Educational Investments to Support Widely Shared Economic Growth:
The Challenge and the Opportunity

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November 20, 2014

- **School enrollment of 15-year olds has grown from 65% in 2003 to 78% in 2012.**

- **Largest gain among countries between 2003 and 2012 in mean performance on the PISA mathematics examination.**

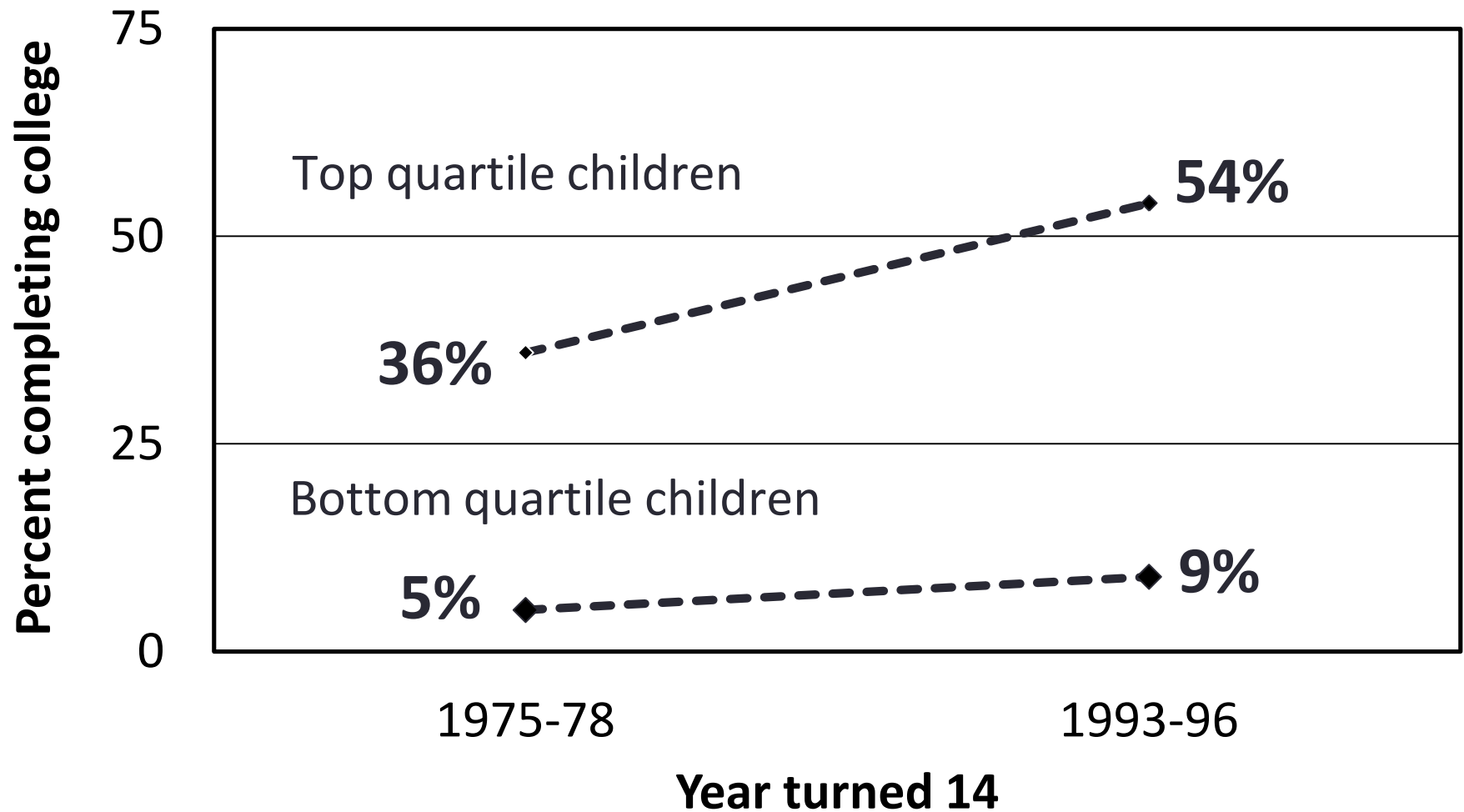# Average Schooling Completed and PISA Learning Outcomes by Income Quintile

