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Estimating the social return to transport infrastructure: A price-difference approach applied to a quasi-experiment

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ABSTRACT

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Using the price differences between two markets, this study proposes a method for inferring the social return to transport infrastructure (in the vein of Fogel (1964)). We apply this approach to an investment that increased the shipping capacity of a thousand-mile-long railroad in western China. The event was quasi-experimental: before the expansion, the railroad was congested in one direction, but not the other. We find that, after the investment, (1) the between-destination price differences of goods shipped in the congestion direction dropped by about 30% and (2) shipping volume increased by around 40%. In contrast, those of goods in the other direction were not affected. These estimates imply a sizable social return to this particular investment: 10% per year in the most conservative case considered. *Journal of Comparative Economics* **41** (3) (2013) 669–683. University of Macau, Macau SAR, PR China; University of Hong Kong, Hong Kong SAR, PR China.

1. Introduction

Physical infrastructure is commonly believed to be important for economic efficiency.[1] For example, the World Bank suggests that developing countries should invest 7% of GDP on infrastructure (World Bank, 2005). However, the empirical studies available are far from conclusive on the economic return to infrastructure investments. Two strands of research have been conducted. Following Aschauer (1989), a number of researchers have estimated aggregate production or cost functions with infrastructure measures as the explanatory variables to infer their economic contribution. The findings vary widely for different data, model specifications, and estimation methods.[2] In the other strand of research, the specific channels by which infrastructure facilitate growth have been explored using disaggregated data. For example, Fernald (1999) shows that highways have

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[1] Nonmilitary infrastructure typically includes streets and highways, airports, electronic and gas facilities, mass transit, water systems, and sewers. Most developing economies spend not more than 4% of GDP on these types of infrastructure.

[2] Macroeconometric studies typically estimate production or cost functions with aggregated measures of infrastructure as the production inputs. Among them, Aschauer (1989), Holtz-Eakin (1988), Munnell (1990), Rubin (1991), and Morrison and Schwartz (1996) find a significant, positive association between infrastructure investments and the aggregate productivity of economies. Using province-level data, Demuger (2001) finds a positive relationship between infrastructure investment and regional economic growth in China. Hulten and Schwab (1991), Tatom (1991, 1993) and Munnell (1992), in contrast, find infrastructure capital to have no impact. Reviewing the literature, Gramlich (1994) points out a series of intrinsic identification problems, which suggests that the aggregate approach may provide unconvincing estimates of the causal effect of infrastructure on an economy.

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differential effects on the productivity of different industries in the US. The microeconometric evidence, however, remains scarce, especially for developing economies.[3]

This study falls into the microeconomic strand of the research literature. In particular, we consider the effects of investments on congested transport infrastructure (e.g., highways or railroads). If these investments effectively reduce congestion, then total social welfare (the Marshallian surplus) may increase as a result of the increased consumption of imported goods at lower prices. To quantify this gain, a two-step approach is introduced. First, the impacts of the investments on the shipping volumes and the price differences of goods traded between two markets are estimated. In the second step, these estimates are then applied to a formula deduced from a simple model of a competitive transport market to calculate the Marshallian surplus gain.

This approach is new to the literature. Although the price of goods across markets has been commonly used to infer market integration (e.g., O'Connell and Wei, 2002), few studies have related it to transport infrastructure investments (an exception is Donaldson (2010)) and calculated the corresponding welfare gain. The social-savings literature (started by Fogel in 1964) may be the closest in nature to the current study: that study calculates the savings in transport costs through replacing traditional transport methods with more cost-efficient railroad shipping.[4] The current study, in contrast, examines the effect of capacity expansion. Moreover, the data requirements and the approach of inference are different. The social-savings literature typically calculates the Marshallian surplus using observed transport costs for different transport modes (without econometric estimation). In the current approach, the premia due to congestion are unobserved, but are estimated econometrically using a novel regression method.

