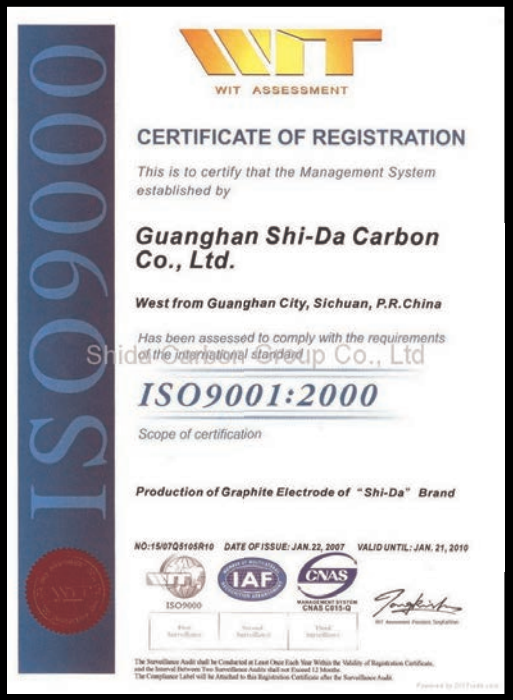
# Supply Chains of Opportunity

## The Role of International Standards in Global Development

The Changing Frontier:
Rethinking Science and Innovation Policy Pre-Conference

October 26-27, 2012




**Hezekiah Agwara**
**Philip Auerswald**
**Brian Higginbotham**
School of Public Policy
George Mason University

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**Motivation:** Changing frontiers

