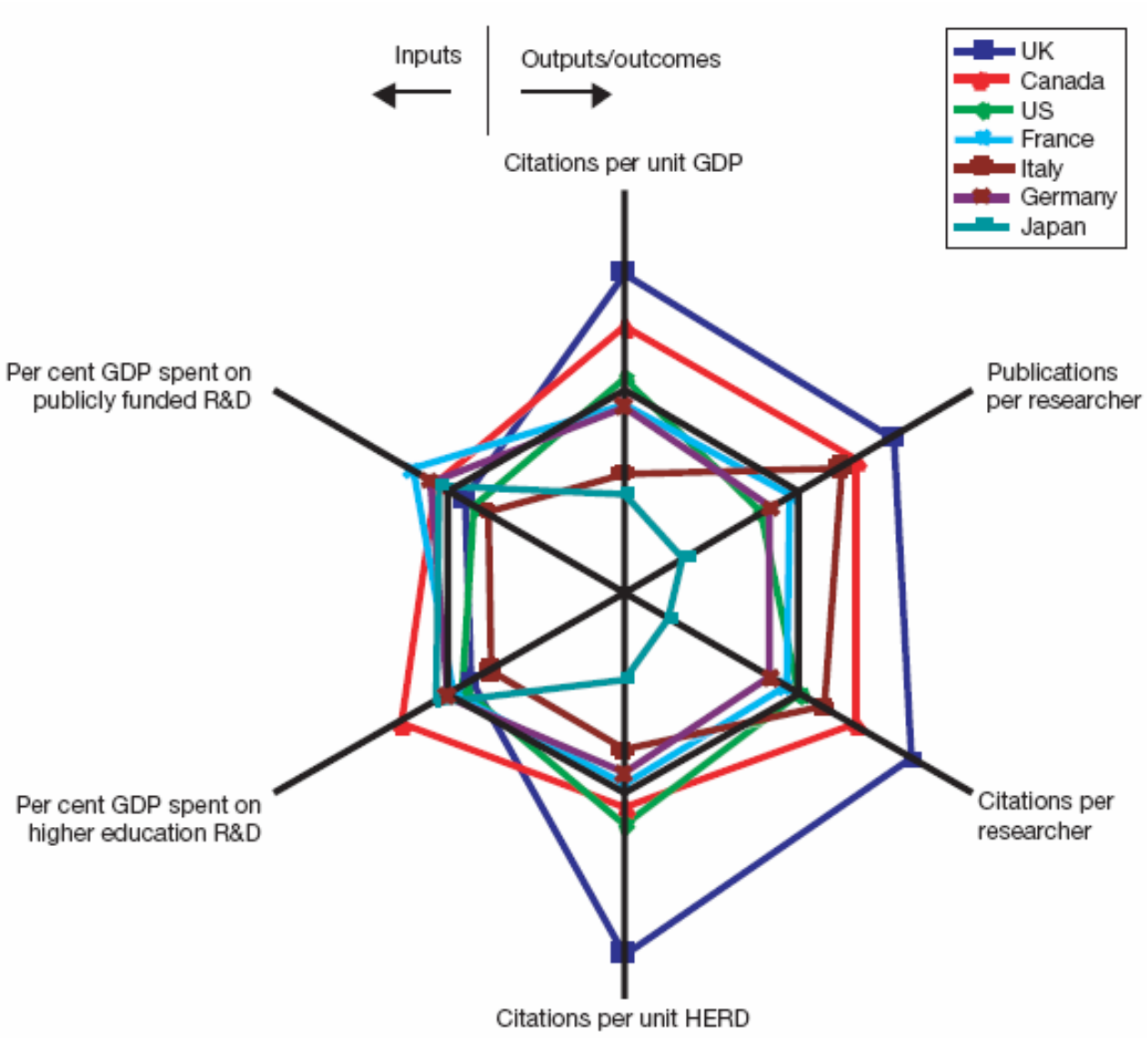
Trends in Inputs and Outputs

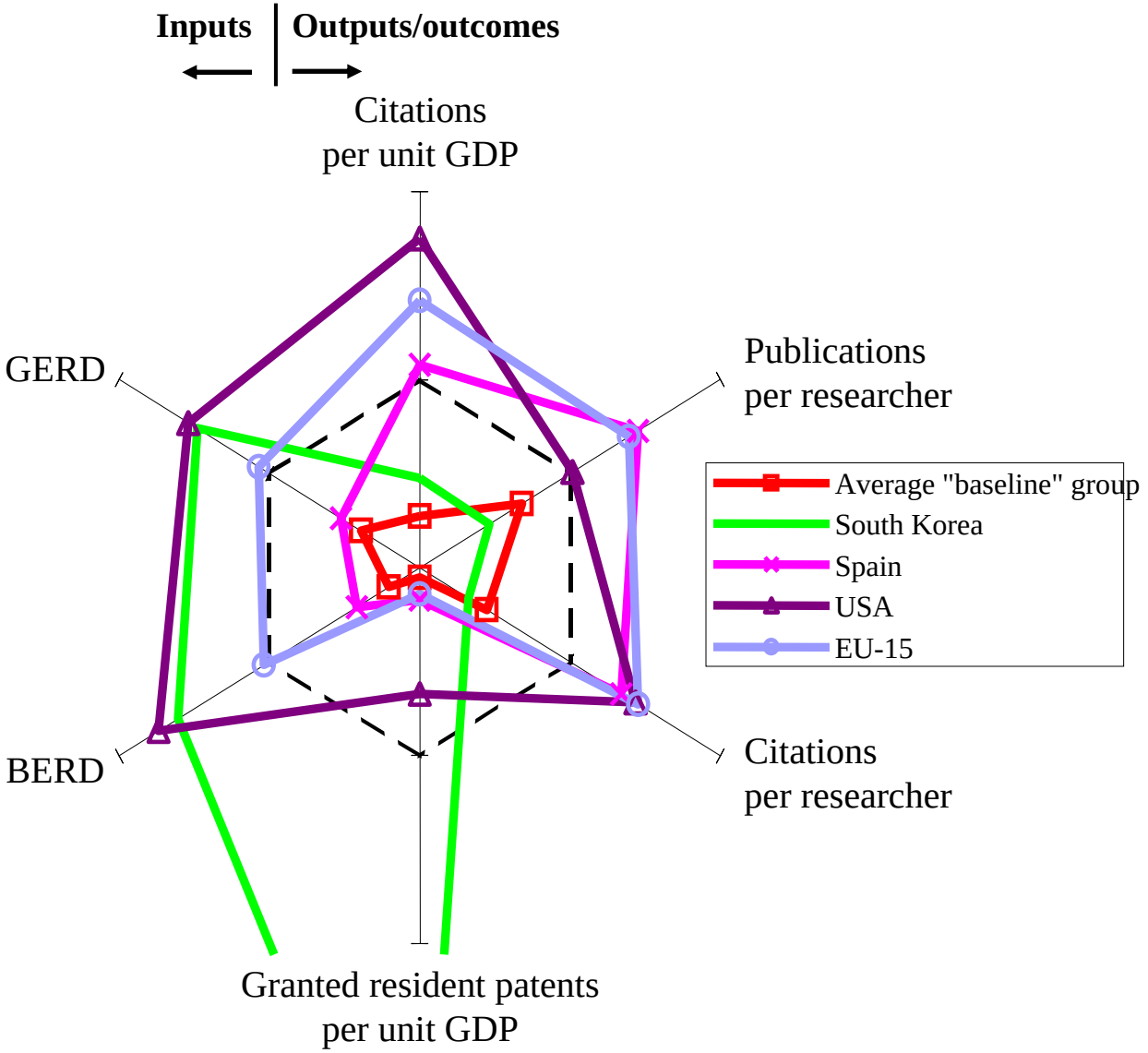


Scientific Productivity in Advanced Nations

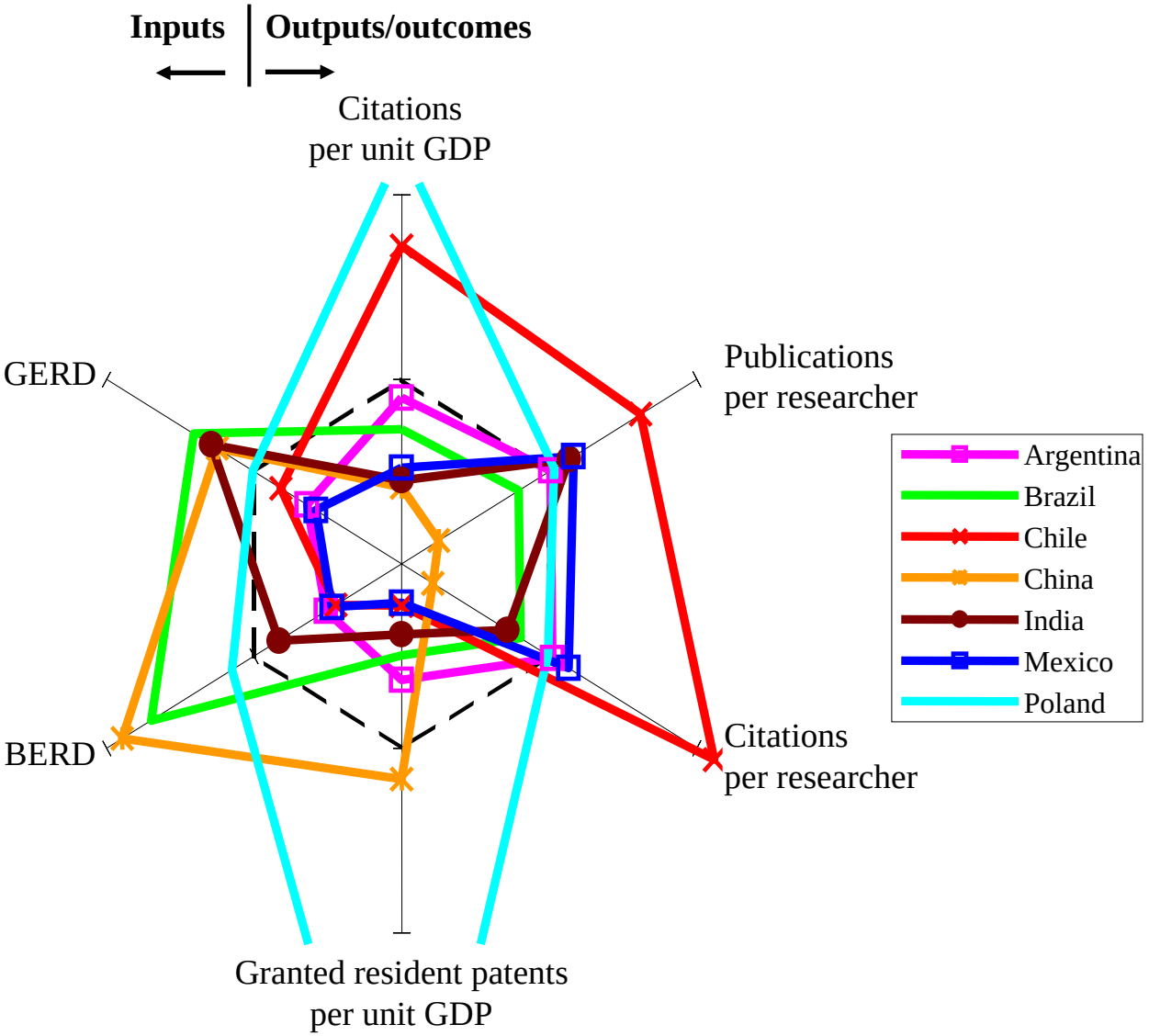


Source: King, 2004

Scientific Productivity
Developing vs. Developed Nations



Scientific Productivity Developing Nations



The Determinants of Research Productivity:
A Study of Mexican Researchers

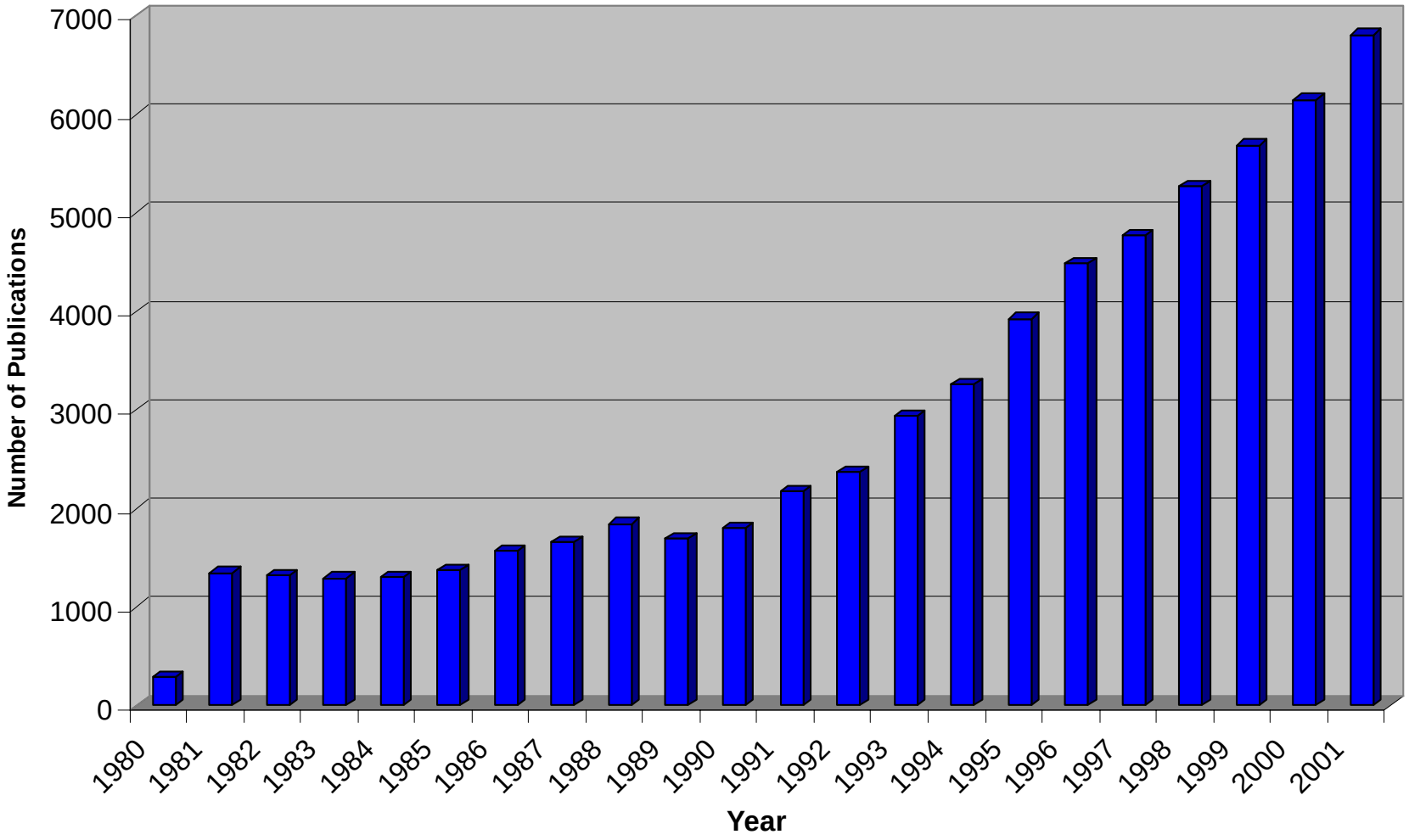
Introduction

- General consensus that S&T investments enhance economic growth, health, education and security.
