Are Big Cities Important for Economic Growth?

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The case for cities as "Engines of growth".

- A large literature estimates that the output elasticity of city size is about 5%.
- There is good evidence that this result extends to inventors, and that a patent elasticity of city size is also about 6% (or larger).
- Economic activity and innovation is concentrated in cities.
- These facts invite the conjecture that big cities play an important role in the growth process.
- US income per capita increased by about a factor of 6 between 1900 and 2000, a growth rate of about 1.8% per year.
- What would have happened if cities were capped at 1m people? 100k people?

Importance of city size elasticity of output, σ_A

Define the following notation

$$
\begin{aligned}
Y_t, Y_{it} &\sim \text{Total output, output of city } i, \text{ period } t \\
L_t, L_{it} &\sim \text{Total population, population of city } i, \text{ in period } t \\
A_{it} = A_i L_{it}^{\sigma_A} &\sim \text{TFP of city } i \text{ in period } t \\
Y_{it} &= (A_t L_{it}^{\sigma_A}) L_{it}
\end{aligned}
$$

To make math easy, $L_{it} = L_{jt}$, all i, j, t and $L_{i,2000} = \kappa L_{i,1900}$, then

$$
\begin{aligned}
\frac{Y_{1900}}{L_{1900}} &= A(L_{i,1900})^{\sigma_A} \\
\frac{Y_{2000}}{L_{2000}} = 6\frac{Y_{1900}}{L_{1900}} &= A(\kappa L_{i,1900})^{\sigma_A}
\end{aligned}
$$

This means $\kappa = 6^{1/\sigma_A} \approx 3 \times 10^{15}$. City size elasticity of output is too small to play an important role in the aggregate growth of per capita output.

Importance of city size elasticity of innovation I

Define the following notation

$$
\begin{aligned}
R_{it} &\sim \text{Patents in city } i \text{ in period } t \\
L_{it} &\sim \text{Population of city } i \text{ in period } t \\
\sigma_B &\sim \text{patent elasticity of city size.} \\
R_{it} &= (BL_{it}^{\sigma_B})L_{it}
\end{aligned}
$$

Assume $L_{it} = L_{jt},$ all i, j. What happens if we double the size of all cities, holding population constant and $\sigma_B = 0.06$?

$$\frac{R_t^1}{R_t^0} = \frac{\sum_1^{137} B(2L_i)^{1+\sigma_B}}{\sum_1^{274} B(L_i)^{1+\sigma_B}} = 2^{\sigma_B} \approx 1.04$$

If the growth rate is proportional to patents, this reduces the growth rate from 0.018 to $\frac{0.018}{1.04} = 0.0173$. Applied to the whole century, this means output in 2000 is 5.5 times 1900, instead of 6.0.

Importance of city size elasticity of innovation II

- This suggests that the effect of cities on innovation need not cumulate to large effects on output.
- However, σ_B could be as large as 0.2, and many cities grew by more than a factor of two. So this example does not seem conclusive.
- We assume so far that the growth rate is proportional to patenting. This is not what we observe.

Importance of city size elasticity of innovation III

- Let g denote the growth rate of output and $y_t = Y_t/L_t$ be per capita output. Bloom et al. [2020] estimate that

$$\Delta g_{t+1} = \frac{R_t}{y_t^{3.1}}$$

  With $y_{2000} = 6y_{1900}$ the contribution of a marginal patent to growth in 2000 less than $\frac{1}{216}$ of its contribution in 1900.
- The effect of city size on innovation operates most strongly towards the end of the 1900-2000 period when cities are larger.
- City size probably also does not have a large effect on the growth of output.

Big cities and growth I

- The back of the envelope calculations above suggest that big cities do not play an important role in the growth process... but we would like to be more precise about how important they are.

Big cities and growth II

- Assume (more-or-less)

$$
\begin{aligned}
Y_{it}^{base} &= (\widehat{A}_{it}\bar{A}_t(L_{it}^{base})^{\sigma_A})K_{it}^{\gamma}(L_{it}^{base})^{1-\gamma} \\
Y_{it}^{alt} &= (\widehat{A}_{it}\bar{A}_t(L_{it}^{alt})^{\sigma_A})K_{it}^{\gamma}(L_{it}^{base})^{1-\gamma} \\
\implies Y_{it}^{alt} &= \left(\frac{L_{it}^{alt}}{L_{it}^{base}}\right)^{\sigma_A} Y_{it}^{base}
\end{aligned}
$$

  For this particular counterfactual, any time invariant city specific heterogeneity drops out.

- Similarly for patents,

$$
R_{it}^{alt} = \left(\frac{L_{it}^{alt}}{L_{it}^{base}}\right)^{\sigma_B} R_{it}^{base}
$$

Big cities and growth III

- Finally,

$$\Delta g_{t+1} = \frac{\Delta A_{t+1}}{A_t} = \frac{R_t}{A_t^{3.1}}$$

- Summing the first two over cities, these three equations are a complete description of how output, patents, and TFP evolve over time under the observed system of cities and a counterfactual where city sizes are capped.

Big cities and growth IV

- We calibrate these three equations using 100 years of MSA level data describing population and patents, one cross-section of city level output data for 2010, and central estimates for σ_A and σ_B.

  $\Longrightarrow$ Counterfactual output as a share of realized output in 2010 when city size is capped at 1m,

	$\sigma_B = 0.06$			$\sigma_B = 0.20$		
σ_A	0.04	0.08	0.12	0.04	0.08	0.12
$\lambda = 1.00,\ \beta = 3.1$	0.917	0.863	0.816	0.877	0.825	0.780
$\lambda = 0.75,\ \beta = 2.4$	0.919	0.865	0.817	0.880	0.829	0.783
$\lambda = 1,\ \beta = 0$	0.866	0.815	0.770	0.741	0.697	0.658

Conclusion

Are big cities important for economic growth?

- Probably not. It is too hard to get to a factor of 6 with 5% city size elasticities. The increasing difficulty of economic growth makes it even harder for big cities to be important.
- Without big cities we probably get about the same level and growth of output from smaller cities.
- This conclusion should be treated narrowly. Moving subsistence farmers into cities is probably good for growth.
- We make no claims about welfare or real income.

Bibliography I

Nicholas Bloom, Charles I Jones, John Van Reenen, and Michael Webb. Are ideas getting harder to find? *American Economic Review*, 110(4):1104–1144, 2020.