**The framework:** Representing production processes

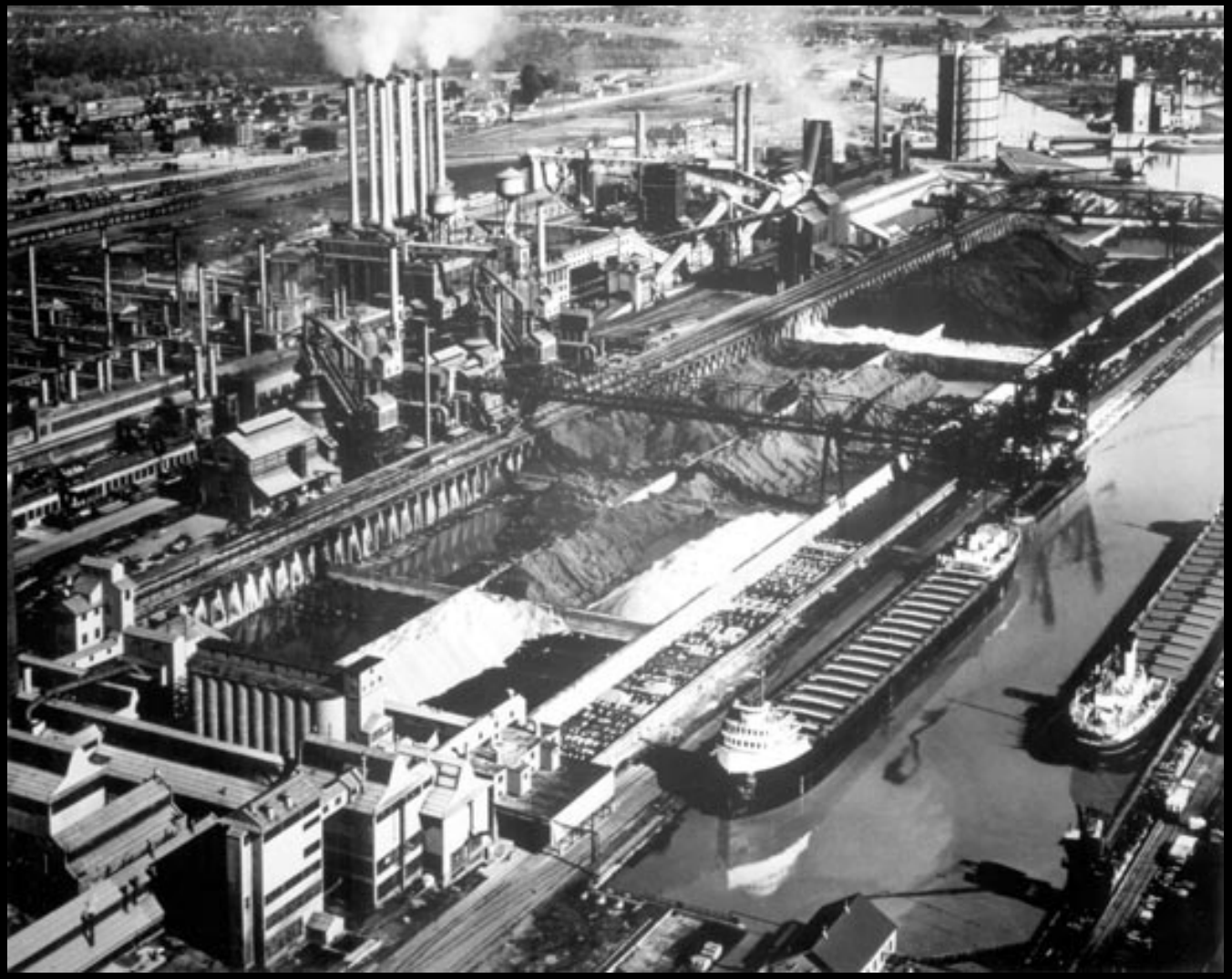
**The data:** Adoption of ISO standards

**Preliminary results**

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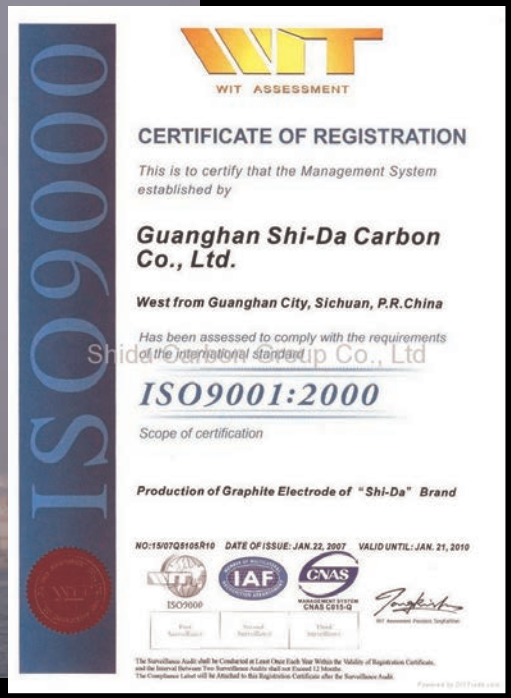
**The “Traitorous Eight” (Fairchild Semiconductor founders)**
From left: Gordon Moore, Sheldon Roberts, Eugene Kleiner, Robert Noyce, Victor Grinich, Julius Blank, Jean Hoerni and Jay Last.

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ISO9000

WIT ASSESSMENT

CERTIFICATE OF REGISTRATION

*This is to certify that the Management System established by*

***Guanghan Shi-Da Carbon Co., Ltd.***

***West from Guanghan City, Sichuan, P.R.China***

*Has been assessed to comply with the requirements of the international standard*

Shida Carbon Group Co., Ltd

***ISO9001:2000***

*Scope of certification*

***Production of Graphite Electrode of "Shi-Da" Brand***

NO:15/07Q5105R10 DATE OF ISSUE: JAN.22, 2007 VALID UNTIL: JAN. 21, 2010

ISO9000 IAF CNAS

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**Motivation:** Changing frontiers

