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# LOCAL PUBLIC SERVICES COSTS AND THE GEOGRAPHY OF DEVELOPMENT: EVIDENCE FROM FLORIDA COUNTIES*

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**ABTRACT.** Theory suggests that the spatial distribution of development within a local jurisdiction affects the costs of providing local public services. We use GINI coefficients to characterize these distributions at the county level and estimate the effects on real per capita expenditures from reductions in the spatial concentration of all buildings and nine alternative types of development. We also estimate the effect on expenditures from expansions in the developed area of a county. The results obtained from a panel of Florida counties confirm our theory and suggest that the geography of development within a county affects public services costs.

## 1. INTRODUCTION

Urban planning has the goal of affecting intrajurisdictional land use to maximize citizens' welfare. The chief tool used to implement local land use plans is zoning, but the planner's tool box also includes a myriad of other land development regulations (Mills, 1979; Ihlanfeldt, 2004). Unfortunately, achieving the welfare-maximizing goal of planning is difficult because the optimal geographical distribution of alternative land uses is unknown. For example, the primary goal of zoning is to mitigate negative externality effects from incompatible land uses, but critics of zoning argue that our knowledge of these externalities is insufficient for zoning to be effective (Mills and Hamilton, 1989, p. 332). Optimal land use also hinges upon having knowledge of the fiscal effects of alternative land uses. On this topic, planners and economists have debated the impact of sprawl on the costs of providing public services.[1] The primary purpose of this paper is to better inform this debate by providing evidence on one sprawl-related issue; namely, as different land uses deconcentsrate within counties what happens to public services costs?[2]

Theory suggests that as buildings spatially concentrate there are opposing forces that work against one another to either raise or lower local public services costs. Concentration lowers costs via economies of density, but raises costs from the harshness of the environment (Bradford, Malt, and Oates, 1969; Ladd, 1992, 1994).[3] There is little

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[1]The relevant studies are reviewed below in section 2.

[2]Our analysis, therefore, is limited to the cost side of local budgets; to fully account for fiscal impacts an analysis of the impacts of alternative development patterns on revenues is also needed.

[3]These terms are defined below and examples are given. Briefly, economies of density refer to savings on public infrastructure costs and harshness of the environment refers to the need for more expenditures to achieve a given level of services where negatives externalities are more prevalent.

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empirical evidence on how these opposing forces play out to affect the budgets of local governments. One reason for this is the difficulty of reliably measuring the spatial distributions of alternative land uses within a local community. In this paper, the spatial detail provided by our Florida county data allows us to use GINI coefficients to measure these distributions. GINI coefficients are a novel and effective means of measuring the intrajurisdictional spatial distribution of development. With these coefficients we address three questions regarding the relationship between the geography of land uses within counties and public services costs. In general, development has become more spatially dispersed over time. Our questions address three dimensions of this dispersal. First, as the developed area of a county expands what happens to public services costs? Second, as the spatial concentration of buildings within the developed area decreases, what is the impact on these costs? Third, how are these costs affected by the spatial deconcentration of alternative land uses (e.g., single-family homes versus office buildings) within the developed area of a county?

If the geography of the built environment is found to matter to public services costs this may aid in the design of cities and counties as we move forward, especially in light of the increasing fiscal stress that local governments have experienced in the recent past.[4]

How concentration's opposing forces on public services costs net out is expected to vary among alternative land uses.[5] Results may also vary for different types of public services.[6] Fortunately, we have a rich panel data set on Florida counties that allowed us to estimate the relationship between per unit costs and land use concentration separately for nine major types of development. In addition, our data enabled us to study concentration's effect, not only on per capita total costs, but also on the costs of providing eight different types of public services.

Because our theory suggests a nonlinear relationship between concentration and costs, we employ McIntosh and Schlenker's (2006) estimator for identifying nonlinearities in fixed effects panel models. Our panel includes all but one of Florida's 67 counties for the years 1995–2013 and provides expenditures and land uses for each county/year observation.[7] A unique characteristic of the data is that Public Land Survey System (PLSS) section boundaries are identified. The PLSS divides each county into unchanging one-mile by one-mile square areas. Our GINI coefficients are computed by counting the number of properties within each square. For each year of our panel separate coefficients are computed for all developed properties and for each of our nine different types of development. The PLSS squares also provide an attractive approach toward measuring urban expansion. As we observe buildings constructed within a previously undeveloped square we count that square mile area as joining the developed area of the county.

[4]The fiscal stress of cities is monitored by the National League of Cities, which conducts surveys of cities (Hoene and Pagano, 2009, 2010, 2011; Pagano, Hoene, and McFarland, 2012). There have been eight recent bankruptcy filings of cities and counties (Governing, http://www.governing.com/gov-data/municipal-cities-counties-bankruptcies-and-defaults.html). Our data show that residential land use is deconcentrating over time. If urban planners are correct that this increases public services costs, changes in the distribution of land uses may be contributing to the current fiscal problems of local governments. However, a complete assessment of this issue requires also examining the effect of deconcentration on revenues.

[5]For example, harshness of the environment may be a stronger force when concentrating industrial land use in comparison to concentrating single-family homes.

[6]For example, environmental harshness effects from concentration may raise public safety expenditures but not spending on culture and recreation.

[7]The excluded county is Baker County, which is a small rural county in northwest Florida. The inclusion of data for this county in our models had an inexplicably large and nonintuitive effect on our results, which suggested the county is an outlier.

Our results are consistent with the idea that the geography of land uses within counties influences public services costs, with impacts observed for aggregate public services and for categories of services. At an aggregate level, within both urban and rural counties, the spatial distributions of multifamily housing, office buildings, and institutional properties all have statistically significant effects on costs. For rural counties, retail properties can be added to this list. Moreover, simulations suggest that changes in GINI coefficients over time have had notable effects on the per capita expenditures of many individual counties. Of the two forces that work against one another in determining the relationship between the spatial distribution of development and public services costs, our results suggest that economies of density is the more dominant force within urban counties, while harshness of the environment is more important within rural counties. However, within both types of counties the relative importance of each factor is found to vary across alternative land uses.

## 2. LITERATURE REVIEW

We found no prior evidence on the relationships that exist between the spatial distribution of alternative land uses and public services costs. There is, however, limited evidence on differences in these costs between sprawled and compact development patterns. This evidence is found in three types of studies that are distinguished based on their methodological approach. The approach of one type of study might be labeled "what if." In the pioneering study on the costs of sprawl, the Real Estate Research Corporation (RERC, 1974) analyzed what if three alternative developments were built from the ground up: low-density sprawl, high-density planned, and a combination mix. Using standard unit cost figures for each type of development, RERC costed out streets and roads, utilities, and public facilities and services and found that costs are significantly greater for the low-density sprawl development alternative. The poor methodological design of RERC's study discredited its findings (Altshuler, 1977; Windsor, 1979; Burchell et al., 1998) and served as a springboard for a follow-up study. Burchell et al. (2002) projected public services costs for the years 2000–2025 under two "what if" scenarios—what if outward growth continued unabated without being controlled, resulting in massive sprawl, versus what if outward growth was instead redirected inward by government imposed restrictions, resulting in more compactness.[8] Costing out these two alternatives with estimation methods that improved upon those used by RERC, Burchell et al. found that public services costs would be about 3 percent less if sprawl was controlled. The lion's share of the savings would come from buildings being situated in greater mass under the compact development alternative.

While the first type of study took an accounting approach to studying differences in public services costs between alternative types of development patterns, the second type used regression analysis to relate per capita public services expenditures to the population density of cities and/or counties using cross-sectional data. In a series of papers, Ladd found that the relationship between expenditures and density is U-shaped (Ladd, 1992, 1993, 1994), but for most counties her model predicted higher expenditures would result from an increase in density. She therefore concluded that, in general, harshness of environment effects dominate economies of density. Holcombe and Williams (2008) found that a relationship between per capita expenditures and population density only surfaces for cities larger than 500,000 in population and that this relationship is

[8]Burchell et al. (1998) recommended the use of an urban growth boundary or the establishment of an urban service area to control outward expansion.

positive, suggesting, like Ladd, that harshness of environment effects are dominant. The results of these studies are relevant to the issue of whether population growth at the local level will increase tax burdens or decrease the quality of public services. Both (and especially Holcombe and Williams) also viewed their results in the context of the debate over urban sprawl. However, it is highly questionable that much can be learned about the impact on public services costs from concentrating population within parts of a city (county) from analyses that relate these costs to average population densities across cities (counties).

The final type of study is most closely associated with at least one of the issues we address. Carruthers and Ulfarsson (2003, 2008) used cross-sectional data on different samples of counties to regress per capita expenditures on population density and the percentage of the county's land area that is developed. They obtained the latter percentage from the U.S. Department of Agriculture's National Resources Inventory, which records the number of acres of urbanized land at the county level every five years. They interpreted their first variable as measuring the vertical dimension of sprawl and their second variable as measuring the horizontal dimension of sprawl. Higher population density is found to reduce expenditures (in contrast to the results of Ladd and Holcombe and Williams), while the percentage of developed land area is found to increase expenditures. The latter finding represents some prior evidence on our first research question; namely, as the developed area of a county expands what happens to public services costs?

While all of the above studies provide evidence on the relationship between population concentration and per capita public services expenditures, none relate these costs to the concentration of specific types of development. Hence, our analysis is unique in this respect. Our analysis is also more directly related to the planner's problem. Decisions must be made on where to locate specific types of properties rather than whether to concentrate or disperse the population. For example, should growth be directed toward already existing locations of development or to new undeveloped areas? Finally, all studies have relied on cross-sectional data, which is more susceptible to omitted variable biases in comparison to the use of panel data employing fixed effects.

## 3. CONCEPTUAL FRAMEWORK

The central feature of our framework is that intrajurisdictional land use concentration has countervailing effects on public services costs—"economies of density" lowers costs, while "harshness of the environment" raises costs. To illustrate these opposing forces, consider a particular land use, say office buildings. At one extreme these buildings are spread out thinly over a county's land area. At the other extreme, they are all located in close proximity to one another (e.g., all within the CBD as in the monocentric city). As the spatial distribution of the buildings shifts from the first toward the second extreme, the buildings are considered increasingly "concentrated." We wish to know how the effects from economies of density and the harshness of the environment net out to determine concentration's impact on the costs of providing local public services.[9]

[9]We focus our theory on the effects on public services costs from concentrating alternative types of development, which is our third research question. To address our first two questions, we measure concentration for all buildings combined and in terms of the fraction of a county's land area that is developed. Our theory highlights the conflict that arises between economies of density and the harshness of the environment as concentration, however measured, increases and therefore is applicable to all three of our research questions.

It is common in the local public finance literature to interpret per capita expenditures as the product of the number of units of services consumed per resident ($S$) and the cost per unit ($C_S$):

$$E = S \times C_S. \tag{1}$$

Beginning with Bradford et al. (1969) and continuing with Ladd (1992, 1994) a distinction is made between final and intermediate outputs of the local public sector. Term $S$ are final outputs that directly affect residents' utility levels. Examples include freedom from crime and a clean neighborhood environment. These final outputs are produced with intermediate outputs ($X$), which are direct outputs of the local public sector. For the final outputs mentioned above, examples of direct outputs are the number of police patrols and the frequency of garbage pickup, respectively. The amount of the intermediate output required to produce one unit of final output is not constant, but varies directly with the harshness of the environment ($H$), which depends on a land use's concentration ($D$):

$$S = f(X, H(D)). \tag{2}$$

Returning to the final output as freedom from crime, more police patrols are necessary to achieve this output if the environment is harsh in the sense that there are many criminals in the area. For example, having more office buildings in close proximity to one another provides criminals access to multiple targets requiring less travel time between them. The concentration of office buildings also enables criminals to spend less time familiarizing themselves with possible escape routes. These elements attract criminals and raise environmental harshness. Similarly, more garbage pickups are necessary to keep a neighborhood clean if the neighborhood's residents produce more garbage creating a harsher environment.

