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Analysis

Do Stormwater Basins Generate co-Benefits? Evidence from Baltimore County, Maryland

Nicholas B. Irwin *, H. Allen Klaiber, Elena G. Irwin

The Ohio State University, 331 Ag Admin Bldg, 2120 Fyffe Rd, Columbus, OH 43212, United States

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ABSTRACT

An often-cited advantage of green infrastructure projects is the potential for "co-benefits" generated from its natural features, which depend on the generation of positive house price capitalization. Using housing transactions data and exploiting variation in placement and design, we examine the capitalization of stormwater retention basins, a common green infrastructure project in suburban housing developments. Results show adjacency causes decreases in housing prices between 13 and 14% for the average home. Additionally this negative effect exacerbates with basin age. Rather than providing co-benefits, we find that stormwater basins generate a cost for proximate households.

1. Introduction

Stormwater runoff poses multiple threats to the environment due to chemical and microbial contaminants that impair water quality and increase water velocity and volume, which degrade aquatic habitats and stream function (National Research Council, 2009). Current trends, including urbanization and increased intensity of storm events from climate change, underscore the critical and growing challenge that stormwater management poses for cities and urbanizing regions. Stormwater is especially problematic in urban areas with combined sewer systems, which are common in many parts of the United States. Combined sewer systems, with sanitary and stormwater passing through the same infrastructure, are prone to overflow when rain events exceed the capacity of the sewers or treatment facilities, leading to a discharge of untreated sewage into nearby waterways. These combined systems have received increasing attention from both regulatory agencies and urban policymakers, with the U.S. EPA prioritizing the issue and using civil penalties to force municipalities to comply with the National Pollutant Discharge Elimination System (NPDES) and mitigate overflows by installing additional infrastructure at a significant cost (EPA National Enforcements Initiative, 2015).

The installation of grey infrastructure, such as large underground storage tanks to collect rainfall or increases in treatment plant capacity, is the traditional means by which municipalities have proposed to comply with NPDES. To offset the high cost of grey infrastructure, urban areas have increasingly incorporated green infrastructure – such as green streets, green roofs, and stormwater retention basins[1] – into citywide comprehensive stormwater management plans. These green techniques have been noted to not only lower costs (Braden and Ando, 2012), but also to provide potential "co-benefits" to residents from the green space that is naturally produced by this type of development (Downing, 2015; LA Department of Public Works, 2016). However, the potential for green infrastructure projects to provide these co-benefits depends on the proximity of nearby households, the size of the project, and the nature of the green space. Small projects – such as green roofs or rain gardens – may be positively capitalized into the immediate house or lot with which they are associated, but are unlikely to provide co-benefits that extend beyond this. Larger projects, such as retention basins, are more likely to generate amenity benefits for multiple households, e.g., by creating a scenic view, providing recreational space, or preventing nearby development. On the other hand, it's possible that

* Corresponding author.
E-mail address: irwin.114@osu.edu (N.B. Irwin).

[1] Green streets are curb extensions or sidewalk planters planted with vegetation that absorb stormwater. Green roofs are roofs with vegetation growing that utilizes stormwater. Retention basins are ponds that retain and filter stormwater before gradually releasing it into nearby waterways.

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natural vegetation may create a disamenity, e.g., by appearing overgrown or attracting unwanted pests. Thus the value of green infrastructure to nearby residents, as capitalized into housing prices, is an empirical question.

A number of empirical studies have demonstrated the positive capitalization of heterogeneous open space into housing prices in urban settings (e.g., Geoghegan, 2002; Irwin, 2002; Anderson and West, 2006; Walsh, 2007; Abbott and Klaiber, 2010).[2] Other studies have found evidence of the positive influence of urban waterbodies, including large increases in housing prices based on proximity to coastal waterfront (e.g., Bond et al., 2002; Walsh et al., 2011), urban lakes (Abbott and Klaiber, 2013), wetlands (Mahan et al., 2000) and waterbodies (Cho et al., 2009). Water clarity and other measures of water quality associated with nearby waterbodies can also positively capitalize into housing values (Leggett and Bockstael, 2000; Poor et al., 2001). In contrast, far fewer studies have focused on the potential benefits from smaller, more distributed water features such as stormwater management infrastructure.

Cadavid and Ando (2013) find that survey respondents are willing-to-pay for reductions in flood frequency and improvements to the hydrological function in watersheds with stormwater infrastructure. While these results reveal a positive demand for the environmental benefits of stormwater management, they do not provide an estimate of the potential benefits from stormwater landscape features associated with basins. Using spatial regression, Lee and Li (2009) find significant correlation between stormwater basins and nearby housing prices in their study of two stormwater basins in a neighborhood in College Station, Texas. However, the positive house price correlation arises from a basin located within a park and raises potential endogeneity concerns. We take care to address potential time-constant unobservables in our research design and do so over a significantly larger dataset.

