The European technology gap

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Why does the technology gap pose an important question?

- Economic welfare, measured at first glance by per capita GNP, depends on 2 components
  - Labor productivity
  - Rate of employment
- In the last 10 years, Europe has been behind the US with respect to both components. In addition, improvement in one component has been made at the expense of the other, in contrast with the US experience of complementary components.

Overall assessment of the technology gap

- Average labor productivity growth (LPG = rate of growth of GNP per worker) in the last ten years (1996-2005):
  - 1.4% in the EU25 versus 2.1% in the US
  - technological gap increased by an average 0.7% per year
- In 2005, labor productivity level is $ 62,500 in the EU25 and $ 87,500 in the US
  - 29% less in EU25
- In 2005, the hourly labor productivity (in US $) and the rate of employment (%) are respectively:
  - (40 $, 63%) in the EU25
  - (48 $, 72%) in the US

Heterogeneity among EU countries

- *1*. ***Low labor productivity and low employment rate****:* Central and Eastern European countries + Greece
- *2.* ***Low labor productivity and high employment rate****:* Slovenia, Cyprus, Estonia, Portugal
- *3.* ***High labor productivity and low employment rate****:* France, Germany, Belgium, Luxemburg, Euro zone
- *4.* ***High labor productivity and high employment rate****:* Scandinavian and Anglo-Saxon countries (Denmark, Sweden, Finland, UK, Ireland, Austria, Netherlands)

Dynamics of LPG: Downward shift since 1995

- *Long-run decomposition in two phases* (Gordon, 2004)

  Phase 1: Long period of technological catch-up since World War II until the mid 1990's

  Phase 2: Downward shift since 1995: the productivity gap between Europe and the US widens from this date. Why?
- Main explanation from endogenous growth theory (Aghion and Howitt, 2005, Lecture at the 20th Annual Congress of the E.E.A.):

  While the structural conditions necessary for catch-up were present in the 1st phase, those needed for creation, innovation and leadership in a knowledge-based economy, were absent in Europe while worked to a significant effect in the US.

Objectives of this lecture

- 1. Refine the diagnosis of the technological gap in Europe by using disaggregated and microeconomic evidence
- 2. What economic policy implications from the microeconomic evidence? Two views.
- 3. Can the failure of the first Lisbon agenda (2000) be corrected by the follow-up Lisbon procedure (2005)?

Organization of the lecture

- **1. Disaggregated and microeconomic evidence**
  - 1.1 *Sector level evidence*
    - ICT taxonomy
    - Innovation taxonomy
  - 1.2 *Firm level evidence*
    - Firm demographics
    - industry dynamics
- **2. Policy implications: Two views**
  - 2.1 *Industrial policy to strengthen European firms*
  - 2.2 *Structural policies to strengthen the creative destruction process in Europe*
- **3. Policy constraints**
  - 3.1 *Complementary structural reforms*
  - 3.2 *Implementation level*

1.1 **Sectoral evidence: Two taxonomies**

- **Sectoral location of the European technology gap and its dynamics**
- Comparison of the labor productivity growth in the US and the EU15 in 56 sectors (manufacturing and services) covering the total aggregate economy of each EU country over 1979-2001
- Sectoral regroupments according to two taxonomies (ICT and Innovation) → allow identification of the main European weaknesses
- Results from O'Mahonny and van Ark, 2003: *EU productivity and competitiveness*

First taxonomy: Information and Communication Technology (ICT)

- Sectors grouped according to whether they *produce (*or not) ICT goods and services and whether they *intensively use* (or not) ICT goods and services. The share of ICT capital in total capital is used to measure the intensity of ICT use.
- Three categories in Manufacturing and in Services:
  - ICT producing sectors (produce directly ICT goods & services)
  - Intensive ICT using sectors (intensity according to the share of ICT capital distribution with the median as the cut-off)
  - Non ICT producers & Non intensive ICT users sectors
- Observations on the locus of the technology gap, measured by Labor Productivity Growth (LPG) Table 1

ICT producing sectors (goods & services)

