

Table 6. Summary of Studies of the Productivity Effects of Highway Infrastructure and Other Public Capital

Study	Sample	Type of Estimation	Sector or Output Measure	Public Infrastructure		Private Inputs		Notes
				Type	Elasticity	Type	Elasticity	
Ratner 1983	U.S. Aggregate, 1949-73 (Time Series)	Production function, Cobb-Douglas	Private business sector output	Public capital: non-military, government owned equipment & structures	Output elasticity: 0.05-0.06	Labor/capital, capital adjusted for capacity utilization	L: 0.71-0.72 K: 0.22	
Costa, Ellson and Martin 1987	U.S. 28 States, 1972 (Cross Section)	Production function, Translog	All sectors manufacturing non-agriculture	State and local public capital	0.20 for all sectors, .19 for manufacturing, 0.21 -0.26 for non-agriculture	Capital, labor	K: -0.06-0.11	Public capital complementary to labor
Keeler and Ying 1988	U.S 9 Regions, 1950-1973 (Time Series/Cross Section)	Cost function, Translog	Trucking industry	Federal-aid highway capital stock	Cost elasticity: -0.07	Capital, labor, fuel, other materials and services		
Deno 1988	U.S. 36 Metropolitan Areas, 1970-1978 (Time Series/Cross Section)	Profit function, translog	Manufacturing	Highways and bridges; water; sewer	Output supply elasticity of highway/ bridge capital: 0.31-0.57	Capital, labor		Highway capital complementary to private capital in growing regions; complementary to labor in full sample
Mills and Carlino 1989	U.S. Approx. 3000 Counties, 1970-80 Growth (Cross Section)	Determinants of county employment and population growth, Simultaneous equation estimation	Total employment, Manufacturing employment, Population	Interstate highway density	Over decade: 0.54 total employment: 0.17 population			
Aschauer 1989	U.S. Aggregate, 1949-1985	Production function, Cobb-Douglas	GNP/private capital	Non-military public capital and core public capital	Non-military 0.39 core 0.24	Labor/private capital	0.38	
Munnell 1990	U.S. Aggregate, 1948-1987	Production function, Cobb-Douglas	GNP	Core public capital	0.31 – 0.39	Capital, labor	K: 0.56 L: 0.11	

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Aschauer 1990	U.S. 48 States (Cross Section)	Determinants of average annual growth rate	State per capita income	Average total highway mileage, 1960-85; disaggregated into rural and urban mileage	Total: 0.22-0.37 Rural: 0.24-0.40 Urban: 0.10-0.17			Higher pavement quality contributes to growth: vehicles/highway mile as congestion measure retards growth
Duffy-Deno and Eberts 1991	U.S. 28 Metropolitan Areas, 1980-1984 (Time Series/Cross Section)	Simultaneous equations; personal income and public investment	Per capital personal income	Public capital	Personal income elasticity of public capital 0.08	Capital, labor, energy		
Eisner 1991	U.S. 48 States, 1970-1986 (Time Series, Cross Section,	Production function, Cobb-Douglas and Translog	Gross State Product	Public capital insignificant, highway 0.05-0.07 in time series; public capital 0.16, highway 0.06 in cross section	Capital, labor	K: 0.29 L: 0.77	Uses data from Munnell 1990; estimates of first differences sensitive to scale constraints	
Tatom 1991	U.S. Aggregate 1950-1988 (Time Series)	Production function, translog, 1 st differences	Private business sector output	Public capital	0.03, not significant	Capital, labor energy	L/K: 0.69 E(price): -0.06	Energy price variable derived from 1 st order condition on energy use

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Garcia-Mila and McGuire	U.S. 48 States, 1969-1983 (Time Series/Cross Section)	Production function, Cobb-Douglas	Gross State Product	Highway capital	0.04	Capital structures, capital equipment, labor	Total K: 0.47 L: 0.36-0.45	
Hulten and Schwab 1991	U.S. 9 Regions, 1951-1986	Multifactor productivity	Manufacturing	Public capital	Not significant	Capital, labor, materials		Model predicts significant coefficient on K if public capital operates through production function; but K coefficient is significant & public capital coefficient is insignificant; interpretations unclear
McGuire 1992	U.S. 48 States, 1969-1983 (Time Series/Cross Section)	Production function, Cobb-Douglas (state fixed effects); translog	GSP	Highway capital	C-D (fixed eff.): not significant translog: 0.24	Capital, labor	K: 0.23-0.46 L: 0.70-75	First-differencing to correct measurement errors in public capital yielded insignificant highway output elasticities