Years of Schooling by Household Income

PISA Math Scores by Income Quintile

Notes: For 20 year old population
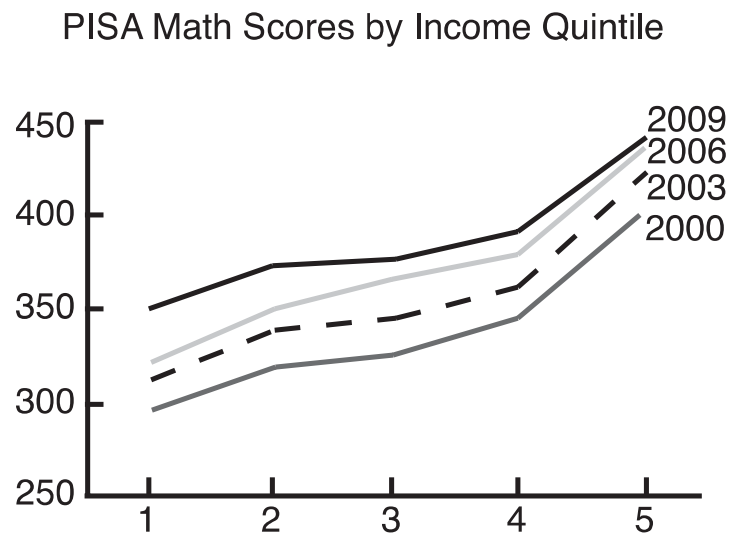
Sources: PNAD (1993, 2009); PISA data (2000–2009).

4-Year College graduation rates for high- and low-income children in the U.S.

Bailey and Dynarski (2011). Reprinted with permission from *Whither Opportunity*? 2011 © Russell Sage Foundation.

Technological Changes increase Demands on Schools

Sources of Changing Skill Demands

- **Computer-based technological changes**

- **Global trade**

- **Changing consumer demands as incomes rise**

- **My focus is on the consequences of computer-based technological changes.**

Types of Tasks Computers can Carry Out

- **All work involves information processing.**

- **Computers do the tasks that can be described in the information processing can be described in terms of following rules. The growing list of such tasks includes:**
  - Filing, typing (speech recognition and natural language processing),
  - Much assembly line manufacturing (robotics),
  - Processing loan applications (Desktop Underwriter)
  - Answering factual questions about the parts of a flower (Siri).
  - Recommending books to read next (Amazon's pattern matching)

  (The examples in parentheses represent relatively recent applications of computers that take advantage of the increasing speed and declining price of computer processing.)

- **So education that prepares students to do these types of tasks no longer serves them well.**

Types of Tasks Computers Cannot Carry Out
(the work for humans)

1. Solving new unstructured problems

- A line cook's sauce has a strange taste.

- A particular model of automobile exhibits unexpected power failures.

