International Center for Climate Governance

CAN TRADABLE DEVELOPMENT RIGHTS BE USED TO MANAGE LAND AND REDUCE FLOOD RISKS?

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Can Tradable Development Rights Be Used to Manage Land and Reduce Flood Risks?

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Abstract

Floods are among the most damaging of natural hazards, having caused over 200,000 deaths and in excess of $400 billion in damages worldwide since 1980. Governments and other nongovernmental organizations are often interested in investigating policies for managing or reducing flood risks. The most common policies for achieving this objective are land use management policies, specifically zoning ordinances. In this brief article, we examine the economic aspects of zoning policies and compare the results with a tradable development rights program, which may provide a more equitable alternative to traditional zoning measures.

Introduction

Floods pose a significant threat to human societies. Evidence suggests that floods have been occurring at an increasing rate in recent years.[1] From 1980 through 2010, the number of reported flood disasters has increased from 39 floods in 1980 to a high of 226 floods reported in 2006. Since 1980, floods have been responsible for more than 200,000 deaths and over $400 billion in damages worldwide. While attributing these observed increases in flood disasters to changing climate is complicated by a myriad of data issues, and scientists have limited confidence in making such assessments or predictions regarding future flood activity, the likely increased precipitation, warmer temperatures, and rising sea levels provide at least a credible rationale for expecting an increasing frequency of floods in the future, placing more lives and assets at risk. Governments and other nongovernmental organizations (NGOs) are likely to be very interested in exploring different approaches for managing or even reducing these risks.

In the United States, the National Flood Insurance Program (NFIP) provides a safety net for communities exposed to flood risk. Participation in the NFIP requires some form of floodplain management be undertaken to reduce flood risk. There are several strategies that could be undertaken in this regard, but by far the most common is command-and-control zoning. Recently, however, there has been increasing interest among some researchers and policymakers about the potential for market-based instruments for reducing flood risk (Chang, 2008; Environment Agency, 2007). One such market-based instrument is known as tradable development rights (TDR), which operate in a fashion analogous to tradable emission permit programs. These programs offer an alternative to traditional zoning ordinances for achieving land use objectives: the right to develop a parcel of land is stripped from the full bundle of property rights, and these development rights (DRs) can be purchased or sold on a market. In what follow, we provide some general economic analysis of these two policy alternatives, with particular emphasis on the economic efficiency and the equity of benefits.

Land Use Management to Reduce Flood Risks

To analyze the effects of zoning and TDR programs, we begin by considering a simple land market. We will assume that there are L homogeneous parcels of land that can be either developed for private use (x) or can remain undeveloped. The demand for developable land (D) represents the marginal private benefits of developing land, while the supply developable land (S) represents the marginal private costs. The supply of developable land also reflects the marginal benefits of leaving land undeveloped, since the costs associated with developing are not just the construction costs, but also the opportunity costs of land conversion. The supply curve becomes vertical once all land is exhausted demonstrating the finiteness of land available for development, regardless of the land price. We assume that land is ordered on the horizontal axis according to increasing benefit in undeveloped use, resulting in an upward-sloping supply curve. We also assume that the characteristics that make land attractive for development are different from those that make land attractive for remaining undeveloped. We assume that the private returns to development are sufficient that, in an unfettered competitive land market, all land would be developed. This results in a competitive market equilibrium where $x^m = L$ units of land are developed, with no land remaining undeveloped. Development in floodplains increases flood risk for this hypothetical society, but, in such a competitive market, developers are not concerned with these potential adverse impacts. These adverse impacts are referred to as negative externalities, since they represent negative costs to society that are external to the individual agents interacting in the market. We assume that, for every level of development, there is an additional cost to society of E, which, when added to the private marginal costs, results in a social marginal cost curve

[1] These statements are based on data from EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.be –Universite Catholique de Louvain, Brussels, Belgium. CRED uses four criteria in categorizing an event as a disaster: (1) 10 or more people killed; (2) 100 or more people affected (injured, displaced, or otherwise requiring immediate attention); (3) declaration of a national state of emergency; or (4) a call for international assistance. If an event satisfies any one of these four criteria, the event is classified in the EM-DAT as a disaster.

denoted MC_s. From the perspective of society, the optimal allocation of land would result in $x*$ units of land being developed, with $L-x*$ units remaining undeveloped. The government may intervene in the market by imposing zoning restrictions to attempt to drive the market to this socially optimal land allocation, or alternatively may initiate a TDR program with the same land allocation objective.