- ***1a.*** **LPG is the highest in the group of *ICT producing goods,* both in the EU15 and the US, but initial American leadership and recent growth acceleration in the US lets Europe very far from the productivity frontier** (11.9% EU vs. 23.7% US).
- In addition, the US obtain a higher share of aggregate value added in this group than the EU15 (2.7% versus 1.3%)
- Group of high-tech industries (*office equipment, electronic valves and tubes, insulated wire, telecommunication equipment, radio and TV receivers, scientific instruments*).
- The cross country dispersion of productivity levels increased after the positive global productivity shock induced by ICT in the mid 1990's →non-uniform obstacles to innovation and diffusion across member countries

- ***1b.*** In contrast**, higher LPG in Europe** (5.9% EU vs. 1.8% US) in the group of ***ICT producing services***, that includes communications, computer and related activities (software). Note that this European advantage occurs despite the absence of software patent protection in Europe.

Intensive ICT services users

- **2. Impressive LPG acceleration in the US** (5.3% per year since 1995) **in the *ICT services users,* not matched by the EU15** (1.8% per year since 1995).
- This group includes wholesale trade, retail trade, banking and finance, insurance, legal, technical and advertising sectors
- Higher share of aggregate value added in the US than in the EU-15 (29.5% versus 23.3)

- **Possible explanations**
  - More restrictive European regulatory environment in distribution and other network sectors (Nicoletti and Scarpetta, 2003, Conway et al., 2006)
  - First mover advantage by the US *ICT users*
  - Insufficient integration of the European internal market in services (failure of the Services Liberalization Directive)
  - Weak European churning among incumbents in services compared to the US (Foster, Haltiwanger, Krizan, 2005)

Non ICT Sectors (Non producing nor intensively using ICT)

- **3. No productivity revival in either the EU15 or the US in the *Non ICT* sectors: Low LPG in both continents**
- Despite a recent deceleration in LPG from 3.6% (1990-1995) to 1.6% (1996-2001), the EU keeps a slight leadership. This group includes *traditional sectors* (vehicles, food, paper, rubber, basic metals, etc.) that represent the core of the European economy (64% of the aggregate VA in the EU-15 versus 58% in the US)
- *Concern raised by this observation:* Could these traditional manufacturing industries retain their role of "power house" of the European economy?

A summary

- The positive US productivity shock induced by the breakthrough of Information and Communication Technologies has not been matched by the EU. Productivity lag widens in ICT producing goods and Intensive ICT user sectors. Diffusion of ICT in the US had a set of technological opportunities that were not appropriated, to the same extent, in Europe.
- In contrast, slight European productivity advantage in traditional sectors (non-ICT) which still forms the core of the European economy. This advantage has been obtained by substantial reduction of employment in traditional sectors .

Second taxonomy: Innovation

- **Focuses on the role of innovation as a driver of productivity growth** (technology + complementary innovative activities) → ***Innovation taxonomy,*** based on Pavitt, 1984, picks-up the variety of innovation sources →clustering around 4 groups of sectors in manufacturing:

- ***Group 1****: **Supplier dominated industries*****:*** *W*eak in-house R&D and engineering capabilities; small firms in traditional sectors →cost-cutting trajectory and mostly process innovation rather than product innovation
- ***Group 2****: **Scale intensive industries*****:*** technological trajectory of large-scale and assembly production → high capital/labor substitution →process innovations from in-house R&D
- ***Group 3****: **Specialized supplier industries*****:*** Strong innovators and specialized firms → Internal R&D product innovations to end users
- ***Group 4****: **Science based industries*****:*** Main source of innovation = Internal R&D based on basic science knowledge, as in chemicals, pharmacy, electronics

Results from O'Mahonny and van Ark, 2003: *EU productivity and competitiveness* →Table 2

Group 1:
Supplier dominated industries

LPG rather low and slightly higher in the EU than in the US + recent deceleration in the EU → trend convergence around 1.8% in both continents

This group includes clothing, furniture, wood products, construction, printing & publishing, and agriculture

This group represents12% of Manufacturing VA in the EU-15 versus 10% in the US. The EU slowdown is rather broad across sectors of this group, while the US picture is more mixed: productivity improvements in agriculture, clothing and furniture and continued slow growth in textiles, wood products and construction.

