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ON DONSKER TYPE THEOREM FOR DISCRETELY REFLECTED BACKWARD SDES

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Abstract. We prove an analog of Donsker's Theorem for Backward Stochastic Differential Equations subject to reflections by random barriers at finitely many points in [0,T]. The discretization gives rise to an algorithm that is shown to converge to the exact solution uniformly in probability.

Keywords. Backward SDEs with Reflections, Discretization, Convergence of Filtrations, Skorokhod Topology.

AMS (MOS) subject classification: 60H10, 60H05, 60Fxx.

1 Introduction

Backward Stochastic Differential Equations (BSDEs), often referred to as Forward Backward Stochastic Differential Equations (FBSDEs), originated during the 1990-ties in a series of works by Pardoux, Peng and El-Karoui [6], [4], [5]. Over the past two decades BSDEs became a subject of intense research and showed direct connections to the Partial Differential Equations (PDEs), with numerous applications to Optimal Control Theory and Quantitative Finance. A continued interest in BSDEs culminated in the recent monographs on the subject by Touzi [9], Crépey [2], Delong [3], Pardoux and Răşcanu [7], which further underscore its growing relevance and generate an interest in the development of effective numerical solution algorithms.

We recall that while classical linear parabolic PDE theory provides closed form solution for the density $p(t,x)$ of diffusion process through the Feynman-Kac formula, the non-linear PDEs lack this property and instead one solves SDE running back in time, whose initial (*deterministic*) value coincides with $p(t,x)$. Key features of FBSDEs are as follows: can solve semi-linear PDEs, provides an alternative to numerical schemes for PDEs, allow non-smooth coefficients in the PDEs (which typically cannot be handled by classical deterministic methods).