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# The Effects of Moratorium on Residential Development

*Evidence from Hartford, Howard and  
Montgomery Counties*

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**The effects of Moratorium on Residential Development:  
Evidence from Harford, Howard and Montgomery Counties**

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## 1. Introduction

During the last decade, the state of Maryland was one of the fastest growing states in the United States. In response, the state has implemented an aggressive “smart growth” initiative. One of the most popular smart growth policies, adopted by several counties in the state of Maryland, is an Adequate Public Facility Ordinance (APFOs). An APFO is a spatially delineated land use control that aims to prevent development from occurring in areas where certain public services are at risk of becoming crowded. An example of an APFO is a standard on elementary school capacity which limits the amount of new development at the school district level. Despite their extensive use, very little is known about the effects of these policies.

The purpose of this paper is to ask the following three questions:

1. What is the direct impact of an APFO? That is, when a policy area is under moratoria, what is the resulting growth of new residential stock and how does that compare with policy areas that do not have moratoria?
2. What is the overall impact of the policy? In other words, does the policy reduce total new development in the county or does it simply re-direct growth from one policy area to another?
3. How much of the areas under moratorium overlap with Priority funding areas, in other words, are county land use policies in conflict with State smart growth priorities?

Over the years researchers have attempted to measure the impacts of land use controls. The key econometric difficulty in this literature results from the fact that the growth controls emerge in a non-random fashion throughout the landscape. This means that not all the areas in a county have the same likelihood of being under moratoria. In the context of adequate public facility ordinances for elementary school, for example, this problem arises because faster growing school districts (and sometimes richer school districts) are more likely to become under moratoria than other school districts in the county. Our major concern is that the decision of adopting such growth controls is clearly endogenous and yet, to date, the entire empirical literature on growth controls has treated them as exogenous variables. As a consequence, previous studies find no impact (and sometimes the wrong impact) of growth controls on the rate of new development<sup>1</sup>.

We overcome these problems using recent “*matching methods*”, first proposed by Rosenbaum and Rubin (1983) and recently applied by Bento et al. (2007) to study the effects of adequate public facilities ordinances in Howard county, Maryland. Matching methods represent a non-parametric alternative to linear regressions. The logic of matching methods is rather simple: First, we match policy areas on the predicted probability of being under moratoria, which is a function of their observed characteristics. Second, once we have the distributions of estimated propensity scores of policy areas that are under moratoria and policy areas that are not, we compare the two densities and measure the extent of their differences. This difference represents the impact of moratoria on new residential development. Unlike traditional regression analysis, this method

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<sup>1</sup> For a survey of the empirical literature on growth controls, see Fischel (1990)

removes from the analysis policy areas that prior to the adoption of the moratoria are not “similar” in observed characteristics to those that adopt.

We follow the methodology developed by Bento et al. (2007) and illustrate the advantages of this technique using spatially disaggregated data on new residential development in Howard, Harford and Montgomery Counties, Maryland and comparing the estimates from propensity score matching to estimates based on the standard linear regression specification in the literature. For these three counties we estimate the impacts of adequate public facilities ordinances starting in 1995 and we measure their impact between 1995 and 2000, accounting for the fact that the policy may be “in” and “out” in some years.

We also provide a descriptive analysis of the overlap between adequate public facilities ordinances – the county growth management tool – with the priority funding areas – the state major policy to concentrate growth in certain areas of the counties.

We have reached several important empirical conclusions:

First, for the three counties we have studied, it is the case that there is a substantial overlap between the county’s policy and the state priority funding area;

Second, we typically find that the policy has a small effect on new residential development in the year of its adoption. We suspect this is the case because the observed new residential development in that year was probably already approved;

Third, we find that after the first year, the policy starts to produce its effects and indeed we observe a drastic reduction in new units, reflecting the fact that the policy areas have frozen approvals for new development. Our results suggest that, on average,

this effect is quite strong during approximately two years. After that, both treated and untreated school districts seem to have again the same levels of growth.

The rest of the report is organized as follows. Section II provides a brief description of matching methods. Section III discusses our dataset for Howard, Harford and Montgomery counties. Section IV presents a variety of maps that spatially illustrate the location of moratorium and their conflicts with priority funding areas. Section V presents results of the models that study the effects of adequate public facility ordinances on residential development. Finally section VI concludes.

