Identifying the Flypaper Effect in the Presence of Spatial Dependence: Evidence from Education in China's Counties

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ABSTRACT In the context of China without a median voter system, this study examines whether the "flypaper effect", an unconditional lump-sum grant from the upper governments to the county governments increases spending in a greater proportion than an equivalent rise in local income, holds true in China. Using China's county-level education data during 2007, the models have been estimated using a spatial econometric technique that accounts for spatial interaction behavior on public education expenditure across local governments. We find that, in the presence of spatial interdependence, there is no evidence of a "flypaper effect" when different spatial weighting schemes and the endogeneity problem of education grants are accounted for. Rather, the "anti-flypaper effect" is found. Important policy implications are drawn for China's fiscal decentralization reform.

JEL classification: H71, H77, R12, C23

Key words: Flypaper effect, Grants, Local government expenditure, Spatial econometrics

Introduction

In the last few decades, China, like numerous other countries around the world, has seen a significant process of fiscal decentralization under which important taxing and expenditure responsibilities have been assigned from national to local governments. Although the reasons to pursue this type of policy vary, one of the main reasons (or goals) is to improve the public service provision and increase the accountability of the local governments, which, according to Oates (1972), are better informed than the national government about individual demands for public services. However, in order to better provide public services, China's local governments, like those in other countries, suffers from an unbalance of expenditure responsibilities and revenue assignments as some local governments, due to lacking of revenue-raising power, do not have adequate tax bases to raise sufficient amounts of revenue and hence rely heavily on transfers from the central authorities in order to fulfill their responsibilities. In addition, the diversity of public service makes it a complex and difficult endeavor to design suitable decentralizing polices and ascertain their implementation to be successful.

The literature on the determinants of public expenditures is abundant (Case, Hines, and Rosen 1993; Ermini and Santolini 2010; Kelejian and Robinson 1993; Lundberg 2006; Painter and Bae 2001; Redoano 2007, to name a few); yet, it rarely takes into consideration the differences between different categories of public service concerning the expenditure determinants. Any study of public service provision and utilization must consider certain factors, such as how services are classified, what are the costs and benefits to provide each class of service (Balachandran and Srinidhi 1994). Public service in general can be classified into three categories by its designated function, that is, the so called "*maintenance public service*", "*economic public service*", and "*social public service*" (Li 2003; Sun 2007). The "*maintenance public service*" includes national defense, diplomacy, public administration service and so on; the "*economic public service*" refers to infrastructure construction, public subsidies to producers, the production of public utilities, and environmental protection, etc., the beneficiaries of which are mainly enterprises rather than the ordinary consumers; the "*social public service*", such as education, social security, public health care, is aimed to meet citizens' direct demand in social, cultural, and entertainment activities. Are there differences in the determinants of different public service? As the beneficiaries and costs of service provision are different for each kind of public service, the contributions to social welfare and economy are different. Hence, given the nature of

heterogeneity of public services, an empirical study should be inclined more to using disaggregated data than aggregate data.

Although studies on a particular public service are rare, voluminous empirical research on public service as a whole can be found. In empirical applications, the determinants of public service include economic, demographic, geographical, and political characteristics of the local government. Intergovernmental transfers are also included in local governmental expenditure studies (see, Bailey and Connolly 1998; Broadway and Shah 2007; Fisher and Papke 2000; Gamkhar and Shah 2007; Hines and Thaler 1995; Oates 1999, for a survey). The possible effects of transfers on local governmental expenditure are ambiguous and have been a heated topic in public finance literature. On the one hand, economic theory predicts that the spending response to a marginal change in transfers should be the same as that in income given that lump-sum grants to a local government increase the resources of the recipient region without affecting the relative price of public goods provided by the local government (Bradford and Oates 1971; Wilde 1968). On the other hand, there is an extensive body of empirical literature that rejects the hypothesis (see, Dollery and Worthington 1996; Inman 2008, for a comprehensive survey)**.** As Inman (2008) reported, until 2008 the literature includes more than 3,500 academic papers (to list a few recent studies, see, for instance, Acosta 2010; Bae and Feiock 2004; Brennan and Pincus 1996; Case, Hines, and Rosen 1993; Gamkhar and Oates 1996; Heyndels 2001; Knight 2002; Strumpf 1998; van de Walle and Mu 2007; Worthington and Dollery 1999). Most studies show that unconditional intergovernmental grants have a higher stimulative effect on local government spending than an equivalent increase in local income, a phenomenon known as the "flypaper effect" because money sticks where it hits.[1]

The presence of a "flypaper effect" has evoked a plethora of explanations from both the theoretic and empirical perspectives, though the reason why a "flypaper effect" occurs has remained less clear. These explanations, some of which are summarized in Bailey and Connolly (1998) and Acosta (2010), include mainly fiscal illusion that exists among voters (Courant, Gramlich, and Rubinfield 1979; Oates 1979), voter uncertainty (Turnbull 1992), and institutional failures from bureaucratic behavior and information asymmetries (Bae and Feiock 2004; Strumpf 1998). Other explanations refer to interest groups in budget determination (Dougan and Kenyon 1988; Mueller 2003), deadweight loss of welfare associated with raising tax revenue (Hamilton 1986), agenda-setting bureaucrats who are able to hide transfers from voters (Filimon, Romer,

and Rosenthal 1982), interaction between politicians and interest groups with the ability to raise funds for local government (Singhal 2008), or econometric issues such as incorrect use of statistical methods, specification errors, omitted variable bias, and possible endogeneity of intergovernmental transfers, among others (Chernick 1979; Gamkhar and Shah 2007; Hamilton 1983; Megdal 1987; Worthington and Dollery 1999).

As far as the diversification of public service is considered, do the above-mentioned determinants work for different categories of public service? Particularly, what is the role of transfers on the local governments' expenditure behavior, or will the transfers, as a source of revenue, change the budgetary behavior of the recipient governments? Does the "flypaper effect" exist in a particular public service? These questions are to be answered in this study.