The cost per unit of the final output ($C_S$) varies with the unit cost of the intermediate output ($C_X$) and $D$:

$$C_S = k\left(C_X, D\right). \tag{3}$$

As noted above, a higher $D$ increases the amount of $X$ needed to achieve a given level of $S$, which raises $C_S$. Term $C_X$ depends on economies of scale ($EOS$) and input costs, where one important input is public infrastructure ($I$):

$$C_X = g\left(EOS, I(D)\right). \tag{4}$$

Planners argue that a higher $D$ lowers the cost of public infrastructure via "economies of density." Returning to $X$ as police patrols, the policemen need a building to come back to after making a patrol. If office buildings are concentrated (high $D$), only one police building may be necessary, while a more dispersed pattern of office buildings may require additional police buildings. The classic planners' example of economies of density is that concentration reduces the need for road services in outlying areas.

Based on equation (1), to isolate the effect of $D$ on $C_S$, the level of $S$ must be modeled. We employ an extensive set of $S$ determinants that can be broken down into four categories. In the first category are determinants suggested by the median voter model. According to this model, local officials produce the level of $S$ demanded by the median voter, which will vary with her preferences, her income and the tax price she faces. The agenda setting model suggests a second set of determinants. According to this model, $S$ can exceed the quantity demanded by the median voter as the result of the budget maximizing preferences of local officials (Romer and Rosenthal, 1978). These preferences are constrained by the availability of fiscal resources. A third category of determinants recognize that businesses also consume public services; hence, $S$ rises with the size of the local business sector. Finally, local governments are responsive to the needs of their

TABLE 1: Expenditure Category Definitions

| Category | Definition |
|---|---|
| Economic environment | Cost of providing services which develop and improve the economic condition of the community and its citizens. |
| Culture/recreation | Cost of providing and maintaining cultural and recreational facilities and activities for the benefit of citizens and visitors. |
| Public safety | Cost of providing law enforcement and fire control. |
| Human services | Cost of providing services for the care, treatment and control of human illness, injury or handicap, and for the welfare of the community as a whole and its individuals. |
| Physical environment | Cost of services provided for the primary purpose of achieving a satisfactory living environment by controlling and utilizing elements of the environment. |
| General government | Services provided by the legislative and administrative branches of the local government for the benefit of the public and the government body as a whole. |
| Transportation | Cost of services for the safe and adequate flow of vehicles, travelers, and pedestrians |
| Courts | All personnel and operating costs of county and circuit courts. |

citizens in times of crisis, resulting in temporarily elevated levels of $S$. In the next section, we identify the variables we used to measure the determinants of $S$ suggested by the above four categories.

In estimation, changes in expenditures are due to changes in $S$ as well as changes in per unit costs. Our conceptual framework suggests, as a cost determinant, the intrajurisdictional concentration of the land use. While empirical work can never rule out omitted variable bias, our extensive set of controls (the $S$ determinants) allays this concern and allows us to interpret the remaining change in expenditures as an estimate of the effect that the deconcentration of a land use has on the costs of public services. A second implication of our theory for the specification of our estimated models is that the relative magnitudes of the opposing forces of economies of density and harshness of the environment on the costs of public services are expected to vary with the concentration of a land use; hence, we allow for nonlinear relationships.

## 4. PANEL OF FLORIDA COUNTIES

Our panel of Florida counties, which covers the years 1995–2013, is constructed from multiple sources. Expenditures and revenues come from the audited Annual Financial Reports (AFR) that each city and county must submit to the Florida Department of Financial Services.[10] Expenditures are broken down into current and capital expenditures and into the eight spending categories defined in Table 1. Within each of these categories, expenditures are further broken down into varying numbers of account codes. All expenditures are expressed in real per capita amounts.

Florida counties include both incorporated and unincorporated areas, and both areas tend to be large in population and geographical size.[11] In the unincorporated area, public

[10] https://apps.fldfs.com/LocalGov/Reports/. Florida requires that state and local government budgets be balanced annually.

[11] According to the 2010 Census of Population and Housing, Florida's population is roughly evenly split between incorporated and unincorporated areas.

services are provided exclusively by the county. In the incorporated area services are provided by both the county and a city. Because service responsibilities between these two levels of government vary across counties as well as within counties over time, we aggregate expenditures for all cities within a county and add this sum to the expenditures of the county. Countywide revenue totals are obtained in a similar fashion, which we use to obtain real intergovernmental transfers per capita.

Regarding the variables, we use to measure the determinants of $S$, the median voter model suggested the inclusion of preferences, median income, and the tax price. Our preference variables include the numbers of registered Democrats and Republicans and the number of registered voters without and other party affiliations. These data come from the Florida Division of Elections.[12] Median income comes from the Bureau of Economic Analysis's Regional Economic Accounts.[13] Our tax price variable is common in the literature and represents the price of public goods faced by the homeowner with the median assessed home value:

$$TP = (r/R) \times (R/B), \tag{5}$$

where $r$ is the median assessed value of owner-occupants, $R$ is the sum of the assessed values of all owner-occupied properties, and $B$ is the sum of the assessed values of all properties on the tax roll.[14] $TP$ is attractive intuitively, because it is higher where homeowners' median assessed value is a larger fraction of the aggregate value of all owner-occupied properties and is lower where the latter value is a smaller percentage of the total tax base. The data used to compute the tax price comes from the standardized property tax roll that each county must submit annually to the Florida Department of Revenue (FDOR).[15] The agenda setting model suggested the inclusion of fiscal resources as a determinant of $S$. Intergovernmental transfers, along with the property tax base, are the two major fiscal resources available to county governments in Florida (Cromwell and Ihlanfeldt, 2015). Transfers come from the AFRs and the base from the FDOR. To measure the size of the commercial sector within the county, we used multiple measures, including the number of business establishments, the number of workers and the size of the labor force. Finally, to capture a rise in the production of public services caused by unexpected needs, we included the number of unemployed workers and a set of variables measuring the annual severity of storm damage within the county. This latter set includes four variables: the number of storm-related injuries and deaths and the dollar values of property and crop damage.[16] Unemployment comes from the Bureau of Business and Economic Research at the University of Florida and the storm variables are from the National Climatic Data Center.[17]

We conduct separate analyses for urban and rural counties. For urban counties, we divide land uses into nine categories, which account for the entirety of the built

[12] http://dos.myflorida.com/elections/data-statistics/voter-registration-statistics/voter-registration-monthly-reports/voter-registration-current-by-county/

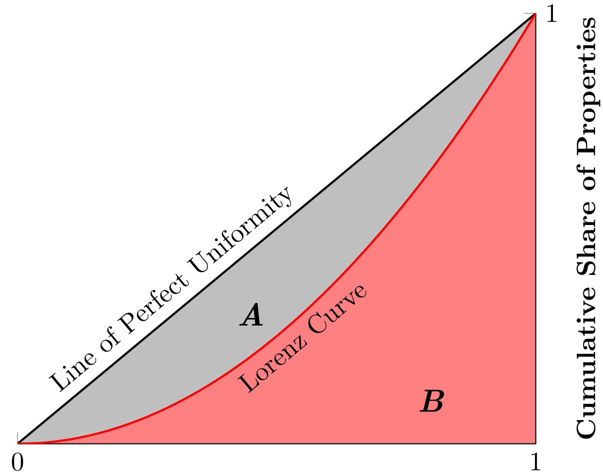
[13] http://www.bea.gov/regional/downloadzip.cfm

[14] Owner-occupant homes are identified using the homestead exemption identifier found on the tax rolls.

[15] http://dor.myflorida.com/dor/property/resources/data.html

[16] The $S$ variables entering our estimated equations were selected from a larger set of variables that included the unemployment rate, additional party affiliation identifiers, and injuries and deaths caused indirectly by the weather. Selection was based on whether adding the variable lowered AIC. This resulted in the urban and rural county models having the same $S$ variables, except the variable indicating no party affiliation and other party affiliation is not included in the urban model.

[17] http://www.bebr.ufl.edu/data/county and http://www1.ncdc.noaa.gov/pub/data/swdi/stormevents/csvfiles/




$$\boldsymbol{GINI} = \frac{\boldsymbol{A}}{(\boldsymbol{A}+\boldsymbol{B})}$$

FIGURE 1: Spatial GINI Coefficient Measurement of the Concentration of Land Use.

environment within a county excluding government-owned buildings: single-family homes, condominiums, apartment buildings, other residential buildings, office buildings, retail buildings, other commercial buildings, industrial buildings and buildings for institutional use.[18] These same categories are also defined for rural counties, with the exception of condominiums, which are seldom found in the rural counties of Florida. The number of properties in each category found in each county for each year of our panel is obtained from the FDOR standardized property tax rolls. These rolls place each property in a PLSS one-mile by one-mile square box.[19] For each land use we count the number of properties falling within each box. Using these counts, we compute a GINI coefficient for each land use, as shown in Figure 1.[20,21] If each box contains the same number of prop-

[18]Other residential land use consists of a mix of heterogeneous living quarters including mobile homes, cooperatives, and retirement homes. Other commercial properties are primarily wholesale outlets, produce houses and manufacturing outlets. Institutional properties include mostly churches and private schools and colleges.

[19]More information on the PLSS can be found at http://nationalatlas.gov/articles/boundaries/a_plss.html.

[20]In lieu of counting the number of properties within each box to obtain our GINI coefficients, we could have used the amount of built space. In this case, the GINI coefficient would measure the concentration of a particular land use's building space rather than the concentration of a land use's properties. Switching to this alternative measure of concentration yields similar results to those reported below. However, lower $r^2$ are obtained, indicating that it is the spatial distribution of properties and not the spatial distribution of developed space that matters the most in determining the costs of public services.

[21]The GINI coefficients are computed using STATA's fastgini command. The fastgini command uses the formula $G = \frac{2}{\mu n^2}(\sum_{i=1}^{n} ix_i) - \frac{n+1}{n}$, where $\mu$ is the mean of the vector sorted on $x$ from smallest to largest. The code can be found at https://ideas.repec.org/c/boc/bocode/s456814.htsl, and is motivated by Karagiannis and Kovacevic (2000).

erties the GINI coefficient equals zero, indicating a perfectly uniform spatial distribution of properties across the county's land area. As the number of boxes containing properties declines, the GINI coefficient increases in value. In the limit, with all properties located in a single box, the GINI coefficient equals one.[22] Of course, in no county are limits reached; however, as shown below land uses tend to be highly concentrated within a relatively small percentage of the boxes found within a county.

