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The Impact of the Smart Growth Incentive Policies on the Water and Sewer Infrastructure Investment in and outside the Priority Funding Area in Maryland

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매릴랜드 주 스마트성장 인센티브정책이 우선투자지역 내외부에서의 상하수도시설투자에 미치는 영향

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Abstract : This paper attempts to examine how Maryland's Priority Funding Area (PFA) designation and incentive program has influenced the location of infrastructure investment. Is Maryland's PFA program reducing sprawl? In order to answer this question, data on the water and sewer infrastructure investments between 1997 and 2003 are collected from each county in the state. Empirical works are composed of two parts. The first part of the empirical analysis examines the pattern of water and sewer investment that has gone in and outside the PFAs between 1997 and 2003 at the county level. The second part of the empirical study shows at a county level the conditions that influence decisions to go in and outside the PFA. Regression models with various specifications are used for the analysis. The findings reveal that state fund has worked as designed. The coefficients of state fund in all estimations are significant and have expected signs implying that a county with more state fund tends to invest more in PFA as less outside.
Key Words : Smart Growth, water and sewer infrastructure, Priority Funding Area, Maryland

요약 : 이 논문은 미국 매릴랜드 주의 우선투자지역 설정과 이에 기반한 인센티브 프로그램이 기반시설의 투자위치에 어떤 영향을 주고 있는지를 검증하려는데 그 목적을 두고 있다. 매릴랜드 주의 우선투자지역 프로그램은 도시스프롤을 억제하고 있는가? 이 물음에 대한 답을 구하기 위하여 본 연구에서는 1997년부터 2003년의 기간 동안 주 내의 각 카운티로부터 상하수도 기반시설 투자에 대한 자료를 수집하였다. 실증분석은 두 부분으로 구성되어 있다. 첫 번째 부분은 1997년과 2003년 사이에 카운티별로 우선투자지역의 내부와 외부에 이루어진 상하수도 시설 투자의 패턴을 대상으로 한 분석이다. 두 번째 부분에서는 카운티 단위에서 우선투자지역의 내부 혹은 외부로 투자결정이 이루어지는데 영향을 준 조건들을 확인하는 분석이다. 분석을 위하여 다양한 방식의 회귀모형이 이용되었다. 분석의 결과 주정부의 지원금은 애초의 의도했던 바와 같은 역할을 한 것으로 확인되었다. 모든 추정방식에서 주정부 지원금의 계수값은 유의하였으며 기대한 바와 같은 방향으로 영향을 주고 있었다. 이는 주 정부의 지원금을 많이 받은 카운티일수록 우선투자지역 내부로의 투자가 많았고 외부로의 투자는 작았음을 의미한다.
주요어 : 스마트성장, 상하수도 기반시설, 우선투자지역, 매릴랜드

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1. Introduction

Urban sprawl is defined as unplanned or ill-planned expansion of urbanized land. Cities in the U.S. have experienced an extensive suburbanization since the mid-twentieth century based on the development of auto travel and abundant land resources. Although not all suburbanization is associated with sprawl, it is evident that relatively low density development has more often occurred in the suburban area. Sprawl causes a variety of social costs (Downs, 1999). For this reason, a number of policy measures have been taken at the local government level in order to fight against sprawl (Cho, 2006).

The state of Maryland has played a leading role in the U.S. in dealing with urban sprawl problems during the governorship of Paris Glendening. Complaints that the Maryland residents have regarding increasing traffic congestion at some existing suburban communities, rapid decrease in open space, worsening air quality, and economic and physical deterioration were expressed as the political support necessary for Governor Glendening to enact "the Smart Growth Initiatives." One chapter in "the Smart Growth Initiatives" is included in order for new development to be constrained in the Priority Funding Area (PFA) and also for counties in the state to restrain development in rural areas (Knaap and Frece, 2007). The purpose of this study is to evaluate if the PFA strategies enacted by the state have been in effect. More specifically, considering investment pattern of the water and sewer infrastructure as the early sign on where the new development occurs, this study intends to examine if the PFA strategies effectively hold growth in the PFA.

An analysis on water and sewer infrastructure is distinguished from the impact analysis on development pattern of other types of activities in twofold. First, a prediction on how the current spatial development pattern evolves in the future can be made by analyzing water and sewer infrastructure investment pattern. This is due to the fact that whether there is a plan for sewer infrastructure provision or not is an important factor of the decision on development permit when the plan for additional development is issued in Maryland. Second, according to the staff in the Maryland Department of Planning, water and sewer infrastructure is usually the first to come among different types of infrastructure (Howland and Sohn, 2007). This means that analyzing water and sewer infrastructure enables us to predict future development pattern at an earlier stage, so that planning and policy reactions can be prepared with sufficient amount of time.

2. Urban Growth Boundaries and Maryland's Priority Funding Area

As mentioned in the previous section, many U.S. cities suffer from urban sprawl problems. While there are different policy tools available in order to handle these problems, urban growth boundary is among the most popular policy measures. Urban growth boundary is the area that contains future development. It is delineated around the already developed area based on the information of the estimated demand on land necessary for future growth. While policy makers are well aware of the significance of sprawl problems and the necessity of urban growth boundary policy at least in a conceptual sense, it may take some more years for these ideas to be enacted and have an impact in many states in the U.S.

As a matter of fact, while a number of states

including Florida, Maryland, Oregon, and Tennessee have passed "Growth Management" initiatives, few states have passed laws that permit or require the designation of urban growth boundaries. According to the American Planning Association's (2002) 'Planning for Smart Growth,' seven states aside from Maryland have proposed laws to permit or require urban growth boundaries and Oregon is the only state aside from Maryland where such an approach has been adopted (See Table 1). The state of Oregon has implemented very strict urban growth boundary since the 1970s. Especially, the urban growth boundary policy in the city of Portland has been known as one of the most famous and successful examples of this type of policies.