Group 2:
Scale intensive industries

Low LPG in both continents and recent deceleration in the US (1.5% in EU, -0.3% in US)**; Higher LPG levels at the EU15 than the US**.

- Traditional industries: mining and quarrying, food, drink & tobacco, oil refining, motor vehicles, ships, and basic metals.

- Ireland, Portugal and Greece see large increases in productivity growth in these industries ❄indicative of catch-up within the EU

- Group of industries largely open to global competition. Produce price sensitive products with large-scale technological trajectories and in which process innovations (cost-cutting) are crucial to survive.

Group 3:
Specialized goods suppliers

Group where LPG is the highest: The EU lags behind the US in each period and the gap is even wider after 1995 (5.5% in EU15 versus 14.5% in US)

- **Specialized supplier and ICT producing industries are the locus of the most important European technological gap.** Confirms the weak innovating role of SMEs in Europe.
- Strong in-house innovations coming from SMEs developing new products or making quality improvements.
- This group includes high-tech industries as mechanical engineering, office machinery, electronic valves & tubes, telecommunication equipment, and scientific instruments

Group 4
Science based industries

LPG greater in the EU than in the US in all periods (2.9% in EU versus 1.1% in the US).

But, recent slowdown in Europe (from 4.3% in 1990-1995 to 2.9% in 1995-2001).

In-house innovation coming from R&D carried out by firms and based on the rapid development of the underlying sciences in universities and elsewhere *(*chemicals, biotechnology, and electronics).

European superiority in this group mitigates the common wisdom that the public-private transfer of knowledge does not work efficiently in Europe. However, the recent European slowdown raises serious concerns about the negative effect that a reduced public research effort may have on these industries.

To summarize

- European technology gap mainly located in high-tech and specialized sectors (ICT producing goods, ICT using services, and specialized innovation suppliers) where the global positive shock induced by the ICT breakthrough in the US during the 1990s has not been matched.
- Explanation by Scarpetta *et al*. 2003 and Conway *et al*., 2006: Restrictive product market and services regulation slows the process of adjustment through which positive productivity shocks diffuse across borders and new technologies are incorporated into the production process.

1.2 Firm level evidence: the industry dynamics

- ***Dynamics of an industry***, captured at the levels of industry structure variations and labor productivity growth, result from different channels:
  - variations *within* incumbent's activity,
  - reallocation *between* incumbents from less productive to more productive,
  - *entry* of new firms,
  - and *exit* of old firms.
- Resulting *churning* process affects not only the ***turnover rate*** and ***labor productivity growth*** but also the ***dynamics of product and labor markets*** that are **at the core of the *creative destruction process*** (Caves, 1998, Bartelsman and Doms, 2000).

- Most empirical studies proceed on a country-by-country basis, using longitudinal firm-level data, mostly for the US. However, there are some studies that succeed in making international comparisons (Bartelsman, Haltiwanger and Scarpetta, 2004).

Firm-level evidence

- Four aspects of the industry dynamics:
  - Firm demography: industry structure by firm size
  - Structural variations: entry, exit, and turnover
  - Labor productivity variations across countries
  - Labor productivity variations across sectors.

Firm demography: Industry structure by size

- *1st observation:* **Greater concentration of employment inside very small firms in the EU** : over 33% of all employees in establishments with less than 10 employees in the EU-15, compared with only 11.5% in the US.
- *2nd observation:* **Higher share of total employment in large firms in the US**: over 47% of all employees in enterprises with more than 250 employees in the US, compared to only 34% in the EU. In addition, wider dispersion of the size distribution in the US.
- *3rd observation:* These different distributions occur in **almost all the sectors**, except in public utilities where similar structures prevail in both continents. More acute differences appear in **retail trade**: the US have the majority of employees in larger firms (big boxes as Wall Mart, Best Buy, etc), while in the EU the majority are in smallest firms.
- Possible explanations:
  - While American firms benefit from their large market to reach an efficient scale, the European internal market does not serve this purpose with the same efficiency (more institutional barriers)
  - Higher barriers to growth for SMEs in Europe.