The purpose of this study is threefold: first, using China's county-level data during 2007, to empirically validate the presence of the "flypaper effect" in education spending based on the public expenditure determination model in a developing country like China, since this theory, due to its important policy consequences, has been predominantly empirically validated for the developed countries; second, while estimating the expenditure models, to examine whether such an effect remains to hold in the presence of spatial interdependence across local governments that may arise when they make spending decisions. According to Manski (1993), fiscal interactions may occur due to mimicking (for example, the local government may mimic policy makers from other local governments in order to reduce costs of learning and obtaining information), competition (for example, in order to attract mobile resources), and spillover (for example, free-riding from the spending on a particular category, say, infrastructure) among local governments. In fact, voluminous empirical evidence has shown that the level of public expenditure can be affected by expenditures of neighboring jurisdictions (e.g., Baicker 2005; Besley and Case 1995; Case, Hines, and Rosen 1993; Elhorst and Fréret 2009; Ermini and Santolini 2010; Kelejian and Robinson 1993; Moscone, Knapp, and Tosetti 2007; Revelli 2006);[2] and third, analyzing the following issues: How do local governments react in their spending on education as a response to the decentralization reform? What are the implications that can be made on designing the fiscal reform based on this study?

This study adds to the existing literature in several ways. First, to the best of our knowledge, this study takes into consideration the diversification of public service and focuses on the education spending for the first time in the "flypaper effect" studies. Second, it adds to the public

expenditure literature by analyzing the behavior of local governments with regard to intergovernmental grants for developing countries in general, and for China in particular. China, with its large population size, deep fiscal decentralization (in terms of expenditure authority assigned to the local governments), and increasing expenditure burden as being experienced in many countries in the globe, has become an interesting case study to examine local governments' expenditure behavior since the decentralization reform in 1994. However, it is probably due to its relatively short history of fiscal reform or lack of comprehensive public finance data that empirical modeling of local governments, explicitly testing for a "flypaper effect" while accounting for spatial interactions as being done in this study, is an approach not yet found in the literature. Third, it adds to the spatial econometric literature by highlighting that spatial interaction cannot be ignored when testing for the "flypaper effect" as failure to account for spatial interactions across local governments' spending behavior can lead to omitted variable bias; traditional ordinary least squares estimates can be biased and inconsistent.

The rest of the paper is structured as follows. The second section provides a brief background of China's fiscal transfer system. The third section specifies first the empirical public expenditure determination model without accounting for spatial effects, then introduces the concepts of spatial econometric models and their selection criteria, and subsequently provides the corresponding estimation techniques. The fourth section describes the data used in this analysis. The fifth section reports the empirical results on the evidence of the "flypaper effect" under different model specifications and estimation techniques. The sixth section discusses some possible explanations for the "anti-flypaper effect". The last section concludes with policy implications drawn from the study.

A Brief Overview of the Fiscal Transfer System in China

Since the 1994 decentralization reform, the central government assigned more expenditure responsibilities to lower tiers of government while providing inadequate financial supports, which leaves local governments highly dependent on fiscal transfers in fulfilling their spending needs or providing mandated social services. While for many well-endowed counties, assigned revenue sources may be able to provide for relatively adequate funding to meet central government mandates, many counties in China, especially those in small, rural areas, lack

adequate fiscal capacity in meeting their legitimate mandates. For such counties, intergovernmental fiscal transfers provide crucial, and even dominant, sources of revenues for funding service delivery programs and administration costs. China's intergovernmental transfers have grown rapidly, from 4.7% of GDP in 1995 to 8.5% by 2011 since the start of 1994 reform (OECD 2013); yet the misalignment of expenditure responsibilities and revenue assignments remains.

In order to narrow the gap of increased local expenditures and tax revenues, the Chinese government designed a new transfer system that can be classified into three broad components (OECD 2013): 1) the general (or unconditional) transfers, which are mainly intended to reduce expenditure disparities and allow the local governments to provide basic services; 2) the earmarked transfers, which are used to subsidize a specific project in the local region and subject to matching funds by the local government; and 3) compensation transfers, which are designed to reduce the revenue loss incurred to some local governments after the 1994 tax reform. The total amount of central government transfers to local governments was 3,731 billion RMB *yuan* (MOF 2011), accounting for approximately 22% of the national tax revenues. Among the central transfers, the unconditional transfers amounted to 1,734 billion *yuan*, and the earmarked transfer was 1,491 billion *yuan*. Thus, general transfer allocations form a significant and the largest share (46%) of intergovernmental transfers to the local sphere (Figure 1). In addition, each of the three groups has a number of sub-components. Specifically, there are more than 20 types of earmarked transfers; unconditional grants are invested in approximately 15 sectors (MOF 2011), among which the equalization transfer (incepted to cease the widening regional disparities) becomes the major component, accounting for 18% of total general transfers in 2011 and the compulsory education of interest takes a share of 3% only. Earmarked grants, although important in China's system of intergovernmental fiscal relations, are beyond the scope of this study. A relatively detailed description of China's transfer system can be found in Zhang and Martinez-Vazquez (2003), Shen, Jin, and Zou (2012), and Wang and Herd (2013).

