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The Productivity of Transport Infrastructure Investment: A Meta-Analysis of Empirical Evidence

Patricia C. Melo, Daniel J. Graham, Ruben Brage-Ardao
Centre for Transport Studies
Department of Civil and Environmental Engineering
Imperial College London
London SW7 2AZ

ABSTRACT

The study of the effect of transport infrastructure on economic output has been the focus of extensive research over the past decades and has produced widely varying results. Transport infrastructure has been hypothesised to impact on the economy by different strands of economics. Classical location theory emphasised the role of transport costs as a determinant of the location of economic activities (Weber, 1928, Moses, 1958, Alonso, 1964). The New Economic Geography (NEG) also emphasizes the role of transport costs as a location factor within the context of imperfect competition and different degrees of interregional labour mobility (Fujita et al., 1999, Fujita and Thisse, 2002). The macroeconomic theory of endogenous growth also developed a framework in which public infrastructure (including transport infrastructure) can be defined as a source of economic growth through its contribution to technical change (Aschauer, 1990, Munnell, 1992, Hulten and Schwab, 1991, Garcia-Mila and McGuire, 1992).

Alongside a reduction in transport costs, transport improvements lead to a reduction in firms' input costs and thus increased factor productivity. In addition, lower production and distribution costs induced by transport improvements can also result in scale effects and foster competition levels, which in turn result in higher productivity levels due to a natural selection process in favour of more productive firms (Nocke, 2006, Baldwin and Okubo, 2006, Melitz and Ottaviano, 2008). Another important contribution of transport to productivity relates to what the literature generally terms as 'transport-induced agglomeration effects'. Agglomeration economies occur when economic agents (firms, workers) benefit from being close to other economic agents. By improving the access of workers and firms to economic activity, transport affects the realization of agglomeration externalities and hence the productivity effects derived from it (e.g. Eberts and McMillen, 1999, Graham, 2007).

The hypothesis that investments in transport infrastructure produce strong economic benefits and foster growth has justified government funding for new and improved transport infrastructure. This view is supported by early estimates of the output elasticity of transport, which have been criticised since the late

1990s on the grounds of model misspecification and spurious relationships. The first estimates of the impact of transport investment on the economy relied heavily on models affected by two main estimation issues in this empirical literature, namely: (i) simultaneity bias, and (ii) omitted variable bias. Simultaneity bias results from reverse causality between economic output and transport investment, while omitted variable bias is a problem of model misspecification which occurs when relevant covariates are not considered in the model. Both estimation issues result in inconsistent estimates of the output elasticity of transport.

In this research we are interested in the effect of transport infrastructure on private output. There are various survey papers (Munnell, 1992, Gramlich, 1994, Rietveld, 1994, Boarnet, 1997, Banister and Berechman, 2000, De La Fuente, 2000), and some meta-analyses (Button, 1998, Bom and Ligthart, 2008, Bom and Ligthart, 2009), on the productivity of public capital. However, these review papers have focused on the role of total public capital. Public capital is a broad term that includes different types of capital, which are expected to differ in the degree to which they impact on private output. There is general agreement that core infrastructure (of which transport infrastructure represents a large part) is expected to have a stronger impact than other components of public capital such as hospital buildings, education buildings, and other public buildings (Boarnet, 1997, Bom and Ligthart, 2009). As a result of the aggregate measurement of public capital, existing literature reviews on the productivity of public capital cannot offer specific guidance on the productivity of transport infrastructure. There are also a number of very useful surveys (Gillen, 1996, Boarnet, 1997, Jiang, 2001) on the economic effect of transport infrastructure. However, these surveys have relied upon traditional literature review techniques. To the best of our knowledge, this is the first meta-analysis of the empirical evidence on the effect of transport infrastructure on economic output. The purpose of the analysis is to improve our understanding of the main factors affecting the range of results found in the empirical literature.

The data used in the meta-analysis include studies that use a production function framework to estimate output elasticities of transport. The sample consists of 563 elasticity estimates obtained from 33 studies. Besides summarising the estimates, we estimate meta-regressions to test for the impact of different study characteristics as sources of variation on existing empirical results. The hypothesised sources of variation relate to the following study features: (1) econometric estimator, (2) model misspecification, (3) data aggregation, (4) measurement of transport, (5) transport mode, (6) country and time period, (7) industrial sector, and (8) time frame of the elasticity estimate.