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$$y = \theta x \tag{1}$$

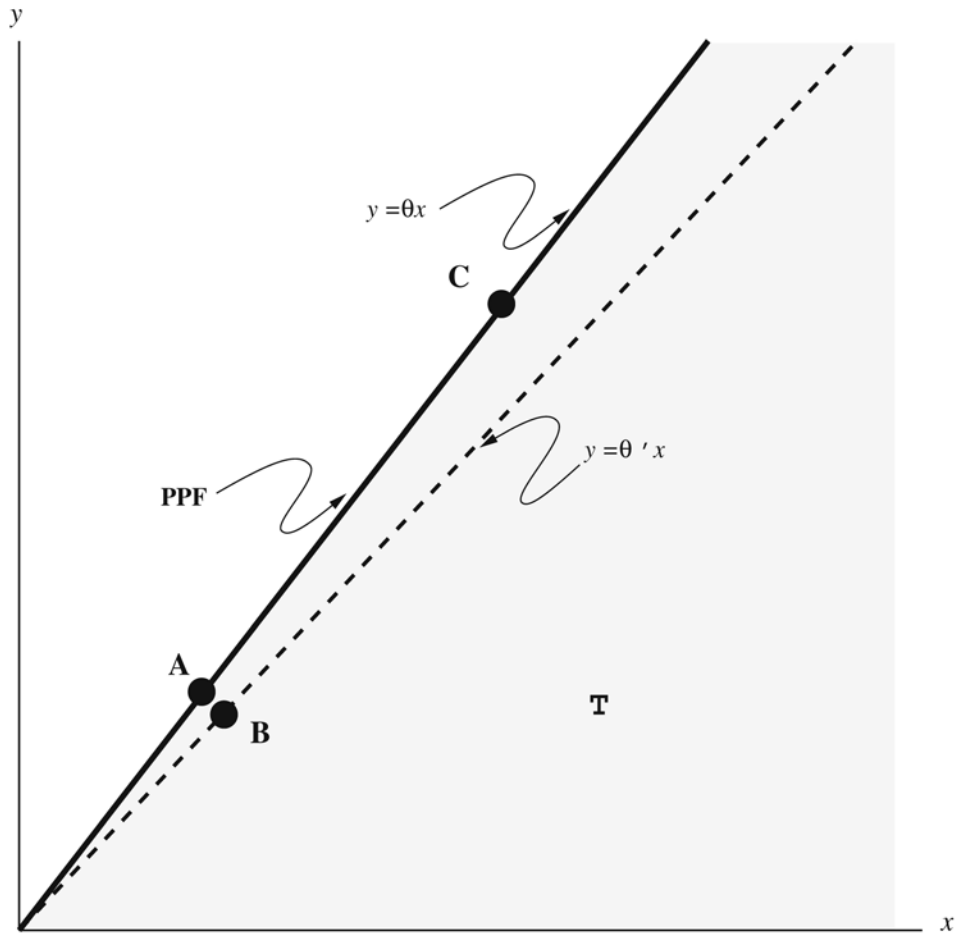



**Fig. 1** Neoclassical technology

"Knowing how to bake a cake" is clearly not the same thing as "knowing how to bring together all of the ingredients for a cake". Knowing how to bake a cake is knowing how to execute the sequence of operations that are specified, more or less closely, in a cake recipe.

- Sidney Winter

“Toward a neo-Schumpeterian Theory of the Firm,” 1967

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Baldwin taught us most of the simple things every
M.B.A. knows. He taught us that different parts of the organization should be established with different responsibilities.... And everything
was working fine: the development and the pre-production engineering for our process and first products was complete;

we had a thick process spec book that recorded all the detailed recipes;

and we had interested customers.

- Gordon Moore, recalling origin of Fairchild

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Evidence on heterogeneity of recipes

- Persistence of profits above the norm (Mueller 1977 and subsequent literature)
- Variability of management practices (Nicholas Bloom et al "Management Practices Across Firms and Countries" 2011 and other work of LSE Center for Economic Performance
- Overall sectoral TFP differences across countries, variation in rates of technology adoption (Comin and Hobijn 2004)

  … much of "management" and "strategy" as domains of study?

*Do recipes generalize the concept of vintages? Ref Arrow (1962)*

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## Best Chocolate Chip Cookies

allrecipes.com



Rated: ★★★★½

Submitted By: Dora
Photo By: Rita

Prep Time: 20 Minutes
Cook Time: 10 Minutes

Ready In: 1 Hour
Servings: 24

"Crisp edges, chewy middles."

**output**

### INGREDIENTS:

- 1 cup butter, softened
- 1 cup white sugar
- 1 cup packed brown sugar
- 2 eggs
- 2 teaspoons vanilla extract
- 3 cups all-purpose flour
- 1 teaspoon baking soda
- 2 teaspoons hot water
- 1/2 teaspoon salt
- 2 cups semisweet chocolate chips
- 1 cup chopped walnuts

**inputs**

### DIRECTIONS:

1. Preheat oven to 350 degrees F (175 degrees C).
2. Cream together the butter, white sugar, and brown sugar until smooth. Beat in the eggs one at a time, then stir in the vanilla. Dissolve baking soda in hot water. Add to batter along with salt. Stir in flour, chocolate chips, and nuts. Drop by large spoonfuls onto ungreased pans.
3. Bake for about 10 minutes in the preheated oven, or until edges are nicely browned.