The purpose of this paper is to empirically identify the capitalization effect of stormwater basins on nearby housing prices and in so doing, investigate the potential for this particular type of green infrastructure to generate (dis)amenities that would augment or offset the intended environmental benefits of improved urban water management. We estimate this capitalization effect using data on the location of 2950 stormwater basins and over 90,000 observations of housing sales between 1996 and 2007 in a suburban county of the Baltimore, Maryland metropolitan region. We exploit spatial and temporal variation in the placement of basins, regulations on their design, and the occurrence of housing near basins of different vintages in close proximity to determine causally the capitalized value of stormwater basins into house prices.

Our results show that stormwater basin adjacency leads to housing prices that are consistently lower, with estimates between 13 and 14%, depending on model specification. For the mean house in our sample, this corresponds to a house price decrease between $28,185 and $30,579, a factor solely attributed to stormwater basin adjacency. Additionally, this negative capitalization effect accentuates as the basin ages. For the case of a house adjacent to a basin that is at least seven years old, we estimate it to have a compounding negative capitalization of approximately 17% when compared to an identical home not adjacent to such a basin. We do not find any significant effect on nearby houses that are not adjacent, suggesting that the effect is highly localized.

This paper is the first study to-date that identifies the causal effect of stormwater retention basins on housing values across a heterogeneous geographic area using revealed preference data on housing markets. Our approach controls for a number of sources of bias that could arise from the presence of unobservable landscape features, lending confidence that the estimated negative effect is robust. The results show that, in the absence of a purposeful approach to amenity creation, the stormwater regulations implemented in our Baltimore County, Maryland study region have resulted in stormwater basins that confer a substantial negative impact on adjacent houses and no significant effect on non-adjacent houses. Thus, households adjacent to stormwater basins bear a disproportionate share of the cost of providing green infrastructure that generates environmental benefits for all residents of the region. While this work does not consider the full costs and benefits of stormwater basins, including their costs of construction and maintenance and the value of the ecosystem services they deliver, it does imply that any ecological benefit further downstream should be sufficiently large to offset these losses in adjacent housing values in order to provide an overall net benefit to the region.

The remainder of the paper is as follows. The following section discusses state and local stormwater regulation in Maryland, with a focus on who bears the cost of compliance, followed by a discussion of data in Section 3 and methods in Section 4. We report results in Section 5 and conclude in the final section with a summary and discussion of implications.

2. Stormwater Policy and Compliance Burden

Stormwater management evolved out of concern for the impact of development on the natural hydrological cycles of the environment. When rainfall occurs in an undeveloped area, it infiltrates the ground surface or undergoes evapotranspiration by vegetation (National Research Council, 2009). In urban landscapes filled with impervious surfaces, the ability of the vegetation and soil to retain water is impaired, leading to stormwater flows that are concentrated and potentially devastating to the surrounding watershed (Thurston, 2012).

Since 1990, the NPDES Stormwater Permit Program, part of the larger Clean Water Act, has regulated water runoff from municipalities, construction activity, and industrial sources in the United States. Prior to 2003, each state had significant leeway in determining the threshold of land disturbance that required the issuance of an individual permit and creation of a stormwater site plan. Post 2003, the EPA set nationwide standards to be followed in each state for any development activity over one acre. The state of Maryland was a much earlier adopter, passing its first set of stormwater regulations in 1984, with the goal of protecting the Chesapeake Bay as a motivating factor. Maryland is much more stringent on stormwater management than the rest of the nation, requiring stormwater controls on every development that disturbs > 5000 square feet (0.11 acres) of land. From 1984 until 2001, all basins were required to hold the first flush of water from a rainfall event. From 2002 until 2008, basins were required to provide a water quality improvement of 20% from the pre-storm baseline through filtering occurring within the basin.

Maryland has also been the beneficiary of several U.S. EPA civil suits against housing developers found in repeated violation of stormwater regulations, with fines totaling over $6 million (EPA Office of Enforcement and Compliance, 2008; EPA National Enforcements Initiative, 2015). The bulk of these fines were due to poor stormwater practices during the construction portion of the homebuilding phase but this belies an important issue underlying stormwater regulations in suburban settings. Once the new development is finished and the initial stormwater infrastructure put into place by the developer, the cost of compliance and control of the infrastructure falls under the auspices of the households living near the stormwater basin, usually under the form of a local homeowner association (HOA) or equivalent. The HOA is responsible[3] for routine maintenance of the stormwater infrastructure, which includes ensuring all retention basin dams are intact, vegetative overgrowth is under control, outflow pipes are clean, and litter is collected. While the upkeep costs vary by basin size and need, the monetary funds required will come from the households who make up the HOA. In Baltimore County, all stormwater basins also require an inspection by the county every three years (Baltimore County Code, 2010).

[2] See McConnell and Walls (2005) for a review of the earlier literature.

[3] HOA's also occasionally arrange for maintenance and care of the stormwater infrastructure by nearby municipalities for a fee.