Structural variations: entry, exit, and turnover in manufacturing

- *1st observation*: **A*verage size of entrants* is smaller in the US compared to other countries**. Lower *entry and exit costs* in the US allow ***easier market experimentation*** (Poschke, 2006). ***Gross turnover rate*** (entry + exit rates) **higher in the US**.
- *2nd observation*: **Low *survival rate*** for very small entrants in the US, but **better *post-entry performance*** for successful entrants in the US than in European countries.
- *3rd observation*: **High positive cross-sectional correlation between e*ntry & exit rates* in the US versus insignificant or negative correlation in some European countries** (France, Italy, Portugal).

Entry, exit, and turnover in manufacturing: a summary

- *Smaller entry size, greater opportunities to experience the market and higher growth rate for successful start-ups indicate that the process of entry and market selection works better in the US than in European countries. Besides **higher barriers to entry**, there are **higher barriers to growth** in Europe: greater scope for expansion among successful young ventures in the US markets than in Europe.*

- *The US positive cross-sectional correlation between entry and exit reflects the **within sector turnover** as part of the **creative destruction process**. In contrast, the negative cross-sectional correlation in Europe reflects more the traditional role of **sectoral shocks** in which entries are driven by high profits in some industries and exits driven by relatively low profits.*

Labor productivity variations: A decomposition

- Starting from firm-level labor productivity (value added per worker), Bartelsman *et al.* (2004) decompose aggregate labor productivity variation in manufacturing over 1990-2000 for 24 countries (10 industrial, 5 Central & Eastern Europe, 9 Latin America & East Asia)
- Decomposition in 5 terms:
  - Within firm effect (internal growth)
  - Between firm effect (reallocation)
  - Cross effect (covariance)
  - Entry effect
  - Exit effect

LPG variations across countries: Within and between effects

- *1.* ***Within firm*** variation is the most important component of the aggregate labor productivity growth in the short term (3 years) but ***between firm*** variation plays a stronger role in the long term (5 years).

- *2.* ***Between firm*** effect varies significantly across countries. Among industrialized countries, it is higher in the US, reflecting a greater role for the reallocation mechanism from less productive to more productive firms. In addition, turnover of firms has a larger contribution to TFP than to LPG in the long term.

- *3.* The ***covariance*** term is negative in most European countries, implying that industries experiencing an increase in productivity are also downsizing their employment rather than expanding it, except in Nordic countries, where a positive covariance term illustrates the job market turnover effect in which job market creations compensate job market destructions.

Entry and exit effects

- 4. The long-run effect of ***entry*** on aggregate manufacturing productivity growth has a smaller magnitude in Europe than in the US (Bartelsman *et al*. 2004). Other studies (Aghion *et al.* 2003) show that the effect of entry depends on the ***industry's distance to the worldwide technological frontier***: The positive effect of entry on productivity growth is all the more significant when incumbents are closer to the technological frontier in the industry (Boone, 2000 offers an interesting theoretical justification).
- 5. The ***exit*** *effect* is always positive : exiting firms are the least productive firms indicating that removal of barriers to exit is just as important as removal of barriers to entry.
- 6. The ***net entry*** effect (entry - exit) is generally positive, accounting for a non negligible part of the aggregate manufacturing productivity growth across countries. This part is relatively high in some US sectors as the retail and wholesale industries (Foster et al., 1998).

Labor productivity variations across sectors

- LPG in sub-sectors of the manufacturing industry vary according to technology intensity.
- Contribution of entrants to labor productivity variation is insignificant or negative in **Low-tech sectors**, whereas it is much more significant and positive in **Medium and high-tech industries**, indicating that the *creative destruction process* is more effective in these last industries.
- Other studies (Nicoletti *et al*., 2003; Conway *et al*., 2006) show that more restrictive regulation lowers productivity growth, indicating that regulatory restraints impede technology diffusion

To summarize

- European technology gap mainly located in high-tech sectors where the global positive shock induced by ICT in the US during the 1990s has not been matched in Europe.
- European technological gap results partly from an inappropriate industrial structure in which small firms occupy the main part of total employment without playing a significant role in the dynamics of the industry, illustrated by their inability to leapfrog incumbents.
- The churning that characterizes the creative destruction process in a knowledge based economy is hindered in Europe by institutional obstacles that result in barriers to growth by small innovating firms.

