



Autobahns and jobs: A regional study using historical instrumental variables

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ARTICLE INFO

Keywords:

Transport infrastructure
Regional labor markets
Historical instrumental variables
Reverse causation
Economic geography

JEL classification:

L91
N73
N74
R11
R40
R49
J3

ABSTRACT

This paper analyzes the impact of investments in the German autobahn network on West German regions' labor market performance. To address problems of endogeneity and reverse causation, we use historical instrumental variables from an 1890 plan for the railroad network and a 1937 plan for the autobahn and major roads network. We find a statistically and economically significant positive causal effect of regional changes in autobahn kilometers on employment and the wage bill. According to our IV results, a one-standard-deviation increase in the growth of autobahn length between 1937 and 1994 led to employment growth of between 2.7 and 3.4% and to wage bill growth of between 3.0 and 3.7% over the period from 1994 to 2008. The results are robust to an alternative regional demarcation and identification strategy as well as to alternative estimation methods.

1. Introduction

Investment in transport infrastructure is intended to extend individuals and firms' radius of action. Mobile consumers are closely linked to suppliers of goods and services. Through well-developed transportation systems, workers obtain access to workplaces and producers obtain access to customers and suppliers. An efficient transportation network is a prerequisite for value-added chains that enable producers to exploit the advantages of specialization and the division of labor. Therefore, there is good reason to assume that investment in transportation facilities is a major driver of regional economic growth. However, it is also true that transport facilities could ease the accessibility of the region to outside deliveries. Hence, better transport infrastructure might be detrimental to home producers because it exposes them to greater competition from outside the region. This view can be traced back to the late-19th century German spatial economist Launhardt, who argued that the best protection for a backward region is a bad road.¹ In the literature, this antagonism has been called the 'two-way roads problem' (see Cheshire et al., 2014). As a consequence of these opposing forces, the net effect of lower transportation costs on economic development is ambiguous in general.

The issue's theoretical ambiguity and relevance for economic policy call for a careful empirical investigation. Investment in transport infrastructure represents a large proportion of total public investment activities. Identifying the size of the effect of transportation investment on economic growth may serve as a guideline for regional development policies. The results could contribute to the debate on the importance of the size and quality of transport systems for the economy.

However, it is well known that empirical studies on the relationship between transportation infrastructure and economic growth are plagued by a reverse causality problem. A positive correlation between transport infrastructure and regional growth might exist because lower transportation costs spur regional growth or because greater regional growth leads to greater demand for transportation infrastructure. Therefore, this issue undoubtedly requires serious methodological consideration.

Our aim is to contribute to a growing body of literature on the causal effect of infrastructure on population growth and economic outcomes at the regional level by using (historical) instrumental data (see Baum-Snow and Turner, 2012 and Baum-Snow et al., 2017 for China, García-López, 2012 and García-López et al., 2015 for Spain, Martincus et al., 2014 for Peru, Hsu and Zhang, 2014 for Japan and

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¹ Launhardt (1885) cited by Cheshire et al. (2014, p. 209).

Duranton and Turner, 2012 for the US)². Our study is the first to provide evidence for Germany in the spirit of the approach taken by Duranton and Turner (2012). Germany appears to be an interesting case for comparison with the US because it is a much smaller and generally more densely populated country. The length of the autobahn network per unit of territory significantly exceeds the equivalent figure in the US. Additionally, public transport plays a more important role in Germany than in the US. Moreover, significant investments in the German autobahn network were made in the 1930s, i.e., earlier than similar investments were made in the US. Unlike the situation in the US, investments in the autobahn system were motivated partly by the Nazi regime's strategic military considerations. All these factors might explain differences in the outcomes of the empirical analysis.

We begin our empirical investigation by replicating the approach taken by Duranton and Turner (2012) with German data. For the sake of comparison, we initially adhere as closely as possible to the definitions and specifications in that pioneering study. Qualitatively, our estimates for Germany corroborate the general results obtained by Duranton and Turner (2012) for the US. In particular, we find strong evidence of a positive effect of investment in regional autobahn length on future employment growth in that location. As in the pioneering study, the coefficient of the autobahn variable in the employment equation declines – but remains highly significant – if population and other controls are added to the specification. Quantitatively, the OLS estimates for Germany appear to be somewhat lower when compared to the findings for the US.

