

# Mathematical Modeling in Quantitative Finance and Computational Economics

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A part of my PhD dissertation deals with optimal control techniques applied to quantitative finance and labour economics. At first glance the mentioned fields of application may look significantly different, but the implemented analytical tools are the same and they all rely on the well-known Bellman principle of optimality.

In this abstract, I would like to focus on the former field by considering some issues raised by the valuation of the early exercise of a financial option in a context of negative interest rates; indeed, in such a macroeconomic scenario that characterises many actual economies, some well-established option pricing properties are no longer verified. Specifically, some critical concerns might arise in the case of an underlying equity that pays no dividends. In this peculiar case, assessing the fair value of an American call option might be challenging as it might not match the value of a corresponding European option with the same financial characteristics. Consequently, a promising research question is whether the established approximation provided by quasi-closed formulas can effectively bypass the problem highlighted above.

One of the papers collected in my dissertation addresses this issue in depth by means of an empirical application in which the estimation of a range of quasi-closed formulas is compared with stochastic lattice methods. In detail, my econometric analysis shows that the gap between the fair value of an American call option at early exercise and the value of the corresponding European call can be strongly reduced by using these latter numerical methodologies and that the impact of negative interest rates on the valuation of that kind of derivatives is very strong. Essentially, many well-established and popular mathematical properties applied in the estimation of the fair value of these assets are no longer valid and they must be re-assessed by starting from their underlying fundamentals. From a practical perspective, the insights emerging from my study have a straight impact on the actual prices of derivatives so that the numerical routines implemented by commonly used pricing software need to be patched accordingly.

It has been a privilege for me to be interviewed on the research topic of Negative Interest Rates by Bloomberg News (2019) and by the Financial Times (2020).