## **2. A Framework for Analyzing the Effects of Adequate Public Facilities on Residential Development**

The key problem with measuring the effects of adequate public facility ordinances on new residential development is that not all policy areas have the same likelihood of being under a moratorium. In fact, one would expect that faster growing policy areas as well as policy areas that are close to reaching capacity for one of the public facilities that is being regulated (e.g., roads or schools) are more likely to be under moratoria. This results in a classic non-random treatment assignment, and as a consequence, traditional regression analysis may not capture the true effects of the policy on residential development. We overcome this problem with matching methods.

In this study we utilize a class of estimators called propensity score-matching estimators, first suggested by Rosenbaum and Rubin (1983) and now quite prevalent in the literature. This is especially true in labor economics where the evaluation of job training programs is fraught with non-random selection issues (e.g. Dehejia and Wahba

2002; Lechner 2002; Smith and Todd 2005a) and the approach has started to make its way into the environmental and agricultural economics literature (e.g. List et al. 2003; Lynch, Gray and Geoghegan 2007). We follow the standard matching procedure described in detail in classic references such as Heckman and Robb (1986), Heckman, Ichimura, and Todd (1997), and Heckman et al. (1998). In addition, we implement small sample methods suggested by Frolich's (2004) Monte Carlo analysis.

Let  $Y_1$  be the potential outcome in the "treated" state, which is the number of new residential units developed in the policy area that adopted a moratorium and  $Y_0$  the potential outcome that would have happened in these policy areas had they not adopted a moratorium. We call these potential outcomes because we observe only one of  $(Y_1, Y_0)$  for each policy area. Let  $D=1$  indicate a policy area that adopted the moratorium and  $D=0$  indicate a policy area that did not. Finally, let  $X$  be a vector of observed covariates affecting both the choice of adoption and outcomes. In the next section, we discuss each of these covariates in great detail. These include, for example, the rate of residential growth of the policy area and the level of congestion of the public facility.

Our parameter of interest - the impact of moratoria on new residential development measured as the number of new housing units constructed - is the mean effect of being in a policy area that has a moratorium versus an observationally equivalent policy area, as measured by  $X$ , that it is not under a moratorium. Formally, the parameter of interest is:

$$\Delta^{TT} = E(Y_1 - Y_0 | D = 1) \quad (1)$$

where  $\Delta^{TT}$  denotes the average treatment effect on the treated observations.

The matching method consists of finding a “surrogate” for  $Y_0$ , since we do not observe  $Y_0$  for this treated observation (i.e.  $D=1$ ). The task of propensity score estimators is to define an estimator for  $E(Y_0 | D=1)$  using an appropriate subset of the  $D=0$  data. Matching estimators pair each treated observation with one or more observationally similar non-treated observations, using the conditioning variables,  $X$ , to identify the similarity. This procedure is justified if it can be argued that conditional on these  $X$ 's, outcomes are independent of the selection process. Rosenbaum and Rubin (1983) proved this condition holds conditional on the propensity score  $P(X)$  as well, which leads to the propensity score matching method.

The steps to estimate the model are: (1) estimate a probit model of moratoria adoption, and then using the estimated coefficients, predict the probability of the moratorium adoption for each observation, which is the propensity score,  $P(X)$ ; (2) divide the data into the treatment group (the policy areas that were in fact under moratoria) and the control group (the policy areas that were not under moratoria but had similar characteristics to the areas that are under moratoria), using the propensity scores; (3) estimate a counterfactual for each treated observation ( $Y_1 | D=1, P(X)$ ) based on ( $Y_0 | D=0, P(X)$ ) using the Epanechnikov kernel as suggested by Frölich (2004). This conditional mean difference,  $E(Y_1 - Y_0 | D=1, P(X))$ , measures the impacts of the moratoria on new residential development and is called the average treatment on the treated,  $\Delta^{TT}$ , from Equation 1.