**production recipe**

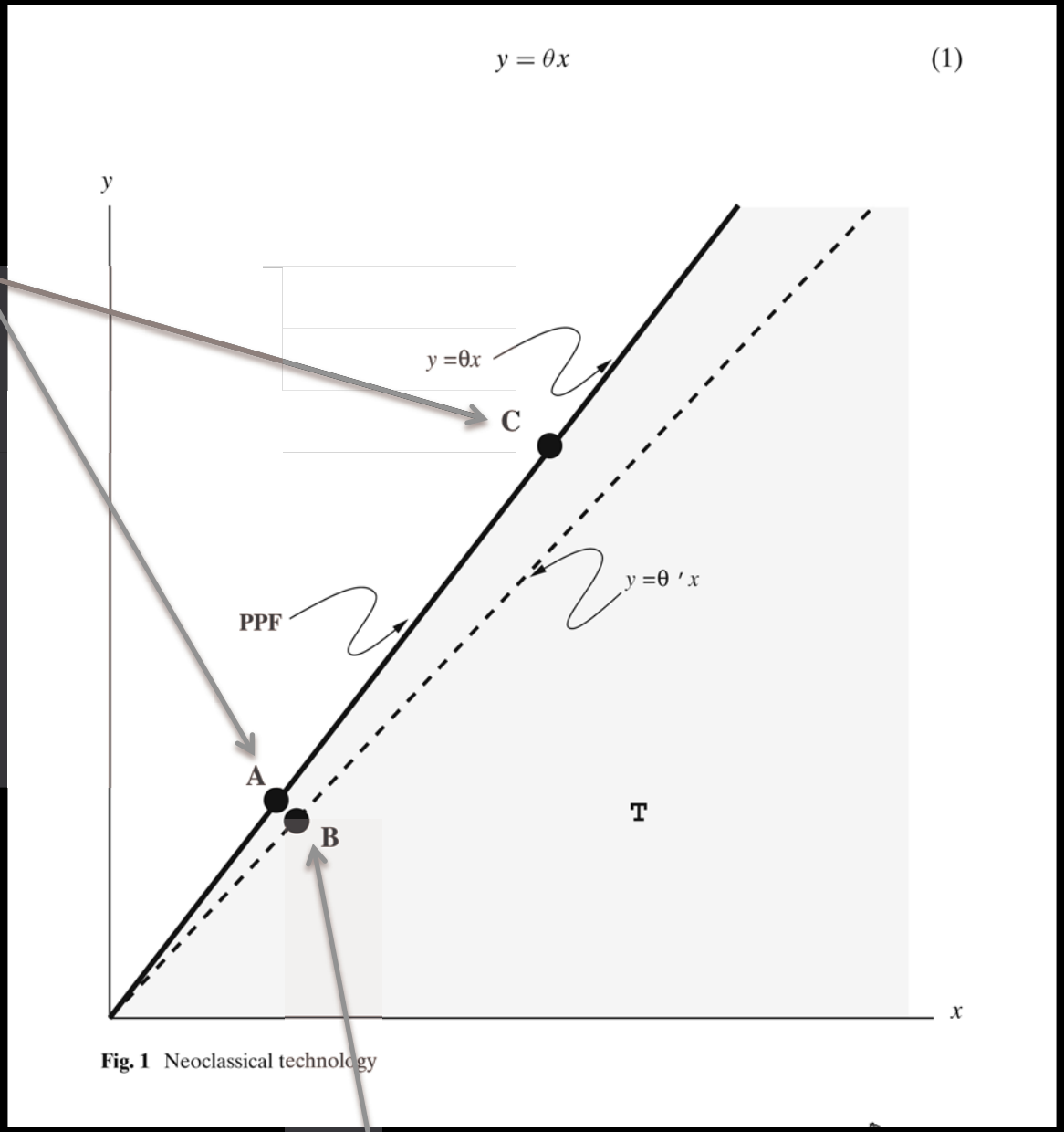
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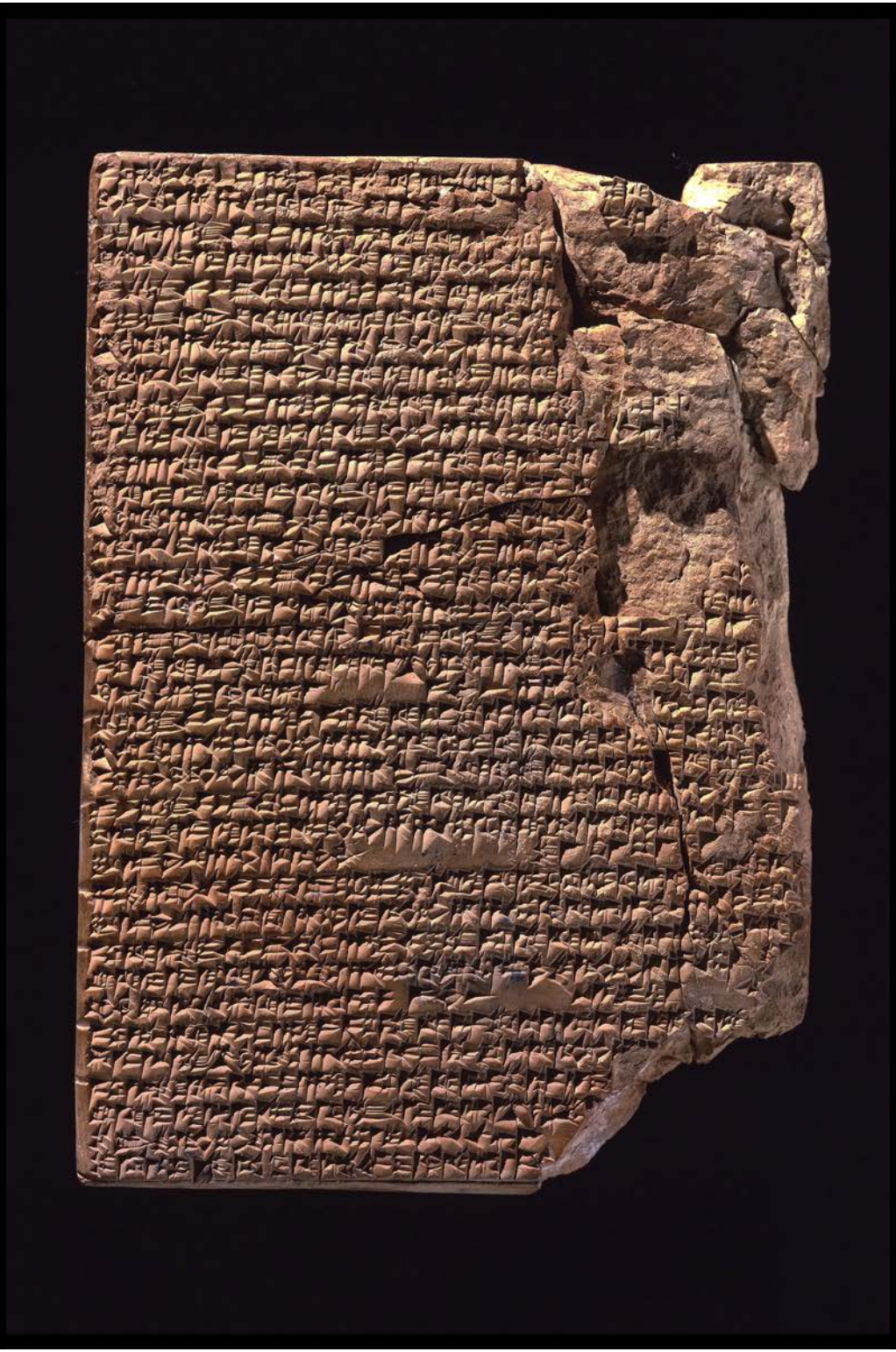
Production involving three operations, each a binary choice