- Customers are not happy with the quality of customer service provided with a new tablet computer.
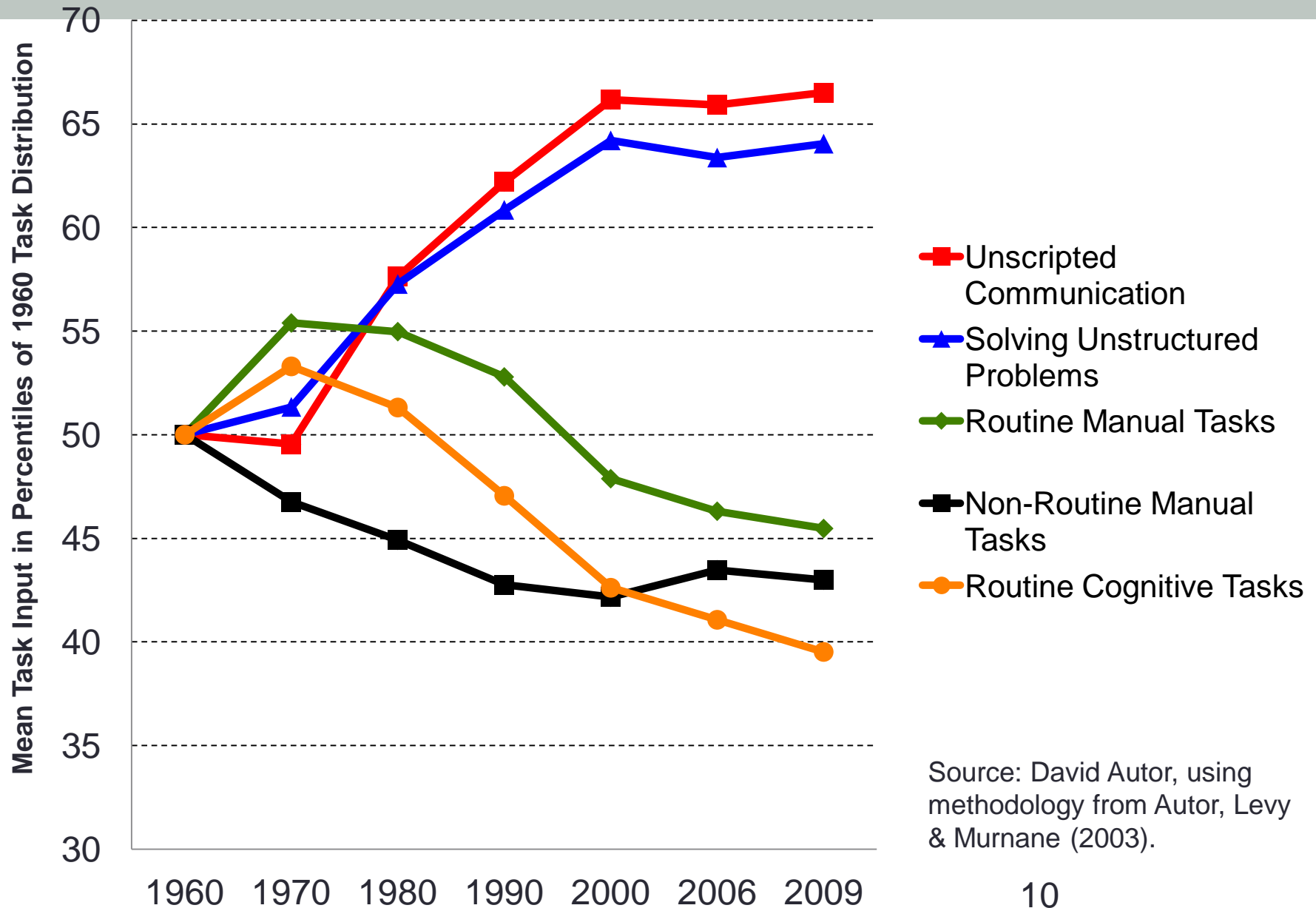
2. Engaging productively in unscripted communication.