## 5. ESTIMATED EXPENDITURE EQUATIONS

We estimate quadratic per capita expenditure equations with county fixed effects. Fixed effects are included to control for unobservable heterogeneity across counties that may affect expenditures.[23] For the moment, put aside specificity, and consider that the standard "global" quadratic model that can be expressed as

$$y_{it} = b_1\, x_{it} + b_2 x_{it}^2 + c_i + e_{it}, \tag{6}$$

where $c_i$ are the group fixed effects and $i$ and $t$ identify group and year, respectively. This model assumes that nonlinearities in the data are found in deviations from the mean of the sample as a whole. However, there may also be nonlinearities found in deviations from the mean of the fixed effect group to which an observation belongs. In our application, the global nonlinearity explains how a change in the concentration of a land use affects the average change in per capita expenditures. Within nonlinearities, on the other hand, are caused by unexpected variations around this average change that result from unplanned shocks in concentration.[24] If the latter nonlinearities are present consistent estimation requires that they not be ignored, as would be the case from estimating (6). McIntosh and Schlenker (2006) introduce a hybrid estimator that allows for consistent estimation when both forms of convexity are present:

$$y_{it} = B_1\, x_{it} + B_2 x_{it}^2 + B_3 (x_{it} - u_i)^2 + c_i + \varepsilon_{it}, \tag{7}$$

where $u_i$ is the mean within group $i$. Our interest is in the global parameters $B_1$ and $B_2$, which are now consistently estimated by also estimating $B_3$. Of course, if $B_3 = 0$, equation (7) reverts back to equation (6) and consistent estimates are obtained from the standard model.

We estimate variants of our per capita expenditure equation to investigate the effects on public service costs from (1) an expansion in the developed area of the county,

[22] An alternative measure of density is suggested by Duranton and Overman (2005), which replaces our use of the PLSS boxes with measurements of the Euclidian distance between all pairs of properties. Ideally, experimentation with alternative measures of the spatial distribution of land uses within a county would be conducted. However, as noted above, the difficulty of finding even a single measure of intracounty land use concentration has limited research investigating the effects of concentration on public services costs. Measuring concentration across jurisdictions has proved to be less of a challenge as evidenced by the studies cited in section 2. In the case of the Duranton and Overman measure, we do not have the addresses of properties prior to 2008, which prohibit us from using this measure.

[23] We use expenditures on public services and the costs of public services interchangeably in this and following sections because our models are designed to control for changes in expenditures not attributable to changes in the number of units of public services produced.

[24] An example of an unplanned shock in concentration would be a loss in properties within selected PLSS boxes due to a fire or other natural catastrophe. However, more prominent examples of unanticipated changes in land use stem from Florida's boom and bust real estate cycle that occurred over the years covered by our panel. During the boom period of the early 2000s "irrational exuberance" drove both residential and commercial over development in a heterogeneous fashion across counties. The crash later in the decade brought the cancellation of many planned projects, with the timing of these cancellations also varying across counties.

(2) a deconcentration of all buildings within the developed area of the county, and (3) the deconcentration of alternative land uses. There are two variants of our expenditure equation, which we label models A and B. Model A is used to study the effects of deconcentrating all buildings within the developed area of the county. Our conceptual framework suggests this model should include, in addition to an all-buildings GINI coefficient (GC) and year ($\gamma$) and county ($C$) fixed effects, three sets of variables. In the first set are variables to register possible economies (diseconomies) of scale in the provision of services (a count of the total number of buildings ($B$) and population ($P$)). In the second set are the $S$ variables affecting the number of units of public services produced (income ($I$), number of registered Democrats ($D$), number of registered Republicans ($R$), tax price ($TP$), intergovernmental transfers ($IT$), property tax base ($TB$), number of business establishments ($ES$), number of workers ($W$), size of the labor force ($LF$), unemployed workers ($U$), number of storm-related injuries ($SI$), number of storm related deaths ($SD$), the dollar value of property damage ($PD$), and the dollar value of crop damage ($CD$)). The final set includes a single variable, which could have its own independent effect on the costs of public services (percentage of PLSS boxes undeveloped ($EB$)).

Theory suggests that the variables possibly affecting per unit costs enter quadratically (GINI coefficient, number of buildings, population, and percentage of PLSS boxes undeveloped). *A priori*, the proper functional form for the $S$ variables is unknown. Hence, for each variable we alternatively tried a linear and a quadratic specification choosing the one that minimized Akakie's information criterion (AIC).[25] Model A can be expressed as

$$E_{it} = \alpha + \sum_{k\in R} \alpha_{1k} k_{it} + \alpha_{2k} k_{it}^2 + \alpha_{k3}\left(k_{it} - \overline{k_i}\right)^2 + \sum_{x\in M} \alpha_{1x} x_{it-1} + \alpha_{2x} x_{it-1}^2 + \alpha_{x3}(x_{it-1} - \overline{x_i})^2$$

$$+ \sum_{z\in T} \alpha_z z_{it} + \gamma_t + C_i + \epsilon_{it}, \tag{8}$$

where
$R = \{EB, P, IT\}$,
$M = \{I, TP, TB, R, D, W, LF, ES, GC, B\}$,
$T = \{SI, SD, PD, CD, U\}$.[26]

Model B is estimated to investigate the effects on public service costs from an expansion in the developed area of the county and the deconcentration of alternative land uses. It is specified exactly as model A except GINI coefficients and count variables for all types of land uses replace the GINI coefficient and count variable for all buildings:

$$E_{it} = \alpha + \sum_{k\in R} \alpha_{1k} k_{it} + \alpha_{2k} k_{it}^2 + \alpha_{y3}\left(k_{it} - \overline{k_i}\right)^2 + \sum_{x\in M} \alpha_{1x} x_{it-1} + \alpha_{2x} x_{it-1}^2$$

$$+ \alpha_{x3}\left(x_{it-1} - \overline{x_i}\right)^2 + \sum_{q\in GLU} \alpha_{1q} q_{it-1} + \alpha_{2q} q_{it-1}^2 + \alpha_{3q}\left(q_{it-1} - \overline{q_i}\right)^2 + \sum_{p\in CLU} \alpha_{1p} p_{it-1}$$

$$+ \alpha_{2p} p_{it-1}^2 + \alpha_{3p}\left(p_{it-1} - \overline{p_i}\right)^2 + \sum_{z\in T} \alpha_z z_{it} + \gamma_t + C_i + \epsilon_{it}, \tag{9}$$

[25] The AIC was compared between a speciation where the variable was entered linearly and quadratically. If the AIC was smaller, say for the linear case, this became the new specification and we moved onto to testing the next variable. While this approach toward model selection is common, it has the drawback that path dependence may affect the results.

[26] Note that the $(z_{it-1} - \overline{z_i})^2$ terms are not included for these variables because they enter the model linearly.

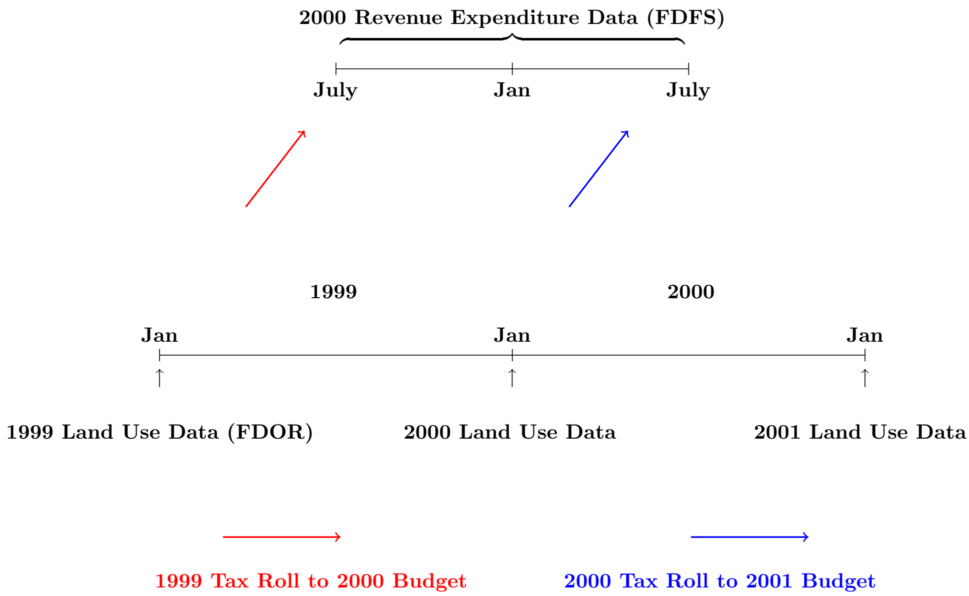



FIGURE 2: Timing of Standardized Property Tax Roll (FDOR) and Annual Financial Reports (FDFS).

where

$R = \{EB, P, IT\}$,

$M = \{I, TP, TB, R, D, W, LF, ES\}M = \{I, TP, TB, R, D, W, LF, ES, NP, OP\}$,

$T = \{SI, SD, PD, CD, U\}$,

GLU = GINIs for land uses {*SF*, *MF*, *Condo*, *Inst*, *Ind*, *Other Res*, *Other Com*, *Office*, *Retail*},

CLU = parcel counts for land uses {*SF*, *MF*, *Condo*, *Inst*, *Ind*, *Other Res*, *Other Com*, *Office*, *Retail*}.

Note that in models A and B some of the explanatory variables are measured for year $t$, while others are measured for year $t - 1$ (i.e., lagged one year). These differences are necessary because in Florida fiscal and calendar years do not coincide. Tax roll data from FDOR are dated January 1 of the calendar year. AFR data from FDFS are for the fiscal year, which runs from July 1 to June 30 of the following year. It is the latter year that is attached to these data (see Figure 2 for an illustration). Terms $E$ and $IT$ are from FDFS and therefore $IT$ enters the model unlagged. $EB$ and $P$ are also not lagged. These variables are measured as of January 1 for year $t$, which is in the middle of the fiscal year. The tax base and land use variables, along with the variables suggested by the median voter model, all enter the models with a one-year lag. These variables are all measured on January 1 of year $t - 1$. To illustrate the timing of these variables, expenditures beginning on July 1, 2000, and ending on June 30, 2001, are related to these variables measured on January 1, 2000. Budget officials base 2001 fiscal year expenditures on the tax base and land uses found on the January 1, 2000, property tax roll. We assume that they seek to satisfy the median voter's demand for public services as measured six months prior to the beginning of the fiscal year. The remaining variables are those found within the final two categories of $S$ determinants. To determine the timing of these variables we tested each one using AIC. The current values of the crisis management variables and the lagged values of the business sector variables minimized AIC.

Our equations are estimated separately for urban counties inside metropolitan areas and rural counties outside of metropolitan areas. There are 35 urban counties and 31 rural counties. In Florida, there are dramatic differences between these two types of counties; for example, with few exceptions, there is a high level of economic development within the urban counties (average population is 473,000 in 2013), while the rural counties are primarily agrarian in nature (2013 mean population is 40,000). These differences are likely to affect estimated relationships between public services costs and a land use's concentration. Models A and B are estimated for total current expenditures per capita and model B is also estimated separately for per capita current expenditures in the eight subcategories of spending defined in Table 1.

The importance of relying on current rather than total expenditures can be seen by referring back to our theoretical model. This model relates the concentration of a land use to local public spending, where the latter is defined as the sum of spending on current operations and the current cost of using public capital. This suggests that our dependent variable should equal the sum of current and capital expenditures (i.e., total expenditures), divided by population. In our data, however, capital expenditures equal capital outlays and not the annual capital cost. If we sum current and capital expenditures, we would be adding a flow and a stock variable together, which would make the results difficult to interpret. Current expenditures equal spending on current operations and account, at least partially, for current capital cost by including spending on debt service. Almost all large capital projects undertaken by Florida cities are debt financed. Hence, we view current expenditures as a measure of the expenditures defined by our theoretical model and use it in per capita terms exclusively in the estimation of our empirical models.