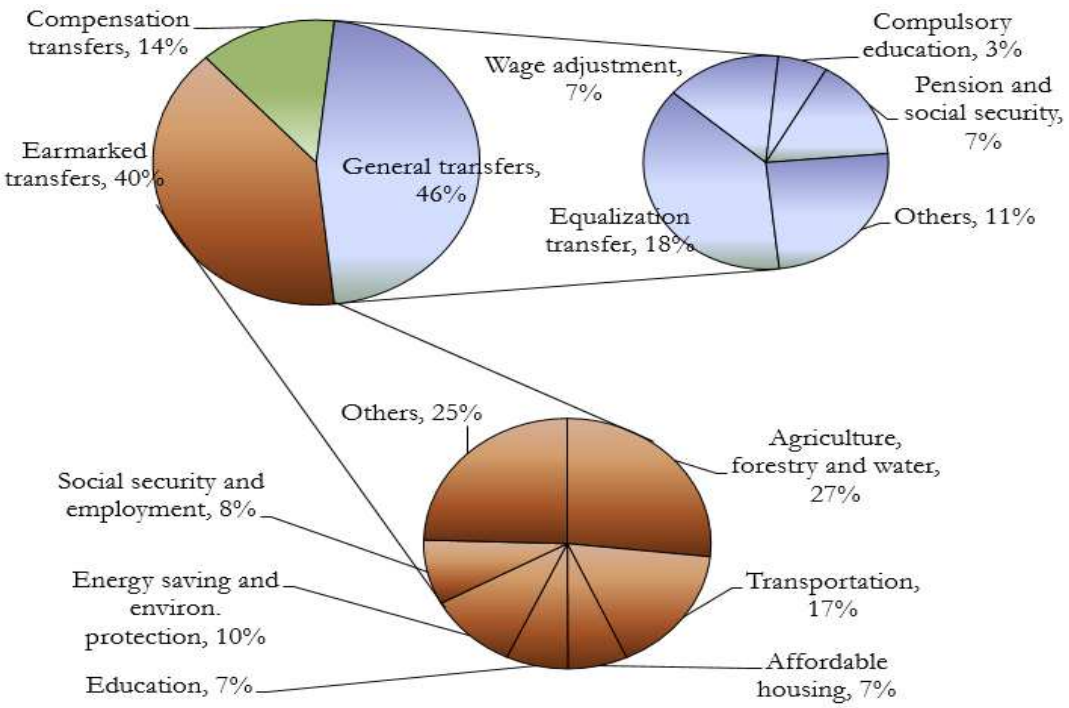

FIGURE 1. COMPONENTS OF CENTRAL GOVERNMENT'S TRANSFERS IN 2011.

Source: author's calculations based on MOF (2011) and the *China Finance Yearbook 2011* (Appendix Table 15).

Model and Methodology

The empirical model to test for the "flypaper effect" is presented in this section. In the context of China without a voting system, the "median voter" model cannot be applied to test for the "flypaper effect" which connects public expenditure with transfers and local income. Instead, the hypothesis is tested through a reduced-form public expenditure model.

Following Manski (1993), we use a general-to-specific approach, that is, to adopt as a point of departure an unconstrained spatial autoregressive and moving-average (SARMA) model, which contains features of a spatially lagged dependent variable (SAR model) and a spatially autoregressive disturbance term (SEM model). The SARMA model is specified in a stacked and reduced form as,

$$y = \alpha \iota_n + \lambda W y + X\beta + \mu,\ \mu = \rho W \mu + \epsilon\ \epsilon \sim N(0,\ \sigma^2 I_n),\ n = 1, 2, \ldots, N \qquad (1)$$

where ι_n is an $n \times 1$ vector of ones associated with the constant term parameter α. y is an $n \times 1$ vector of the dependent variable denoting local public expenditure on education, X represents an $n \times k$ vector of explanatory variables that affect education spending in the sample period. β is a $k \times 1$ vector of parameters to be estimated. ε are unobservable shocks to public spending. W is the predetermined $n \times n$ spatial weights matrix, which can take several forms. The first form is a contiguity-based binary matrix in which each element w_{ij} is set to one if two counties i and j ($i \neq j$) share a common border ("first-order contiguity"), and zero otherwise. The alternative assumes that the element w_{ij} is equal to the inverse of the geographic (or greater circle) distance (d_{ij}) for each pair of counties i and j ($i \neq j$).[3] For a better interpretation, the weight matrix is often standardized so that the elements of each row sum to one, hence Wy can be considered as the weighted average of neighboring observations of y.

In this model, the parameters to be estimated are the usual regression parameters β, σ^2, and the spatial autoregressive parameter ρ and spatially lagged parameter λ. The spatially lagged parameter is most important in that it allows us to test for possible spatial interaction. Anselin (1988) presents the procedures to estimate this spatial model (including the SAR or SEM model) using the maximum likelihood estimation (MLE) method, since the traditional OLS can be biased and inconsistent in the presence of spatial lag dependence, unbiased but inconsistent in the presence of spatial error dependence.[4]

Indeed, before estimation, we will conduct several specification tests to choose a proper model specification with better statistical properties in the empirical implementation. If $\lambda = 0$, this model reduces to the SEM model, whereas if $\rho = 0$, this model reduces to the SAR model, otherwise if $\lambda = \rho = 0$, the SARMA model reduces to a classical ordinary least-squares (OLS) regression model. To choose empirically among the models, we use the Moran's (1950) I test for spatial autocorrelation, two Lagrange Multiplier (LM) tests (i.e., LM-Lag and LM-Error tests) and two versions of robust LM tests are developed to identify a spatial autocorrelation in the error term or a spatial dependence in the dependent variable. Technical details of the LM and the robust LM tests can be found in Anselin (1988), Anselin and Florax (1995), Anselin, Bera, Florax, and Yoon (1996), and LeSage and Pace (2009). The decision rule as suggested by Anselin, Bera, Florax, and Yoon (1996) is: If both LM tests for spatial error dependence and spatial lag dependence are significant, the two versions of robust LM tests should be used to identify the proper alternative. If both statistics are significant, the smallest one is taken as model

specification, however, in empirical studies, a general spatial model (say, the SARMA model) will also be observed. It should be mentioned that in practice, LeSage and Pace (2009) also suggest using the likelihood-ratio (LR) test to choose between the SAR, SEM, and SARMA models.

