Available online at www.sciencedirect.com
ScienceDirect
Journal of Economic Theory 146 (2011) 1699–1711
JOURNAL OF Economic Theory
www.elsevier.com/locate/jet

Notes

Learning about the arrival of sales

Robin Mason [a,b,*,1], Juuso Välimäki [c]

[a] University of Exeter Business School, Streatham Court, Rennes Drive, Exeter EX4 4PU, UK
[b] CEPR, UK
[c] Aalto University School of Economics, P.O. Box 21210, FI-00076 Aalto, Finland

Received 16 May 2008; final version received 9 July 2010; accepted 28 January 2011

Available online 3 March 2011

Abstract

We analyse optimal stopping when the economic environment changes because of learning. A primary application is optimal selling of an asset when demand is uncertain. The seller learns about the arrival rate of buyers. As time passes without a sale, the seller becomes more pessimistic about the arrival rate. When the arrival of buyers is not observed, the rate at which the seller revises her beliefs is affected by the price she sets. Learning leads to a higher posted price by the seller. When the seller does observe the arrival of buyers, she sets an even higher price.

JEL classification: D42; D81; D82

Keywords: Optimal stopping; Learning; Uncertain demand

1. Introduction

Models of optimal stopping capture the trade-off between known current payoffs and the opportunity cost of future potentially superior possibilities. In many of their economic applications, the environment in which the stopping decisions are taken is assumed to be stationary. In the standard job search model, for example, a rejected offer is followed by another draw from the same

* Corresponding author at: University of Exeter Business School, Streatham Court, Rennes Drive, Exeter EX4 4PU, UK.

E-mail addresses: mason.robin@gmail.com (R. Mason), juuso.valimaki@hse.fi (J. Välimäki).
1 Robin Mason acknowledges financial support from the ESRC under Research Grant RES-062-23-0925.

0022-0531/$ – see front matter
doi:10.1016/j.jet.2011.03.013

distribution of offers. See [19] for a survey. The predictions of these models are at odds with empirical observations. Prices of houses decline as a function of time on the market; see e.g., [17]. Reservation wages of unemployed workers decline in the duration of the unemployment spell; see e.g., [14].

We propose a simple and tractable model of optimal stopping where the economic environment changes as a result of learning. Rather than using the deterministic model of optimal stopping typically used in optimal search models, we generalize the other canonical model of stopping in economic theory, where stopping occurs probabilistically (as in e.g., models of R&D).

We cast the model in the language of the classic problem of how to sell an asset [10]. (In the concluding section, we discuss alternative interpretations of the model.) A seller posts a take-it-or-leave-it price; potential buyers arrive according to a Poisson process and observe the posted price. They buy if and only if their valuation exceeds the posted price. The seller is uncertain about the arrival rate of buyers. The seller does not observe whether a buyer is present: she sees only whether a sale occurs or not. The seller updates her beliefs about the arrival rate in a Bayesian fashion, becoming more pessimistic about future arrivals after each period when a sale does not occur. The rate at which beliefs decline depends on the current posted price. Hence, when choosing the current price of her asset, the seller controls her immediate expected profit, conditional on a sale, as well as the beliefs about future demand if no sale occurs.

Even though our model is a standard Bayesian learning model, the belief dynamics are a little unfamiliar. When we describe the evolution of beliefs over time, we are implicitly conditioning on the event that no sale occurred in the current period. Since this event is bad news about the prospect of a future sale, the seller becomes more pessimistic over time. The seller can control the downward drift of her beliefs through her choice of price.

We identify two key effects. A more pessimistic future implies a lower current value of being a seller and hence a lower current price. We call this feature the *controlled stopping effect*. By setting a lower price, the seller can cause her beliefs to fall further in the event of no sale occurring. A more pessimistic seller has a lower value than a more optimistic seller—there is a capital loss from learning. Holding fixed the probability of a sale occurring, the seller has an incentive to increase her price in order to reduce this capital loss. We call this feature the *controlled learning effect*.

Which effect dominates? Does learning cause the seller to raise or lower her price, relative to the case when no learning occurs? The benchmark is a model where the rate of contact between the seller and buyers is fixed at her current expected level. We show that in our model, the controlled learning effect dominates: the optimal posted price exceeds the price posted in the equivalent model with no learning.

We gain further insight into the effect of learning by looking at the case where the seller does observe the arrival of buyers. In this case, the updating of the seller's beliefs is independent of the price that she sets. We show that the seller optimally sets an even higher price than when she cannot observe arrivals. The key difference when arrivals are observed is that now the seller can raise her price after positive news i.e., after a buyer arrival, even when there is no sale. We therefore obtain an upper bound for the price increase resulting from controlled learning, when arrivals are not observed: it is no larger than the price increase resulting from the observability of arrivals.