Smart growth is a more comprehensive concept that includes urban growth management (Sohn and Knaap, 2007). The term was first used in the late 1980s and implies a package of urban growth management policies and social movements seeking sustainable economic growth, preservation of natural environment, and amenable living environment (Lee, 2006). Smart growth in a narrower sense is defined as various policy reactions in order to prevent sprawl and is related to well-planned efficient land use and urban growth management (Daniels, 2001; Alexander and Tomalty, 2002; Downs, 2005; Cho, 2006). As is the term "smart" not value-free, there are two opposing groups of urban planners regarding the need for growth management (for example, see Ewing (1997) and Gordon and Richardson (1997)). Against the sprawl problems, the group who believes the power of invisible hands is against the policy intervention on land and housing market. On the other hand, smart growth supporters insist some planning and policy measures to be taken including discouraging low density development, constraining spatial expansion of new development, pedestrian-oriented arrangement of functions and mixed land use, charging development impact fees, promoting transit-oriented development, preparing redevelopment strategies for deteriorated inner cities, providing

Table 1. States that considered urban growth boundaries as a Smart Growth strategy in the U.S.

state	urban boundary	adopted/year	legislation
Arizona	requirement to adopt 10-year growth boundary	introduced and defeated in 2001	Proposition 202
California	urban growth boundary	introduced and defeated in 2001	A.B. 1514
Colorado	urban growth boundary	introduced and defeated in 2001	Amendment 24
Kentucky	urban growth boundary	introduced 2000-2001, passed but not signed by the governor	H.B. 524
Maryland	priority funding area	passed in 1997	Smart Growth Area Act
Minnesota	urban growth boundary	introduced and defeated in 2001	S.F. 786 and H.F. 882
Pennsylvania	urban growth boundary	issued in 1998 but not enacted	proposed by the Governor's 21st Century Environmental Commission
Oregon	urban growth boundary	enacted in 1973 and adopted in Portland in 1980	
Washington	urban growth boundary	enacted in 1990	Growth Management Act

Source: American Planning Association (2002)

sufficient amount of affordable housing, removing the obstacles that prevent the motivation of developers, and preparing various regulations for smart growth (Alexander and Tomalty, 2002; Downs, 2005; Cho, 2006).

In spite of the merits that the idea of smart growth has, there have been few attempts to turn this idea into the legislation. In fact, Maryland has been the only state so far that has the legislation reflecting a comprehensive framework of smart growth. According to Downs (2005), several obstacles exist for smart growth to be enacted in a larger number of local governments. Those include redistribution of benefit and cost from development, transition of the authorities from local governments to metropolitan governments, opposition against high density development, increase in housing price, failure in reducing traffic congestion, increase in financial loss of developers, decrease in financial benefit of agricultural land owners, and increasing role of regional planning.

Maryland's "Smart Growth" approach was first initiated in 1992 and had an explicit purpose of preserving environmentally and economically important landscapes by leading new growth to existing areas of population concentration in the state.[1] In order to accomplish this purpose, designation of the PFA is a key element of the Maryland's Smart Growth strategies. Maryland's PFAs are not the same as urban growth boundaries, with the latter's borders generally more firmly defined for a longer period of time. For example, urban growth boundary proposals generally prohibit growth outside a defined boundary, whereas Maryland's strategy takes the carrot approach - no state assistance will be forthcoming for projects outside the PFA (American Planning Association, 2002). Further, the PFA boundaries are more flexible and can be revised annually whereas urban growth boundaries are revised usually in 10-year intervals. In terms of urban geographical context, urban growth boundary shows a continuity in its spatial entity whereas PFA is characterized by the high degree of segmentation from each urbanized area. This difference is ascribed to the difference in how to define those two spatial entities. That is, the former is delineated in the way that the expected growth of urban land use in a single city in the future is included in the boundary. On the other hand, the latter is defined based on the current land use pattern observed in a multiple number of urbanized areas in the state.

The continuation of Maryland's history of local control over land use decisions was critical to the passage of the 1997 Smart Growth Areas Act. Local counties are given discretion and flexibility in establishing their PFAs. The legislation authorizes counties to draw up county-designated PFAs that meet minimum state requirements based on land use, development density, zoning density, and water and sewer service criteria. Types of areas that may be eligible for PFA designation included areas zoned for industrial employment,[2] existing communities with sewer connections, existing communities with water only, areas beyond the periphery of existing development areas if they receive public or community sewer service, communities within a planned water and sewer service areas as shown in their 10-year plan and locations consistent with patterns of orderly growth, and rural villages.[3] The act also defines municipalities, areas within the Baltimore Beltway(I-695), jurisdictions inside the Maryland portion of the National Capital Beltway(I-495), and enterprise zones as PFAs. The shaded areas in Figure 1 shows the areas designated as PFAs as of 2002. The areal share of PFA is only about 19% of the whole state, but the PFA's population share is as large as 81%.

The "teeth" in the legislation comes from the "Smart Growth" Areas Act of 1997,[4] which requires the State to target their funding for

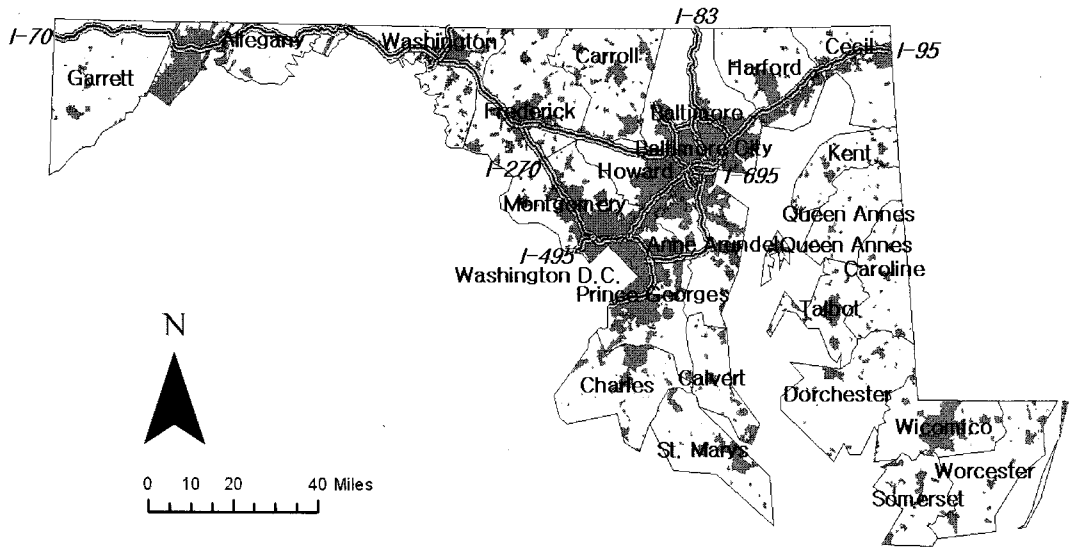

Figure 1. Maryland's PFA and counties

"growth related" projects in PFAs. This law took effect on October 1, 1998. Growth related projects are defined in the legislation and include most State programs which encourage or support development such as highways, sewer and water construction, economic development assistance, and State leases and construction of new office facilities. According to the legislation, private or public projects must be inside of the PFAs to be eligible for state assistance, which can be in the form of state grants and low interest loans.