Our results can provide some guidance for future research in this subject matter. They reveal the importance of considering the effect of transport infrastructure on economic output in its contextual framework, including its role across different transport modes, industry groups, and country

characteristics. We find that the estimates of the output elasticity of transport tend to be larger for the US than for European countries, which is reasonable given that the US economy is generally more dependent on road transport that Europe, and that road transport studies represent a large part of the meta-sample. The findings also confirm the importance of using statistical estimators that are capable of addressing the main estimation issues in the empirical literature, namely those of omitted variable bias and reverse causality. We find that elasticity estimates obtained from studies that do not address the issues of unobserved heterogeneity and omitted variable bias tend to be higher than those obtained from studies using panel data techniques based on fixed-effects and generalised method of moments estimators. Model misspecification also affects the results. In particular, we find that studies which do not account for the urbanization levels and spatial spillover effects tend to also produce upward biased elasticity estimates. Finally, the meta-regressions confirm the intuitive result that estimates of the output elasticity of transport are higher in the long-run.

JEL Classification: H54, O40, R11, R15

Key words: Meta-analysis, Transport infrastructure, Economic performance

References:

ALONSO, W. 1964. *Location and Land Use,* Cambridge, Massachusetts.

ASCHAUER, D. A. 1990. Highway Capacity and Economic Growth. *Economic Perspectives,* 14**,** 14-24.

BALDWIN, R. E. & OKUBO, T. 2006. Heterogeneous Firms, Agglomeration and Economic Geography: Spatial Selection and Sorting *Journal of Economic Geography,* 6**,** 323-346.

BANISTER, D. & BERECHMAN, J. 2000. *Transport Investment and Economic Development,* London, Routledge.

BOARNET, M. G. 1997. Highways and Economic Productivity: Interpreting Recent Evidence. *Journal of Planning Literature,* 11**,** 476-486.

BOM, P. & LIGTHART, J. 2008. How Productive is Public Capital? A Meta-Analysis. *CESifo Working Paper No. 2206.*

BOM, P. & LIGTHART, J. 2009. What Have We Learned from Three Decades of Empirical Research on the Productivity of Public Capital? *Working Paper.* Tilburg University.

BUTTON, K. J. 1998. Infrastructure Investment, Endogenous Growth and Economic Convergence. *The Annals of Regional Science,* 32**,** 145-162.

DE LA FUENTE, A. 2000. Infrastructures and Productivity: A Survey. *Instituto de Analisis Economico CSIC*.

EBERTS, R. W. & MCMILLEN, D. P. 1999. *Agglomeration Economies and Urban Public Infrastructure*, Elsevier Science B.V.

FUJITA, M. M., KRUGMAN, P. & VENABLES, A. J. 1999. *The Spatial Economy-Cities, Regions and International Trade,* Cambridge, Massachusetts and London, England.

FUJITA, M. M. & THISSE, J. F. 2002. *Economics of Agglomeration-Cities, Industrial Location and Regional Growth,* Cambridge: Cambridge University Press.

GARCIA-MILA & MCGUIRE, T. J. 1992. The Contribution of Publicly Provided Inputs to States' Economies. *Regional Science and Urban Economics,* 22**,** 229-241.

GILLEN, D. W. 1996. Transportation Infrastructure and Economic Development: a Review of Recent Literature. *Logistics and Transportation Review,* 32**,** 39-62.

GRAHAM, D. J. 2007. Agglomeration, Productivity and Transport Investment. *Journal of Transport Economics and Policy,* 41 (3)**,** 317-343.

GRAMLICH, E. M. 1994. Infrastructure Investment: A Review Essay. *Journal of Economic Literature,* 32**,** 1176-96.

HULTEN, C. R. & SCHWAB, R. M. 1991. Public Capital Formation and the Growth of Regional Manufacturing Industries. *National Tax Journal,* 44**,** 121-134.

JIANG, B. 2001. A Review of Studies on the Relationship between Transport Infrastructure Investments and Economic Growth. Canada Transportation Act Review Panel.

MELITZ, M. J. & OTTAVIANO, G. I. P. 2008. Market Size, Trade and Productivity. *Review of Economic Studies,* 75**,** 295–316.

MOSES, L. N. 1958. Location and the Theory of Production. *Quarterly Journal of Economics,* 78**,** 259-272.

MUNNELL, A. H. 1992. Policy Watch: Infrastructure Investment and Economic Growth. *The Journal of Economic Perspectives,* 6**,** 189-98.

NOCKE, V. 2006. A Gap for Me: Entrepreneurs and Entry. *Journal of the European Economic Association,* 4**,** 929-956.

RIETVELD, P. 1994. Spatial Economic Impacts of Transport Infrastructure Supply. *Transportation Research Part A,* 28**,** 329-341.

WEBER, M. 1928. *Theory of the Location of Industries,* Chicago, University of Chicago.