# How to close the Productivity Gap between the US and Europe:
## A quantitative assessment using a semi endogenous growth model

Werner Röger, Jan in ‘t Veld,
Janos Varga

European Commission
DG ECFIN

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Europe's productivity performance

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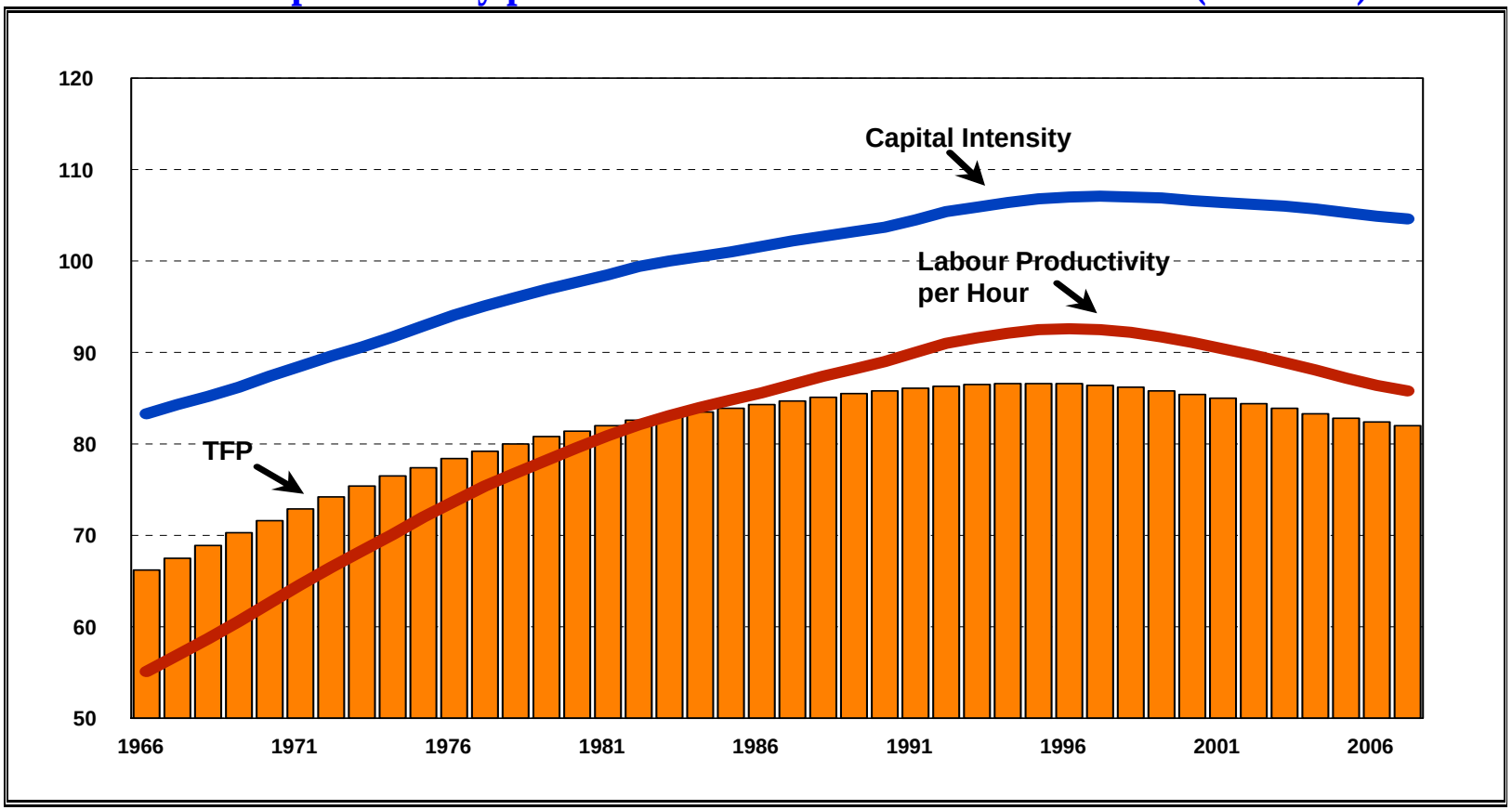
## Labour productivity per hour levels – EU15 relative to the US (US = 100)



This paper:

1. What are the factors preventing further convergence?

2. How is the productivity gap related to other observed stylised differences?

   - The EU has a knowledge (R&D) investment share which is only about 2/3 of the US level.