3. Previous Studies on the Relationship between Water and Sewer Infrastructures and Urban Development Pattern

The main subject of this study is water and sewer infrastructure and this empirical analysis attempts to examine if the state fund program has an influence on the spatial pattern of water and sewer infrastructure investment. However, there are only a small number of previous works conducted that explore the relationship between these factors. Water and sewer infrastructure is a critical element for forecasting urban spatial expansion pattern in that this infrastructure presents an early sign of the forthcoming urban development pattern. Despite this significance, one possible reason for the shortage of relevant works is ascribed to the difficulty in systematic access on required data on water and sewer infrastructure. The study of Howland and Sohn (2007) has been one of the few empirical works that are closely related to this study. They observed the presence of the policy effect on water and sewer infrastructure in their empirical analysis to examine the impact of urban growth management policies on the investment pattern of water and sewer infrastructure. The study adopted logit regression analysis on water and sewer infrastructure investment data in Maryland. They found that water and sewer infrastructure investments in the counties with state funds are made in the PFA as encouraged by the state and

also that the state's incentive policy has been in effect at least on the investment pattern of water and sewer infrastructure to some extent. Newburn and Berck (2006) analyzed the impact of zoning density maximum and growth management strategies through the provision of water and sewer services on development pattern. In their study, two distinctive spatial settings for policy application are suggested and treated in a separate way: suburban area adjacent to the city and rural area spatially distant from the city. With the logit analysis on individual parcels in Sonoma County in California, the authors showed that water and sewer services are critical determinants for suburban development whereas they are not so for rural development where leapfrogging development is dominant. On the other hand, a series of studies by Burge and Ihlanfeldt (2006a, 2006b) were conducted in order to analyze the impact of impact fees for infrastructure development on housing construction. While both studies adopted panel regression analysis method on counties in Florida, one focused on the construction of single-family housing (Burge and Ihlanfeldt, 2006b) and the other on the construction of multi-family housing (Burge and Ihlanfeldt, 2006a). In case of single-family housing, water and sewer infrastructure improvement project did not have significant impact, but impact fees for other types of infrastructure than water and sewer infrastructure have increased housing construction. In case of multi-family housing, unlike single-family housing, impact fees for other types of infrastructure have increased housing construction in the suburban area whereas impact fees for water and sewer infrastructure have decreased overall housing construction at the metropolitan level.

4. Empirical Study Frameworks

This paper focuses on water and sewer infrastructure investment. In addition to water and sewer infrastructure, there are other investments such as roads, electricity, and public transit that may contribute to the expansion of urbanized areas. However, the uniqueness of the water and sewer infrastructure is that this is usually the first one to be planned and built when an urban residential and commercial expansion occurs. Thus, documentation of water and sewer investment provides the earliest signs of urban expansion (Howland and Sohn, 2007).

The empirical study section first provides an overview of water and sewer infrastructure investment in Maryland between 1997 and 2003 and summarizes the sources of funding and location of investments in and outside the PFAs. The second part of the empirical study uses regression analysis to examine the factors that influence county decisions to invest inside and outside their PFAs. This second portion tests the extent to which the State's "carrot" approach is working to constrain investments inside the PFAs. It is expected county governments dependent on state funds to limit their investments within their PFAs. The model is described in more detail below.

5. Data

The water and sewer investment data was collected individually from each county. County planning and water and sewer departments were contacted and asked to send their water and sewer plans. Where these plans did not include the relevant information (i.e. project cost, source of funds, and location), they were re-contacted

and information was collected over the phone or at their offices for the missing information. The city of Baltimore was excluded because the whole city falls inside a PFA. The data sources are shown in Appendix 1. The PFA boundary map as of 2002 was used as a GIS basemap. This data was obtained from the Maryland Department of Planning. The data on the county characteristics was taken from the population, income and tax statistics of the U.S. Census Bureau and the Maryland Department of Planning.

Six counties (Caroline, Dorchester, Queen Anne's, St. Mary's, Talbot, and Worcester) claimed to have no water and sewer system investment during the period. As these are rural countries, expansion presumably took place on septic tanks and wells. Seventeen counties, outside the city of Baltimore had water and sewer projects planned or constructed during the period of study.

There are a number of data shortcomings and complications. First, some projects serve residents inside the PFA as well as support growth outside the PFA. When this is the case, the project is not eligible for state funding. Therefore, the state criteria is followed and the project is counted as outside the PFA independent of the share of service in or outside the PFA. Second, a projects on the fringe of the PFA boundary and those miles from the nearest PFA are treated the same as outside. Third, the study attempts to get an understanding of the degree to which Maryland's policy is constraining urban sprawl. A factor that makes this attempt difficult is that in the planning process some counties such as Anne Arundel were conservative in drawing their PFA boundaries. Other counties such as Howard left more space within their boundaries for growth. Thus, the same kind of project may show up as outside in Anne Arundel County and inside in Howard County. However, the major focus of the study is not whether it is inside or outside of existing urban area, but whether the designation of the PFA as a policy tool for growth management works. As a result, it is assumed that the variation in the spatial extent of the PFA in different counties does not make difference in the result. Fourth, the data on 100% privately sponsored projects are most likely not complete. Projects which are fully covered by private developers are difficult to capture in county water and sewer plans and therefore this portion of the counties' investments have undoubtedly been underestimated. These investments have a greater probability of falling outside of PFAs. In spite of these shortcomings, the results seem reasonable for an early evaluation and can provide a baseline for future studies.