1. Zoning

An example of a zoning regime is shown in Figure 1. Here, the government restricts which lands that can be developed. Land from 0 to $x*$ may be developed, while land from $x*+1$ to L (i.e., floodplains) must remain undeveloped. When zoning policies are put into force, there are societal benefits that are reaped, due to an internalization of the negative external costs associated with increased flood risk. These benefits are shown by the red parallelogram $acef$ in Figure 2. These benefits accrue to the developable land, and are capitalized into the value of developable land. This is shown as the increase in the value of developable land above and beyond the price that must be paid for a unit of land. At the same time, since the zoning policy restricts the development of land from $x*+1$ to L, the value of these parcels declines. The aggregate loss of value for undevelopable land is shown by the blue trapezoid $abdf$. These landowners are not compensated for this lost value. So as a result of a zoning policy, total economic efficiency has been increased (since the socially optimal land allocation has been achieved, with $x*$ units of land under development), aggregate land values have been maximized, but there is a very skewed distribution in the benefits of this policy. Owners of developable land see a “windfall” increase in their land values, while owners of undevelopable land receive a “wipe-out” in their land values.

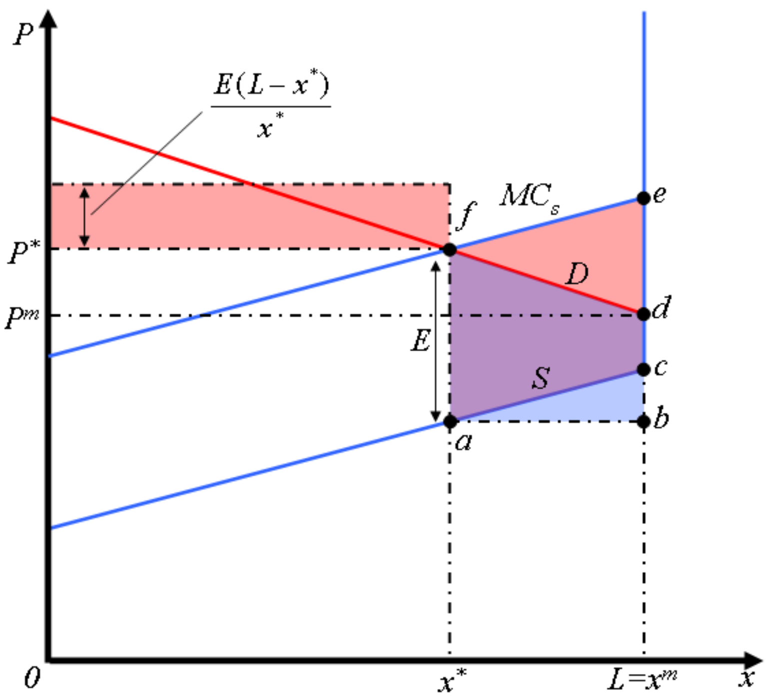

Figure 1: The Efficiency and Equity Effects of Zoning Policies

2. Tradable Development Rights Programs

An example of a TDR program is shown in Figure 2. We assume that all land is initially undeveloped, but government authorities fear that development will encroach on environmentally fragile lands (e.g., floodplains), and that such development may increase flood risks in the community. In an attempt to manage the land allocation, while not creating the system of "windfalls and wipe-outs" that is common to zoning policies, the government introduces a TDR program. The right to develop land is severed from the remaining bundle of property rights, but in their stead the government issues L DRs to property owners, which can be exchanged for development at a pre-determined conversion ratio of L/x^* DRs per unit of development. This implies that the maximum level of development in society can only be x^*. But can we be sure that the "best" x^* parcels will be preserved, thus generating the maximum flood risk reduction? Even without government zoning policies in force, the x^* units of land that generate the highest excess returns in developed use will be used for development. These are parcels 0 through x^* in Figure 2. Coincidentally, these leaves as undeveloped the parcels of land that have the highest value in undeveloped use (parcels x^* through L).