   - The US has a higher skill premium (about 20% more for high skilled workers (engineers and scientists) compared to the EU).

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Possible explanations often found in the literature:

Product Market Competition and Regulation
E. g.: Bayoumi (2004), OECD (2003)

Education,Skill composition
E. g.: de la Fuente (2003) Woesmann (2006)

Financial Market Frictions
E. g.: Aghion and Scarpetta (2007)

R&D Policy
E. g. Mairesse (2006), Mohnen (2007)

(Labour market)

In this paper we ask the following questions:

- What is the relative importance of these four factors for explaining the productivity gap?

- Can differences in product market competition, skill distribution, financial markets also explain the other stylised facts?

For this purpose we use an endogenous growth model (Jones)
In order to better understand how

Productivity
R&D and
Skill premia

interact with each other.

The presentation is organised as follows:

- Model description
- Discussion of structural differences between EU and US in the four areas mentioned above
- Results from our "accounting exercise"

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## Why using a semi-endogenous growth model?

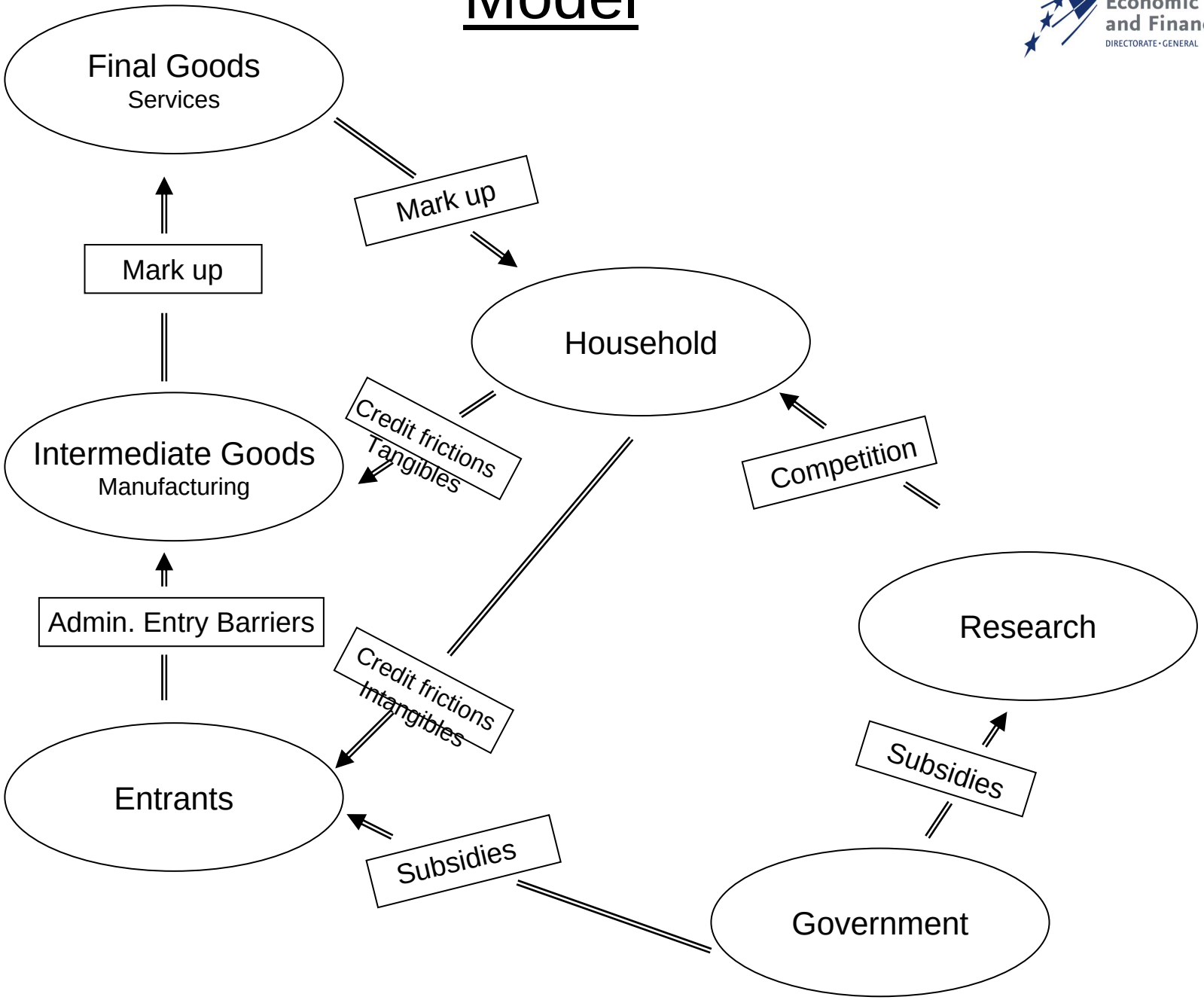
It can be used to explain long run GDP level differences