6. Statewide Patterns of Water and Sewer Investment in Maryland

Figure 2 presents the amount of investment on water and sewer infrastructure by each county in thousands of dollar. Statewide, the expenditure on water and sewer infrastructure was a little over 3.1 billion dollars with about 42% of these funds invested inside the PFAs and 15% invested outside the PFAs. Nearly 44.5 % of expenditure locations were indeterminate for the following reasons. Some projects were in the planning phase and therefore there was no specific location at the time of data collection. Some projects are county-wide projects and therefore inherently serve areas both inside and outside the PFAs. Some projects have multiple locations, both in and outside PFAs, and a few projects serve the county but are located outside the county. Figure 2 shows that Baltimore, Montgomery, Anne Arundel, Howard, Prince George's, and Frederick counties made the largest financial investment in water and sewer infrastructure over the period of

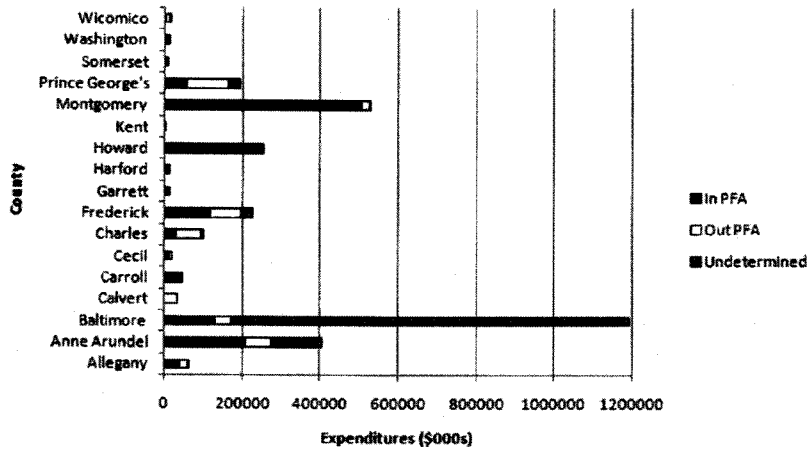

Figure 2. Water and sewer infrastructure investment in and outside the PFA between 1997 and 2003

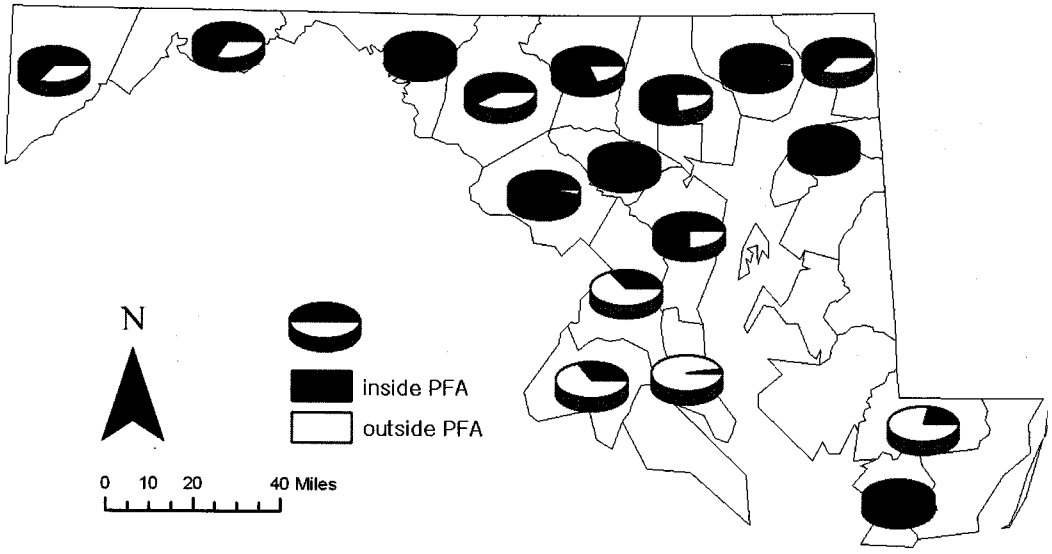

Figure 3. Water and sewer infrastructure investment ratio in and outside the PFA between 1997 and 2003

study, which is not surprising since these are the most populated, geographically largest, and most urban counties in the State. These counties are concentrated along either the I-95 corridor between Washington D.C. and Baltimore or on I-270 between Washington D.C. and Frederick.

Figure 3 shows the counties' shares of investment in and outside their PFAs. Eight counties have more than 25% of their total investment outside of PFAs. They are Allegheny, Calvert, Cecil, Charles, Frederick, Garrett, Prince George's, and Wicomico counties. The fast-growth high population counties are not necessarily the ones that strayed out of their PFAs. The more peripheral counties in the state (Calvert, Charles, Garrett, and Wicomico) have the larger share of their water and sewer investments outside their PFAs. However,

because the size of investment is relatively small in those counties, the statewide effect is negligible. Prince George's County is the exception among urbanized counties with more than 50% of their investment showing up outside the PFA. Washington, Montgomery, Kent, Harford, Howard, and Baltimore counties put less than 5% of their water and sewer expenditures outside of PFAs. The numbers are in Appendix 2.

Enforcement of the PFA initiative in Maryland relies on the "carrot" of state funding. The data indicates two findings. One is that state money as a source of water and sewer investment is relatively minor in terms of total funds and therefore not sufficient to contain growth and, two, the state has funded projects outside of PFAs. Figure 4 shows total expenditure by source of funds broken into projects in and outside PFAs. The graph shows that local funds are the major source of water and sewer spending and that state funds support some projects outside of PFAs. Figure 5 reports the same statewide data by each source's share of funding in and outside of PFAs. Local funds were more likely to support