- However, there is an increased necessity to assess the impact of S&T programs.
- This situation has shaped a culture of evaluation and monitoring in research.
  - Publications and citations are the most common ways to measure the importance of the contributions of a researcher or an organization.
- Not many studies explore the determinants of individual and collective research productivity

Main Findings of Studies Related to the Determinants of Research Productivity

Age	Life cycle with peak between 40 and 50
Gender	Women publish between 26 to 91% less than men
Cumulative advantage	Inequality between productive and unproductive researchers increases with age
Education	Graduates from top schools, with RA experience and employed in research universities are more productive. Graduates from Grande Ecoles are more productive
Cohort effect	No evidence
Countries studied	United States, France and Israel.

Mexican Publication in ISI



SNI Background Information

- The National System of Researchers (SNI)
- Created in 1984 to enhance the quality and productivity of researchers in Mexico.
- Gives pecuniary compensation, as a complement to salary, to the most productive researchers.
- SNI grants represent on average 30% of the income of researchers in the program.
- In 1999, 33% of researchers in Mexico were in SNI.
- Program ranks researchers in 4 levels, with compensation depending on level (Candidate, Level 1, 2 and 3)

Objective

- To explore the determinants of research productivity using a data base of the most productive researchers in Mexico.
  - Age
  - Gender
  - Areas of Knowledge
  - Cohort
  - Country of PhD
  - Level in SNI
  - Critical Mass
  - Budget