The matching estimator has two primary advantages over traditional estimators such as least squares. First, in a traditional regression approach relies on a functional form assumption to construct a relevant counterfactual for each treated observation which is

troubling in areas of sparse data. In a matching procedure, all treated observations that do not have comparable observations in the control group, are dropped. This phenomenon is referred to as a failure of the common support. Second, the kernel-weighted counterfactual provides a non-parametric estimate of the mean impact. Kernel weights allow untreated observations close, in propensity score, to their treated counterparts to be weighted higher than observations at more distant propensity scores when constructing counterfactuals for each treated observation. These advantages minimize the impact of functional form restrictions present in traditional regression estimators. The key problem with the measurement of the effects of adequate public facility ordinances on new residential development comes from the fact that not all policy areas have the same likelihood of being under moratoria. In fact, it is likely that faster and richer policy areas as well as policy areas that are close to reach capacity for one of the public facilities that is being regulated (e.g. roads, schools) are more likely to be under moratoria. As a consequence, traditional regression analysis will not capture the true effects of the policy on residential development.

### **3. Dataset for Howard and Harford Counties**

We have collected an extensive dataset to address the questions of this project. For the three counties we have studied, we have combined data from the Maryland Property View on residential development with GIS maps for the different policy areas and re-created the years in which each of these areas was in and out of moratoria. In order to apply the methods described in the previous section, we have re-created the landscape for Howard, Harford and Montgomery Counties in 1990 – that is, prior to the 1995 moratoria.

Through GIS calculations, we have computed several variables that we use to calculate the probability that a policy area has a moratorium in 1995 and sub-sequent years.

We have group the variables that capture the determinants of being under moratoria in the following categories: (a) *School quality capacity of the county*; (b) *quality of the existing housing stock*; (c) *characteristics of the households living in the different school districts*; (d) *urban development in each school district*, (e) *additional geographical variables* (f) *priority funding areas* and (g) *policy variable of interest, including the year of adoption of the APFO*.

#### **4. Which Policy Areas have adopted Moratorium?**

In this section, we present a sequence of GIS maps to illustrate the location of the adoption of moratorium for Howard, Harford and Montgomery Counties from 1995 to 2000. We also discuss the potential conflict between the state's priority funding area and the county's policy. We concentrate our analysis in the elementary and secondary school districts, since those were the only school district maps available to us.

*Are priority funding areas and moratoria undoing each other?*

To answer this question, we have calculated two measures:

1. The area under moratoria divided by the area of the county;
2. The area under moratoria divide by the priority funding area.

We start the analysis with Harford County. Figure 1, presents the different elementary school districts of the county. The yellow areas represent the state designated

priority funding areas. In the figures 2 and 3, we overlap the county policy – that is we highlight the school districts that were under moratorium from 1995-2000

The results are striking. In 1995, 15% of the area under moratoria overlapped with the area that was designated by the state as priority funding area. Furthermore, when we compare this number with the area under moratoria county-wide, we concluded that, countywide the area under moratoria was only 8%. This leads us to conclude that in Harford County there is a lack of coordination between state's policy and county's policy. Indeed, we see that the incidence of the policy is substantially higher in the areas designated as priority funding areas.

When comparing 1995 with 1997, the following results stand out: First, the overall amount of land under moratorium fell to only 4% of the county area - a reduction of 50% relative to 1995. However, and surprisingly, the area under moratoria that overlaps with the priority funding area continues to be high (12%), suggesting, that the county is probably undoing the state strategy to concentrate growth in specific areas.

Figures 4 and 5 present the same information for Howard County. Comparing to Harford, the results for Howard County are even more striking. As documented by Figure 4, in 1995, 40% of the county falls under the priority funding area. In Howard, the area under moratoria represents 12% of the area under priority funding area in 1995 (Figure 4). In figure 5, we see that the area under moratoria represents 25% of the area under priority funding in 1997.

Maps 6 and 7 for Montgomery county display similar information.

Together, these figures document a key finding of this report: At least for these three counties, it is the case that there is a lack of coordination between the State's priority

funding policy and the County's moratoria policy. While the first aims at promoting growth in designated areas, the second attempts to slow down growth.

## **5. The effects of Moratoria on Residential Development**

In this section, we present the results for the two models we have estimated. These are the effects of moratoria between 1995 and 2000 on residential development of the three counties. To illustrate how the estimation strategy works and following recent work by Bento et al. (2007), we also present maps that plot the predicted probability of adoption of moratoria so that one can visually compare the school districts that served as control groups. We start with the analysis for Howard County for which we present these maps. We should also mention that, to capture potential spatial heterogeneity of the policy areas, all the variables listed in section 2 were calculated at the census block group. This means that even inside a school district, we can have areas with slightly higher probability of adoption.