Data Sources

China has five tiers of local government: the province, prefecture, county, township, and village. Specifically, there are 33 provincial level regions, 332 prefectural level regions, 2,853 county-level regions, 40,466 township-level regions and even more village-level regions (NBS 2012). This study uses the county as the unit of analysis. After removing the missing observations for the variables, mainly the transfer and unemployment variables that are used in this study, we have a total of 1,329 Chinese counties in 2007.[5] Figure 2 maps the sample counties that are shaded in yellow and account for approximately 47% of all Chinese counties. Comparing the characteristics of the included counties versus the omitted counties, first, we can find from the map that most counties that are used in this study are inland counties. Second, the sampled counties have slightly larger population size on average than the excluded counties even though the paired *t*-test (Samuels, Witmer, and Schaffner 2011) on these two groups yields no statistically significant difference. Third, these included counties have more rural population on average and a larger share of them belong to the officially designated "national poor county" than the excluded countries.[6] The differences are statistically significant based on the paired *t*-test result. Similarly, we find notable differences between the included versus excluded counties in terms of some other statistics such as public education spending (per capita) and own-source revenue (per capita). In brief, the sampled counties are in general more rural, poor, remote (from the coast) compared to the omitted counties. As a result, it is worth mentioning that the study sample does not appear to be representative of the overall counties, and the conclusions made in the empirical analysis may not be generalized to China as a whole.

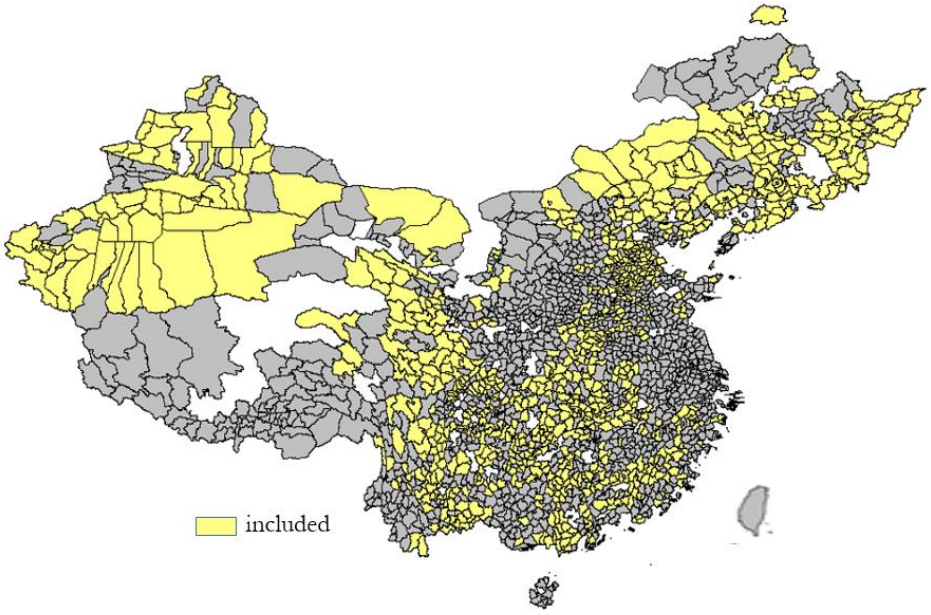

FIGURE 2. COUNTIES EXAMINED.

All variables, unless otherwise noted, are provided by the *Statistical Materials of City and County Public Finances 2007* (*2007 quanguo di shi xian caizheng tongji ziliao*, henceforth, "public finance dataset"). The dependent variable (EDU) is measured as the county government's spending on education divided by the number of people living in that county and is expressed in log terms. The county population data are taken from the *China County Statistical Yearbook 2008* (*2008 Zhongguo xian shi shenghui jingji tongji nianjian*). To test for the flypaper effect, the two important explanatory variables are REVENUE and TRANSFER, where the former is defined as the county government's own-source revenue per capita, and the latter is the county government's education transfer (per capita) obtained from the central government. These two variables are taken in logarithm form as well. Based on the extensive literature of flypaper effects in public finance (for instance, Acosta 2010; Bae and Feiock 2004; Dahlby and Ferede 2012; Gamkhar and Oates 1996; Heyndels 2001; Karnik and Lalvani 2008; Levaggi and Zanola 2003; Strumpf 1998), the analysis includes the following control variables. POPDENS, which is defined as total population living in the county divided by total land areas, which measures the population density and controls for possible scale or congestion effects. The coefficient of this variable can be negative if the presence of economies of scale dominates the congestion effect in public good provision, and positive otherwise. SECOND (PRIMARY) is defined as the ratio of the total number of students who attend the secondary (primary) school to the county's total

population. These two variables are used to control for group-specific demands. We expect the signs on these two covariates to be positive. UNEMP is the percentage of the population who are unemployed. An increase in the unemployment rate requires county governments to spend more on social assistance for the unemployed, such as job training programs, while crowding out education expenditures with a constant government budget constraint. Thus, we expect the coefficient for the unemployment rate to be negative. URBAN is the percentage of total population living in the urban area. The expected sign for urbanization is indeterminate, which may depend on two opposing forces (Yu, Zhang, Li, and Zheng 2011): one is the economies of scale in public good provision due to which counties with a higher urbanization rate may spend less on public goods; the other is the agglomeration economies which increase the return to public expenditures in urban areas, due to a higher urbanized population that may demand more public services.

Table 1 presents the descriptive statistics for the variables used in this study. Local public education expenditure amounts to about 385 *yuan* per capita, while transfers from central authorities received by a typical county average 26 *yuan* per capita, representing a moderate income source (7% of local education spending). Since annual average county income amounts to 544 *yuan* per capita, per capita local education expenditure represents approximately 70% of local income. It can be seen that counties differ considerably in terms of economic and demographic characteristics.

