Journal of Choice Modelling 28 (2018) 124–136

Contents lists available at ScienceDirect

Journal of Choice Modelling

journal homepage: www.elsevier.com/locate/jocm

Fishermen's location choice under spatio-temporal update of expectations

Barbara Hutniczak [a], Angela Münch [b,*]

[a] NOAA NMFS, USA
[b] Integrated Statistics, under contract to NOAA NEFSC, Woods Hole, MA, USA

ARTICLE INFO

JEL classification:
Q22

Keywords:
Bayesian updating
Location choice
Spatio-temporal data

ABSTRACT

Information acquired by individuals over time plays a crucial role in their decision-making process. Gained experience updates beliefs on expected payoffs and is used in a range of decisions each individual is facing. In this paper, we focus on the formation of beliefs about the payoffs associated with spatial choices set in an uncertain environment. We task ourselves with better understanding of day-to-day flexibility of actions as a result of continuous update of prior expectations. We built a model where private and common knowledge on expected economic returns blend and lead to divergence of expectations between individuals. This innovation expands the frontiers of spatio-temporal modeling of micro-behavior to offer a new insight on decay of information relevance with increasing spatial and temporal separation. Application to fishermen harvest location choices demonstrates the use of the model. Successful fisheries management must be able to accurately predict the response of fishermen to regulations with particular attention paid to flexible technologies which allow individuals to adjust effort and alter behavior. Good understanding of fishing locations choice and location adjustment flexibility can contribute substantially to a design of management practices with spatial components.

1. Introduction

Information plays a crucial role in the decision-making process of individual agents facing uncertainty (Sulganik and Zilcha, 1997). Pieces of information acquired by agents over time are used to update their beliefs and consequently form the basis for decision making. However, the process of the formation of beliefs is not observable, and indirect methods are required to understand the way beliefs are formed and transformed into actions. In this paper, we present a novel method of treating expectation formation by agents who face spatial choices with uncertain payoffs. We build a model where private and common knowledge on expected economic returns blend and lead to divergence of expectations between individuals. This innovation expands the frontiers of spatio-temporal modeling of micro-behavior to offer a new insight on decay of information relevance over time and space. Specifically, we build a methodology to draw conclusions on the time span over which an obtained signal is considered valid (knowledge decay over time) and the distance over which a signal proliferates (knowledge decay over space). Observing the location-specific payoffs, as well as associated decisions, we consider plausible processes regarding the way individuals transform their experiences into beliefs, and finally into actions. The goal is

* Corresponding author.
E-mail addresses: barbara.hutniczak@noaa.gov (B. Hutniczak), angela.muench@cefas.co.uk (A. Münch).

https://doi.org/10.1016/j.jocm.2018.05.002
Received 3 April 2017; Received in revised form 8 May 2018; Accepted 11 May 2018

1755-5345/

to derive the transformation path of the signal into action using easily collectable data.

The parameters of the learning process are derived by fitting a dynamic Bayesian model to available data on location choices. We develop an updating framework for individual decision makers that accommodates knowledge decay over time and space, hence, incorporates intertemporal and spatial correlation between gained experience and future expectations. We use informed priors for common knowledge factors derived with spatio-temporal interpolation. The signal propagation parameters are derived by fitting the multinomial logit model to simulated expectation data paired with observed discrete location choices. The empirical goal of this study is to understand the rationale behind spatial choices in terms of probabilities of changing the location based on the associated set of payoff expectations (expectation mean and expectation variance) and associated costs.

We use commercial fishing as an example of multiple spatial decisions where gathering information about spatio-temporal distribution of payoffs plays a key role. In case of fisheries, common knowledge is likely to be coarse. Informed priors reflect seasonal productivity patterns of the potential fishing grounds and capture effects like fish reproductive and feeding migrations. However, unless the regulatory system stirs economic incentives to share information, fine scale knowledge gained by individual's experience is more likely to be privately held. Thus, our paper adds to a scarce literature (Abbott and Wilen, 2011) on how individual knowledge blends with general knowledge of broad seasonal patterns. Moreover, fisheries present an advantage in terms of extent of information available for analysis, as data on spatial choices is typically collected by authorities as part of a reporting requirement.