2. What policy implications? First view

- Dosi, Llerena & Sylos Labini, 2006 emphasize two facets of the European weakness:
  - a poor performance of the system of research lagging behind the US both in basic science and in applied research leading to innovations
  - a relatively weak European industry due to smaller and weaker corporate firms in worldwide oligopolistic markets
- Policy suggestions by Dosi *et al.*
  - Increase support for high quality basic science
  - Develop the higher education system by funding research oriented universities among other forms of tertiary education
  - Push back the boundaries between *open research* and *appropriable research*
  - Develop large-scale, technologically daring missions
  - Rediscover the use of industrial policies as a device to foster a stronger, more innovative, European industry

- **This view recommends therefore more effort towards policy measures aimed at strengthening both frontier research and European corporate actors →Scientific policy and Industrial policy**

2.2 My view

- In my view, supported by previous observations, European technology gap finds its origin in somewhat different sources, even if not totally different:
  - i/ ***inappropriate industrial structure*** in which the main part of the activity is still in traditional capital intensive sectors in which productivity growth comes at the expense of employment,
  - ii/ **insignificant role of SMEs** in the industry dynamics, despite their important weight in total employment,
  - iii/ **institutional obstacles** that hinder the creative destruction process (lack of venture capital, labor market rigidities, concentration of public subsidies towards big projects, restrictive regulatory framework particularly in services, etc.),
  - iv/ **too weak financial effort** devoted to both basic science and applied research (publicly or privately funded), both at the EU level and the member countries level.

Policy implications

- Even if the two views share a lot of common features, they do not lead to the same overall policy implications, insofar as they differ in their methodological approach.
- I emphasize the *market industry dynamics* from which labor productivity growth occurs, while Dosi *et al.* focus on the *voluntary role of the State* through an industrial policy to promote European firms.
- In my view, no single supply-side policy could be sufficient. Illustration: the construction of the internal market put a too strong emphasis on maintaining competition as the main instrument to foster innovation. But, even if competition policy is still desirable, it is in no way a sufficient instrument for filling the technological gap (Encaoua and Guesnerie, 2006)

3.1 Complementary structural policies

- **Defining the appropriate structural reforms to strengthen an active creative destruction process in product and labor markets is a difficult question.**
- **A tentative and very incomplete list of complementary structural reforms should include:**
  - **Labor market reforms complementing drivers of productivity growth**
  - **Public procurement policy at the European level**
  - **Substantial increase of the public R&D budget and greater efficiency of the funding process both at the European and member countries levels**
  - **Reinforced cooperation between specific member countries to foster technologically daring missions in specific areas as: Defense, Health, Energy, Transport, Infrastructure, Space**
  - **Creation of a genuine European IP system available at a cheap cost**
  - **Liberalization of services including banking, financial activities, retail and wholesale trade**
  - **Creation of a common regulatory framework for European public utilities**
  - **Strong action to drive forward the higher education system in Europe**

Complementary requirements

- ***First complementary requirement*: reforms favoring both labor productivity and rate of employment.**
- Drivers of productivity growth are well known: investment in knowledge, improvement of skills by education and training, more favorable management practices and labor relationships, removals of barriers to entry and barriers to growth, services liberalization, consistent policy in favor of SMEs
- But, drivers of productivity growth are not sufficient. They must be complemented by labor market reforms allowing job creation to compensate job destruction
- *Illustration*: Failure of the European Services Directive, due to the absence of a coordinated labor market reform (Delgado, 2006). Workers of the wealthier member states fear that services liberalization should be an open door to service providers from countries where wages are lower and social protection less developed.