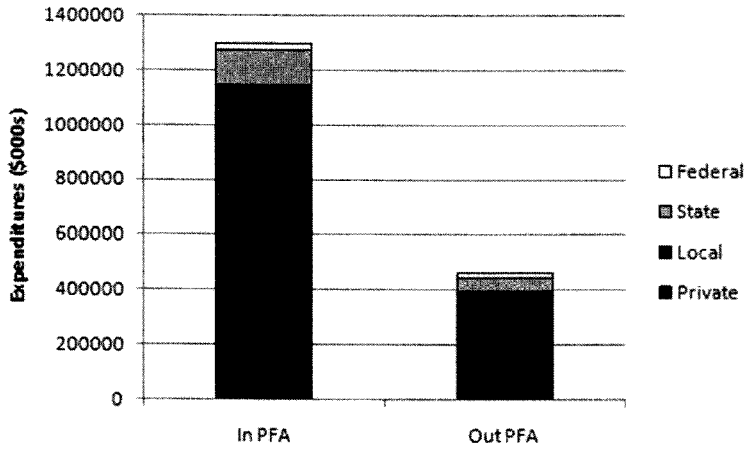

Figure 4. Water and sewer investment magnitude by source of fund between 1997 and 2003

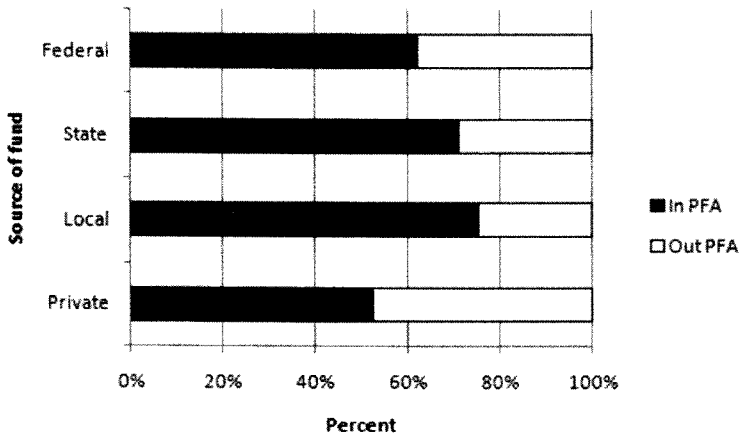

Figure 5. Investment ratio in and outside the PFA by source of fund between 1997 and 2003

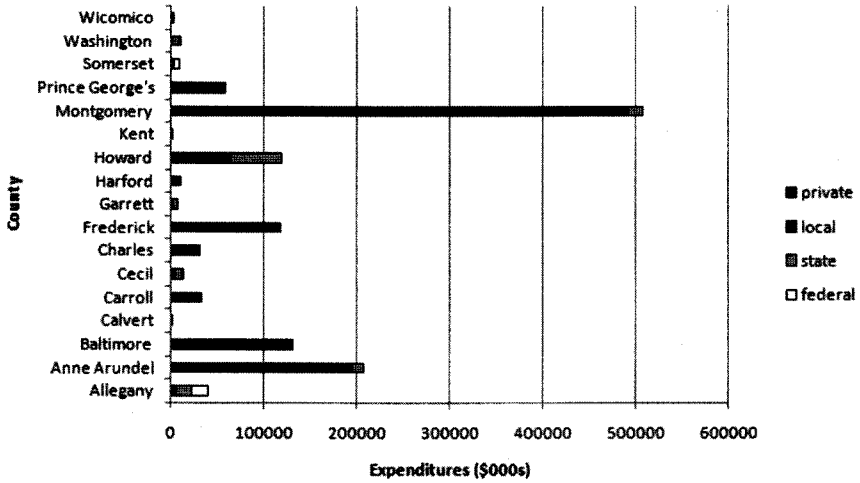

Figure 6. Source of fund for water and sewer project in the PFA by county between 1997 and 2003

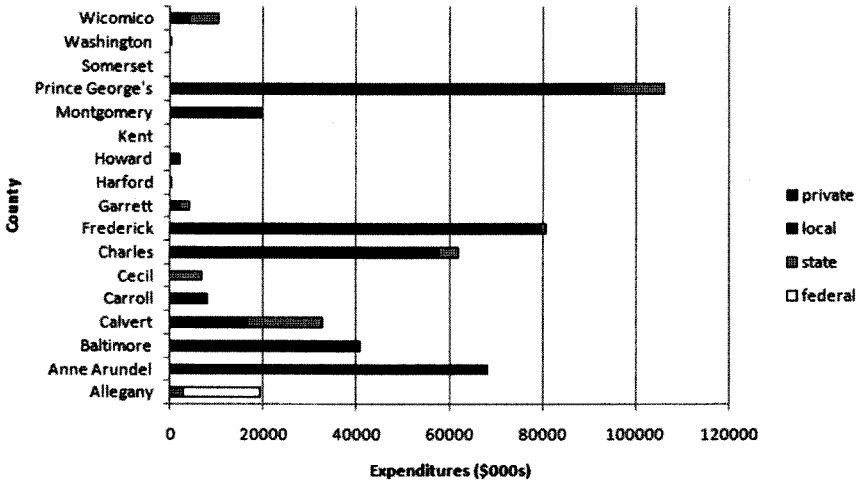

Figure 7. Source of fund for water and sewer project outside the PFA by county between 1997 and 2003

projects inside PFAs than were state funds. Private funds were most likely to fund projects outside the PFAs among the four sources.

Among the projects where location could be determined, 71% of state water and sewer funding went to projects inside of PFAs leaving 29% of state water and sewer funding going to projects outside of PFAs. Why did 29% of state funds go to projects outside of the PFAs when the state smart growth legislation calls for state money to support only projects inside? One legitimate reason is that some projects outside of PFAs were deemed necessary for citizen health and safety and therefore considered as exceptions.

Figures 6 reports the source of funds by county inside PFAs and Figure 7 reports the source of funding outside of PFAs. For the majority of counties, local funds from county taxes or bond issues are the largest source of support. Counties

with a relatively heavy dependence on state and federal money are the rural counties: Washington, Somerset, Kent, Garrett, Cecil, Calvert, and Allegany counties.

7. Regression Models of Factors Influencing the Location of Investments

County water and sewer investment pattern is also examined in order to check if more state fund is associated with more investment inside the PFA and less investment outside the PFA at a county level as intended. The relationship between the amount of state fund and the amount of fund invested inside and outside the PFA at a county level is summarized in two graphs in Figure 8. Each point in the graph represents each county and the unit in both of the graphs is thousand dollars.