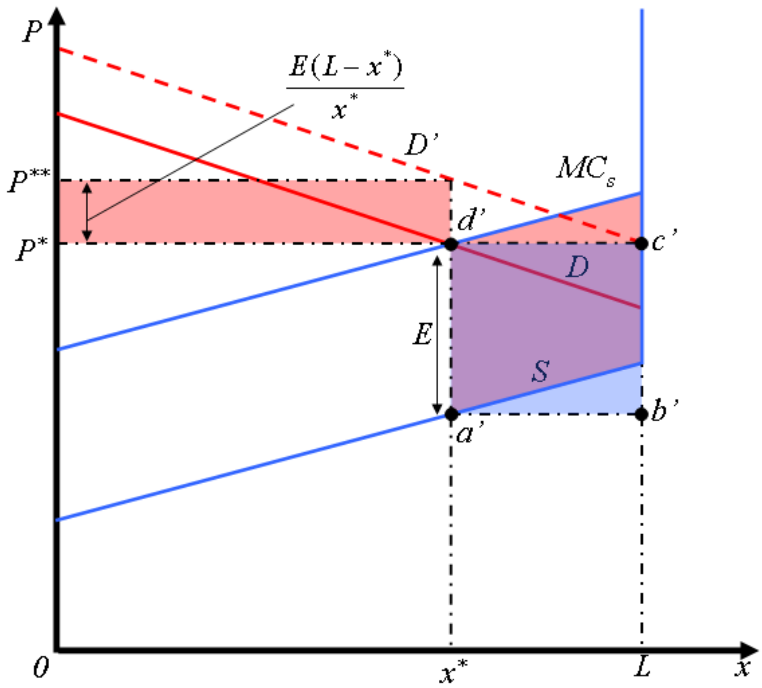

Figure 2: The Efficiency and Equity Effects of a TDR Program

As with under the zoning, the fact that $L-x^*$ units of land are restricted from being developed, there are social benefits that arise from reduced flood risks. As before, these benefits accrue to the developable lands and are capitalized into the land values. But since landowners must purchase DRs in order to develop in these lands, this additional value represents the maximum that landowners would be willing to spend on purchasing DRs. The price for DRs becomes the difference between the value of land in developed versus undeveloped uses for the x^*th parcel of land. This is given by the vertical distance E in Figure 2. Owners of land from 0 to x^* are happy to pay this price, since the private net benefits exceed this value, while owners of land from x^* through L are happy to receive this price, since their foregone net benefits are less than this amount. Since those landowners from x^* through L are sellers of DRs, they will receive blue rectangle a'b'c'd' as compensation for their DRs, which exactly offsets the increase in value on developable land. Thus, the TDR policy achieves its objective in terms of achieving the socially optimal land allocation and maximizing the aggregate land value, similar to zoning policies. But unlike zoning policies, the distribution of benefits is much more equitable. No property owners are made worse off as a result of the TDR policy, those property owners who are zoned out of development are compensated for this loss, and some of these property owners are actually made better off, receiving compensation in excess of the minimum that would be required to offset the loss in land value.

Conclusion

Both zoning and TDR programs are land use management policies that have been used for various purposes to preserve or conserve land that provides some value to society in excess of its value to private developers. In this analysis, we have shown that, while zoning may achieve socially optimal land allocations, it does so very inequitably. Those landowners who are zoned out of developing their land are never compensated for their lost right to develop their land in the most profitable way. TDR programs, on the other hand, allow for market transactions of development rights, which allow those owners of preserved lands to sell their development rights, receiving due compensation, while still allowing for a socially optimal level and location of development. While these programs have not yet been implemented for the explicit purpose of reducing flood risk, our analysis shows that this might be a fruitful application of these programs.

References

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