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Hulten and Schwab 1991	U.S. 9 Regions, 1951-1976 (Time Series)	Multifactor productivity	Manufacturing	None		Capital, labor		No observed role for public infrastructure in different interregional growth rates
Morrison & Schwartz 1992	U.S. States	Cost function		Annual cost reduction due to infrastructure investment varies between 15-30%				
Carlino & Voith 1992	U.S. States	Production function						Highway density in states increases productivity by 21%, urbanization impact 38%
Jones, Miaow, Lee and Rickert 1993	U.S. States, 1983-1989 (Time Series/Cross Section)	Production function, Cobb-Douglas, 5 equation system	GSP/L	Lane mileage, vehicle miles traveled, separate urban and rural, different groups of highway classes	VMT: 0.16-0.23 LM, total: 0.09-0.14 urban VMT, LM: positive rural VMT, LM: negative	Capital /labor	K/L: 0.36-0.38	Endogenous congestion and VMT
Moomaw and Williams 1991	U.S. 48 States, 1954-1976 (Time Series/Cross Section)	Multifactor productivity	Manufacturing	Highway density	Significant positive effect			Use regional dummies with state data
Nadiri-Mamaneus 1996	U.S. 1947-1989	35 Industries	Highway capital, non-local highway capital	Cost elasticity -0.044				Net rate of return for highway capital, contribution to TFP growth by industry

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Mera 1973, '75	Japan 8 Regions 1954-1963 (Time Series/Cross Section)	Production Function, Cobb-Douglas	Primary, Secondary, Tertiary	Transportation and communication; 3 other categories	0.35** for transport & communications in secondary; 0.39-0.42 in tertiary; transp. and comm. Not used in primary	Capital, labor	K: 0.15-0.33 L: 0.55-0.85, according to sector	
Elhance & Lakshmanan 1988	India National 1950-1979 (Time Series) And 6 States 1970-1971 (Cross Section)	Normalized restricted cost function, Translog, with endogenous private adjustment to publicly supplied infrastructure	Manufacturing Value Added	Economic infrastructure (roads, rail, electric capacity); Social infrastructure (hospital beds, etc.)	Economic infrastr. cost elasticities; at state level, -0.04 to -0.47; at national level - 0.01 to - 0.03	Capital, labor energy, materials		Adjustment period of about 5 years
Seitz 1995	Japan	Production function						GDP/land area a function of capital, labor, road system attributes & level of urbanization
Johansson 1993 Johansson & Karlsson 1994	Sweden 280 And 284 Munic. 1980-1988 (Time Series/Cross Section)	Production function, Cobb-Douglas	Aggregate income, Industry-level income	Highway capital, Public transit capital, Road accessibility	Highway 0.12-0.18; Public transp. 0.18-0.20; Road accessibility 0.20-0.27	Capital, labor	K: 0.47-0.50	Adjustment periods of 14-26 years, depending on industry
Seitz 1993	Germany 1970-1989 (Time Series/Cross Section)	Cost function, Translog, industry fixed effect time series	Real output, 31 Industries	Road mileage, Road capital	Negative and significant	Capital, labor		Roads complementary to private capital, substitute for labor; these effects small

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Seitz 1994	Germany 1970-1989 (Time Series/Cross Section)	Cost function, Translog, industry, Fixed effect time series	Public capital, "Core" public capital	On demand for: 0.36 on demand for L: -0.13 to -0.15	Capital, labor	Rental elasticity of K demand, -0.04; wage elasticity of L demand, -0.09		
Conrad And Seitz 1994	Germany, 1961-1989 (Time Series/Cross Section)	Cost function, Translog	Gross output, 3 Sectors; Manufacturing, construction, Trade & transport	Public capital	Negative & significant	Capital, labor, material		Estimated shadow price of public infrastructure approx. Half of user cost of private capital; decrease in pub infrastr. Partially responsible for observed productivity decline
Lynde And Richmond 1992	United Kingdom Aggregate, 1958-89 (Time Series)	Cost function, Translog	Manufacturing	Public capital	Significant cost reduction effect	Capital, labor		Public capital complementary to private capital; aggregate constant returns to scale with public capital
Lynde And Richmond 1993	United Kingdom Aggregate 1966: 1-1990; 2 (Time Series)	Cost Function Translog (Cointegrated)	Manufacturing, Value added	Public capital	Significant cost reduction effect	Capital, labor, materials		Public capital contributes 17% of manufacturing productivity growth

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Anderson, Anderstig And Harsman 1990	Sweden 70 Commuting Regions 1970 and 1980 (Cross Section)	Production function, Variable returns to scale	Aggregate income	Main roads, railroads, airport capacity accessibility	Roads significant in 1980; rail significant in 1970; airports significant only when interacted with R&D	Capital, labor	K: 0.25 L: 0.28; 0.57-0.75 combined with knowledge capital	
Prud'homme 1993	France, 22 Regions, 1981-1988 Growth (Cross Section), 1988 (Cross Section)	Production function, Cobb-Douglas	Aggregate income/L	Public capital	Significant only when measured per unit of L times land area	Capital/labor	K/L:0.20-0.26	