More formal analysis is conducted using regression model for examining the factors that influence county decisions to invest inside or outside the PFAs. Understanding the conditions which lead to investments outside the PFA may help fine-tune future state efforts to contain urban sprawl. Two regression models are used: one for investment in PFA and the other for investment outside PFA. Since there are only 16 counties that have data usable for the regression analysis in the study, the amount of investment in each year of the same county is treated as a separate observation. As a result, there are 67 observations used in the estimation on the investments in and outside PFA respectively. The dependent variable is the amount of investments in and outside PFA in the corresponding models.

The explanatory variables used in the model are (1) the year in which construction started, (2) PFA areal share, (3) population growth rate, (4) median family income in 2000, (5) per capita county government tax revenue in 1997, (6) total expenditure on infrastructure in a specific year, and (7) amount of state fund. Table 2 lists these explanatory variables.[5)]

The year of project initiation is included in order to determine whether there was a lag until the Smart Growth initiative became observable

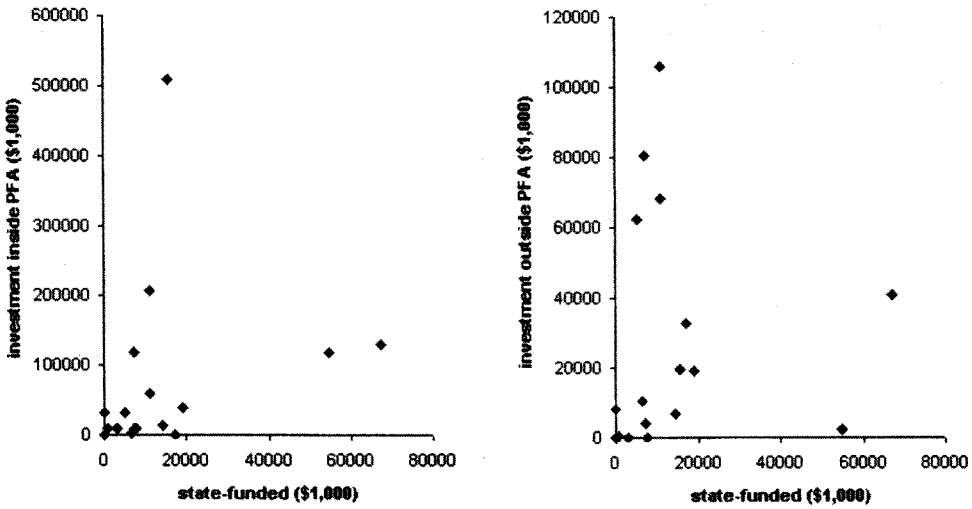

Figure 8. State funds and the amount of investment for 17 counties in and outside the PFA between 1997 and 2003

Table 2. Explanatory variables used in the regression analysis

variable	description
YEAR	year to begin
PFA	PFA area share
POPGR	five year population growth rate
MFI	median family income in 2000 ($1,000)
PCTR	per capita tax revenue in 1997 ($1,000)
EXP	total expenditure on infrastructure ($million)
STATE	state fund ($million)

with investments in latter years more likely to be inside the PFA than earlier ones. The PFA area share measures the proportion of the county's land inside PFA. This variable is included to control for the bias resulting from the relative size of the PFA in each county. The share of county land falling inside PFAs ranged from 0.02 in Garrett County to 0.52 in Prince George's County. All of Baltimore City is inside a PFA, but it is excluded from this study. Population growth rate is included to see the impact of development pressure in a county on the amount of investment in and outside PFA. Similarly, median family income and per capita county government tax revenue are included to examine the impact of the wealth of a county on the amount of investment in and outside PFA. The total expenditure of a county is included to control for the size of the investment in each county per each year.

Among the explanatory variables, more focus is on state fund. State fund is included in order to examine if the fund supported by the state encourages more investment in PFA. Moreover, it is included to check what impact the state fund has on the investment outside PFA; does the investment outside PFA increase, decrease, or remain unchanged? Recall that the "carrot" of smart growth is that state money requires investments inside the PFA. The expected sign on the state fund is positive in the equation for investment in PFA. The expected sign of the coefficient in the equation for investment outside PFA is indeterminate. If the state fund discourages investment outside PFA, the expected sign will be negative. On the other hand, if the state fund encourages investment outside PFA (through an income effect), the sign will be positive.

One potential problem of using dataset is that a number of values in dependent variable are zeros. For example, if all expenditure in a county in a specific year is spent on investment in PFA, the value of the dependent variable (i.e. investment outside PFA) in the other regression becomes zero. In the dataset, in five out of 67 cases, investment in PFA is zero and, in 37 of 67 cases, investment outside PFA is zero. If those zeros are real zeros (i.e. no intention of investment in and outside PFA at all), the regular OLS estimation with the full set of data provides a correct estimate on coefficients. If, however, those zeros mean that the intention is latent and not observed in the data, the coefficients above may be underestimated. This occurs in part due to the missing data problem. However, this also occurs when actual investment is not made even with the intention of investment due to the budget constraint. In this case, if the investment outside the PFA is not made (y=0) despite the fact that the investors are willing to do so outside, it is more likely to be caused by the lack of fund to be used in investment rather than by those explanatory variables used in the model. If there are counties with this latent intention among the counties that have zeros in the dependent variable, the estimation model needs to be adjusted. For this reason, two different estimation methods are applied along with the baseline model: truncated regression and censored regression models. Both of these regressions use

tobit model. The latter is usually used when there are no observed values of dependent variables (y=0) in some portion of data whereas the former is typically used when both dependent and independent variables (x=0) are assumed to be unobservable.

