THE EFFECTS OF PUBLIC INVESTMENT ON PRODUCTIVITY

An analysis of infrastructure spending

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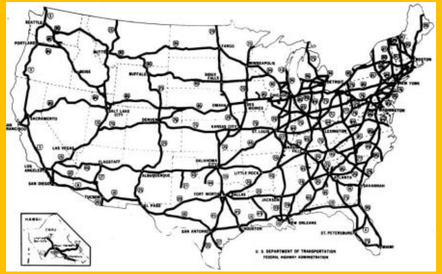
MATH 2414

Types of public stimulus

- Tax decrease
  - Decreases tax burden to put more cash into markets
  - Decreases public revenues
- Direct payments
  - Increases money supply in markets
  - Increases public deficits
- Subsidies
  - Decreases prices for consumers by paying industry
  - Increases deficits
- Infrastructure projects
  - Increases money supply with shovel ready jobs
  - Provides logistics for productive activity
  - Increases deficits

Infrastructure and subsidies



- High speed rail (HSR)
  - Japan and China
- Eisenhower Interstate system
  - For every $1 spent has created $6 of economic activity
- NASA patents
  - Gave SpaceX and other private companies cost savings on prior research
- Google NSF grants
  - $4.5 million grant turned into a trillion-dollar company plus spillover effects

Research Methods: Highspeed Rail

High-speed rail and regional economic productivity through agglomeration and network externality: A case study of inter-regional transportation in Japan

The average share of HSR distance out of total trip distance, represented by d_i, is defined as:

$$d_i = \frac{1}{N} \sum_{j \in N} \left[\frac{DH_{ij}}{D_{ij}} \right]$$

The average share of HSR travel time out of total travel time to/from a region, represented by r_i, which is defined as:

$$r_i = \frac{1}{N} \sum_{j \in N} \left[\frac{TH_{ij}}{T_{ij}} \right]$$

Does High-Speed Rail Promote Enterprises Productivity? Evidence from China

$$\ln\_persale_{cit} = \delta_0 + \delta_1 d\_hsr_{ct} + \delta_r X_{it} + \delta_m \Omega_{ct} + \delta_n \nu_{ct} + \lambda_c + year_t + \phi_i + \varepsilon_{cit}.$$

Research Methods: General Infrastructure

- Public Infrastructure and Economic Productivity A Transportation-Focused Review
- Public Productive Infrastructure and Economic Growth
- Estimating Productivity of Public Infrastructure Investment

The general equilibrium approach to the problem of public infrastructure productivity offers attractive solutions to these and other issues. To illustrate a basic example and clarify the above discussion, Haughwout's (*41*) model is followed. Firms produce output as with Equation 1, but minimize costs, defined as

$$C = WL + P_Z Z \tag{6}$$

where W is the wage rate for labor L, and Z is a local land input with rent P_Z. Households maximize utility obtained from consuming output Y, land Z, and public infrastructure G, represented by

$$U = U(Y, Z, G) \tag{7}$$

but are constrained by a fixed income earned by inelastically supplying one unit of labor in the production process. Thus,

$$W = P_Y Y + P_Z Z \tag{8}$$

$$Y_1 = t_{11}Z_1 + t_{21}Z_2 + \ldots + t_{n1}Z_n$$

$$Y_2 = t_{12}Z_1 + t_{22}Z_2 + \ldots + t_{n2}Z_n$$

.

$$Y_n = t_{1n}Z_1 + t_{2n}Z_2 + \ldots + t_{nn}Z_n$$

Being: Y_i the i-th factor, Z_j the typified variable S_j and t_{ij} the weightings.

2.4 Calculating the Return

With estimates of β, the firm-specific elasticity e_{it} defined in (5) can be obtained by a nonparametric/polynomial regression, where ω_{it} is obtained by (7). Then, we use sales revenue of each firm as the weight to aggregate these firm-level output elasticities into an industry average, and adjust the ratio between value-added and sales revenue:

$$e_{st} = \left(\sum_i e_{it} \frac{R_{ist}}{R_{st}}\right) \frac{dv_s}{dr_s}, \tag{9}$$

where $\frac{R_{ist}}{R_{st}}$ represents firm i's revenue as a share of total revenue in industry s and year t; the ratio $\frac{dv_s}{dr_s}$ is obtained by a fixed-effect regression of log value-added on log sales revenue for industry s. Finally, we use value-added of each industry as the weight to aggregate these industry-level output elasticities into an average for the manufacturing sector:

$$e_t = \sum_s e_{st} \frac{V_{st}}{V_t}, \tag{10}$$

where $\frac{V_{st}}{V_t}$ denotes industry s's value-added as a share of total value-added in the manufacturing sector in year t.