Complementary requirements

- ***Second complementary requirement*: basic science and applied research**
- The Lisbon's objective of reaching 3% level of R&D intensity is not under the exclusive control of public authorities. Private R&D effort is still too weak in Europe because R&D is too strongly concentrated among larger firms.
- Public R&D effort is also insufficient. *Illustration*: FP7 budget = € 50 billion for 7 years (2007-2013) in all areas, contrasted to the US NHI budget: $ 28 billion for 1 year, devoted only to medical research! Indirect public funding by the EBI, initiated in 2000, could contribute to supplement the FP budget. Possibility also to increase the FP budget by allocating to this budget the revenue collected by fines paid by the cartel members (leniency program).

Complementary structural policies

- Opportunity also to introduce some institutional innovations as:
  - creation of a judicial statute for a genuine European enterprise,
  - creation of a trans-European venture capital market devoted to risky projects and young innovating firms,
  - development of a European Agency for the Defense procurement policy,
  - creation of some European versions of the US Small Business Act and Small Business Innovation Research Act.

3.2 Implementation level

- At what level should the structural reforms be implemented? The question is crucial.
- The initial Lisbon agenda (2000) introduced the so-called "Open Coordination Method" (OMC) in which European countries agreed to *voluntarily cooperate* in areas that remained the preserve of member states.
- The failure of this agenda, 5 years after its launch, led to the Kok report (2004) recommending three key changes:
  - More limited policy goals
  - Provision of appropriate EU funding
  - A "Stick and Carrot" mechanism in which poor performing countries would be "named and shamed" while best performers would be rewarded (as for the budget deficit constraint)

Implementation level

- The 2005 European Council retained only the first of these governance principles. The revised Lisbon (2005) maintains National Reform Programs (NRP) in which country members keep the political responsibility in implementing “less but the same” objectives as in the initial Lisbon.
- This raises two questions:
  - Is it rational to maintain “national political ownership” for some structural policies while adopting “common implementation rules” for others?
  - Is it feasible to fully coordinate at the European Union level the same set of structural policies, given the heterogeneity between country members?

Coordinated or delegated implementation?

- Argument from the budget federalism theory (Tabellini and Wyplosz, 2004):

- In a free-trade area, a structural reform in a single country has in general **cross-border effects** (externalities). Some unilateral reforms involve externalities that are **pecuniary**, in the sense that they benefit to the citizens of that country without harming other countries. Price or wage effects.
- For instance, a **labor market reform** aimed to reduce unemployment or to improve labor productivity in one country is supposed to be of the pecuniary type, since it essentially boosts the growth in that country without harming others. In addition, it signals the successful method to other countries. This suggests that its implementation does not require coordination between countries.

Coordinated or delegated implementation?

- In contrast, a reform presenting externalities of the **non-pecuniary** type involves higher cross-border effects that are not reduced to wage and price variations. It therefore requires a common implementation level.
- **Competition policy** offers an illustration of such non-pecuniary externality. Collusion and Mergers under the same standards in the EU. The European Commission control of the **state aids** rests also on this argument, insofar as a state aid distorts the exchange terms that result from a free-trade mechanism.

Coordinated or delegated implementation?

- Do these arguments allow a precise frontier between the reforms that should be left to national sovereignty and those that should be coordinated at the European level ?

- Main arguments in favor of autonomous reforms:
  - The heterogeneous positions of country members
  - The learning effect: each country learns from the others

- Main arguments against autonomous reforms are:
  - National priorities too often prevail over a commonly European agreed agenda
  - Risk of watering down the whole exercise of the renewed Lisbon agenda

- Despite the difficulty to reach an overall assessment on the merits and drawbacks of the two implementation procedures, I think that the arguments in favor of coordinated reforms outweigh those against cooperation and coordination.

A word to conclude

- Finally, return to the initial question: Can Europe catch-up to the US in the technology race? Refining the diagnosis is not sufficient. In my view, the answer depends on the level of cooperation and coordination in implementing the supply side policies, discussed so far. Until recently, this cooperative framework was lacking, particularly in the Euro-zone.
- However, to conclude on a less pessimistic view, one can say that the recent thrill in favor of the pursuit of the European construction, after the previous negative vote of the French and Dutch citizens against the European Constitution Treaty, is an encouraging signal. A positive answer in long term cannot be discarded, insofar as impediments to build a knowledge-based society in Europe are no more considered as inbred obstacles that are inevitably to persist.