TABLE 1. SUMMARY STATISTICS OF VARIABLES (CHINESE COUNTIES, 2007)

	Obs.	Mean	Std. Dev.	Min.	Max.
Dependent variable					
EDU (*yuan*/person)	1,329	384.871	189.901	35.595	1,910.196
Independent variables					
REVENUE (*yuan*/person)	1,329	543.742	815.381	33.538	13,045.100
TRANSFER (*yuan*/person)	1,329	26.199	9.826	0.068	92.353
POPDENS (person/km^2)	1,329	271.127	264.390	0.148	2,409.639
SECOND (%)	1,329	0.060	0.016	0.011	0.141
PRIMARY (%)	1,329	0.084	0.027	0.032	0.214
UNEMP (%)	1,329	0.710	0.128	0.062	0.953

URBAN (%)	1,329	0.222	0.159	0.030	0.993

Note: EDU: per capita public spending on education (*yuan/person*)

REVENUE: county government's own revenue per capita (*yuan/person*)

TRANSFER: education transfer per capita to the county government (*yuan/person*)

POPDENS: total population divided by total land area (person/km^2)

SECOND: ratio of the total number of secondary school students to the county's total population (%)

PRIMARY: ratio of primary school students to the county's total population size (%)

UNEMP: percentage of the population unemployed (%)

URBAN: percentage of total population living in the urban area (%)

Empirical Results

This section reports the empirical results starting from the parsimonious model to the spatial models. Further implementations are done to check whether the empirical results are robust for different spatial weighting schemes, and estimation strategies.

"Flypaper effect" without spatial dependence. Model 1 in Table 2 shows the results from the most parsimonious model which includes only the fiscal revenue variable and assumes away transfers from the central authorities. As expected, the coefficient on fiscal revenue is positive and statistically significant. As the model is specified as log-log form, the coefficient can be interpreted as an elasticity. Assuming away other covariates, the education expenditure elasticity with respect to governmental revenue is 0.182, in other words, public expenditure on education increases by 0.18% per additional 1% increase in fiscal revenue. When an additional transfer variable is added to the parsimonious model, the new model has a better fit as the adjusted R^2 value becomes larger. The coefficient on per capita revenue is 0.214, and the coefficient on per capita transfers is 0.276. The result suggests some evidence of a "flypaper effect" (the recipient government spends more to increase public goods, education here, with intergovernmental grants than with an equivalent increase in its revenue). Yet, this model suffers apparently from omitted variable bias problem. Thus, Model 3 reports full OLS model results when other county demographic characteristics are controlled for. It can be seen that the full model has the best fit. More importantly, both the revenue and transfer variables remain positively associated with

public education spending and statistically significant, while these two coefficients show that the marginal propensity to spend out of fiscal revenues is larger than the one from fiscal transfers, which contradicts the conclusion made in Model 2, and clearly reveals no evidence of a "flypaper effect". Regarding other covariates, the coefficient of population density is negative, implying a dominant role of economies of scale over the congestion effect in public good provision. The coefficient on the unemployment rate is positive and bears the unexpected sign. This could imply that even under a constant budget constraint, there is no "crowding out" effect of the increase in social assistance on public education spending. If this were the case, the result may further imply that when the local unemployment rate rises, county governments will, on the one hand, spend more on social assistance, and on the other hand spend more on education by providing education and job training projects for the unemployed. Urbanization is positively associated with public expenditures, suggesting that a more urbanized county tends to spend more on public education. Counties with a larger proportion of groups with expected high demand for public goods, that is, the primary and secondary school students, are found to have mixed evidence on demanding public expenditures.[7]

TABLE 2. ESTIMATES OF "FLYPAPER EFFECT" (DEPENDENT VARIABLE: ln(EDU), CHINESE COUNTIES, 2007)

	Model 1	Model 2	Model 3	Model 4
		OLS		SARMA
ln(REVENUE)	0.182***	0.214***	0.165***	0.175***
	(0.012)	(0.012)	(0.012)	(0.011)
ln(TRANSFER)		0.276***	0.131***	0.148***
		(0.019)	(0.019)	(0.017)
POPDENS			-0.002***	-0.001***
			(0.000)	(0.000)
SECOND			0.092	-0.050
			(0.161)	(0.149)
PARIMARY			0.786***	0.722***
			(0.088)	(0.085)
UNEMP			0.323***	0.256***

			(0.050)	(0.045)
URBAN			0.476***	0.191***
			(0.065)	(0.062)
λ (Lag)				0.981***
				(0.018)
ρ (Error)				0.980***
				(0.021)
CONSTANT	5.787***	4.350***	5.204***	-1.315**
	(0.087)	(0.127)	(0.120)	(0.625)
Obs.	1,329	1,329	1,329	1,329
adj. R-squared	0.236	0.272	0.435	
Squared corr.				0.442
Diagnostics Tests				
Spatial error:				
Moran's *I*			52.892 [0.000]	
Lagrange multiplier			654.050 [0.000]	
Robust Lagrange multiplier			16.576 [0.000]	
Spatial lag:				
Lagrange multiplier			1,675.931 [0.000]	
Robust Lagrange multiplier			1,038.457 [0.000]	

Note: Standard errors are shown in parentheses. *p*-values are shown in brackets. * (**, ***) indicates statistical significance at α = 0.10 (0.05, 0.01). "Squared corr." is the goodness of fit measure for the spatial lag model, which is calculated as the squared correlation between the predicted and observed values of the dependent variable.