The results of the regression model are reported in Table 3. Adjusted R2 of six estimation results ranges from .418 to .932. It is also noted that estimations for investment in PFA are better explained (i.e. higher R2) than the other. Tests for heteroskedasticity and spatial dependence of the baseline and truncated regression models show no sign of related problems. Five variables (year to begin, PFA areal share, population growth, median family income, and per capita county tax

Table 3. Regression analysis result: in and outside the PFA by county

variable	base		truncated		censored	
	in	out	in	out	in	out
constant	-188.14 (1,093.6)	188.15 (1,093.6)	-236.7 (1,170.6)	-3,175.6 (2,266.3)	-105.2 (1,081.5)	1,930.9 (1,979.5)
YEAR	.090615 (.546377)	-.090618 (.546376)	.11498 (.5848)	1.59262 (1.1310)	.04887 (.5403)	-.96921 (.9890)
PFA	-4.1762 (9.49333)	4.1763 (9.49332)	-3.3313 (10.997)	13.0833 (16.998)	-6.6875 (9.651)	-5.6142 (16.922)
POPGR	-30.4813 (44.3257)	30.4811 (44.3256)	-34.081 (48.19)	133.224 (85.51)	-25.386 (44.12)	14.648 (79.47)
MFI	.0878602 (.14814)	-.0878597 (.14814)	.096245 (.15961)	-.461352 (.28527)	.098956 (.14692)	.046307 (.26804)
PCTR	1.87619 (3.7304)	-1.87621 (3.7304)	1.6579 (4.065)	3.8537 (7.610)	1.6833 (3.714)	-.7998 (6.729)
EXP	.72757** (.0322952)	.27243** (.0322951)	.72598** (.0339)	.31199** (.0459)	.73321** (.0317)	.32333** (.0513)
STATE	.599** (.16)	-.599** (.16)	.597** (.17)	-.724** (.21)	.601** (.16)	-.631* (.25)
Adj-R^2	.9314	.5024	.9300	.6005	.9285	.4189
K-B test	5.1553 (.641023)	5.1552 (.641025)	4.8667 (.676)	7.3091 (.397)		
Moran	.93905 (.34771)	.93902 (.34772)	.87205 (.3832)	.46666 (.6407)		
LM error	.37552 (.54001)	.37549 (.54003)	.28769 (.5917)	.05843 (.8090)		
LM lag	1.6746 (.196)	.0496 (.824)	1.4475 (.229)	.6389 (.424)		
total obs.	67	67	67	67	67	67

dependent variable: amount of investment in and outside the PFA ($million)

* significant at 95% ** significant at 99%

standard error in parenthesis

K-B test: Koenker-Bassett heteroskedasticity test Moran: Moran's I test on regression errors

LM error: Langrange Multiplier test on spatial error dependence LM lag: Langrange Multiplier test on spatial lag dependence

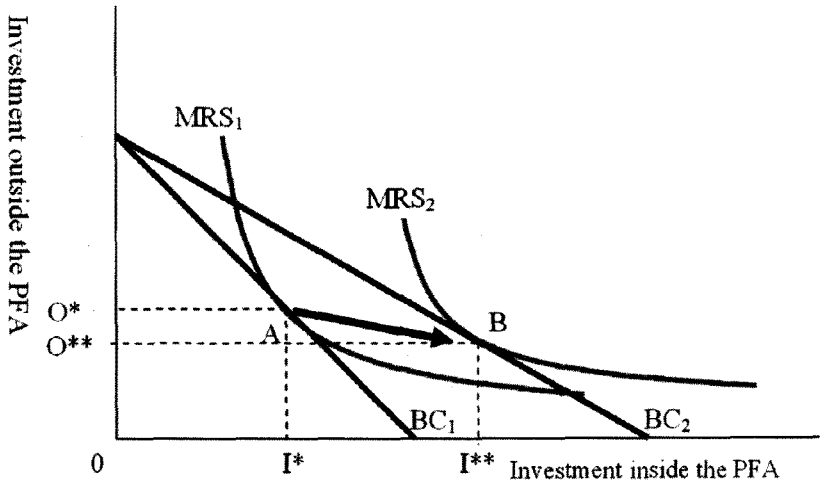

Figure 9. Income and substitution effects of state fund on investment pattern

revenue) are insignificant predictors of the investment decision inside or outside PFAs. At least, at a county level, development pressure in a county or the wealth of a county does not seem to have been an effective explanation variable. The coefficient of total expenditure is positive and significant in both of the equations regardless of an estimation method. The magnitude of the coefficients suggests that approximately 70-75 cents out of an investment of a dollar stay in the investment inside PFA and about 25-30 cents of a dollar go to the investment outside PFA.

State fund coefficient in all results has an expected sign. All the state fund coefficients in equations for investment in PFA have positive and significant signs implying that more state fund a county receives, more investment it makes in PFA. On the other hand, the negative and significant coefficient of state fund in equations for investment outside PFA suggests that state fund actually discourages county government's decision to invest outside PFA. At a theoretical level, Figure 9 provides a probable economic explanation of why this might happen. The x-axis in Figure 9 represents the amount of investment inside the PFA whereas the y-axis is for the amount of investment outside the PFA. Without state fund, a certain county's decision is optimized at point A where the initial budget constraint line (BC_1) meets the marginal rate of substitution curve (MRS_1). State fund on infrastructure investment inside the PFA may work in the way to decrease the unit price of investment inside the PFA. This is represented by the new budget constraint line (BC_2). Through the substitution and income effect, the new optimum can be achieved at B with the new MRS curve (MRS_2), at which investment in the county increases inside but not outside the PFA. This seems to imply that the substitution effect (of cheaper unit price when investment is made in PFA) is greater than the income effect (of increased budget to be spent on investment both in and outside PFA).

There is a possibility that the causal relationship found in the regression for the investment outside the PFA can be interpreted in an opposite direction: an increase in state fund caused by a decrease in total expenditure. It seems reasonable in the sense that more amount

of state funding is assigned to places where expenditure on infrastructure is short. However, this reversed causal relationship is not likely at least in the state of Maryland. The state delineates the boundary of the PFA and encourages additional development including infrastructure project within the boundary. Therefore, the state would not willing to support any development outside the PFA even if the level of infrastructure expenditure is low. Rather, this is exactly what the state would like to observe. On the other hand, even if counties may be willing to consider development outside the PFA, they are well aware that chances of receiving state subsidy decrease by doing so.