A shortage of transport capacity may be a particularly relevant issue for developing economies, in which infrastructure investments typically lag behind economic growth. For example, with China's rapid growth since 1978, according to Park et al. (2002), "...in the mid-1990s, congestion on China's long-distance train, truck, and shipping networks had risen to such critical levels ...that traders had to pay high premia to guarantee access to rail car or barge space, which more than doubled the freight and handling charges."

This study applies the approach to an investment that doubled the track capacity of a railroad that covers a thousand-mile-wide desert in northwestern China. Before this expansion, the railroad exhibited a special "one-way congestion" feature: only goods shipped eastbound through the railroad were constrained by the rail-shipping capacity; those shipped westbound were not. Hence, the westbound goods are not expected to have been affected by the expansion. We use them as a control group to check whether the effect of the railroad investment could have been confounded by other simultaneous unobserved changes. Such an omitted variable problem could arise, for example, from changes in aggregate demand for shipping or in local protectionism due to China's reform.

Within the quasi-experimental setting, we first estimate the impact of this railroad expansion on the congestion premia (approximated by price differences between two cities connected by the railroad). This estimate, together with information on the change in actual shipping volumes, allows us to infer (a lower bound of) the investment's social welfare gain. Our main findings are as follows. Within 3 years of the capacity expansion, the freight volumes of eastbound goods had increased by 40% and the origin–destination price differences had decreased by about 30%. In contrast, both the volume and price of transport changed little for the westbound goods.[5] This evidence is consistent with the implications of the "one-way capacity constraint" feature. The implied annual internal rate of social return to the project is 10% in the most conservative case considered, but could be as high as 50%.

Several caveats with regard to this approach need to be noted. First of all, the quasi-experimental approach assumes that goods traded in different directions are affected similarly by confounding factors (e.g., aggregate demand shock or local protectionism). Some evidence supporting this condition is provided in the paper. Second, some assumptions about the transport service's market are required (the case of perfect competition is considered, but the results could be more general). Third, this study focuses on a partial-equilibrium effect of railroad capacity on traded goods, thus omitting a number of other possible effects. Among them the most significant include the reallocations of production and consumption between regions connected by the railroad, which may occur in the longer term. In addition, capacity expansion should benefit passengers by reducing the congestion and travel time. Impact on the environment is another important concern, although the residential pollution effect is likely to be small in the current case, as the railroad under study crosses primarily unpopulated areas (between Urumqi and Lanzhou, China).

[3] Keeler and Ying (1988) provide direct evidence on how highways may affect the costs of truck firms. Golob and Regan (2001) surveyed 1200 managers of trucking companies in California and found that over 80% of them considered road congestion to be a serious problem. Recently, Shirley and Winston (2004) also find that highway infrastructure investments are negatively associated with inventory costs in the US. Michaels (2008) shows that the US Interstate Highway System has had an impact on local labor markets. A recent study by Donaldson (2010) shows that the presence of railroads is significantly associated with smaller price differences, larger inter-regional trade volumes, smaller price volatility, and higher incomes across regions of India. A related body of research focuses on estimating the effect of infrastructure on property prices. For example, Haughwout (2002) finds infrastructure to be an important determinant of property value. Micro-econometric evidence on the economic effects of highways in China is limited. Two recent studies, Li and Li (2012) and Li et al. (2012), empirically show that highway investment in China has significantly reduced transport costs and inventory costs.

[4] For example, Fogel (1964) used this approach to investigate the impact of railroads on the American economy during the late nineteenth century. See McClelland (1972) and Mercer (1970) for further examples. In this literature, the change of trade costs is typically calculated directly using observed shipping rates, and thus no econometric estimation is needed.

[5] Monthly prices collected by the Bureau of Statistics of China are used for the study. This price data set has been used by Young (2000) and Fan and Wei (2006) to investigate market integration in China, but transport infrastructure was not their focus. Another study that has used goods prices to study China's market integration is that of Shiue (2002). Prices across regions have been commonly used to study market integration in other economies, e.g., Berkowitz and DeJong (1998) is a study on Russia.