"Flypaper effect" revisited in the presence of spatial dependence. Numerous studies of public finance have found that the spending of one jurisdiction depends on its own characteristics but also on the level of spending by its neighbors (see, Brueckner 2003, for a review). In other words, local governments are interdependent when making their expenditure level decisions,

which gives rise to fiscal interaction. The results on the diagnostic tests for spatial dependence based on the residuals from the full OLS model (Model 3) are reported in the bottom of Table 2. The Moran's *I* test statistics (52.892, $p = 0.000$) reveal evidence of spatial dependence in the unobservable shocks. Further, the robust versions of the LM tests for spatial lag and error dependence, respectively, seem to indicate that both the autoregressive processes for the dependent variable and the disturbance terms should be accounted for simultaneously ($p = 0.000$ for all LM tests). The proposed tests imply that it is necessary to account for spatial effects in the estimation procedure. Particularly, a general spatial model, sometimes called the spatial autoregressive moving average (SARMA) model, should be used in order to identify the true effect of transfers and revenue on public education spending. Model 4 in Table 2 reports the SARMA results.

The positive and statistically significant coefficients on the spatial autoregressive parameters for the dependent variable and error term confirm the usage of a spatial model. The positive spatial parameters could imply that local governments act strategically (through mimicking or competing with its "neighbors") in terms of the public education spending. It can be seen that the education expenditure effect of county revenue does not differ substantially from the OLS estimate (0.175 versus 0.165), while the coefficient on transfers appears to be higher than the OLS estimate (0.148 versus 0.131). Unfortunately whether such differences in magnitude from the OLS and spatial models are statistically different are beyond our reach due to the absence of development of a comparison test between these two models, which merits further exploration. In contrast to the full OLS model, the SARMA model shows larger coefficients on transfers and fiscal revenue, implying the public expenditure impacts of transfers and revenues are underestimated by ignoring spatial effects. However, the coefficient on transfers being smaller than that on revenue when accounting for spatial interaction across county governments confirms the conclusion that can be made in the full OLS model that there is no presence of a "flypaper effect".

Robustness Checks

In this section, exercises are done to check whether the empirical results are robust for different spatial weighting schemes and to provide some insights on tackling the endogeneity issue of grants.

Alternative spatial weighting matrixes. A potential concern with the spatial model results is the arbitrary definition of neighbors, as the weight matrix is usually defined as a *priori* and does not include parameters to be estimated, and interpreted as a function of relevant measures of geographic, social, economic, or demographic distance (Anselin 2002). The empirical approach consists of examining alternative spatial weight specifications to assess robustness and econometric concerns. Hence, in this subsection, two trials are practiced in relation to different spatial weights matrices. They are the *K*-nearest neighbor weights and the economic weights. The *K*-nearest neighbors' method rests on the idea that, in regions where the counties are densely (sparsely) located, the spatial context of the analysis will be smaller (larger). An advantage to using such a specification is that it ensures there will be some neighbors for every jurisdiction, even when the densities vary widely. In this practice, K is set to 4.[8] In other words, each county is assumed to be bordered with four neighbors. The economic-based weight matrix rests on the idea that two jurisdictions (say, Beijing and Shanghai) with closest economic variables (GDP or employment) are more relevant in economic activities (say, public expenditures). In other words, the economic weight matrix using the GDP variable can be defined, in a simplest form, as $w_{ij} = 1/|GDP_i - GDP_j|$ where i and j stand for two different counties.

The econometric results are reported in Table 3. It can be seen that under the 4-nearest neighbor weights or the economic weights specification, the main results remain the same. Specifically, we still find a spatial effect in public education expenditures across the county governments. The revenue and transfer variables, respectively, have similar but generally smaller coefficient estimates to those in the SARMA model which uses the distance-based spatial weight matrix (Model 4 in Table 2). More importantly, the coefficient on own revenue is larger than that on education transfers, reconfirming the previous conclusion that there is no "flypaper effect".

TABLE 3. "FLYPAPER EFFECT" FOR DIFFERENT SPATIAL WEIGTH MATRICES (SARMA MODEL, DEPENDENT VARIABLE: ln(EDU), CHINESE COUNTIES, 2007)

	4-nearest neighbor weights	Economic weights
ln(REVENUE)	0.163***	0.146***
	(0.012)	(0.011)
ln(TRANSFER)	0.155***	0.126***
	(0.019)	(0.019)

λ (Lag)	0.348***	0.370***
	(0.061)	(0.086)
ρ (Error)	0.356***	-0.252**
	(0.072)	(0.125)
Obs.	1,329	1,295
Diagnostics Test		
Spatial error:		
Moran's *I*	22.381***[0.000]	2.697***[0.000]
Lagrange multiplier	465.904***[0.000]	6.554***[0.010]
Robust Lagrange multiplier	35.627***[0.000]	1.819[0.177]
Spatial lag:		
Lagrange multiplier	485.802***[0.000]	16.348***[0.002]
Robust Lagrange multiplier	55.526***[0.000]	11.612[0.001]

Note: Results for other covariates are not reported to conserve space. The sample size is smaller in the SARMA model which uses economic weight matrix as there are some missing values for the county GDP variable. Standard errors are shown in parentheses. *P*-values are shown in brackets. * (**, ***) indicates statistical significance at $\alpha = 0.10$ (0.05, 0.01).

Endogeneity. One of the criticisms on the empirical studies supporting evidence of the "flypaper effect" is that it is not real but a pure statistical artifact (Becker 1996). Specifically, most studies fail to solve the identification problems properly, one of which is that central intergovernmental transfers can be endogenous. The local government may have incentives to collect less revenue from their own sources in order to receive higher transfers, or intergovernmental transfers are functions of local government spending (Becker 1996; Islam and Choudhury 1990). This is a typical endogeneity problem (due to reverse causality) in econometrics. To control for the simultaneity between transfers and expenditures, instrument variables are preferable and regular solutions.