## 6. DESCRIPTIVE STATISTICS

Table 2 reports means of the GINI coefficients for selected years of our panel (see Table 2).[27] The means are broken down by type of county (urban and rural) and by the individual types of alternative land uses. Not surprisingly, within both types of counties, single-family homes are the least concentrated and office, multifamily, and industrial properties are the most concentrated. Retail and other commercial properties are also highly concentrated within rural counties but less so in urban counties. The concentrations of institutional and other residential properties fall in between these other properties within both counties.

The GINI coefficients for all properties combined (first column, Table 2) indicate that, in general, properties in both types of counties have become more spatially dispersed over the years covered by our panel. However, the GINI coefficients for the individual property types show that only single-family, multifamily, and condominium properties account for these results. The spatial distributions of the other land uses have remained remarkably similar over the years.[28]

[27]Means and standard deviations for expenditures per capita and the control variables are reported in Table A1 in the online appendix.

[28]While these averages show little variation in the nonresidential GINI coefficients over the panel, there is considerable variation at the county level, which facilitates the estimation of their effects. As an illustration, for each county we computed the percentage change in each GINI coefficient over the course of our panel. For retail properties, the range across counties is −4.3 percent to 10 percent, which is representative of the ranges for the other nonresidential land uses.

TABLE 2: Mean GINI Coefficients Urban Counties

| | | Residential | | | | Commercial | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | All | Single-family | Multifamily | Condos | Other | Offices | Retail | Other | Industrial | Institutional |
| 1995 | 0.709 | 0.740 | 0.910 | 0.920 | 0.842 | 0.905 | 0.862 | 0.873 | 0.906 | 0.832 |
| | (0.113)[a] | (0.112) | (0.073) | (0.075) | (0.107) | (0.068) | (0.080) | (0.071) | (0.067) | (0.077) |
| 2000 | 0.702 | 0.734 | 0.916 | 0.922 | 0.858 | 0.907 | 0.866 | 0.877 | 0.914 | 0.837 |
| | (0.109) | (0.107) | (0.053) | (0.075) | (0.083) | (0.058) | (0.064) | (0.056) | (0.031) | (0.059) |
| 2005 | 0.691 | 0.722 | 0.910 | 0.917 | 0.859 | 0.903 | 0.865 | 0.872 | 0.913 | 0.832 |
| | (0.118) | (0.115) | (0.060) | (0.082) | (0.082) | (0.061) | (0.067) | (0.057) | (0.033) | (0.059) |
| 2010 | 0.678 | 0.706 | 0.890 | 0.912 | 0.861 | 0.902 | 0.869 | 0.885 | 0.911 | 0.829 |
| | (0.121) | (0.122) | (0.069) | (0.077) | (0.082) | (0.058) | (0.057) | (0.055) | (0.042) | (0.069) |
| 2013 | 0.677 | 0.704 | 0.897 | 0.913 | 0.860 | 0.902 | 0.868 | 0.888 | 0.913 | 0.825 |
| | (0.122) | (0.122) | (0.068) | (0.077) | (0.080) | (0.058) | (0.055) | (0.051) | (0.043) | (0.066) |

Rural Counties

| | | Residential | | | | Commercial | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | All | Single-family | Multifamily | Condos | Other | Offices | Retail | Other | Industrial | Institutional |
| 1995 | 0.730 | 0.774 | 0.968 | | 0.773 | 0.971 | 0.938 | 0.947 | 0.934 | 0.890 |
| | (0.055) | (0.051) | (0.027) | | (0.080) | (0.021) | (0.028) | (0.033) | (0.047) | (0.036) |
| 2000 | 0.725 | 0.771 | 0.970 | | 0.730 | 0.970 | 0.939 | 0.943 | 0.937 | 0.889 |
| | (0.057) | (0.051) | (0.028) | | (0.081) | (0.020) | (0.027) | (0.039) | (0.033) | (0.038) |
| 2005 | 0.719 | 0.766 | 0.967 | | 0.727 | 0.970 | 0.941 | 0.941 | 0.935 | 0.890 |
| | (0.063) | (0.056) | (0.029) | | (0.085) | (0.019) | (0.027) | (0.039) | (0.035) | (0.036) |
| 2010 | 0.714 | 0.758 | 0.927 | | 0.728 | 0.968 | 0.941 | 0.939 | 0.935 | 0.890 |
| | (0.064) | (0.059) | (0.053) | | (0.088) | (0.019) | (0.028) | (0.042) | (0.037) | (0.033) |
| 2013 | 0.713 | 0.756 | 0.932 | | 0.727 | 0.969 | 0.942 | 0.942 | 0.934 | 0.889 |
| | (0.065) | (0.059) | (0.051) | | (0.086) | (0.018) | (0.027) | (0.040) | (0.037) | (0.032) |

[a]Standard deviations in parenthesis.

## 7. SPECIFICATION TESTS

Before we report the individual results, the findings from tests supporting the specification of our estimating equations merit comment. We validate our models with five separate sets of tests. First, we tested whether estimated GINI coefficient effects are nonlinear by conducting a joint significance test of the squared terms of the GINI coefficients.[29] They are significant at the 5 and 10 percent levels for urban and rural counties, respectively. Second, we conducted a joint $F$-test of all of the GINI coefficient terms and for both urban and rural counties they are significant at the 1 percent level. These results provide strong support for the hypothesis that the geography of land uses within counties effect the costs of providing public services. Third, joint $F$-tests are conducted on the control variables and they are significant at the 1 percent level for both types of counties.[30] Fourth, we test for group-specific nonlinearities by conducting a joint $F$-test of the $(x_{it} - u_i)^2$ terms. For both urban and rural counties, these terms are jointly significant at the 5 percent level or better. We also checked the AIC with and without the terms and AIC is minimized from their inclusion by a large margin. These results support our use of the McIntosh and Schlenker model.[31] Finally, consistent estimation requires that explanatory variables be strictly exogenous (Wooldridge, 2002, chapter 10). If land use concentration is not strictly exogenous to expenditures, simultaneity or feedback bias may result. A strictly exogenous variable does not react to past changes in expenditures, displays no traditional simultaneity, and is not correlated with time-varying omitted variables. To test for strict exogeneity, Wooldridge (2002, p. 285) recommends adding the leading value of the variable to model B and testing its statistical significance. The rational for the test comes from the fact that, if feedback is present, measures of concentration in $t + 1$ should be correlated with expenditures in $t$, controlling for concentration and other covariates in $t$. We tested the strict exogeneity of each of our GINI coefficients by doing a joint $F$-test on the leading value of the variable and its square, given that the variable enters our model as a quadratic. For each of the nine land use types entering the model estimated for urban counties we are unable to reject the hypothesis that the GINI coefficient is strictly exogenous at even the 10 percent level based on tests robust to serial correlation and heteroscedasticity. For rural counties, strict exogeneity cannot be rejected for seven of the eight land use types. The exception is the GINI coefficient for office buildings. We recognize that Wooldridge's test for strict exogeneity may have low power in testing for contemporaneous exogeneity. The latter may be violated by simultaneity or omitting variables that are correlated with both our measures of concentration and expenditures. As noted above, our extensive inclusion of control variables mitigates possible omitted variable bias. Simultaneity may arise if the jurisdictions within the county (cities and the county) respond to changes in the costs of public services by using their expenditures or zoning powers to either concentrate or deconcentrate economic development. The use of expenditures would be difficult given statutory requirements that public services be uniform within jurisdictions. The zoning option is more realistic. But as our results will show, if local governments use their zoning powers to reduce the costs of public services they must be able to concentrate some land uses and deconcentrate others. This flexibility was severely constrained for all but the last two years of our panel because the land use

[29]We focus on the specification test results from estimating the more general of our two models (model B), but results for model A also support our specification.

[30]All of our statistical significance tests are based on estimated standard errors that are clustered at the county level; hence, the tests are robust to both heteroscedasticity and serial correlation.

[31]As noted by an editor, it is also of interest to compare the GINI coefficient results from including and excluding these terms. Unsurprisingly, the results are very different. Estimated signs and significance levels change for multiple land uses. Specific changes are noted below after presenting our results.

regulatory environment in Florida was top down, as the result of Florida's strong growth management laws. These laws required statewide review of local land use and zoning decisions, which constrained the zoning powers of local governments and may account for our inability to reject strict exogeneity.

It is important to note that while Wooldridge's strict exogeneity test may show no evidence of feedback this does not obviate the possible need for treating a variable as endogenous. Ideally, more common Hausman (1978) like tests of exogeneity should be conducted, but these require instruments for conducting the test and for estimating two-stage least squares models in the event that endogeneity is detected. In our case, such instruments are unavailable. However, in long panels such as ours, Wooldridge (2002, p. 302) has shown that the bias from violating strict exogeneity is minimal in a fixed effects (FE), but not necessarily in a first differences (FD) model. Hence, our choice in favor of FE over FD for dealing with unobservable heterogeneity.

## 8. RESULTS FROM ESTIMATING MODEL A

We estimate model A to investigate the effect on public services costs from the deconcentration of all buildings combined within the developed area of the county. Detailed results are found in Table A2 in the online appendix.[32] The estimated effects of the All-Buildings GINI coefficients are illustrated in the graphs at the bottom of Table 3, which show the nonlinear effects the GINI coefficients have on urban and rural county expenditures, respectively. Reported next to the graphs are the *F*-statistic and *P*-value testing the joint significance of the GINI coefficient and its square (i.e., the assumed quadratic functional form). To judge the quantitative importance of a change in the GINI coefficient on costs, we also report the percentage change in expenditures from the GINI coefficient decreasing from its mean value to one standard deviation below its mean value, obtained from the estimated effects on the GINI coefficient and its square. For urban counties, a decrease in the all-buildings GINI coefficient from its mean value to one standard deviation below its mean value increases costs by 1.7 percent, but the effect is not statistically significant ($P = 0.66$). In contrast, the results for rural counties show that deconcentrating all buildings within the developed area reduces costs and the effect is statistically significant at the 3 percent level. A change in the all-buildings GINI coefficient from its mean value to one standard deviation below its mean value decreases costs by about 1.3 percent. This result suggests that within rural counties the environmental harshness effects from concentrating economic development has a stronger impact on public services costs than economies of density.

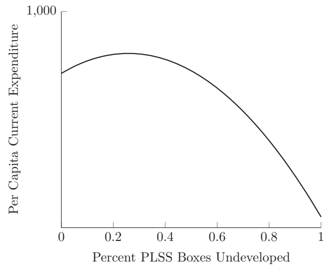
## 9. RESULTS FROM ESTIMATING MODEL B

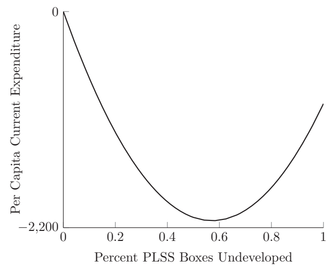
We estimate model B to investigate how public services costs are affected by an expansion in the developed area of a county and by the deconcentration of alternative land uses within the developed area. While we address these questions using total current expenditures as our dependent variable, we fully exploit the detailed nature of our data by also estimating the model for categories of expenditures. If we find that the

[32]We focus exclusively on the results obtained with our test variables, although the results obtained with the control variables are reported in the online appendix for both model A and B. Space constraints preclude a detailed discussion of the results obtained with the control variables. We note only that these results yielded no surprises. With few exceptions, the fiscal resource, crisis management and size of commercial sector variables increased expenditures. The number of registered Republicans decreased expenditures, while the number of registered Democrats had the opposite effect.