In this paper, we analyze the formation of fishermen's beliefs about the productivity of fishing grounds, and the impact of these beliefs on the decision with respect to location choice. We are interested in the at-sea day-to-day location adjustments based on signals obtained through harvest activity. We examine whether fishermen respond in a flexible way to signals received whilst fishing or rather adhere to a once chosen area or a small subset of areas ("Old Habits Die Hard"; Holland and Sutinen, 2000). The work on understanding the spatial distribution of harvest activities is important from a management perspective, as it allows for improved evaluation of the effects of policies, such as spatial closures or designation of marine protected areas. It is also extremely useful for calibration of fine scale integrated models like agent-based models. However, we are less interested in predicting the spatial behavior. In this paper, the focus is on obtaining consistent estimates of parameters of the underlying process of expectations formation and a better understanding of individual's behavior specificities.

Although our location choice model is embedded in the fishery context, the use of this kind of spatio-temporal Bayesian updating framework is easy to imagine for, e.g. studying the determinants of neighborhood crime (Bernasco and Kooistra, 2010; Bernasco et al., 2013) or real estate buying decisions (Gelfand and Ghosh, 1998). Hence, our model has a wide range of applications in which location choices are based on former experience transmitted through time and space.

The paper is structured as follows: the background of the study and the empirical application are explained, before we provide the theoretical background our model is embedded in. We then explain how we derive the expected payoffs based on Bayesian updating framework. We include details on the generation of priors, factoring in variance of expected returns, as well as knowledge decay over space and time, all crucial for this study. After deriving the expected revenues, we explain how we fit a mixed logit model to our data. The example is used to demonstrate how our method can be applied to derive the parameters of the spatio-temporal updating process of forming expectations by individuals. Results are presented in section four, followed by conclusions and general findings.

2. Background

Successful fisheries management must be able to accurately predict the response of fishermen to regulations and their alternatives (Wilen, 1979; Bockstael and Opaluch, 1983; Opaluch and Bockstael, 1984). In particular, attention should be paid to flexible technologies where individuals are able to adjust the effort and alter fishing behavior (Wilen, 1979). Good understanding of fishermen's location choice and location adjustment flexibility can contribute to more effective design of spatial management practices (Wilen et al., 2002), such as permanent marine reserves and rotating spatial closures (Smith, 2000).

Commercial fishermen are known to respond to economic incentives (Lane, 1988; Hilborn et al., 2005). Their beliefs about profitability at different locations are the most important determinants of location choices (Smith, 2000). But decisions are made in an uncertain and constantly changing environment (Opaluch and Bockstael, 1984), and understanding of the spatio-temporal patterns of fish productivity is a key to a successful harvest. There is evidence of information sharing between fishermen working in cooperatives (Haynie et al., 2009; Abbott and Wilen, 2010), but more often fishermen rely on information acquisition through their own activity and use personal experience to guide decisions on fishing location (Wilson, 1990; Holland, 2008; Evans and Weninger, 2014). The process is commonly based on realized long-term regularities in the movement and location of fish in the environment, but fine-grained information related to immediate distribution of fish can also be incorporated to location choices (Wilson, 1990). Andersen et al. (2012) find that seasonal availability of target species is an important factor determining the choice of harvest grounds, whereas Salas et al. (2004) show that economically efficient fishing requires continuous learning about complex resource and flexible adjustment of fishing locations on a day-to-day basis.

In this paper, we considered fishermen as decision makers who face a set of harvest location options. We assume the decision if made after analyzing private knowledge accumulated over previous trips accompanied by coarse-grained information about the long-term patterns occurring in the exploited resource. The beliefs that form as a result of combining multiple sources of information are unobservable by an analyst, so from his perspective, choices are probabilistic or random. But the underlying information can be identified from observed choices. Understanding of how beliefs are transformed into action is a first step to creating a reliable map of predicted