Yet, to find valid instrument(s) is difficult. We propose two instruments for the potentially endogenous transfer variable. One is a dummy variable (ZONE) that indicates whether the county (the administrative unit in this analysis) belongs to the "Old Revolutionary Base (*geming laoqu*, in Chinese)", and the other is also a dummy variable (GENERAL) indicating whether the

county belongs to a "General County (*jiangjun xian*, in Chinese)". In relation to the first instrument variable, the "Old Revolutionary Base" areas are revolutionary bases established by the army of the Communist Party of China during war times (mainly from 1927 to 1945). Given that those areas have made a huge contribution to the founding of China, it is reasonable to believe that they are the central government's priority in allocations of central transfers. In relation to the second instrument variable, China implemented a military ranking system in 1955, under which nineteen grades are classified in six categories. One of the six categories is the General Office Category. A particular county is honored the "General County" due to that several generals were born in that county. The reason to choose this potential instrumental variable is simple as we hypothesize that a county is able to obtain more transfers from the central authorities if that county has more generals nominated.

Adapting from the generalized spatial two-stage least squares (GS2SLS) method as proposed by Kelejian and Prucha (1998, 2010) and Arraiz, Drukker, Kelejian, and Prucha (2010), we estimate the GS2SLS model with spatially lagged dependent variables and spatially autoregressive disturbances based on a set of instruments *H* (ZONE, GENERAL). The results confirm the absence of a "flypaper effect", however, the Sargan test of overidentifying restrictions is rejected at 5% (but not at 10%). Hence, the IV results may be problematic, and are not provided here but are available upon request.

Discussions

The median voter theorem and government bureaucracies in China. The theoretical basis of fiscal illusion, one of the most popular explanations of the "flypaper effect", is the median voter model (Yu and Ding 2008). Under the assumption of single-peaked preferences (Black 1969) and a single-dimensional public good (Hotelling 1929), the median voter theorem states that a majority rule voting system will select the outcome most preferred by the median voter (Holcombe 2006).[9] However, it is known that the formal voting process for provinces to address their preferences does not exist in China. The government bureaucracies are organized by function (education, culture, public security) and by economic sector (agriculture, coal, machinery), not by territory. Members of the State Council (the top hierarchy) are heads of commissions (the middle hierarchy) and ministries (the bottom hierarchy), not the governors of provinces. Although provinces send delegations to annual planning, budget and other meetings

and can directly petition the State Council, they do not have permanent formal membership in the bureaucratic arena (Shirk 1993). Although the provincial governments can formally decide their own expenditures, the central government is capable of managing provincial finances leaving aside the preference for expenditures in their prefectures. Thus, it is reasonable to derive that the median voter mechanism may not work well in China.

Lin (2006) argues that local or regional preferences could be expressed sufficiently without voting actions by participating in the process of decision-making in China. Thus democracy might not be a prerequisite for the median voter hypothesis in the case of China. Nevertheless, sufficient evidence can be found to justify that the median voter hypothesis may not be fit for China. The fact that the policy information available to the median voter is often fairly limited, which keeps the median voter mechanism from working, should not be ignored. Also, voter ignorance opens the door to the strategic games of interest groups and the bureaucrats who may manipulate voters by appropriately subsidizing various kinds of information and act counter to median voter interests in policy areas where the median voter is unlikely to be well informed (Congleton 2002).

Characteristics of education and possible explanations of "anti-flypaper effect". Different from public goods such as parks, subways, and railways that can be used generally by all residents, education is mostly consumed by certain age groups. Since counties' education spending is the main interest of this study, we can reasonably infer that the vast majority of beneficiaries are students aged from 6 to 15 because counties (smaller administrative units than cities) in China rarely sponsor colleges or universities, and residents who enjoy benefits from education care more about the local education expenditure than others. However, as the share of childless households is rising in China due to the growing population aging as well as the late marriages and late childbirth, it is less and less likely that the pivotal voter at the local level has children at school age (Cesi 2010). These facts mentioned above could cast doubt on the presence of a "flypaper effect" in China, especially in the education sector.

The failure to find a "flypaper effect" in the Chinese education sector does not necessarily support the "equivalence theorem". Rather, the "anti-flypaper effect" has been nfound in this study. One explanation, which is a highly likely one in China, would be that policy decisions made by local governments are not based on the median voter's or households' preference but instead by their selfishness in pursuing their own interest (or maximizing their utility/budgets).

Compared to other public goods, education or compulsory education (elementary and middle school education) in particular is a kind of non-profit or non-GDP-creating social public service, the coverage of its beneficiaries is relatively smaller and its direct contribution to local GDP is relatively less evident. The current evaluation regime of government achievement and performance focuses mainly on economic indicators like GDP (per capita), GDP growth, and FDI, etc. Therefore, education would not be local governments' priority.

Another possible explanation is based on the idea of agenda control model (Filimon, Romer, and Rosenthal 1982). The model predicts that local spending is determined with exogenous reversion level, usually mandated by the local government, if local spending is not approved. If the reversion level is less than or near the median voter's preferred level, "anti-flypaper effect" can occur (Wyckoof, 1985). The reversion seems plausible in China since the fiscal decentralization reform starting from 1994. The lower tiers of government are entitled more autonomy to carry out their fiscal responsibilities, they tend to support various types of public expenditure not only to meet local demand, but also for the sake of political interests of themselves. Local governments prefer to invest more on public services such as highway, railway, airport that can help improve their evaluation score and less on education. Hence, if there is an education spending level that is in line with median voter's preferred level, we can reasonably argue that the reversion level would be lower than the aforementioned spending level. As a result, "anti-flypaper effect" appears.

A further explanation is related to the "competition effect" across local governments. Under current government performance evaluation systems, a local government tends to maximize the output from the same amount of government grants obtained from the central government to outstand themselves from the same tier of government. In other words, local governments are more likely to invest the grants into public sectors with higher returns. As a result, the unconditional grants increase education expenditure in a smaller proportion than an equivalent rise in local income.