*What are the impacts of moratoria on residential development in Howard County?*

*Predicted Probabilities of Adoption*

Maps 8 and 9 plot the predicted probabilities of being under moratoria in Howard County during 1995 and 1997. Lets start by examining figure 8. The following points stand out: First, our model does a very good job at predicting – given the observed characteristics of the school districts – the districts that indeed have implemented moratoria. As we can see from the map, we have darker blue areas in the school districts that have adopted the policy (those school districts are marked in red. Second, the map also shows that there are

some school districts in the county for which the probability of adoption was as high as the probability in the school districts that adopted. However, these districts did not adopt moratoria. These are the school districts we will be using as counterfactuals. Finally, the model put low weight on the light blue areas, since those areas have low probability of being under moratoria. Indeed, based on observed characteristics, these areas are substantially different from the other school districts.

*What are the effects of moratoria on new residential development?*

Table 1 displays the effects of moratoria for the 3 counties between 1995 and 2000. Comparing the 3 counties, the following results stand out:

First, in the year of the adoption (1995) the effects of being under moratoria are relatively small. We also note that the effects vary between a reduction of 28 new housing units in Howard county and a reduction of 67.2 new housing units in Montgomery county. This difference is primarily attributed to the extent of the policy. That is, there were relatively more policy areas under moratoria in 1995 in Montgomery County.

Second, we note that the effects become substantially stronger in the year immediately after the adoption. For example, in Howard County the effect of moratoria is almost 3 times larger. Given the fact that between 1995 and 1996 the number of policy areas in Howard county has not increased, this result reflects exclusively the policy in the 1995 areas. We are finding larger impacts because most of the new development observed in 1995 was probably approved prior to the adoption of the policy. Indeed, we suspect that the true effect of the policy can only be measured one year after its adoption.

Third, with the exception of Harford county, we also note that the effects of moratoria operate by cycles. That is, the effect is stronger the year after the adoption but it rapidly disappears. For example, in Montgomery county in 1997 the effect is only 122.5 houses.

Forth, it is important to quantify these reductions relative to county potentials. Our results indicate that, the effects of moratoria over a 3 year period represent on average a decline of new housing stock of about 10%. For example, in Montgomery county between 1995 and 1997 this reduction was 375 new units. Several authors have estimated that the potential growth of Montgomery county during this period is about 3500 new units, which suggests that the policy reduced new housing stock by about 10%. We should point out that these results are consistent with a new report issued by Montgomery county.

## **6. Conclusions**

This paper uses matching methods to study the effects of adequate public facilities ordinances on residential development in Howard, Harford and Montgomery counties, Maryland. We have documented the location and timing of moratoria in Howard, Harford and Montgomery Counties in 1995 and 1997; we have also demonstrated that county moratoria overlap substantially with state priority funding areas. Our results suggest that this overlap is stronger in Howard County; Finally, we have calculated the effects of moratoria on new residential development in Howard Harford and Montgomery Counties between 1995-2000. The results suggest that the impacts of the policy are not trivial. In fact the policy can stop growth as much as 10% of the projected growth for a 3 year period in each of the counties;

Together our results also highlight some of the potential problems of moratoria. Moratoria are essentially command and control regulations that do not reflect market forces. As a consequence there are at least two perverse consequences of moratoria: First, if set too strict, moratoria will translate in an excessive reduction of the new housing stock and a potential increase of housing prices; Second, because moratoria does not increase the price of providing basic public services, the growth that does not take place in the county that adopts moratoria will happen somewhere else. Therefore, a serious perverse effect of moratoria is the displacement of growth, which in turn can exacerbate the externalities associated with sprawl.

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**Table 1 – Effects of Moratoria on Residential Development**

**A. Howard County Results**

<u>Year</u>	<u>Reduction in New Housing</u>
1995	28
1996	78
1997	49
1998	116
1999	154
2000	203

**B. Harford County Results**

<u>Year</u>	<u>Reduction in New Housing</u>
1995	42
1996	150
1997	220
1998	230
1999	240
2000	112

**C. Montgomery County Results**

<u>Year</u>	<u>Reduction in New Housing</u>
1995	67.2
1996	186
1997	122.5
1998	138
1999	196
2000	157