Recipe {0,1,0} maps to scalar organizational capital level $\theta$

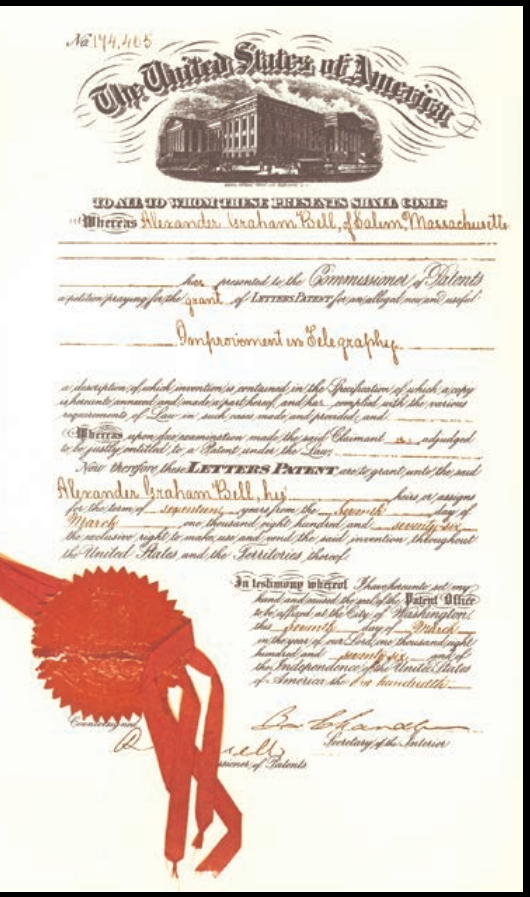



Recipe {1,0,1} maps to scalar organizational capital level $\theta'$

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The United States of America

TO ALL TO WHOM THESE PRESENTS SHALL COME:

Whereas Alexander Graham Bell, of Salem, Massachusetts

Improvement in Telegraphy

Whereas upon due examination made the said Claimant ... adjudged to be justly entitled to a Patent under the Laws

Now therefore these LETTERS PATENT are to grant unto the said Alexander Graham Bell, his ... heirs or assigns for the term of ... years from the ... day of March ... one thousand eight hundred and ... seventy-six ... the exclusive right to make use and vend the said invention throughout the United States and the Territories thereof.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington this ... day of March in the year of our Lord one thousand eight hundred and ... seventy-six ... of the Independence of the United States of America the ... hundredth

