OPTIMAL INVESTMENT AND LOCATION DECISIONS OF A FIRM IN A FLOOD RISK AREA USING IMPULSE CONTROL THEORY

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INTRODUCTION

Climate change puts increasing environmental pressure on coastal zones and on areas around lakes and rivers. On top of the list of potential impacts of climate change are effects of sea level rise on coastal cities and effects of extreme events on built infrastructure like floods from heavy precipitation events ([1]). Floods and other extreme weather events increase economic losses ([2]). Large-scale flood disasters from recent years gained attention among decision makers (e.g. businesses). Implementing actions to reduce disaster risks and build flood resilience facing limited resource needs decision support tools ([3]).

The aim of this paper is to understand investment decisions of firms and their implications on businesses in flood risk areas. [4] developed a conceptual descriptive model to understand the feedbacks of flood risk reduction (i.e. investments in flood defense and moving away from the river) and flood damage from a societal perspective. [5] introduced an optimal decision framework to investigate the interaction of a society's investment in flood defense and productive capital.

FUNDAMENTAL OF THE PROBLEM

In this paper we look at a partial equilibrium model and try to understand the firm's investment decisions in its interrelations with the hydrological system. A representative firm can have multiple choices: First, it can choose the optimal investment in capital used for production, second the optimal investment in flood risk reduction measures and third, the optimal location for its production plant.

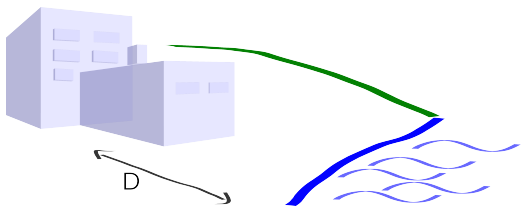

Figure 1: The firm chooses where to build its production plant by choosing the distance to the water.

Our qualitative model helps to understand feedback mechanisms between the firm's decisions and the hazard of flooding. We apply Impulse Control Theory (see [6]) and develop a continuation algorithm to solve the model numerically. We provide analytical and numerical solutions and analyse variations of these solutions under different parameterizations of the model[1].

[1]Please find more details in the full working paper version [7].

RESULTS AND DISCUSSION

We find that, the higher the flood risk and the more the firm values the future, i.e. the more sustainable the firm plans, the more the firm will invest in flood defense. Investments in productive capital follow a similar path. Hence, planning in a sustainable way leads to economic growth. Sociohydrological feedbacks are crucial for the location choice of the firm, whereas different economic settings have an impact on investment strategies. If flood defense is already present, e.g. built up by the government, firms move closer to the water and invest less in flood defense, which allows firms to accrue higher expected profits. Firms with a large initial productive capital surprisingly try not to keep their market advantage, but rather reduce flood risk by reducing exposed productive capital.

CONCLUSION

This paper provides the investment behaviour and location choice of a firm in a flood risk area within an optimal decision framework. Sustainable investment planning of the firm leads not only to a safer environment with less flood risk, but also to economic growth both in the short and the long run. If the area is already protected against floods, firms still invest in flood defense, but less. And if the firm is more capital intensive potential damage is larger, but the timing and amount of impulse investments do not change.

Anthropogenic flood risk reduction can affect the environment resulting in changes of the water system and consequently again increase flood risk due to negative feedbacks. In this case, production output is much less and the firm decides to build its production far away from the water.

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