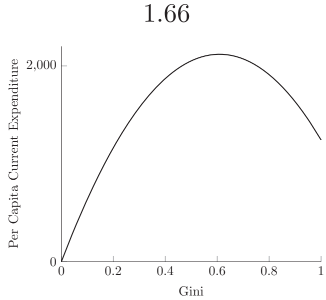
TABLE 3: Effects on Public Service Costs from Expanding Developed Area and Deconcentrating All Buildings within Developed Areas

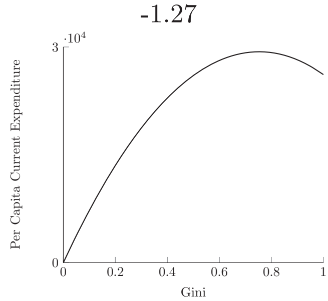
| | Urban Counties | Rural Counties |
|---|---|---|
| Expansion of Developed Area | | |
| F-Statistic | 2.22 | 0.96 |
| p-value | .123 | .395 |
| %Δ[a] | 1.19 | 0.01 |




| | Urban Counties | Rural Counties |
|---|---|---|
| GINI All-Buildings | | |
| F-Statistic | 0.42 | 3.97 |
| p-value | .66 | .029 |
| %Δ [b] | 1.66 | -1.27 |




[a]The percentage change in real per capita expenditures from developing an additional PLSS box.

[b]The percentage change in real per capita expenditures from reducing the GINI coefficient from its mean value to one standard deviation below its mean value.

deconcentration of a particular land use affects total expenditures, by estimating categorical models we are able to pinpoint the types of expenditures that may account for this result. Our analysis consists of four steps. The results from each step are discussed below.

### *Step 1*

We estimate model B with an eye toward determining which of the land use GINI coefficients have a statistically significant effect on total current expenditures. We also focus on the estimated coefficients obtained for the number of empty PLSS boxes (*EB*), which is our measure of urban expansion. The *EB* results are presented at the top of Table 3 and the GINI coefficient results for alternative land uses are reported in Table 4.

The average urban county has 989 PLSS boxes and 443 are undeveloped, yielding an undeveloped percentage of 44.8. If we add an additional PLSS box to the developed area of the average county (a 0.1 percent reduction in the undeveloped percentage), public services costs increase by about 1 percent and the effect is statistically significant at the 12 percent level. Rural counties, on average, have 761 PLSS boxes and 427 are undeveloped,

TABLE 4: Estimated Impact of Changes in GINI Coefficients on Total Expenditure

| | Single-family | Multi-family | Condo | Office | Retail | Industrial | Institutional | Other Residential | Other Commercial |
|---|---|---|---|---|---|---|---|---|---|
| Urban | | | | | | | | | |
| *F*-statistic[a] | 1.34 | 4.51 | 6.30 | 6.30 | 1.88 | 0.10 | 2.87 | 1.45 | 0.41 |
| *P*-value | 0.274 | 0.018 | 0.005 | 0.019 | 0.168 | 0.907 | 0.07 | 0.249 | 0.668 |
| %Δ[b] | −0.24 | 0.49 | 24.54 | 1.34 | 1.54 | 1.59 | −5.52 | 0.00 | −0.86 |
| Rural | | | | | | | | | |
| *F*-statistic | 0.24 | 3.76 | | 6.53 | 6.72 | 0.29 | 3.03 | 1.48 | 0.21 |
| *P*-value | 0.785 | 0.034 | | 0.004 | 0.003 | 0.751 | 0.063 | 0.244 | 0.813 |
| %Δ | −2.12 | −1.04 | | 1.26 | −1.39 | −1.78 | 0.58 | −17.4 | 0.64 |

[a]The *F*-statistic (*P*-value) test the statistical significance of the GINI coefficient and its square.
[b]The percentage change in real per capita expenditures from reducing the GINI Coefficient from its mean to 0.10 below its mean value.

yielding an undeveloped percentage of 56.1. As is true in urban counties, adding a PLSS box to the developed area of a rural county increases public services costs, but the effect is trivial in magnitude and not significant (0.01 percent increase in expenditures, with a $P = 0.395$). These results suggest that if urban expansion or "sprawl" affects public services costs, the effect is likely to be felt only within urban counties, with the spread of development over a larger area causing an increase in costs. There is therefore some support for the idea that economies of density are lost within urban counties as the density of development falls within the county.

The results presented in Table 4 showing the estimated GINI coefficients for the individual land uses include the *F*-statistic and *P*-value testing the joint significance of a land use's GINI coefficient and its square on total expenditures. To judge the quantitative importance of a change in a GINI coefficient on costs, we next report the percentage change in expenditures from a GINI coefficient decreasing from its mean value to 0.10 below its mean value.[33] For most land uses, the 0.10 increment represents a one to two standard deviation change. The curvilinear relationships of Table 4 are graphed in Figure 3.

Within urban counties the deconcentration of four of the nine land uses is found to have a statistically significant effect on real per capita current expenditures at the 10 percent level or better—multifamily housing, condominiums, office buildings, and institutional properties. For all but institutional properties, deconcentration is found to increase costs. The smallest increase is 0.5 percent for multifamily housing and the largest increase is 24.5 percent for condominiums. These results suggest that within urban counties economies of density has a stronger impact on public services costs than harshness of the environment. Within rural counties the deconcentration of four of the eight land uses is found to have a statistically significant effect on total current expenditures—multifamily housing, office buildings, retail properties, and institutional properties. The multifamily and retail effects are negative. The office and institutional effects are positive. The absolute magnitudes of all four estimated effects roughly equal 1 percent.[34]

[33]Because relationships are nonlinear, the percentage change in expenditures from an incremental change in concentration will depend upon the starting value used for the GINI coefficient. We choose the sample mean value of the GINI coefficient for each land use. Using the median value produces similar results.

[34]To investigate the sensitivity of the results to the inclusion of the McIntosh and Schlenker's terms $((x_{it} - u_i)^2)$, we dropped these terms and re-estimated model B. The estimated GINI coefficients for

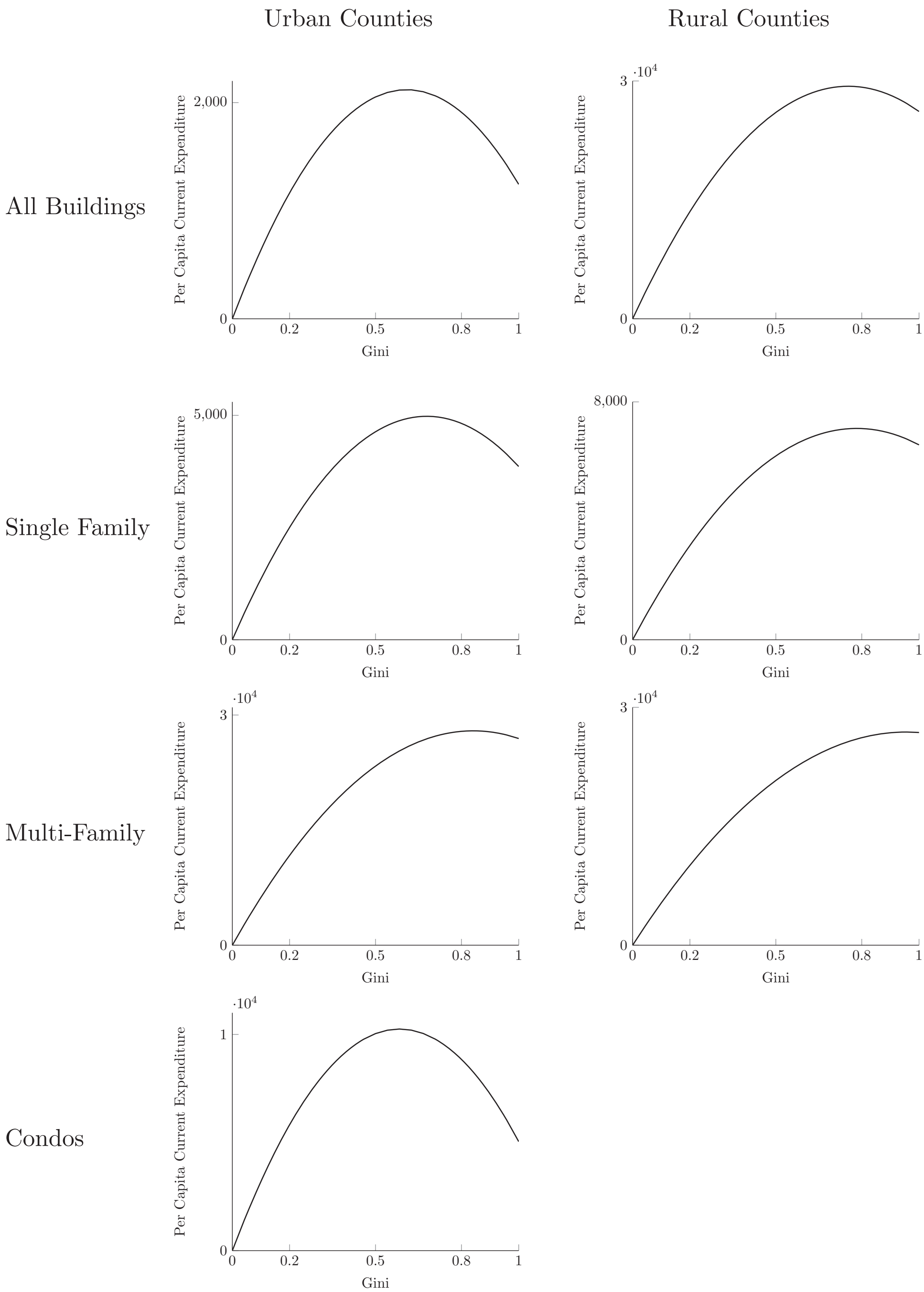



FIGURE 3: Graphs Displaying Quadratic Relationships.