Secretary of the Interior

Countersigned

Recorded

Assistant Commissioner of Patents



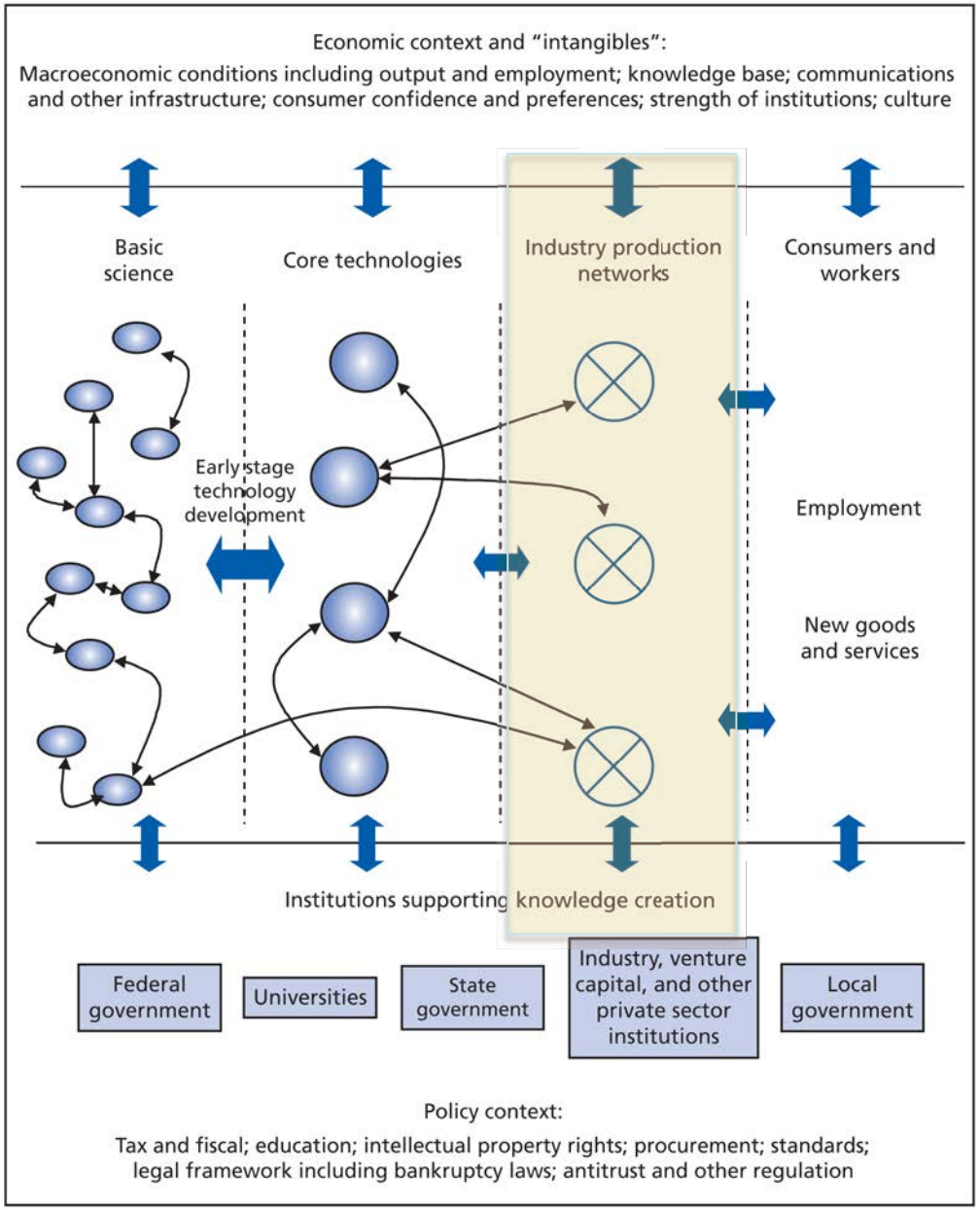

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# ISO Management Standards (9000, 14000)

- ISO 9000 addresses “Quality Management”
  - What an organization does to fulfill:
    - quality and regulatory requirements,
    - enhance customer satisfaction,
    - and achieve continual performance improvement
- ISO 14000 addresses “Environmental Management”
  - What an organization does to minimize harmful effects on the environment caused by its activities.
  - And to achieve continual improvement of its environmental performance.