   - often an essential part of problem-solving
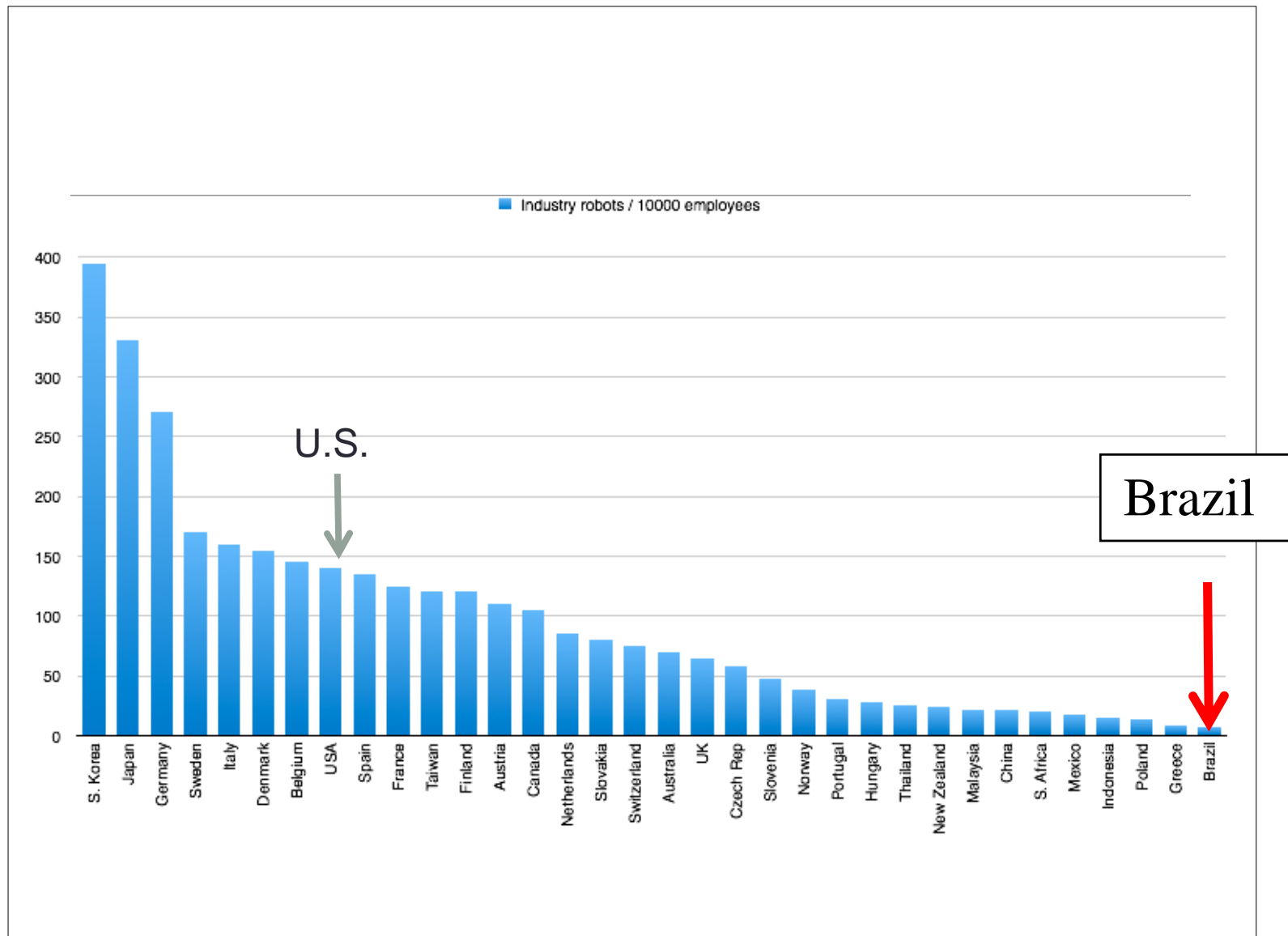   **- much work at creative companies like Google and Apple is done in teams**