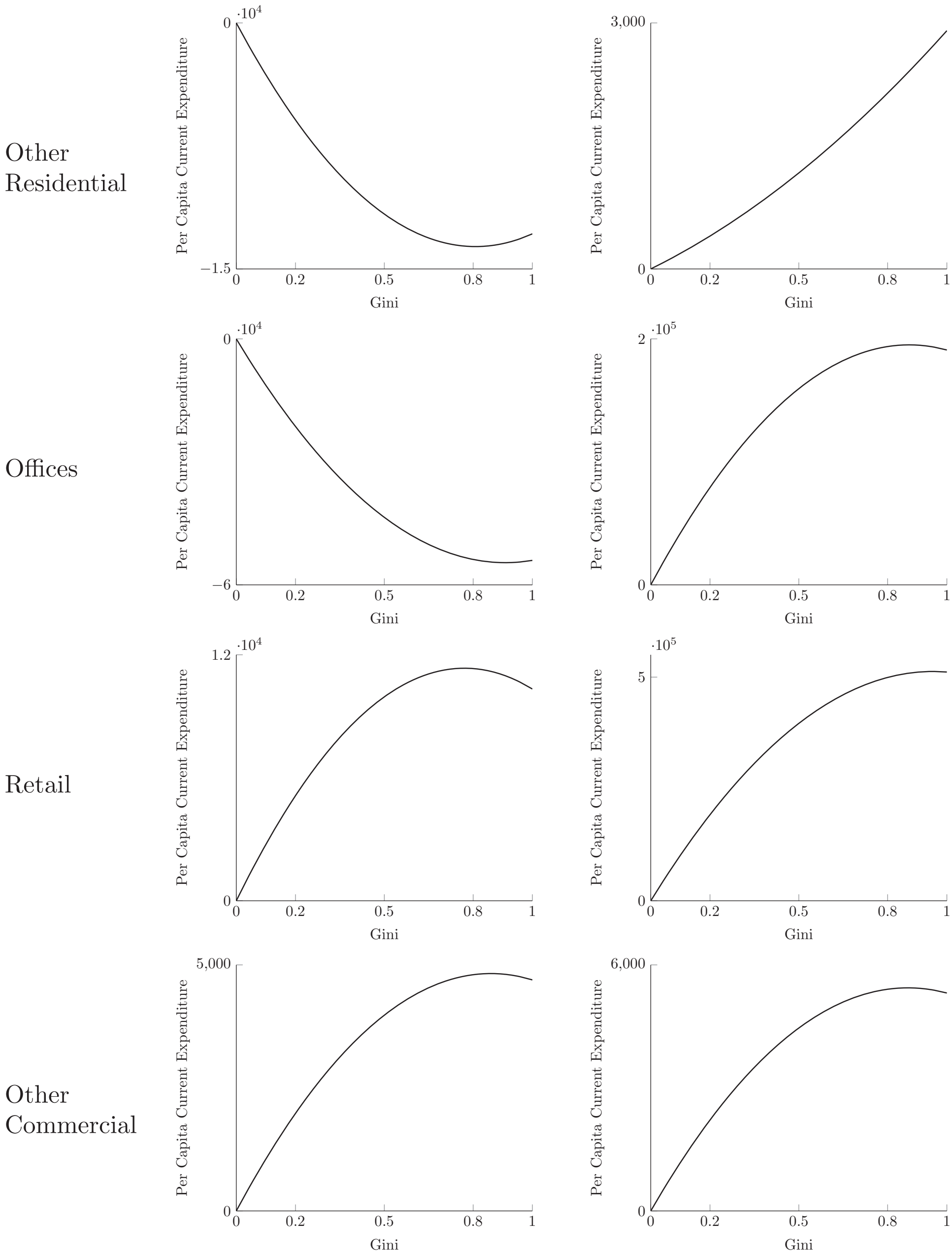



FIGURE 3: *Continued.*

condominiums and other residential properties in the urban counties model and for multifamily, institutional, and other commercial properties in the rural counties model changed signs after dropping these terms. Also, within the urban counties model, the estimated coefficients on multifamily and offices properties became insignificant, while the coefficient for retail properties became significant. In the rural

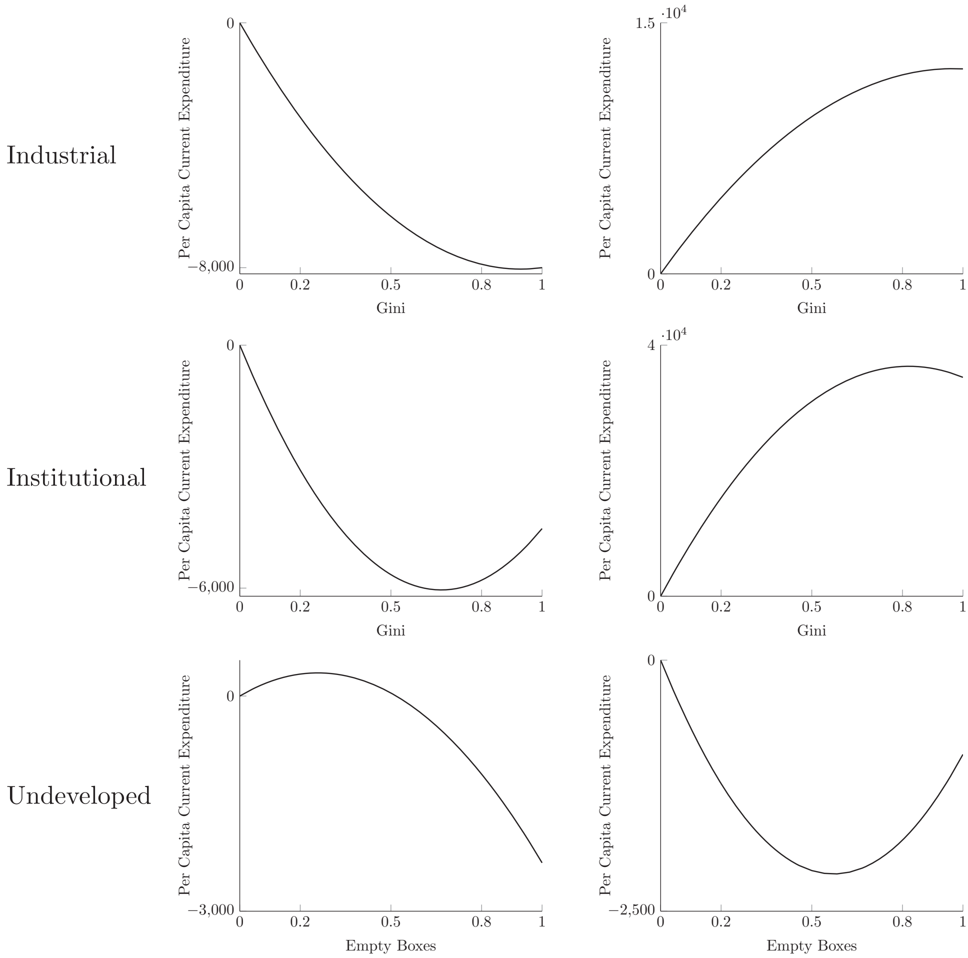



FIGURE 3: *Continued.*

*Step 2*

For those land uses where we find that deconcentration matters to total expenditures we would like to know which categories of expenditures underlie this result. To pursue this, we re-estimated model B replacing total expenditures with expenditures falling within each of the categories listed in Table 1. If a land use's GINI coefficient fails to have a statistically significant effect on a category, it is unlikely that this category contributes much in explaining the total effect.

Tables A3 and A4 in the online appendix report the results obtained for each of the expenditure categories for urban and rural counties, respectively. Tables 5 and 6 identify from the online appendix tables those categories of expenditures that are significantly affected by each of the land uses having a significant effect on total expenditures. To illustrate, for urban counties (Table 5), the deconcentration of multifamily housing in-

counties model the coefficient on other residential properties became significant. These results, along with the specification tests reported in section 7, underscore the importance of including the McIntosh and Schlenker's terms in our estimated models.

creases public safety and transportation expenditures. These results suggest that these two spending categories account for multifamily's effect on total expenditures. As shown in Table 5, different categories of expenditures matter depending on land use, but public safety expenditures most frequently play a role in explaining the effect that the deconcentration of a land use has on total expenditures. Transportation, general government, and human services expenditures also are important for multiple land uses. The results for rural counties contrast to those for urban counties (Table 6). For all four of the land uses that have a significant effect on total expenditures, the economic environment spending category matters, while this category is unimportant in explaining the results for urban counties. Also, while public safety expenditures are important for three of the four land uses that effect total expenditures within urban counties, within rural counties this category is only relevant for one land use (retail properties).

*Step 3*

The results reported in step 2 help identify the categories of expenditures that may account for the effect that a land use's GINI coefficient has on total expenditures. However, the significance of a GINI coefficient in a categorical model is a necessary but not a sufficient condition for the category to play an important role. Even if a significant effect is found for the category, the category may still represent too small a percentage of total expenditures for its effect to be important. In recognition of this possibility, for those categories where a significant effect is found, we re-estimated model B where the dependent variable equals total current expenditures minus current spending within that category. If the exclusion of the category's expenditures from total current expenditures renders the GINI coefficient of the land use statistically insignificant, this is a good indication that the category is important in explaining the effect that the land use has on total current expenditures. These auxiliary regressions are useful because they account for both the significance of the land use on a category's expenditures as well as the importance of the category as a percentage of total current expenditures. *P*-values are reported in brackets in Tables 5 and 6 from regressions where the expenditures within a category are removed from total expenditures, for urban and rural counties, respectively. To illustrate, the results from step 2 suggest that general government and public safety expenditures may account for the positive effect that the GINI coefficient for condominiums has on total expenditures within urban counties. In Table 5 for urban counties the *P*-values are 0.389 for general government and 0.001 for public safety. Hence, if general government expenditures are excluded from total expenditures, the GINI coefficient for condominiums no longer has a significant effect on total expenditures. Dropping public safety expenditures, on the other hand, does not affect the significant effect that the condominium GINI has on total expenditures. These results suggest that the deconcentration of condominiums cause general government expenditures to rise and it is this increase that explains the positive effect that the deconcentration of condominiums has on total expenditures. Sticking with the urban county results, step 2 suggests that human services, physical environment, and transportation expenditures may explain the negative effect that the GINI coefficient for institutional properties has on total expenditures. Excluding either physical environment or transportation expenditures from total expenditures results in the GINI coefficient no longer having a statistically significant effect on total expenditures, suggesting that these two expenditure categories account for the total effect. The step 2 results also suggest that public services and transportation expenditures are possibly important for multifamily housing. Excluding either one of these categories from total expenditures fails to change the significance of the multifamily housing GINI coefficient. It therefore appears that no single category of expenditures drives the effects that the deconcentration of this land use has on total expenditures. Finally, step 2 results indicate that general government, human services, public services, and transportation expenditures may be important for office properties. Only the exclusion of general government expenditures from total expenditures renders the office properties GINI coefficient statistically insignificant, suggesting that the deconcentration of offices buildings on general government expenditures explains the effect that these properties have on total expenditures.

Table 6 reports step 3 results for rural counties. These results suggest that the multifamily housing, retail, and institutional GINI coefficient effects on total expenditures can largely be attributed to spending within the economic environment category. For offices, the results from excluding from total expenditures the three expenditure categories that may be important in explaining the GINI coefficient effects on total expenditures (economic environment, general government, and courts) suggests that no one type of expenditures is dominant in explaining the positive effect that the deconcentration of office properties has on total expenditures.

*Step 4*

Finally, we dig deeper into our data to find what types of spending *within an expenditure category* may be most important in explaining a land uses' deconcentration on public services costs. For each category of expenditures our data contain 6–12 account codes that make up the category.[35] Model B regressions are run for expenditures within each account code. Sometimes the land use has a statistically significant effect in just one or two of these regressions, which suggests that it is spending within this code (or codes) that is central to explaining the effect that the land use has on total current expenditures. Other times, the results are too similar across account codes to pinpoint further the types of expenditures that matter most. The account code regressions are also not helpful if the land use's effect is the strongest in the "other spending" account code category.[36]

Tables 5 and 6 report the results for urban and rural counties, respectively. Listed under each category of expenditures where the GINI coefficient of the land use has a statistically significant effect on total and categorical expenditures are the account code expenditures that are also significantly affected by the land use. As before, we report the percentage change in expenditures from a reduction in the GINI coefficient from its mean value to 0.10 below its mean value. In parentheses under the percentage change is the $P$-value on the $F$-statistic testing the joint significance of the GINI coefficient and its square. In braces under the $P$-value is average account spending as a percentage of categorical expenditures. To illustrate, for urban counties we know from step 1 that the deconcentration of multifamily housing increases total expenditures. From step 2, we know that public safety is one of the two categories of expenditures affected by the deconcentration of multifamily housing. Table 5 shows that the deconcentration of multifamily housing significantly affects expenditures within four of the account codes within the public safety category—AC521 (law enforcement), AC526 (ambulances and rescue services), AC527 (medical examiners), and AC528 (consumer affairs). The other expenditure category affected by the deconcentration of multifamily housing is transportation. The

[35]For example, there are nine account codes for public safety expenditures: law enforcement, fire control, retention and correction, protective inspections, emergency and disaster relief services, ambulance and rescue services, medical examiners, consumer affairs, and other public safety expenditures.