Importance

- This is the most comprehensive study of its kind.
  - Number of researchers
  - Recent and long time span
  - Considers all areas of knowledge
  - Includes new variables
  - The first outside the developed world

- Implications for administrators & policy makers
  - Forecast the expected productivity of faculty
  - Design policies to enhance productivity
  - Parameters to compare researchers across different areas of knowledge and across countries

Data Base

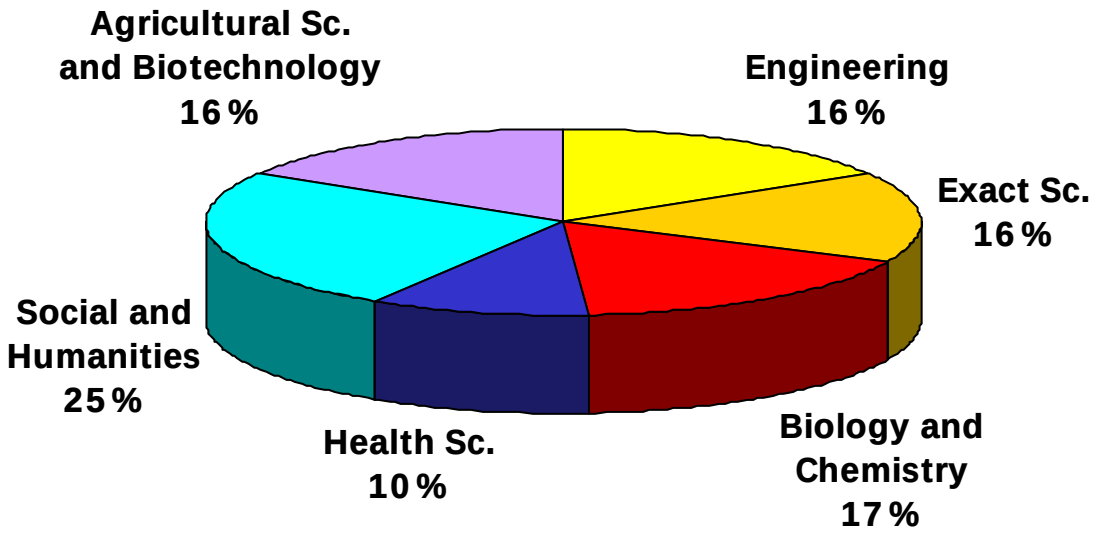
- Information on 14,328 researchers in the SNI from 1991 to 2002.
- The data are classified in two categories:
  1. Characteristics of the researchers:
     - Age
     - Gender
     - Country where PhD was earned
     - Area and discipline

Data Base (cont.)