Concluding Remarks

The objective of this paper is to examine whether the "flypaper effect" holds true in China using cross-sectional data of China's counties during 2007, that is, to test whether an unconditional lump-sum grant from the upper governments to the county governments increases

spending in a greater proportion than an equivalent rise in local income. The models have been estimated using a spatial econometric technique that accounts for spatial interaction behavior on public expenditures across local governments. We find that, in the presence of spatial interdependence, the estimated expenditure effect of intergovernmental transfers is substantially lower than income. This result does not reveal evidence of a "flypaper effect", nor does it support Bradford and Oates's (1971) equivalence theorem. As revenue is found to generate a larger expenditure effect than equivalent increase in grants. In fact, the "anti-flypaper effect" is observed, confirming Barnett's (1993) conclusion that "...in modelling local government expenditure the institutional nature of the grants-in-aid program needs to be correctly specified: the B & O [Bradford and Oates] equivalence result is not a general result."

In the context of China without a voting system, the "median voter theorem" cannot be applied, where the response to an increase in grants may be observed to be the same to the response to an increase in local income. Hence, deviation from the "equivalence theorem" has to be explained in other ways. We provide three potential explanations. First, public education, unlike infrastructure, is a kind of non-profit or non-GDP-creating social public service, the coverage of its beneficiaries is relatively smaller, and it does not make obvious contribution to local GDP compared to infrastructure investment. More importantly, in light of the Chinese appraisal system for local officials that bases officials' promotion on the GDP, there is a bias towards physical investment (OECD 2005), education will not become the local governments' priority. These features make the elasticity of grants with respect to education expenditures to be lower than the elasticity of local income, thus an unconditional lump-sum grant from the upper government to the county government increases spending in a smaller proportion than an equivalent rise in local income. Second, fiscal decentralization reform makes the reversion spending plausible in China and the reversion level of spending in education could be less than the preferred level given the education's characteristics as mentioned above and current evaluation system in China, if this were the case, the "anti-flypaper effect" occurs according to Filimon, Romer, and Rosenthal's (1982) agenda control model. Third, the competition effect results in a smaller portion of government grants that are invested in education spending.

Under the fiscal decentralization reform where local governments have more autonomy to allocate their expenditures, and particularly in the categories which are able to generate the most benefits for them, the central government's transfer policy is ineffective to promote more

education. The policy implication thus is clear: first, earmarked mandatory transfers (matching or non-matching) on education instead of unconditional lump-sum grants should be expanded to promote more education spending; second, given that the local governments have less motivation to spend on certain public services like education or healthcare due to their less contribution to the GDP growth compared to other categories like public infrastructure spending, the current evaluation and promotion system for local officials needs to be reformed. The new appraisal system should be diversified and include, when measuring performance, not just the GDP indicator, but also other indicators such as resource conservation, environment protection, education, healthcare, and so on.

Although we provided some possible explanations for the "anti-flypaper effect", the major issue remains to be left is about how to explain thoroughly the causes of such effect. Future research, on the one hand, should be focused on testing for the "flypaper effect" using alternative types of dataset or estimation techniques, and more importantly, on finding the reasons for the (non-) existence of the effect on the other hand.

NOTES

1 "Money in the private sector (i.e., from private income) tends to remain in the private sector rather than being taxed away, while money in the public sector (i.e., from intergovernmental transfers) tends to be spent by the public sector rather than being rebated to citizens" (Végh and Vuletin 2012).

2. Excellent surveys on strategic behavior of local governments can be found by Brueckner (2003) and Revelli (2005).

3. Alternatively, one specification can be such that $w_{ij} = 1$ for $d_{ij} > d$, where d is a distance cut-off value ("distance-based" contiguity). Other types of spatial weighting matrix as can be seen in some studies are not related to the geographic distribution/distance of units, but can be related to the so-called "economic distance", under which spatial relationships between two units are stronger if their socio-economic status (GDP, employment, or population) are similar.

4. The log-likelihood function of this model can be found in Anselin (1988) or LeSage and Pace (2009). It should be mentioned that an alternative is to use the instrumental variable approach which, suggested by Kelejian and Prucha (1998, 2010) and Arraiz, Drukker, Kelejian, and

Prucha (2010), uses a set of instrumental variables that include spatially lagged covariates (WX, W^2X, ...).

5. The most recent public finance dataset for years of 2008 and 2009 does not have detailed categories of public expenditure.
6. China has 592 officially designated poor counties as of 2014, or about 21% of all county-level administrative districts. More details on poor county designations can be found from World Bank (1998) and Park, Wang, and Wu (2002).
7. It is worth mentioning that primary and secondary education variables can be endogenous (due to reverse causality). We re-estimate Model 3 excluding these two variables and find out that, although the coefficient estimates change slightly for the key variables (transfer and revenue), the conclusion regarding the existence of a "flypaper effect" made from Model 3 does not change. Hence, we will assume the endogeneity problem is not a main concern and continue to include these two education variables in the subsequent regressions. We acknowledge and appreciate this issue raised by one anonymous reviewer.
8. Readers can refer to Pace and Zou (2000) and De Smith, Goodchild, and Longley (2007) for a detailed introduction on the nearest neighbor methods.
9. Numerous studies have analyzed the median voter hypothesis and shown it to play an important role in determining expenditure-related local finance policy in the United States and European countries (Bergstrom and Goodman 1973; Borcherding and Deacon 1972; Gramlich and Rubinfeld 1982; Turnbull and Djoudourian 1994). Congleton (2002) states that the median voter always gets his/her most preferred policy, and anything that affects the median voter's assessment of the relative merits of alternative policies or candidates will also affect political outcomes. Empirical studies, such as those by Gross (1995), Doi (1998), Turnbull and Chang (1998), Dahlberg and Johansson (1998, 2000), Aronsson, Lundberg, and Wikstrom (2000), appear to support the hypothesis that the median voters' preferences determine government fiscal behavior.

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