[36]Because the account code regression results are voluminous and sometimes uninformative they are discussed but are not tabled. Table A5 in the online appendix provides a complete description of each account code. These descriptions come from the *Uniform Accounting System Manual* published by the Florida Department of Financial Services.

only account code within the transportation category affected by multifamily housing is AC541 (road and street facilities). The numbers in braces reveal that law enforcement and road and street facilities represent the majority of expenditures within their respective categories, 53.07 percent and 69.34 percent, respectively. Hence, the results suggest that spending within these two account codes largely account for the positive impact that the deconcentration of multifamily housing has on total expenditures. Though there is a statistically significant effect of deconcentrating multifamily housing on medical examiners (AC527) and ambulance and rescue services (AC526), these two account codes make up such a small percentage of public safety expenditures, 0.52 percent and 6.76 percent, it is unlikely that they are responsible for the effect that deconcentrating multifamily housing has on public safety expenditures. Following this same logic for the other land uses within urban counties whose GINI coefficients affect public services costs (condominium, office, and institutional properties) and taking into consideration the results from step 3, the deconcentrations of condominium and institutional properties affect total expenditures primarily by raising debt service payments (AC517) and decreasing electric utility spending (AC531), respectively. In light of the findings from step 3 that none of the four spending categories affected by the deconcentration of office buildings seem to drive the estimated effect on total expenditures, the results from the account code regressions are less informative. However, the deconcentration of office properties has a significant effect on health services (AC562) within the human services category and law enforcement (AC521) within the public services category and both of these account codes represent a majority of the spending within their respective categories.

The account code results for rural counties are in Table 6. For all four of the land uses whose deconcentration affects total expenditures, the only account code that matters within each of the expenditure categories that appear particularly important based upon step 3 results is “other spending.” Hence, step 4 results are uninformative for rural counties.

We also conducted steps 2–4 for model A to determine the specific expenditures that account for the decrease in total expenditures within rural counties from a decrease in the all-buildings GINI coefficient (as reported above in section 8).[37] Step 2 revealed that the deconcentration of all buildings has a significant and negative effect on two categories of expenditures—general government and physical environment. Step 3 showed that the GINI coefficient effect is no longer significant if physical environment expenditures are excluded from total expenditures. The account code regressions of step 4 indicated that within the physical environment category AC534 (garbage and solid waste control services) has the strongest effect on expenditures. These results lend support to Ladd (1994) who hypothesized that higher density may raise the social costs of inappropriately disposed waste and therefore may require more garbage pickup and disposal.

## 10. FURTHER EXPLORATION OF THE EFFECTS ON PUBLIC SERVICES COSTS FROM URBAN AREA EXPANSION

We reported above that adding a PLSS box to the developed area of the county has a positive effect on public services costs that is borderline significant in urban counties but highly insignificant in rural counties. To further explore the effects of urban expansion on costs we estimated model B at the categorical and account code levels focusing on

[37] In the interest of saving space, these results are not tabled but are available upon request.

TABLE 5: Urban Counties Impacts of Changes in GINI Coefficients on Categorical and Account Code-Level Expenditure

| Land Use | Expenditure Account Category Code | | Account Code Title |
|---|---|---|---|
| Multifamily | | | |
| | Public safety | 0.79[a] | |
| | | (0.012)[b] | |
| | | [0.031][c] | |
| | AC 521 | 0.53 | LAW ENFORCEMENT |
| | | (0.050) | |
| | | {53.07}[d] | |
| | AC 526 | 0.45 | AMBULANCE AND RESCUE SERVICES |
| | | (0.012) | |
| | | {6.76} | |
| | AC 527 | 7.87 | MEDICAL EXAMINERS |
| | | (0.000) | |
| | | {0.52} | |
| | AC 528 | 4.31 | CONSUMER AFFAIRS |
| | | (0.004) | |
| | | {0.06} | |
| | Transportation | 0.20 | |
| | | (0.048) | |
| | | [0.034] | |
| | AC541 | 0.21 | ROAD AND STREET FACILITIES |
| | | (0.056) | |
| | | {69.34} | |
| Condominium | | | |
| | General government | 335 | |
| | | (0.009) | |
| | | [0.389] | |
| | AC 516 | 2.99 | NON-COURT INFORMATION SYSTEMS |
| | | (0.040) | |
| | | {1.20} | |
| | AC 517 | 11.54 | DEBT SERVICE PAYMENTS |
| | | (0.002) | |
| | | {16.94} | |
| | AC 518 | 4.76 | PENSION BENEFITS |
| | | (0.000) | |
| | | {7.04} | |
| | Public safety | 4.06 | |
| | | (0.036) | |
| | | [0.001] | |
| | AC 522 | 16.88 | FIRE CONTROL |
| | | (0.068) | |
| | | {18.80} | |
| | AC 524 | 3.34 | PROTECTIVE INSPECTIONS |
| | | (0.054) | |
| | | {4.53} | |

(*Continued*)

TABLE 5: Continued

| Land Use | Expenditure Account Category Code | | Account Code Title |
|---|---|---|---|
| Offices | | | |
| | General government | 0.59 | |
| | | (0.028) | |
| | | [0.335] | |
| | AC 512 | 0.08 | LAW ENFORCEMENT |
| | | (0.082) | |
| | | {3.89} | |
| | AC 517 | 1.74 | DEBT SERVICE PAYMENTS |
| | | (0.062) | |
| | | {16.94} | |
| | AC 518 | 0.65 | PENSION BENEFITS |
| | | (0.061) | |
| | | {0.018} | |
| | Human services | 3.49 | |
| | | (0.018) | |
| | | [0.021] | |
| | AC 562 | 1.33 | HEALTH SERVICES |
| | | (0.090) | |
| | | {50.00} | |
| | AC 564 | 17.70 | PUBLIC ASSISTANCE SERVICES |
| | | (0.018) | |
| | | {24.91} | |
| | AC 569 | 1.50 | OTHER HUMAN SERVICES |
| | | (0.001) | |
| | | {23.63} | |
| | Public safety | 3.89 | |
| | | (0.004) | |
| | | [0.025] | |
| | AC 521 | 2.96 | LAW ENFORCEMENT |
| | | (0.063) | |
| | | {53.07} | |
| | AC 529 | 0.65 | OTHER PUBLIC SAFETY |
| | | (0.013) | |
| | | {2.11} | |
| | Transportation | 0.55 | |
| | | (0.090) | |
| | | [0.030] | |
| | AC 542 | 1.49 | AIRPORTS |
| | | (0.002) | |
| | | {12.21} | |
| | AC 543 | 2.21 | WATER TRANSPORTATION SYSTEMS |
| | | (0.017) | |
| | | {3.74} | |
| | AC 544 | 0.87 | MASS TRANSIT SYSTEMS |

(*Continued*)

TABLE 5: Continued

| Land Use | Expenditure Account Category Code | | Account Code Title |
|---|---|---|---|
| | | (0.006) | |
| | | {11.67} | |
| Institutional | | | |
| | Human services | −5.33 | |
| | | (0.000) | |
| | | [0.074] | |
| | AC 561 | −1.70 | HOSPITAL SERVICES |
| | | (0.000) | |
| | | {7.05} | |
| | AC 562 | −36.14 | HEALTH SERVICES |
| | | (0.011) | |
| | | {41.00} | |
| | AC 563 | −0.24 | MENTAL HEALTH SERVICES |
| | | (0.052) | |
| | | {5.69} | |
| | AC 564 | −0.50 | PUBLIC ASSISTANCE SERVICES |
| | | (0.019) | |
| | | {24.84} | |
| | AC 565 | −2.96 | DEVELOPMENTAL DISABILITIES |
| | | (0.09) | |
| | | {0.18} | |
| | Physical environment | −1.63 | |
| | | (0.006) | |
| | | [0.252] | |
| | AC 531 | 8.58 | ELECTRIC UTILITY SERVICES |
| | | (0.017) | |
| | | {17.14} | |
| | Transportation | −0.08 | |
| | | (0.015) | |
| | | [0.111] | |
| | AC 544 | −0.11 | MASS TRANSIT SYSTEMS |
| | | (0.13) | |
| | | {11.67} | |

[a]The percentage change in real per capita expenditure of the category or account code from reducing the GINI coefficient from its mean value to 0.10 below the mean value.

[b]In parentheses is the *P*-value on the *F*-statistic testing the statistical significance of the GINI coefficient and its square on total that expenditure category.

[c]In brackets is the *P*-value on the *F*-statistic testing the statistical significance of the GINI coefficient and its square on total expenditure minus the expenditure category.

[d]In braces is average account code spending as a percentage of the total expenditure within the category.

the results obtained with *EB*, which is our measure of the developed area of the county. The last column of Tables A3 and A4 in the online appendix show *EB*'s estimated effects on each category of expenditures for urban and rural counties, respectively. For urban counties, *EB* has a positive and significant effect on economic environment, human services and transportation expenditures. *EB* has a negative effect on public safety and court-related expenditures. Step 3 results indicate that the positive effect that *EB*

TABLE 6: Rural Counties Impacts of Changes in GINI Coefficients on Categorical and Account Code-Level Expenditure

| Land Use | | | Account Code Title |
|---|---|---|---|
| Multifamily | | | |
| | Economic environment | −0.84[a] | |
| | | (0.054)[b] | |
| | | [0.561][c] | |
| | AC 559 | −1.07 | OTHER ECONOMIC ENVIRONMENT |
| | | (0.060) | |
| | | {19.65}[d] | |
| | General government | −1.30 | |
| | | (0.027) | |
| | | [0.098] | |
| | AC511 | −5.60 | LEGISLATIVE |
| | | (0.011) | |
| | | {14.87} | |
| | AC515 | −2.79 | COMPREHENSIVE PLANNING |
| | | (0.001) | |
| | | {2.59} | |
| Offices | | | |
| | Economic environment | 0.50 | |
| | | (0.033) | |
| | | [0.004] | |
| | AC 559 | 3.79 | OTHER ECONOMIC ENVIRONMENT |
| | | (0.041) | |
| | | {19.65} | |
| | General government | 1.56 | |
| | | (0.087) | |
| | | [0.009] | |
| | AC 519 | 1.51 | OTHER GENERAL GOVERNMENTAL SERVICES |
| | | (0.030) | |
| | | {25.27} | |
| | Courts | 0.42 | |
| | | (0.000) | |
| | | [0.004] | |
| | AC 1 | 0.49 | CIVIL CIRCUIT COURT |
| | | (0.01) | |
| | | {5.91} | |
| | AC 5 | 0.91 | PROBATE CIRCUIT COURT |
| | | (0.064) | |
| | | {1.37} | |
| | AC 6 | 0.42 | CIVIL COUNTY COURT |
| | | (0.072) | |
| | | [3.32] | |

(*Continued*)

TABLE 6: Continued

| Land Use | | | Account Code Title |
|---|---|---|---|
| Retail | | | |
| | Economic environment | −1.46 | |
| | | (0.001) | |
| | | [0.551] | |
| | AC 559 | −1.50 | OTHER ECONOMIC ENVIRONMENT |
| | | (0.002) | |
| | | {19.65} | |
| | Public safety | −1.58 | |
| | | (0.086) | |
| | | [0.013] | |
| | AC 521 | −2.46 | LAW ENFORCEMENT |
| | | (0.058) | |
| | | {47.39} | |
| | AC 523 | −2.89 | DETENTION AND/OR CORRECTION |
| | | (0.028) | |
| | | {18.21} | |
| | AC 525 | −1.17 | EMERGENCY AND DISASTER RELIEF SERVICES |
| | | (0.070) | |
| | | {5.16} | |
| Industrial | | | |
| | Economic environment | 0.29 | |
| | | (0.006) | |
| | | [0.974] | |
| | AC 559 | 0.37 | OTHER ECONOMIC ENVIRONMENT |
| | | (0.007) | |
| | | {19.65} | |
| | Physical environment | 1.42 | |
| | | (0.043) | |
| | | [0.046] | |
| | AC 534 | 2.90 | GARBAGE/SOLID WASTE CONTROL SERVICES |
| | | (0.035) | |
| | | {33.98} | |
| | AC 539 | 0.22 | OTHER PHYSICAL ENVIRONMENT |
| | | (0.090) | |
| | | {4.38} | |

[a]The percentage change in real per capita expenditure of the category or account code from reducing the GINI coefficient from its mean value to 0.10 below the mean value.