Eisenhower Interstate System

- For every dollar spent at least $6 in economic activity is generated annually
- That's a 600% return on investment per year
- We can fashion projected economic outcomes as a geometric series

$$s_n = \frac{a_1(1-r^n)}{1-r}$$

$$a = 1$$

$$r = 6$$

$$|r| > 1$$

Diverge

Geometric Series

- Current proposed infrastructure bill is $2 trillion
- Conservative estimates give a .3 percent increase in GDP per year

$$I(n) = \$2T \sum_{k=0}^{n} 0.3^k$$

Year	0	1	2	3	4
Economic Growth	$\$0$	$0.3 * \$2T = \$600B$	$0.3^2 * \$2T = \$180B$	$0.3^3 * \$2T = \$54B$	$0.3^4 * \$2T = \$16.2B$

Annual Growth

$$s_n = \frac{a_1(1 - r^{n+1})}{1 - r}$$

$$s_n = \frac{\$2T(1 - 0.3^{n+1})}{0.7}$$

$n(year)$	$n = 1$	$n = 2$	$n = 3$	$n = 4$
Economic Growth	$\$2.6T$	$\$2.78T$	$\$2.843T$	$\$2.8502T$

Finding the convergence of growth

$$I = \lim_{n\to\infty}\sum_{k=0}^{n} Ar^k = \frac{A}{1-r}$$

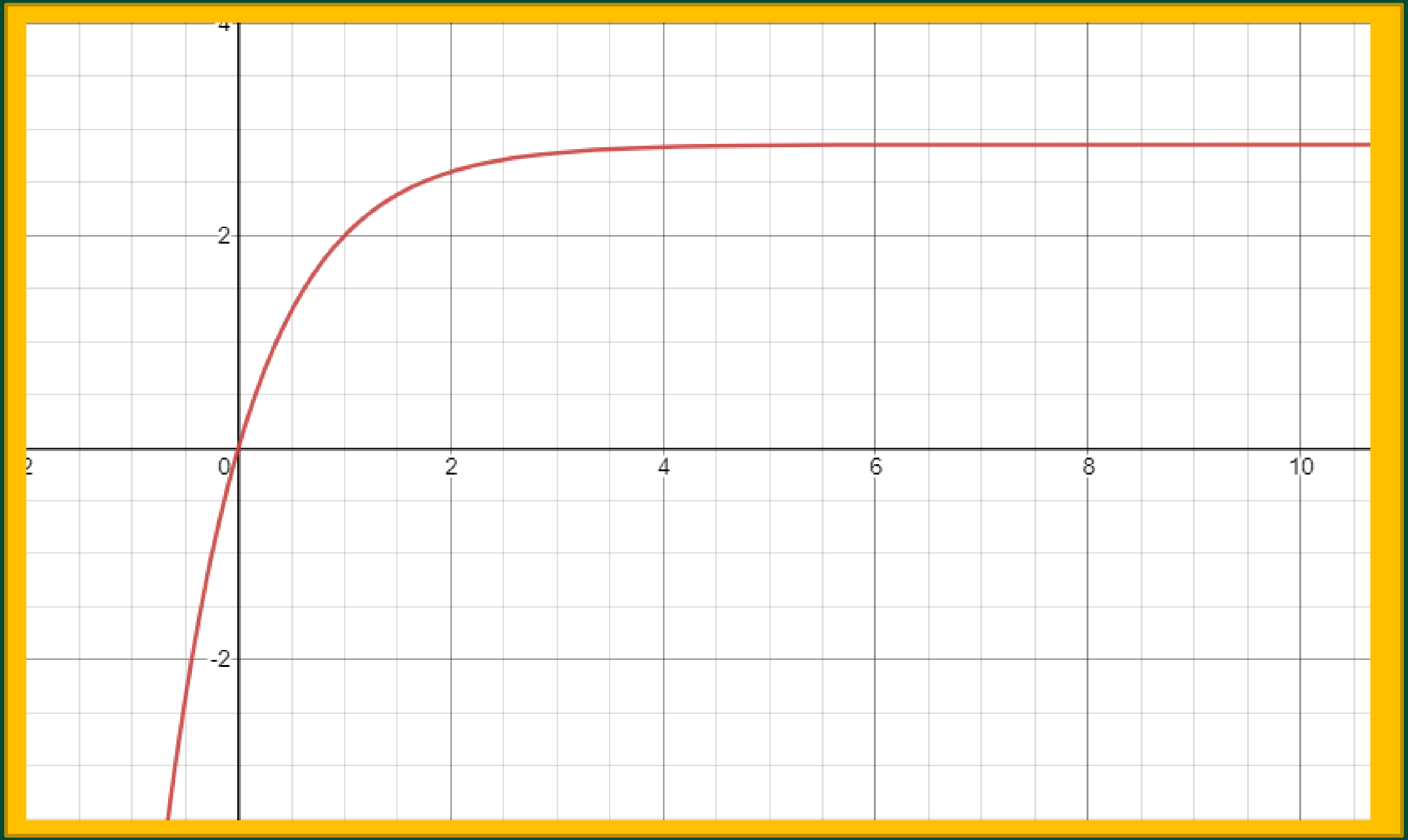
$$= \$2.85714T$$

Reaches convergence
after 10 years

$n(year)$	$n = 1$	$n = 2$	$n = 3$	$n = 4$	$n = 5$	$n = 6$
Economic Growth	$\$2.6T$	$\$2.78T$	$\$2.843T$	$\$2.8502T$	$\$2.85506T$	$\$2.85652T$

$n(year)$	$n = 7$	$n = 8$	$n = 9$	$n = 10$	$n = 11$
Economic Growth	$\$2.85696T$	$\$2.85709T$	$\$2.85713T$	$\$2.85714T$	$\$2.85714T$

Convergence



Conclusions

- You can use these analysis to show the benefits of public investment
- Private business has a place but public spending often does the heavy lifting
- Public spending is especially beneficial for non-excludable and non-rivalrous goods

Sources

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