3. Non-routine manual tasks
  - Cleaning buildings
   - Waiting on table

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Work Tasks in the U.S. Economy 1960-2009

Source: David Autor, using methodology from Autor, Levy & Murnane (2003).

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Industrial Robots per 10,000 Employees

Requirements for Solving Unstructured Problems in a Particular Domain

- **A great deal of well organized knowledge about the problem (not memorized facts, but well understood relationships)**
  - The ability to learn efficiently over a career

- **Metacognition (ability to monitor one's problem-solving strategy)**

- **Initiative (a disposition)**

Skills Needed for Unstructured Communication

- **Observing and listening**

- **Eliciting critical information**

- **Interpreting the information**

- **Conveying the interpretation to others**

Providing all students with the learning experiences that will enable them to:

1. **develop the capacity to solve new problems in their domain of work,**

2. **the desire to do this,**

3. **the ability to do so productively as part of a team,**

4. **and ability to communicate effectively in a wide range of settings.**

To acquire skill in solving new problems, working productively in groups, and engaging in unscripted communication, students need to engage in these tasks in studying every subject in school.

Enabling all students to acquire the skills that are increasingly valued in labor markets requires highly effective teachers.

Benefits of improved education for all students include not only economic growth, but a strengthening of civic life by enabling citizens to understand and debate difficult issues such as global warming.

Thank you

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- **Slides to use in answering questions follow. (I do not plan to use them in my talk.)**

Occupational Outlook Handbook for 1976:

Secretaries relieve their employers of routine duties so they can work on more important matters.
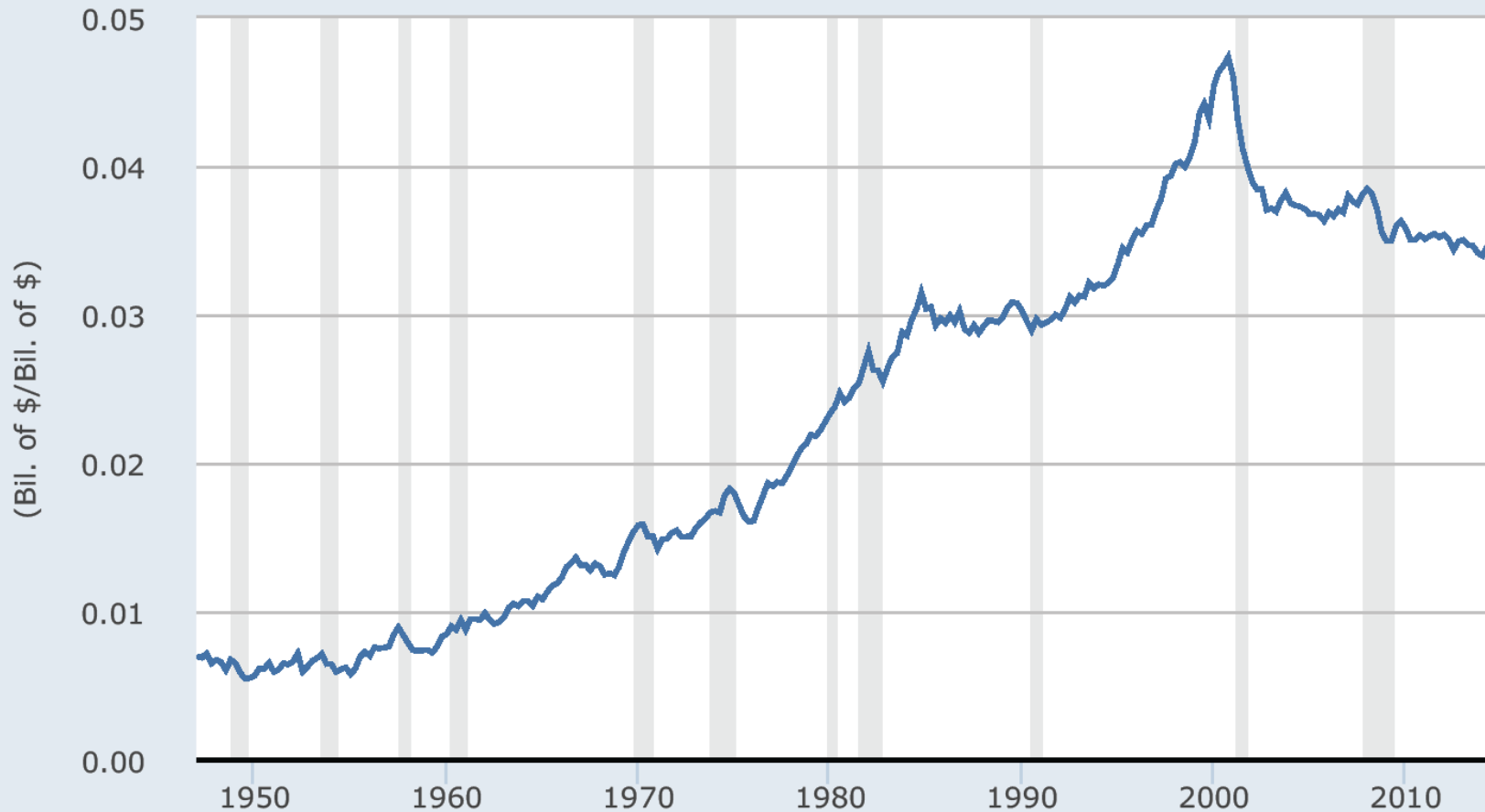
Occupational Outlook Handbook for 2000:

Office automation and organizational restructuring have led secretaries to assume a wide range of new responsibilities once reserved for managerial and professional staff. Many secretaries now provide training and orientation to new staff, conduct research on the Internet, and learn to operate new office technologies.

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Trend in U.S. Investment in computer-based technology as a percentage of GDP

FRED — Private fixed investment in information processing equipment and software/Gross Domestic Product

Shaded areas indicate US recessions - 2014 research.stlouisfed.org

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Types of Information Processing

Increasingly Difficult to Program Computers to Carry Out

→

Rules-Based Logic	*Pattern Recognition*	*Human Work*
Information Processing using Deductive Rules	Information Processing using Inductive Rules	Processing Rules cannot be Articulated and/or Necessary Information Cannot Be Obtained

Examples

Issuing an Airline Boarding Pass,	Recognizing Spoken Words.	Diagnosing a New Problem in a Car
Executing Spreadsheet Equations	Predicting a Mortgage Default	Writing a Convincing Legal Brief
		Moving Furniture into a third Floor, walk-up apartment

Literacy and Numeracy are not less important today than in the past, but they need to be tools for knowledge acquisition and communication, not just tools for following directions.

- example, changing definition of literacy

Solving Unstructured Problems and Unscripted Communication are not new subjects to add to the curriculum. They should be at the center of instruction in every one of the existing subjects.

This requires new learning for adults in schools, too, not just students. And it requires a new way of organizing that adult learning.

Key requirements for constructive change include:

1. **Strong supports, including modeling of desired pedagogy**
2. **Time**
3. **Accountability (we adults do not change our behaviors easily)**

High Stakes Assessments:

      "What you test is what you get."