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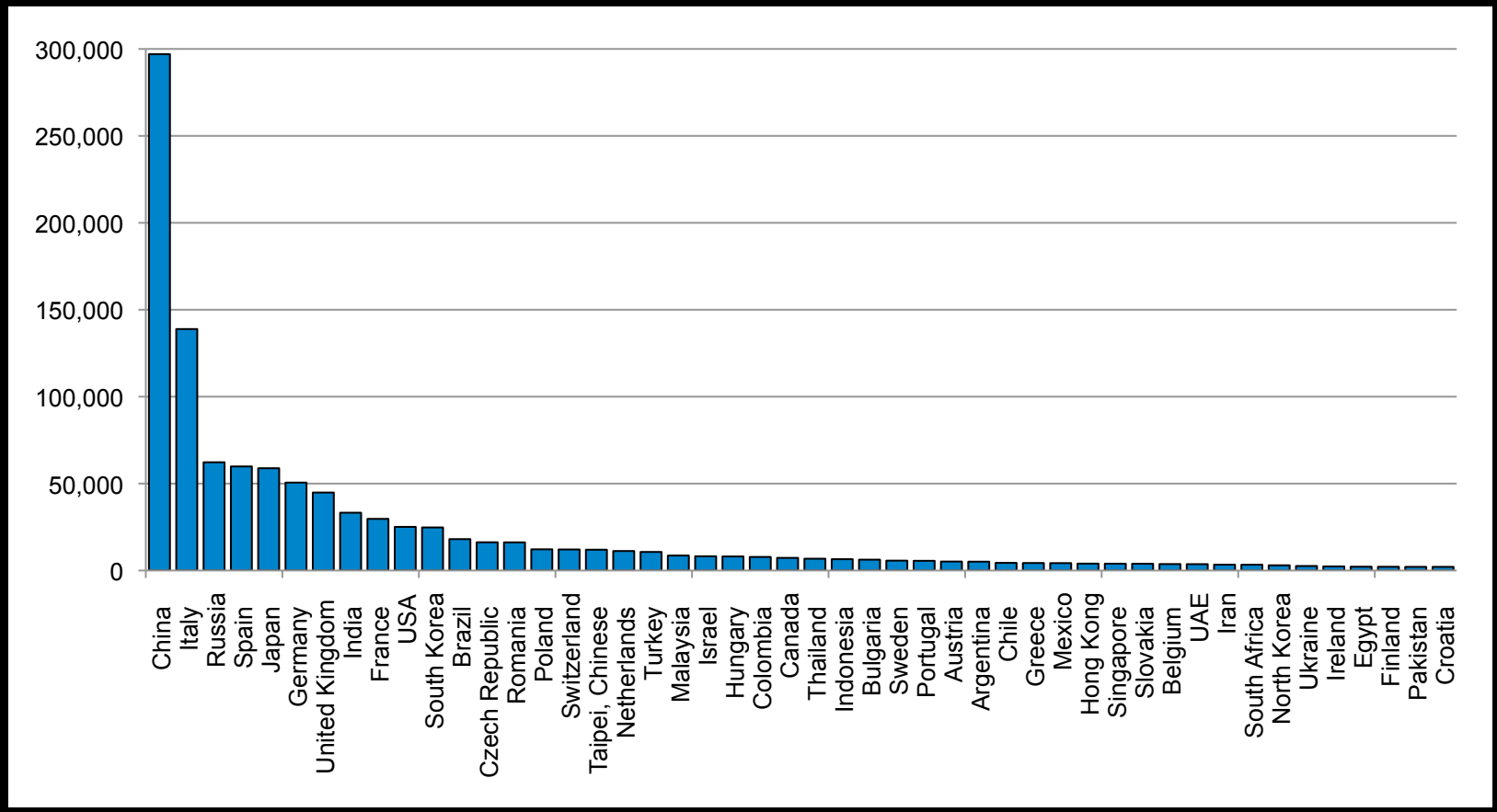
**Representation of the Complex Network of Resources, Capabilities, and Institutions that Sustain a Region's Innovative Capabilities**




*Source*: Derived in part from Auerswald 2001.

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# ISO 9001 Certifications by Top 50 Countries (2010)




Source: ISO Survey 2012

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**Motivation:** Changing frontiers

**The framework:** Representing production processes (A different frontier)

**The data:** Adoption of ISO standards

**Preliminary results**

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Vector of all efficiency values = $\boldsymbol{\Theta}_t$
Average efficiency of current market competitors = $\Theta_t$
Firm's own current productive efficiency = $\boldsymbol{\theta}_t$

Firm either continues learning by doing ("lbd"), or undertakes formal certification process ("adopt") at cost $\kappa^{\text{adopt}}$

A competitive equilibrium in the model consists of a sequence of wages $(w_t)$,[8] entry decisions, and exit decisions that jointly satisfy the static labor market equilibrium condition[9] and the following standards adoption equation:

$$\mathbf{V} = V^{\text{adopt}}(\boldsymbol{\Theta}_t) - V^{\text{lbd}}(\boldsymbol{\Theta}_t) = V\left(\theta_t^{\text{adopt}}, \Theta_t\right) - V^{\text{lbd}}(\boldsymbol{\Theta}_t) = \kappa^{\text{adopt}}$$

