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Estimating individual effects and their spatial spillovers in linear panel data models: Public capital spillovers after all?☆

K. Miranda, O. Martínez-Ibañez, M. Manjón-Antolín *

QURE-CREIP Department of Economics, Rovira i Virgili University, Spain

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ABSTRACT

Individual-specific effects and their spatial spillovers are not generally identified in linear panel data models. In this paper we present identification conditions under the assumption that covariates are correlated with the individual-specific effects and derive appropriate GLS and IV estimators for the resulting correlated random effects spatial panel data model. We also illustrate the proposed estimators using a Cobb–Douglas production function specification and US state-level data from Munnell (1990). As in previous studies, we find no evidence of public capital spillovers. However, public capital does play a role in the positive "outwards" spatial contagion of the individual effects.

1. Introduction

Does public capital have an effect on private output? And if it does, does this effect spill over nearby geographical areas? Using US state (and/or county) panel data, production function estimates have consistently concluded that public capital and its spatially weighted counterpart are not statistically significant.[1] In contrast, studies using alternative methodologies (e.g., VAR models), seem to suggest

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* Corresponding author.
E-mail address: miguel.manjon@urv.cat (M. Manjón-Antolín).

[1] See e.g. Munnell (1990); Baltagi and Pinnoi (1995); Holtz-Eakin and Schwartz (1995); Garcia-Mila et al. (1996); and Kelejian and Robinson (1997).

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otherwise (Pereira and Andraz, 2013). In this paper we provide production function estimates supporting the existence of public capital spillovers. To be precise, we find no evidence of a direct positive effect of public capital on private output. However, we find evidence of a relation between public capital and the unobserved productivity of the states (i.e., the individual specific effect of the production function) and its spatial spillover.[2]

To obtain these results, this paper introduces a correlated-random effects model (Mundlak, 1978; Chamberlain, 1982) that presents spatial correlation in the individual effects. To our knowledge, only the random effects model of Kapoor et al. (2007) accounts for this spatial correlation. In the fixed effects case, Beer and Riedl (2012) advocate using an extension of the Spatial Durbin Model for panel data that includes the spatially weighted individual effects. Ultimately, however, they argue that "it is (...) advisable to remove the spatial lag of the fixed effects from the equation as the inclusion of both, [the individual effects] and [their spatial lags], leads to perfect multicollinearity" (p. 302). Removing the spatial lag of the fixed effects does not generally preclude the consistent estimation of the parameters of the model (see e.g. Halleck Vega and Elhorst, 2015). However, this practice rules out obtaining an estimate of the individual-specific effects (net of the spatially weighted effects).[3]

This raises the question of whether both individual effects and their spatial spillovers can indeed be identified in linear panel data models. In this paper we provide identifying conditions in a model specification that spatially weights both the independent variables and the individual effects. In particular, we show that there is no identification problem if the covariates are correlated with the individual-specific effects and the individual effects correspond to deviations from the constant term.

Having proved that the model is identified, we then consider the estimation of its parameters under alternative exogeneity assumptions on the explanatory variables. Under the assumption that all the explanatory variables are strictly exogenous (with respect to the idiosyncratic term), we derive a Feasible Generalised Least Squares (FGLS) estimator. We also prove that, regardless of the structure of the variance–covariance matrix of the correlation functions shocks, this estimator coincides with the within (fixed effects) estimator when all the explanatory variables are used to construct the correlation functions. Under the assumption that the explanatory variables are predetermined, we propose an Instrumental Variables (IV) estimator to address the endogeneity of the means of the predetermined explanatory variables used to approximate the correlation functions. We also advocate using the backward means of these variables (i.e., the means taken, for each period, over only current and past values) as instruments.

Lastly, we use these estimators and a (correlated random effects) production function specification to address the existence of capital spillovers. Using the data and (a spatially weighted variant of) the specification used by Munnell (1990), we find that, under strict exogeneity, our FGLS estimates of a Cobb–Douglas production function for the US states over the period 1970 to 1986 are largely consistent with those reported in related studies (using this data set, as e.g. Baltagi and Pinnoi, 1995; Kelejian and Robinson, 1997; and using analogous data sets, as e.g. Holtz-Eakin and Schwartz, 1995; Garcia-Mila et al., 1996).[4] However, when we explore the possibility that (some of) the explanatory variables are not exogenous, we find evidence of predeterminedness in the public capital. We then estimate the model by IV to find that, under a sequential exogeneity assumption, states with a larger/smaller estimated individual effect tend to have larger/smaller negative spatial spillovers. In particular, we consider both "spill-in" and "spill-out" effects (LeSage and Chih, 2016), although only the spill-out effects turn out to be statistically significant. Also, while the part of the individual effects associated with the private capital produces negative spatial contagion, the part associated with the public capital produces positive spatial contagion. Consistent with previous literature, however, we find no significant spatial spillovers in the public capital.

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[2] As Boarnet (1998, pp. 381–382) points out, "[p]ublic capital is provided at a particular place, and if such capital is productive, it enhances the comparative advantage of that location relative to other places". Also, "productive public capital might shift economic activity from one location to another".

[3] This is a critical issue, for example, in two-step models that use this estimate as the dependent variable (Combes and Gobillon, 2015). Similarly, obtaining an estimate of the spatial spillovers of the individual-specific effects may be of great interest (e.g., for assessing their geographical distribution, which is what we do in our empirical application).

[4] The data set we employ is publicly available and can be downloaded, for example, from the **Ecdat** package in R (a standardised binary contiguity spatial weights matrix of the US states is also included in the package).