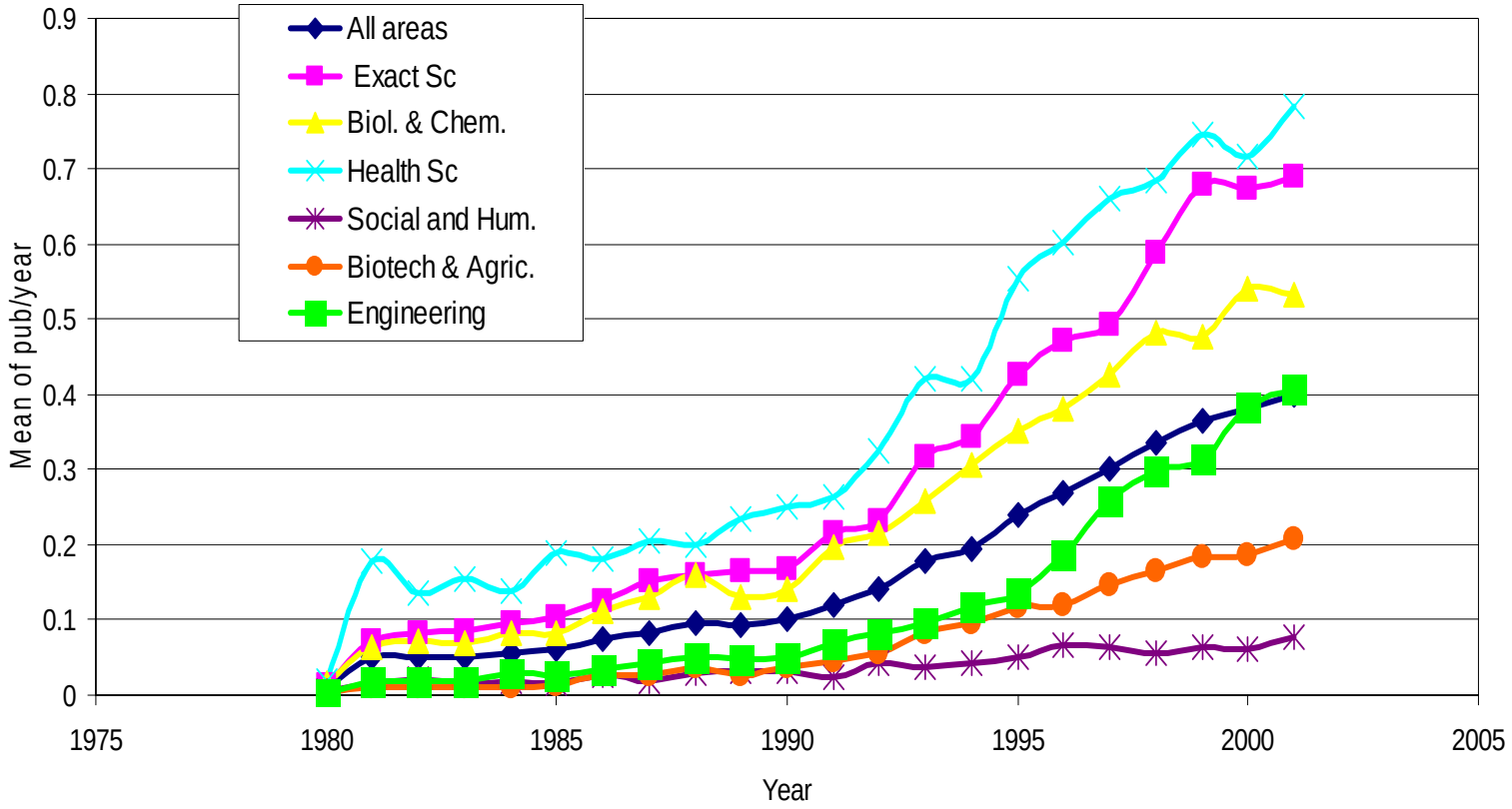
2. SNI variables:
   - Level in the system for each year (or no presence)
   - Budget of Conacyt
   - Total number of researchers in SNI by area and discipline
   - Total number of publications by SNI researchers by area and discipline.

- The source of publications is the Science Citation Index produced by the ISI.
  - Publications per year per researcher
  - Cites per publication per year

Distribution by Area of Knowledge



Evolution of the mean of ISI publications per year by SNI authors



The model

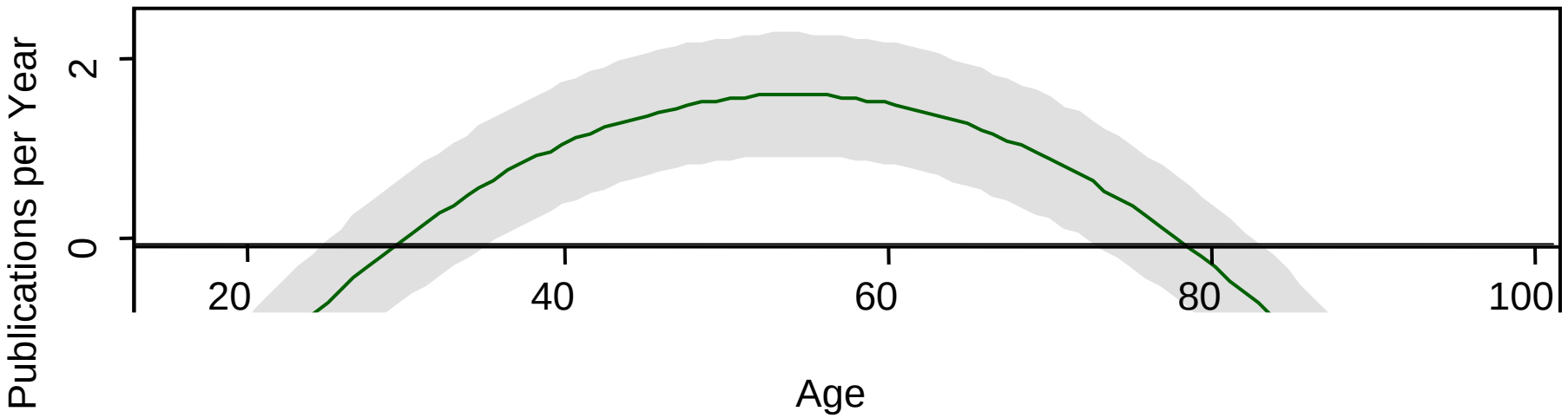
- $Publications_{it} = F(X_{it}, Z_i, c_i, u_{it})$
  - Z_i: Stable across time but not across researchers
    - area, gender, country of PhD, cohort
  - X_{it}: varies in both dimensions
    - age, age^2, level in SNI, lagged budget, total number of researchers, total number of publications.
  - c_i: individual unobserved effect
  - u_{it}: unobserved effect

