Pricing American options with endogeneous negative rates under Heston model.

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Abstract: Some decision-making problems in finance can be formulated as American options with endogeneous negative interest rates. Recently, in [1], the authors proved that such problems involve the presence of a double continuation region when there is only one underlying stochastic factor following a geometric Brownian motion. Indeed, a continuation region appears when the option is not enough in the money (standard case for endogeneous positive rates), but also when the option is too deep in the money (non standard case). This properties are theoretically obtained for the call and put American option. As real options applications, the case of a gold loan and a capital investment are considered.

In the present work, specially motivated by the case of the gold loan, we extend the modelling approach proposed in [1] by considering a stochastic volatility model for the underlying asset, so that not only the gold price but also its volatility are stochastic, which is more realistic that a constant volatility. Thus, for American options with endogeneous negative rates we pose the pricing problem in terms of partial differential equations under the Heston model [2]. Numerical methods allow to obtain the behaviour of the continuation region and compare the results with the ones in [1]. Also the pricing of the gold loan is addressed in this more realistic modelling approach.

References:

[1] Battauz, A., De Nonno, M., Sbuelz, A. (2015), Real options and American derivatives: The double continuation region, Management Science, 61 (5), 1094–1107.

[2] Heston, S.L. (1993), A closed-form solution for options with stochastic volatility with applications to bond and currency options, Review of Financial Studies, 6, 327–343.