8. Conclusions and Policy Suggestions

This paper examines the extent to which Maryland Smart Growth incentive program successfully constrains the water and sewer infrastructure investment in Maryland to the areas inside PFAs. The data reveals that a sizeable share of water and sewer investment, 16% of the total value, have gone outside the PFAs since the passage of the 1997 law. These results do not prove how much would have gone outside the PFAs in the absence of the State's Smart Growth initiative, so they do not imply the program is ineffective. Rather this study provides a baseline for future monitoring. As a matter of fact, it is found from the regression analysis that state fund, while holding other factors constant, encourages an investment inside the PFA and discourages investment outside the PFA. The regression results based on three different specification methods consistently show the positive and significant coefficients of the state fund variable in the regressions for the inside the PFA case and the negative and significant coefficients in the regressions for the outside the PFA case. In the former case, coefficients obtained from three different specifications are not much different from each other while in the latter case the absolute value of the coefficients has risen after taking care of latent demands. This means that the actual impact of the state fund on constraining water and sewer infrastructure investment could be larger than what we observe from the data. The finding of a decrease in water and sewer infrastructure investment outside the PFA with an increase in state fund may imply that the substitution effect of the state fund on the investment pattern has been greater than income effect. In other words, where state funds are involved, they are more likely to be located inside the PFA. Thus, to the extent that state funds are available, they are constraining sprawl.

The results show that Maryland's policy appears to be putting some constraint on urban sprawl. The bar graphs and regression analysis show that counties have concentrated their growth within their PFAs. Discussions with county officials during the data collection phase of this project indicates that the state policy has created a climate among county officials where "Smart Growth" and limiting sprawl is considered good planning by county officials. In other words, the state policy carries moral suasion, which appears to carry more weight than the carrot of state funding.

A shortcoming of this analysis is that there is no baseline for comparison and there is no way to know what the geographical pattern of water and sewer investments would have been in the absence of the Smart Growth legislation. It is important for both Maryland and the local governments in general who are interested in this type of policy effect that outcomes be monitored over time and, to do this, consistent, geographically disaggregate, and over-time data need to be collected. Planning departments in

Table 4. Data required for monitoring

project name
total cost of project
source of project funds in dollars by source (private, local, state, and federal)
project location
project service area
Is the project inside the PFA?
Is the project requesting an expansion of the PFA boundary?
If project is outside the PFA boundary, why? a. health and safety b. others?

local government in general such as Maryland Department of Planning in Maryland case are the logical places to collect and manage the data on water and sewer investment in terms of effectiveness and efficiency. A study by Whipple (2000) documented the extent to which the state currently fails to collect consistent and comparable data from the counties in their water and sewer plans. This lack of enforcement of current water and sewer application standards is a problem the state will have to correct to effectively monitor the state's PFA initiative. The data collection shown in Table 4 is suggested to facilitate future evaluations.

In addition to the data collected, adding information on changes to the PFA boundary is recommended. This will permit monitoring and distinguishing between the expansions of PFA boundaries versus PFA infill development. Another recommended extension is to collect information on individual infrastructure investments located outside the PFA. This may help find out answers on why the investments are outside the PFA and whether and how these investments should be constrained in the future.

Another limitation of this study is that ideas and opinions of the urban planners in individual counties could have been collected and discussed in depth along with the findings of the regression analysis. This can aid a better understanding of what is really going on in the infrastructure investment process and how the state fund functions in that process.

Notes

1) Refer to "Economic Growth, Resource Protection, and Planning Act of 1992" in the Maryland Department of Planning website (http://www.mdp.state.md.us/planningact.htm).
2) For example, in Garrett County where county wide zoning does not exist, areas that are classified as industrial in the Comprehensive Plan as of January 1, 1997 may be designated as PFAs.
3) For a full description of the criteria for PFA designations and definitions, see Maryland Office of Planning (1997).
4) Chapter 759 of the Laws of Maryland of 1997
5) The regression model is limited in that the variables in the model are specified in the way that the possibility of budget assignment and reassignment cannot be observed by each year and by each county.

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Appendix 1. Source of Data

Allegany County, Five Year Capital Improvement Program.
Anne Arundel County, Capital Budget and Program.
Baltimore County, Capital Budget.
Calvert County, Comprehensive Water and Sewerage Plan.
Carroll County, Capital Improvement Program.
Cecil County, internal data provided by Department of Public Works.
Charles County, Approved Capital Improvement Program.
Frederick County, Board of County Commissioner Approved Capital Improvements Program.
Garrett County, Sanitary District Capital Projects Budget.
Harford County, Water and Sewer Master Plan.
Howard County, Water Capital Projects & Sewer Capital Projects.
Kent County, internal data from Department of Water/Wastewater Services.
Montgomery County, Washington Suburban Sanitary Commission Adopted Capital Improvements Program.
Prince George's County, Washington Suburban Sanitary Commission Adopted Capital Improvements Program.
Somerset County, internal data from Sanitary District, Inc.
Washington County, internal data from Water and Sewer Department.
Wicomico County, Capital Improvements Program.

Appendix 2. Investment in water and sewer infrastructure in and outside the PFA by county, 1997-2003 (thousand dollars)

County	In PFA	%	Outside PFA	%	Undetermined	%	Total
Allegany	39606	66.4	19268	32.3	788	1.3	59662
Anne Arundel	208819	50.4	76180	18.4	129691	31.3	414689
Baltimore	130628	10.9	40910	3.4	1023397	85.6	1194935
Calvert	1000	2.9	32900	97.1	0	0.0	33900
Carroll	32767	69.3	8036	17.0	6462	13.7	47265
Cecil	12551	64.5	6900	35.5	0	0.0	19451
Charles	30997	31.2	62049	62.5	6250	6.3	99296
Frederick	118606	51.9	80667	35.3	29314	12.8	228587
Garrett	8082	65.9	4174	34.1	0	0.0	12255
Harford	8525	96.9	270	3.1	0	0.0	8795
Howard	118740	46.5	2078	0.8	134739	52.7	255557
Kent	100	100.0	0	0.0	0	0.0	100
Montgomery	507770	96.2	19527	3.7	498	0.1	527795
Prince George's	58605	30.1	105971	54.4	30197	15.5	194773
Somerset	9569	100.0	0	0.0	0	0.0	9569
Washington	9052	98.8	106	1.2	0	0.0	9158
Wicomico	2849	19.7	10559	73.0	1066	7.4	14474
Total	1298265	41.5	469594	15.0	1362402	43.5	3130262