Growth, Size, and Openness: 
a Quantitative Approach

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PSU, 2009
Growth and the Size of Countries

- Quasi Endogenous Growth Models (QEGM): growth is driven by aggregate economies of scale (Jones, 95; Kortum, 97; Eaton and Kortum, 01)

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  - \( g_y = 0.01 \) is growth rate of real output per worker in the OECD over the last four decades (K-RC, 05)
  - \( g_L = 0.048 \) is growth rate of R&D employment over the last decades in the top five R&D countries (Jones, 02)
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The Income-Size Elasticity: Data

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The Income-Size Elasticity: QEGM and Data

![Graph showing real income per worker as a share of US income for OECD(19) as a share of total OECD(19) income, with data points marked by QEGM and actual data.](image-url)
The Income-Size Elasticity: The “Belgium Puzzle”

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  - we reconcile the income-size elasticity observed in the data and the one implied by a quasi-endogenous growth model.
A Simple Growth Model (based on Kortum 1997, EK 2001)

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Technology Frontier and Growth Rate

- The economy’s technology frontier is determined by the best idea available for the production of each good.

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Intermediate goods are used to produce intermediate goods - labor share $\beta$ (EK 2002)

Using AL parameters, we get

$$\eta = \frac{1-\alpha}{\beta} = \frac{1-0.75}{0.5} = 0.5$$

Further using $g_L = 4.8\%$ and $g = 1\%$, then we need

$$\theta = 7.2$$

Growth comes from technological change in intermediate goods, $\eta g_L / \theta$, and in final goods, $g_L / \theta$, with

$$g / g_L = \frac{1}{\theta} + \frac{\eta}{\theta} = 0.21$$

$$0.07 + 0.14$$
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Intermediate goods are tradable but subject to iceberg trade costs; final goods are non-tradable
Ideas

- There are national and global ideas

\[ \dot{G}_{ni} = \epsilon \dot{N}_{ni} \]

where \( \epsilon \) is the speed of diffusion. In steady state \( \dot{G}_{ni}/G_{ni} = g_L \), hence \( G_{ni} = (\epsilon/g_L)N_{ni} \).

- We have trade and MP for intermediate goods
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  - for global ideas this is not recorded as MP
  - moreover, ideas are first national and then global (as in EK 2006),
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    \dot{T}_{ni}^G = \epsilon T_{ni}^N
    \]
    where $\epsilon$ is the speed of diffusion. In steady state
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Gains

Some results

$$GT_n = \left( \frac{X_{nn}}{\eta Y_n} \right)^{-\eta/\theta}$$

$$GMP_n = GMP_{gn} \cdot GMP_{fn}$$

where

$$GMP_{gn} = \left( \frac{Z_{gnn}}{\eta Y_n} \right)^{-\eta/\theta}$$

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- The share of global ideas is \( \kappa \equiv \iota/g_L \). Then

\[
GD_n = \left( 1 + \kappa \frac{\sum_{i \neq n} L_i}{L_n} \right)^{-\frac{1+\eta}{\theta}}
\]

(note: no efficiency loss in use of foreign global ideas)
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Finally,

\[GO_n = GT_n \cdot GMP_n \cdot GD_n\]
Start by assuming that countries interact only through Trade.
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We use data and $\eta / \theta = 0.07$ to compute

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We calculate the implied income under isolation $y_n / GT_n$. 
The Income-Size Elasticity: Adding Trade

![Graph showing the relationship between L as share of total OECD(19) and real income per worker (as share of US) implied by QEGM adjusted by GT.](image_url)

- **Y-axis:** Real income per worker (as share of US)
- **X-axis:** L as share of total OECD(19)
- **Legend:**
  - Blue dots: implied by QEGM
  - Green dots: adjusted by GT

The diagram illustrates the elasticity between economic size and income per worker, adjusted for trade, across different countries in the OECD.
The Income-Size Elasticity: still the “Belgium Puzzle”

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- Now, assume that countries interact through trade and MP, and MP is possible for tradable (T) and non-tradable goods (NT)
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- We use MP data to compute

\[
GMP_n = \left( \frac{Z_{gnn}}{\eta Y_n} \right)^{-\eta/\theta} \times \left( \frac{Z_{fnn}}{Y_n} \right)^{-1/\theta}
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We use MP data to compute

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GMP_n = \left( \frac{Z_{g_{nn}}}{\eta Y_n} \right)^{-\eta/\theta} \times \left( \frac{Z_{f_{nn}}}{Y_n} \right)^{-1/\theta}
\]

We calculate the implied income under isolation

\[
y_n / (GMP_n \times GT_n)
\]
The Income-Size Elasticity: Adding MP

![Graph showing the relationship between L as share of total OECD(19) and real income per worker (as share of US) implied by QEGM adjusted by GT and GMP.](image)
The Income-Size Elasticity: Closing the Gap

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Diffusion: Reconciling the Puzzle

- Countries interact through trade, MP, and diffusion of ideas (for both T and NT goods)

\[ GD_n = \left(1 + \kappa \sum_{i \neq n} L_i L_n \right) - 1 + \eta \theta \]

We use equipped labor to measure \( L_i \)

- We calculate the implied income under isolation \( y_n / GO_n \) where \( GO_n = GD_n \times GMP_n \times GT_n \), for \( \kappa = 0.042 \)

- \( \kappa = \frac{\epsilon}{g L} \) which implies a diffusion lag of \( \frac{1}{\epsilon} = 500 \) periods (would be lower if there were efficiency losses associated with the use of global ideas)
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- Countries interact through trade, MP, and diffusion of ideas (for both T and NT goods)
  - Diffusion: countries have access to foreign ideas at no cost

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We calculate the implied income under isolation \(y_n/GO_n\) where \(GO_n = GD_n \times \text{GMP}_n \times \text{GT}_n\), for \(\kappa = 0.042\).

\(\kappa = \epsilon / g\) which implies a diffusion lag of \(1/\epsilon = 500\) periods (would be lower if there were efficiency losses associated with the use of global ideas).
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- Countries interact through trade, MP, and diffusion of ideas (for both T and NT goods)
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The Income-Size Elasticity: Adding Diffusion
The Income-Size Elasticity: the “Belgium Puzzle” Reconciled

<table>
<thead>
<tr>
<th></th>
<th>$\varepsilon$</th>
<th>$y_{belgium} / y_{US}$</th>
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</thead>
<tbody>
<tr>
<td>Quasi Endogenous Growth</td>
<td>0.21</td>
<td>0.47</td>
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<tr>
<td>Data OECD(19)</td>
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<tr>
<td>Trade</td>
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<td>0.79</td>
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<tr>
<td>Trade + MP</td>
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<tr>
<td>Trade + MP + Diffusion ($\kappa = 0.042$)</td>
<td>0.21</td>
<td>0.47</td>
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</table>
The Gains from Openness, Trade, MP, and Diffusion

Figure: Gains and Size. OECD(19).
Final remarks

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  - We focus on Trade, Multinational Production (MP), and Diffusion of Ideas

- We show that to reconcile key facts about Trade, MP, Growth, and Size, we need to include diffusion of ideas across countries
  - even if a small country is closed to trade and MP, the data suggest that this country is much richer than implied by its small size