In the United States, it would be impossible to change instruction without changing the assessments that have significant stakes for students or for educators.
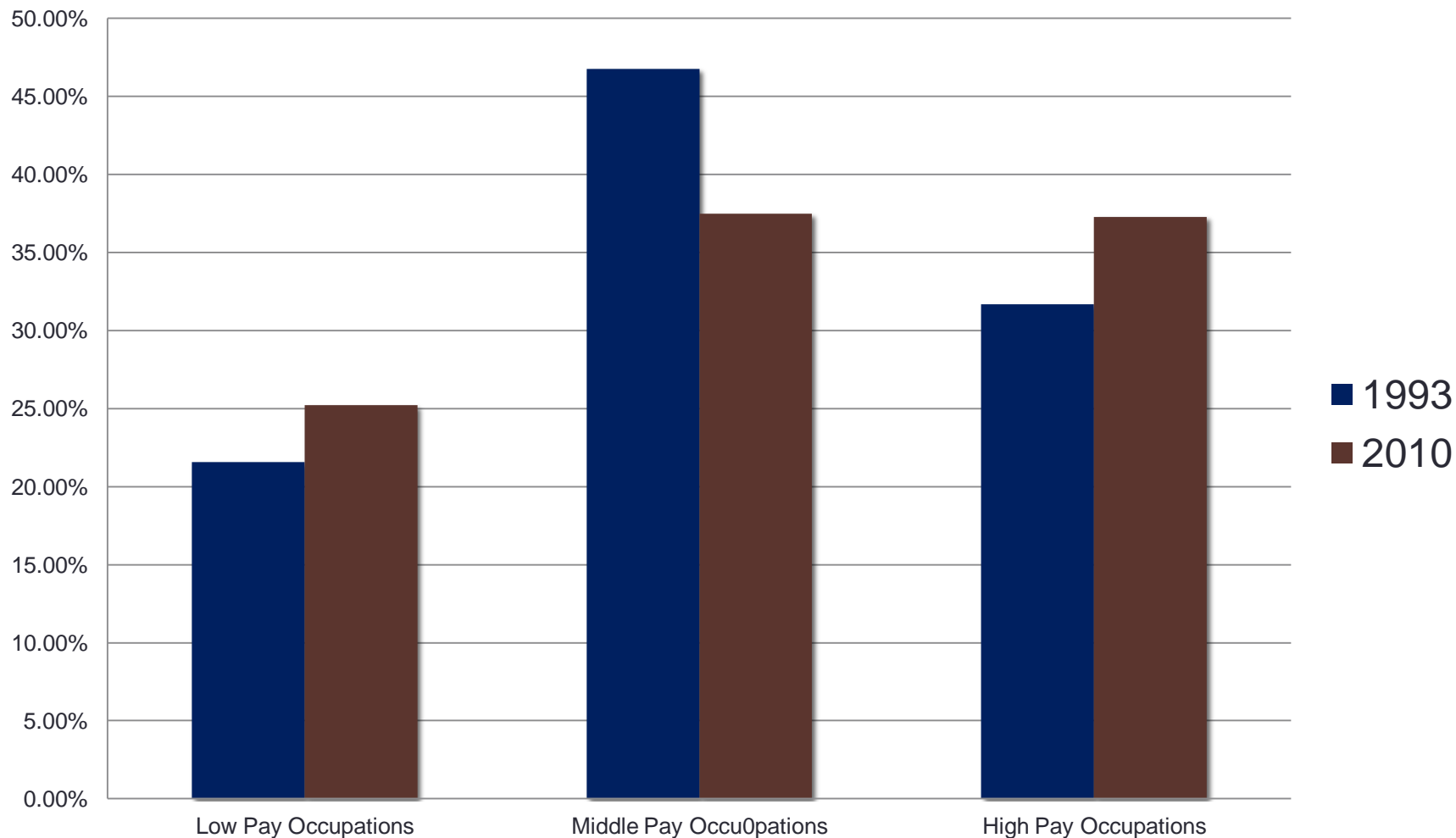
Polarization of the Occupational Distribution:
1979 to 2009