We want to explain productivity and R&D simultaneously

We want to trace how concrete (policy) measures affect various macro variables: productivity, R&D, wages (wage structure) and employment.

We want to distinguish between short and long run effects.

# Model


Final Goods
Services
Mark up
Mark up
Household
Intermediate Goods
Manufacturing
Credit frictions
Tangibles
Competition
Admin. Entry Barriers
Credit frictions
Intangibles
Research
Subsidies
Entrants
Subsidies
Government

# Knowledge Investment in QUEST

Households require a rate of return on intangible capital (A) which is given by the following arbitrage relationship:

$$i_t^A \approx \left(i_t - \pi_{t+1}^A + \delta^A\right) + rp_t^A$$

$i^A$: Rental rate required by the investor
$i$: Risk free rate of return
$\pi^A$: Inflation rate (capital gain) on intangible capital
$\delta^A$: (Economic) depreciation rate on intangible capital
$rp^A$: Risk premium on intangible capital

Market entry occurs until the PDV of profits (where the discount factor contains the risk premium for intangible capital) is equal to the price of the patent (intangible) and a fixed entry cost

$$P_t^A + FC_X = \sum_{\tau=0}^{\infty} \prod_{j=0}^{\tau} \left( \frac{1}{1 + r_{t+j} + rp_{t+j}^A} \right) PR_{t+\tau}^x$$

.

In this set up knowledge investment could be low because of

1. High financing costs ($rp^A$ is large)
2. High administrative entry barriers ($FC_X$ is high)
3. High price($P_A$) for intangible capital (inefficient research sector)
4. Low profits (high costs for tangible inputs in the production of intermediate products)

# Structural Differences: EU - US

| | EU | US | Source |
|---|---|---|---|
| **R&D sector** | | | |
| Research workers (%of L) | 0.01 | 0.02 | EUROSTAT/OECD |
| $\psi$ Efficiency per worker | 0.73 | 0.86 | calibration (constrained by equations) |
| $\lambda$: Domestic K. stock | 0.53 | 0.64 | Bottazzi-Peri (2007)/Coe-Helpman (1995) |
| $\gamma$: Foreign K. stock | 0.45 | 0.32 | Bottazzi-Peri (2007)/Coe-Helpman (1995) |
| **Intermediate sector** | | | |
| Mark up | 0.11 | 0.12 | ECFIN estimate (EU-KLEMS) |
| Risk-premia on intangibles | 0.05 | 0.03 | calibration (constrained by equations) |
| Administrative entry costs | 0.38 | 0.02 | Djankov LaPorta Lopez Shleifer |
| **Final goods sector** | | | |
| Final good mark up | 0.24 | 0.20 | ECFIN estimate (EU-KLEMS) |
| **Skill distribution** | | | |
| Low skilled | 0.35 | 0.12 | EUROSTAT/OECD |
| Medium skilled | 0.59 | 0.80 | EUROSTAT/OECD |
| High skilled | 0.06 | 0.08 | EUROSTAT/OECD |
| **Efficiency levels** | | | |
| Low skilled | 1.00 | 1.00 | calibration (constrained by equations) |
| Medium skilled | 2.10 | 4.52 | calibration (constrained by equations) |
| High skilled | 8.18 | 30.14 | calibration (constrained by equations) |
| **Taxes and subsidies** | | | |
| B-index | 0.96 | 0.89 | OECD/Warda (2006) |
| Labour taxes | 0.39 | 0.31 | ECFIN estimates |

**Determining the risk premium for intangibles:**

It is well known that the US has a more developed venture capital market.

1) US venture capitalists have more expertise.
2) Better options to terminate an engagement (IPO)
3) More opportunities to diversify risk

How can this be translated into an estimate for the risk premium on intangible capital?