The value of adoption, **V**, and therefore the incentive to adopt, is
— increasing in the difference between the global output price and local price
*The signaling value*
— decreasing in the average efficiency of current market competitors $\boldsymbol{\Theta}_t$
*The learning value*
— indeterminate with regard to own $\boldsymbol{\theta}_t$

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Aggregate prediction – S-shaped. Diffusion starts slow (correct timing of onset is critical), followed by growth at increasing rates, before slowing toward the plateau. We examine annual growth rates of ISO certifications per country.

Firms in countries more engaged with global markets most likely to pursue ISO. Trade openness as proxy for geographical proximity – the PWT Trade Openness index.

Correlation of economic growth with certification. We predict low rates of certification in both Afghanistan and the US; high rates in China and other rapidly growing, globally connected countries.

Correlation between export levels and ISO certification.

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# Data

Micro (firm) level

- The World Bank Group's project on Enterprise and Investment Climate Surveys (ICS) - BEEPS 2002-2009 unbalanced panel of Eastern Europe and Central Asia (ECA) countries.

Macro (country) level –

- Number of ISO certifications from the International Standards Organization (ISO)
  - Certification counts per year for the period 1993-2010 for 144 countries.
  - Annual changes by ISO standard, country, industry and region.
- Country characteristics (population, income, education, institutions, trade) from the World Development Indicators (WDI) and the Quality of Government (QoG) Dataset (Teorell et al., 2011)

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# Variables

- Cross country diffusion of ISO certification
  - ISO certification per 1,000 people
  - Annual real GDP per capita (constant US$) and the annual growth rate of total real GDP.
  - PWT Trade Openness index
  - Human capital, represented by the average number of years of education for males.
  - Quality of institutions – the ICRG Quality of Government Index.
  - Legal origins – the La Porta et al. (1998) five-category dummy variable for the origins of the legal systems.
  - Services value-added (current US$)
  - Latitude

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# Variables

- Firm level adoption choice
  - ISO certification status – binary variable that is one if it is certified in any of the ISO standards and zero otherwise.
  - Innovation activity – has a website, uses email, has broadband internet.
  - Exporting status, firm size, firm age.
  - Value of fiscal year total sales (revenue).
  - Total labor.
  - Foreign stake – binary variable (one if firm has some foreign shareholding and zero otherwise).

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# Estimation

Firm level adoption

- Bivariate probit model of ISO adoption and exporting activity.
- Van de Ven and Van Pragg (1981) Probit model with sample selection.

Cross country diffusion of ISO certification

- The population-averaged panel-data models by using GEE to estimate adoption rates
- The linear regression with panel-corrected standard errors, to estimate levels of adoption.
- The Heckman selection model to test for selection bias in our diffusion model.

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**Motivation** (Changing frontiers)

**The model** (Algorithms of development)

**The data** (Standards and supply chains)

**Preliminary results**

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# Preliminary Results

Firm level adoption

- Exporting not significantly associated with ISO adoption.
- ISO certification strongly associated with greater exporting activity, at the 1% level.
- Firms that maintained a website (greater innovation capability), recorded higher sales per worker, were larger in size, and had foreign shareholding were the most likely to adopt ISO certification.
- Significant selection bias in the choice to export – firms selecting into ISO certification more likely to also export.
- After controlling for selection into ISO certification, all other covariates of exporting activity are insignificant.

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# Preliminary Results

Cross country diffusion of ISO certification

- ISO certification diffused rapidly over the period under review. On average, certifications across all countries was increasing by 1.2% per year, significant at the 1% level.
- Significant determinants of increased adoption include per capita real GDP, average education, the quality of institutions, trade openness, and service value added.
- Firms in Europe and the Far East countries were the leading adopters, while North American firms were significantly less likely to adopt ISO certification.
- ISO adoption is highest in countries with English legal systems and lowest for Scandinavian legal systems.

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# Preliminary Results

Cross country growth in ISO certification adoption

- Growth in ISO certification has gradually declined over the period under review. On average, the rate of adoption of certification declined by between six and 11.6 percentage points per year, significant at the 1% level. After faster growth through 1996, adoption rates rapidly declined from 1999 onwards.
- This decline in the rate of adoption has been highest for countries with higher per capita real GDP. For a 1% increase in per capita real GDP, the difference in the expected mean rate of adoption is -0.244 percentage points.
- North America has recorded significantly higher deceleration in adoption than the rest.
- Growth in adoption has been highest in countries with Socialist legal systems.

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END

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