We then tested alternative specifications of the estimated equation using a general-to-specific strategy. Two main conclusions can be drawn from this exercise. First, including the full set of control variables leads to over-parameterization of the estimated equation. Second, the procedure suggests modifying the specification of the key explanatory variable. The corresponding test statistic recommends using the *lagged change* in the autobahn variable instead of its *initial level*. Although the modified specification yields more precise estimates, the OLS coefficients are rather similar in the two variants. For the IV method, however, the differences between the two specifications are substantial. According to the IV test statistics, the modified specification clearly outperforms the original one, particularly with respect to the relevance of the instruments. We therefore use the modified specification in the rest of the paper.

The main finding of the IV approach is that the positive effect of autobahn length on employment growth decreases somewhat relative to the OLS estimates but remains highly statistically significant. The employment elasticity of autobahn kilometers is between 0.015 and 0.020. The result implies that adding one standard deviation to the growth of the regional autobahn network in the period from 1937 to 1994 would have led to approximately 3% more jobs over the period from 1994 to 2008. This finding is robust with respect to the choice of the estimation method (2SLS, GMM, LIML) and alternative regional demarcation (NUTS 3 instead of quasi-MSA regions³). As a robustness check, we also applied the so-called inconsequential units approach. This alternative identification strategy also leads to remarkably similar results. When comparing our IV results to those of Duranton and Turner (2012), one can see that the impact of German autobahns on regional employment is considerably lower than the corresponding impact of express highways in the US. We discuss several possible reasons for this finding in the concluding section.

In addition to the outcome variable used in the pioneering study, we also considered the total regional wage bill as an alternative indicator of regional labor market performance. In most cases, the effect of increasing the autobahn length on the wage bill is slightly higher than the

pure employment effect. This finding suggests that changes in transport infrastructure might also positively affect the regional wage level. Relative to the impact on employment, however, the wage effect appears to be relatively small.

The remainder of the paper is organized as follows. In the next section, we briefly introduce the theoretical background and the results of previous studies. Section 3 describes the data and presents some descriptive evidence. To address the reverse causality issue, we adopt an approach using historical instruments for regional railroads from 1890 and for road networks from 1937. Section 4 contains the results of the econometric estimates, and Section 5 is devoted to various robustness checks. Section 6 discusses our main findings and concludes the paper.

2. Background

Roughly three-quarters of the German population live in metropolitan areas, i.e., big cities and their surroundings within commuting distance (Sturm, 2011). The transport system is of paramount importance for the development and functioning of the economy within spatial and settlement structures, especially for manufacturing industries, which still play an important role in Germany. In many fields, such as the automotive industry, supply chains are a constituting element of industrial organization. Transport infrastructure is likely to influence the allocation of the working population and firm location.

2.1. Theoretical considerations

In regional research, the importance of transport and transport costs for economic development has long been recognized (see, for instance, Thünen, 1842). Classical and New Economic Geography have shown that transport costs play a crucial role in shaping the spatial structure of the economy (e.g., Fujita et al., 1999). Of special interest is the impact of transport infrastructure on regional economic performance as measured by employment or the wage bill, for instance.

Duranton and Turner (2012) investigate how changes in a city's supply of transportation infrastructure affect the city's growth. To clarify various effects, they develop a model describing the relationship between transport networks and urban population growth. The theory is structured along four equations. First and foremost, they consider transport costs and population or employment in a static model of a monocentric city. In equilibrium, workers are indifferent between alternative locations. The authors assume that homogenous workers commute to a central business district (CBD) to earn their wage. Generally, the equilibrium population depends on the attractiveness of the city (e.g., regional wages and the value of the city's amenities) and local transport costs. The fundamental idea is that commuting costs are directly related to a city's size. In a dynamic setting, the model implies that large cities grow more slowly than smaller ones. As a consequence, there is convergence to the steady state. The adjustment is not symmetrical. Cities larger than their steady state will decline slowly, whereas cities smaller than their steady state will grow relatively quickly. Third, transportation costs can be construed as a function of the transportation infrastructure and population. The relationship must satisfy the condition that commuting costs increase with population but decrease with the transportation infrastructure. Furthermore, transport costs can vary with local conditions.

Further insights into the role of investment in transport infrastructure can be obtained from Economic Geography approaches. A given location is embedded in a spatial structure that involves other locations at various distances and of various sizes. A suitable concept to capture the spatial economic context of a location is the market potential, as introduced by Harris (1954). The market potential, M , of region r depends on the accessibility or reachability of all s locations in a wider economic space, S , surrounding the firm's location, as well as on the number of customers living there and their incomes. According

² For a broader discussion of the approach, see Redding and Turner (2014) and Baum-Snow and Ferreira (2014).

³ NUTS 3: fr. Nomenclature des Unités Territoriales Statistiques, MSA: Metropolitan Statistical Area.

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