[b]In parentheses is the *P*-value on the *F*-statistic testing the statistical significance of the GINI coefficient and its square on that expenditure category.

[c]In brackets is the *P*-value on the *F*-statistic testing the statistical significance of the GINI coefficient and its square on total expenditure minus the expenditure category.

[d]In braces is average account code spending as a percentage of the total expenditure within the category.

has on total expenditures can be attributed to its effect on transportation expenditures. The account code regressions for this category of expenditures indicate that expenditures on road and street facilities largely explain the effect that *EB* has on transportation expenditures.

For rural counties *EB* has a significant effect in only two of the expenditure category regressions—physical environment and court-related expenditures, and in each case the effect is negative. The account code regressions yielded no additional information.

An interesting finding common to both types of counties is that the expansion of the developed area is found to reduce court-related expenditures. Adding a PLSS box to the developed area reduces court expenditures by about 0.2–0.3 percent in both types of counties. This suggests that there may be a negative relationship between the dispersal of development and crime. In the context of our conceptual framework crime may be an important contributor to the harshness of the environment as the developed area of a county becomes more compact. Exploring possible relationships between crime and the geography of land uses goes beyond the purview of this paper. Our results suggest that this may be an important topic for future research.

Finally, we investigated why the expansion of the developed area of the county has a stronger effect on public services costs within urban in comparison to rural counties. This was easy to investigate with our FDOR data because from these data we know what types of properties are getting built within each PLSS box. In urban counties development occurs most frequently from the construction of single-family homes, which is consistent with our finding that urban area expansion increases costs by raising expenditures on streets and roads. In rural counties development is generally the result of mobile homes entering the PLSS box, which is not expected to have the same need for street and road services as single-family homes.

## 11. ECONOMIES OF DENSITY VERSUS HARSHNESS OF THE ENVIRONMENT: A SUMMARY OF THE RESULTS

We return to the question of the relative importance of economies of density versus harshness of the environment as factors affecting public services costs as economic development within a county becomes less concentrated. For urban counties, spreading development over a larger area of the county and the deconcentration of three prominent land uses within the developed area are all found to increase public services costs. These results suggest that economies of density is the stronger of the two factors. For rural counties, the deconcentration of all buildings combined, and the deconcentration of multifamily and retail properties considered separately, is found to decrease public services costs. These results suggest that within rural counties the harshness of environment is the dominant effect. However, for both counties the relative importance of the two factors is found to vary across land uses. Within urban counties, the deconcentration of institutional properties is found to decrease costs, while within rural counties the deconcentration of office and institutional properties is found to raise public services costs. Also, within both counties, the deconcentration of a number of the land uses is not found to affect public services costs. This is true for single-family, retail, industrial, other residential, and other commercial properties with urban counties. Within rural counties the deconcentration of single-family, industrial, other residential and other commercial properties is not fond to affect public services costs. In the cases where the deconcentration of a land use is not found to matter to public services costs, it may be that neither economies of density nor the harshness of the environment affects public services costs. Alternatively, the countervailing effects of these forces may offset one another throughout the range of GINI coefficients found within our data.

TABLE 7: Percentage Changes in Real Per Capita Expenditures from GINI Coefficient Changes and Expansions in Developed Areas, 1995–2013

| | | Urban Counties | | | Rural Counties | | |
|---|---|---|---|---|---|---|---|
| | | 10th | 50th | 90th | 10th | 50th | 90th |
| Change in GINI for: | All buildings | −3.64[a] | 1.25 | 5.45 | −29.06 | −5.38 | 4.40 |
| | Single-family | −6.93 | 1.31 | 7.26 | −5.54 | −0.00 | 2.10 |
| | Multifamily | −4.35 | 0.00 | 9.61 | −7.02 | −0.00 | 1.55 |
| | Condos | −9.47 | 6.30 | 30.78 | | | |
| | Other residential | −6.14 | 0.36 | 3.55 | −11.18 | −1.58 | 7.22 |
| | Offices | −7.11 | −0.76 | 5.71 | −11.16 | 11.08 | 36.97 |
| | Retail | −2.98 | 1.19 | 5.48 | −12.16 | −1.04 | 27.06 |
| | Other commercial | −0.79 | 0.00 | 1.43 | −1.14 | 0.17 | 2.12 |
| | Industrial | −0.47 | 0.00 | 0.33 | −1.25 | −0.00 | 2.54 |
| | Institutional | −11.09 | −1.61 | 2.09 | −18.67 | 2.12 | 14.22 |
| Expansion in developed area | | −0.41 | 3.33 | 12.42 | −4.29 | 3.18 | 19.78 |

[a]Reported is the percentage increase or decrease in 2013 expenditures from the change in the GINI coefficient (or expansion in the developed area) 1995–2013.
[b]Columns contain the 10th, 50th, and 90th percentile changes.

Our conclusion that economies of density play a more important role within urban than rural counties may be explained by differences between the two types of counties in the numbers of total buildings found within each county. To illustrate, in 2010 the average urban county had 12 times more total buildings, 15 times more office buildings, nine times more retail buildings, and 20 times more apartment buildings than the average rural county. Hence, in comparison to rural counties, concentration within urban counties means that far larger numbers of buildings are in close proximity to one another. If economies of density are conditional on both concentrating the existing number of buildings and having a large total number of buildings within concentrated areas, this may account for the differences between urban and rural counties in the importance of these effects.

## 12. SIMULATIONS SHOWING THE POTENTIAL IMPACT OF LAND USE CHANGES OVER TIME

As shown by the GINI coefficient means in Table 2, all buildings and residential properties have spatially dispersed over the 18 years covered by our panel. In addition, while these averages show little variation in the nonresidential GINI coefficients over the panel, as we reported in section 6 there is considerable variation in the GINI coefficients of these land uses at the county level. How important are these trends in producing changes in real per capita expenditures for individual counties? To investigate this, we used our estimates of models A and B to make two predictions for each county: the level of per capita expenditures in 2013 assuming a land use's 2013 GINI value and the level of per capita expenditures in 2013 assuming its 1995 GINI value, in each case holding all other GINI coefficients and the control variables constant. With these predictions we addressed the question how much larger or smaller are 2013 expenditures per capita as the result of the change in a GINI coefficient? Depending on the shape of the curve defining the relationship between a GINI coefficient and expenditures and where a county sits in 2013 on this curve (see graphs displayed in Figures 2 and 3), the change in the GINI coefficient may increase or decrease its expenditures. For example, the first row of Table 7 shows the results from using the estimates from model A to predict the effect on 2013 expenditures from the change in the all-buildings GINI coefficient. We report the percentage changes in 2013 expenditures at the 10th, 50th, and 90th percentiles. For example, for urban counties at the 10th percentile expenditures are 3.64 percent smaller in 2013 as the result of the change in the all-buildings GINI coefficient. At the 50th and 90th percentiles, they are 1.25 percent and 5.45 percent greater, respectively. Using the results from estimating model B, the rest of the rows in Table 7 report the percentage change in 2013 expenditures from the change in the GINI coefficient for each land use. The range in estimates across percentiles suggest that for most land uses GINI coefficient changes produced nontrivial changes in per capita expenditures in both urban and rural counties. Only the effects produced by other commercial and industrial land uses may be considered unimportant.

Also reported in Table 7 are percentage changes in 2013 expenditures predicted from changes in the expansion of the developed area of counties. For urban counties the 10th, 50th, and 90th percentile changes are −0.41 percent, 3.33 percent, and 12.42 percent, respectively. For rural counties the corresponding percentage changes are −4.29, 3.18, and 19.78. Hence, as is true for changes in the GINI coefficients, our simulations suggest that changes in the developed area of counties have had important effects on per capita expenditures.[38]

## 13. CONCLUSION

As a result of the growing fiscal stress that local governments have experienced in recent years, more importance has been placed on the “fiscalization” of land use planning, where all decisions are made with an eye toward their budgetary consequences. Theory suggests that the geography of land uses within the borders of cities and counties may have budgetary consequences and therefore may have a role to play in the fiscalization movement. However, in our review of the literature we were unable to find a convincing test of the hypothesis that geography matters to public services costs. In addition, while there is some evidence on the relationship between costs and urban sprawl, we found no evidence on the relationships between costs and the spatial distributions of alternative types of development. What has limited research in this area has been the difficulty of reliably measuring these distributions.

In this paper, we have used GINI coefficients to measure the spatial deconcentrations of alternative land uses, which was made possible by the assignment of properties to PLSS boxes in our data. These boxes also enabled us to study how public services costs are affected by the expansion of developed areas within counties.

Our results provide support for the hypothesis that the geography of land uses within counties influences public services costs, both at an aggregate level and for categories of public services. We have identified which types of land uses have the largest impacts separately for urban and rural counties. Of the two forces that work against one another in determining the relationship between the spatial distribution of a land use and public services costs, our results suggest that economies of density is the more dominant force within urban counties and that harshness of the environment is more important within rural counties. While we cannot claim that our results are applicable outside the state of Florida, the opposing forces of economies of density and the harshness of the environment as factors affecting the relationship between the spatial

[38]As pointed out by a referee, these estimates are done *ceteris paribus* and therefore fail to capture general equilibrium effects. They serve only to demonstrate that there is wide variation in the magnitudes of the effects across individual counties, with some counties experiencing relatively large changes (both positive and negative) in their expenditures from changes in the concentration of alternative land uses.

distribution of development and public services costs are universal. Concentrating economic activity creates cost savings especially in the provision of public infrastructure and at the same time the congestion such concentration creates is a source of negative externalities.

Our suggestion for future research is to continue the types of analyses that we have pioneered in this study. In addition to Florida, PLSS surveys have been done in 29 other southern and western states. Hence, the use of GINI coefficients to measure the spatial distribution of alternative types of development within cities or counties could be extended well beyond what we have done for Florida.[39] Future research should also investigate whether and how local government revenues are affected by the geography of development. Knowing both the cost and revenue effects from alternative spatial patterns of development could help these governments adopt plans and policies to alleviate some of their fiscal stress.

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[39]In addition to the PLSS data, however, the replication of our analysis for other states requires access to the property tax rolls and budgets of local governments. While tax roll data are now frequently collected by state governments in order to monitor the performance of local property tax assessors, detailed expenditure data akin to that provided by the Florida Department of Financial Services is generally not available. In our search for such data we only found the state of Ohio providing something similar to our FDFS data.

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## SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher’s web site.

**Appendix Table A1:** Means of Per Capita Expenditures and Control Variables
**Appendix Table A2:** Complete Results for Total Current Expenditures
**Appendix Table A3:** GINI Coefficient and Developed Area Results for Urban Counties
**Appendix Table A4:** GINI Coefficient and Developed Area Results for Rural Counties
**Appendix Table A5:** Account Code Definitions