- Method
  - First step: Negative binomial fixed effect model
    - To estimate the parameters of X_{it}
  - Second step: Non linear least square method
    - To estimate the parameters of Z_i

- Sample
  - Researchers with at least one publication in 1991-2001. N=7,793

Results - Age

Research Productivity Over the Life Cycle:
All Areas of Knowledge



Results - Age (cont.)

Area of Knowledge	Researchers are productive between: (years old)	Peak of publications per year	The peak of productivity is at age: (years old)
All	30-79	1.76	53
Exact Sc.	31-85	2.10	56
Biol. & Chem.	27-83	2.17	53
Health Sc.	27-78	2.04	50
Social & Human.	36-74	0.95	53
Agric. & Biotech	32-74	1.27	53
Engineering	34-72	1.24	51
Disciplines			
Physics	29-83	2.06	55

Comparison with Other Studies (Physics)

Factor	Mexico	USA (Levin & Stephan)	France (Tuner & Mairesse)
Peak of publications / year	2.06	2	2.9
Decline starts (age)	55	45	52
Women publish (paper on average / year)	-0.18	NA	-0.9

Possible Explanations

- SNI encourages researches to continue publishing
  - The base salary in Mexico is about one third of what researchers actually receive.
    - Cannot easily be tested because of the lack of an adequate control sample.
- The eldest researchers of a research group tend to appear as coauthors in the publications of their colleagues.
  - Will be tested in future research.
- Mexican researchers start and finish their careers years later than their colleagues in other countries.
  - There are no systematic differences between those who got their PhD when they were 30 or younger and those who were above 30.

Results - Gender

- Women publish 0.08 papers less than men on average per year

Area of knowledge	Proportion of female (%)	Gender difference in scientific productivity (paper per year)
Exact Sc.	15	-0.16
Biology & Chemistry	36	-0.15
Health Sc.	39	-0.25
Social & Humanities	38	0
Agricultural Sc. & Biotech.	22	-0.07
Engineering	12	0.06

Other Results

- Cites
  - When adjusting for quality of publications, considering cites per four years, the estimation also confirms a quadratic relation between age of researchers and citations that was found using publications.
  - The peak is at 56 (3 years later)
- Cohort effects
  - The latest educated are the most productive
    - The best educated due to the change in the knowledge base
    - Greater pressure to publish
- Country of PhD
  - There is no significant difference depending on the country where the PhD was earned.
- Level in SNI
  - The big jump in research productivity is seen when researchers change from candidate to level 1.
  - Researchers in level 3, the highest level, received more citations than researchers in other levels.

Other results (cont.)

- Critical Mass
  - Small but positive effect in the total number of publications in the same area of knowledge
  - Some saturation effect - considering the total number of researchers in the same area of knowledge
- Budget
  - Positive relation between the budget of the previous year and publications
- Reputation/Experience
  - Matters for the number of citations but not for the number of publications – focus and impact!

Conclusions

- Growing presence of advanced developing economies in international science, as investors and contributors
- Important heterogeneity in investments and productivity among developing nations

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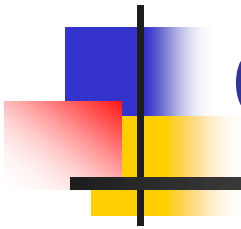
- Effect of age in research productivity not very important
- Significant differences among areas of knowledge.
- There is no important gender gap in research productivity.
- Track record drives focus and impact, but not output



Questions/comments