As a solution of the model we obtain a long run relationship between the R&D share and structural parameters

$$R\&D = F(MUP^{Ser}\ MUP^{Man}, EntryCosts, Tax, P^{A}(researcheff.), RISK\,PREMIUM, .....)$$

# Factors explaining US-EU Gaps:

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| | Y/L | L | Skill premium high vs. medium | Skill premium medium vs. low | R&D intensity |
|---|---|---|---|---|---|
| Lower mark up (final goods) | 2.99 | 0.18 | 0.30 | -0.57 | 0.06 |
| Increase mark up (intermediates) | 0.03 | -0.01 | 1.40 | 0.00 | 0.12 |
| Reducing entry barrier | 1.07 | -0.02 | 2.38 | -0.07 | 0.20 |
| Reducing risk premia | 2.16 | -0.02 | 5.21 | 0.02 | 0.45 |
| Reducing labour tax | 1.07 | 3.32 | 1.45 | 3.08 | -0.01 |
| Skill composition | -0.30 | 5.05 | -3.26 | -1.36 | -0.01 |
| Efficiencies | 2.35 | 0.80 | 15.07 | 25.84 | -0.01 |
| R&D subsidies | 0.32 | 0.00 | 0.67 | 0.04 | 0.06 |
| Total* | 9.71 | 9.31 | 24.10 | 32.97 | 0.86 |
| Initial gap | 10.00 | 18.61 | 22.06 | 30.01 | 0.81 |

**Lower mark up (final goods):** (-4% points)

| | Y/L | L | Skill premium high vs. medium | Skill premium medium vs. low | R&D intensity |
|---|---|---|---|---|---|
| Lower mark up (final goods) | 2.99 | 0.18 | 0.30 | -0.57 | 0.06 |
| Initial gap | 10.00 | 18.61 | 22.06 | 30.01 | 0.81 |

- Closes productivity gap by about 25%
- Increases the demand from incumbents, only small entry/R&D effects
- Effects on employment and skill premia are not significant

**I**

**Increase mark up (intermediates)=shift towards high tech sectors:** (+1% point)

| | Y/L | L | Skill premium high vs. medium | Skill premium medium vs. low | R&D intensity |
|---|---|---|---|---|---|
| Increase mark up (intermediates) | 0.03 | -0.01 | 1.40 | 0.00 | 0.12 |
| Initial gap | 10.00 | 18.61 | 22.06 | 30.01 | 0.81 |

- Entry/R&D is stimulated
- Insignifcant productivity effects, because higher mark ups reduce demand for intermediates
- Small increase in the skill premium

**Reducing entry barriers:** -36% of GDP per capita (admin cost)
-2% points (risk premium)

| | Y/L | L | Skill premium high vs. medium | Skill premium medium vs. low | R&D intensity |
|---|---|---|---|---|---|
| Reducing entry barrier | 1.07 | -0.02 | 2.38 | -0.07 | 0.20 |
| Reducing risk premia | 2.16 | -0.02 | 5.21 | 0.02 | 0.45 |
| Initial gap | 10.00 | 18.61 | 22.06 | 30.01 | 0.81 |

- Reducing admin and financial entry barriers does not have offsetting price effects.
- This policy has the largest impact on productivity and R&D.
- Because of higher R&D, there is also a significant effect on skill premia. Explains about 30% of the skill premium gap.

**R&D Subsidies:** Increase rate of tax credit by 5% points

| | Y/L | L | Skill premium high vs. medium | Skill premium medium vs. low | R&D intensity |
|---|---|---|---|---|---|
| R&D subsidies | 0.32 | 0.00 | 0.67 | 0.04 | 0.06 |
| Initial gap | 10.00 | 18.61 | 22.06 | 30.01 | 0.81 |

- Moving to US levels of R&D subsidies only marginally affects R&D
- Crowding out effect in the form of an increase of high skilled wages (about 20% of the increase in R&D spending)

## Conclusions

1) An important obstacle to higher productivity levels are entry barriers in innovating sectors. Reducing them would both increase the R&D share and labour productivity in the long run.

2) Increasing competition in services could also significantly increase aggregate productivity, but not R&D.

3) Direct policy measures to increase R&D spending have only small effects on both R&D spending and productivity.

4) All these measures taken together explain about 50% of the difference in the skill premium.


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