Low-wage jobs

High-wage jobs
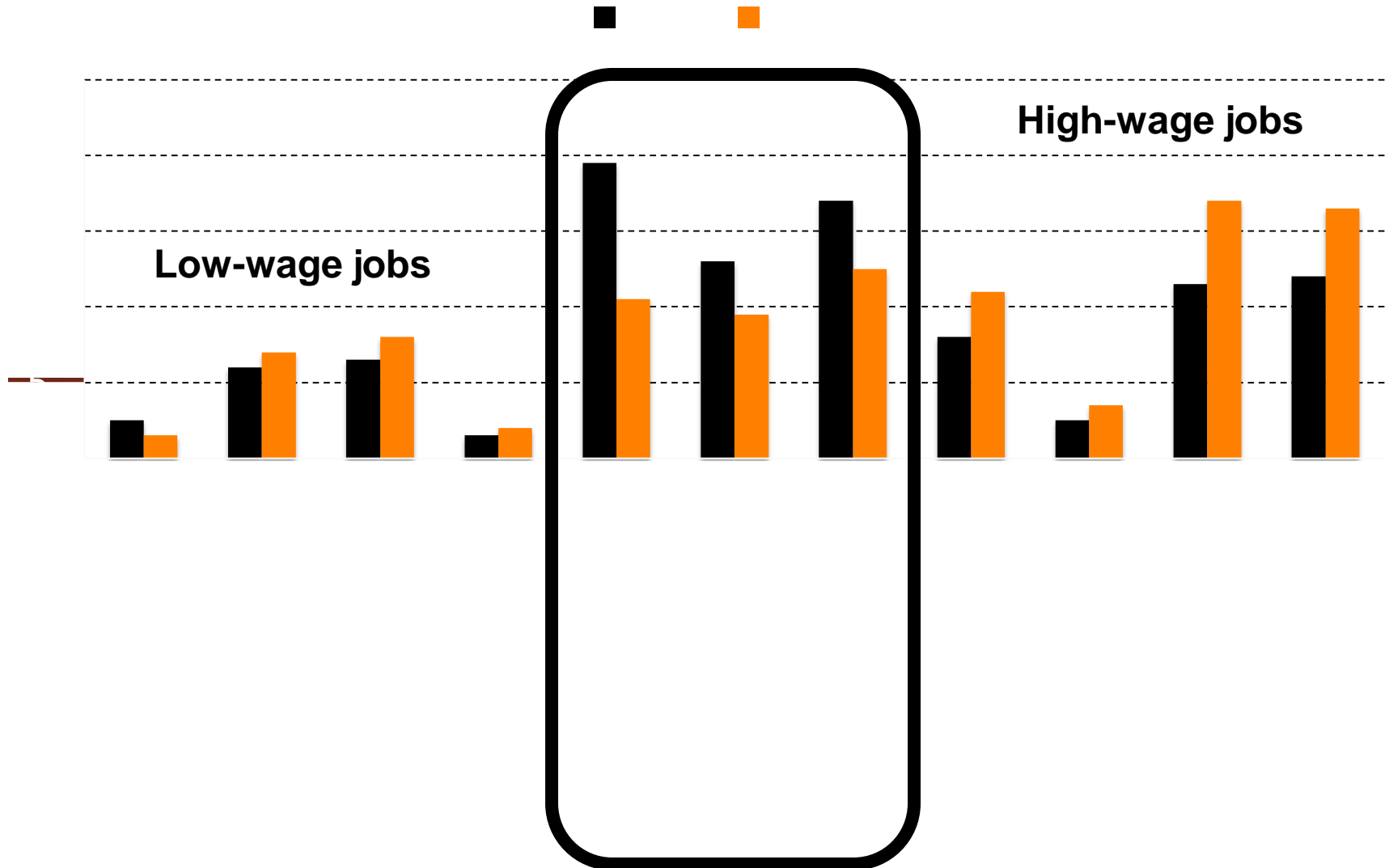
Source: Analyses of Current Population Surveys, U.S. Census Bureau

Occupation Polarization in
16 European Countries
(1993-2010)
(Source: Goos, Manning and Solamans, 2014)

Five Kinds of Workplace Tasks

- **Routine Cognitive (filing, bookkeeping)**

- **Routine Manual (assembly line work)**

- **Solving Unstructured Problems (managers, teachers, technicians; lawyers; doctors)**

- **Unscripted Communication (negotiating, selling, and many of the occupations involving solving unstructured problems)**

- **Non-Routine Manual (custodian, food preparation)**