# Title Page Dummy

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Title page logo

Abstract Dummy Page.

*"These violent delights have violent ends"*
*(Romeo and Juliet: Act 2, Scene 6, Line 9)*

# Sammanfattning

Jag skriver på svenska här.

# Преглед

Ова теза злата вреди!

# List of papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

I Radial Basis Function generated Finite Differences for Option Pricing Problems

II BENCHOP — The BENCHmarking Project in Option Pricing

III BENCHOP-SLV: The BENCHmarking project in Option Pricing — Stochastic and Local Volatility problems

IV Pricing Derivatives under Multiple Stochastic Factors by Localized Radial Basis Function Methods

V Pricing Financial Derivatives using Radial Basis Function generated Finite Differences with Polyharmonic Splines on Smoothly Varying Node Layouts

VI SMOOTHING PAPER TITLE

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# Contents

# 1. Introduction

The purpose of this thesis is to report on state of the art in Radial Basis Function generated Finite Difference (RBF-FD) methods for pricing of financial derivatives. Based on the six appended papers, this work provides a detailed overview of RBF-FD properties and challenges that arise when the RBF-FD method is used in financial applications. Furthermore, the manuscript aims to motivate further development of RBF-FD for finance.

Across the financial markets of the world, financial derivatives are traded in substantial volumes. Therefore, knowing the prices of those financial instruments is of utmost importance at any given time. In order to make that possible in practice, it is very often required to employ a set of skills incorporating knowledge in financial theory, engineering methods, mathematical tools, and the programming practice — which altogether constitute the field known as *financial engineering*.

Many of theoretical pricing models for financial derivatives can be represented using partial differential equations (PDEs). In great deal of cases, those equations are time-dependent, of high spatial dimensions, and with challenging boundary conditions — which most often makes them analytically unsolvable. In those cases, numerical approximation as a mean of estimating their solution needs to be utilized. The field of *numerical analysis* is concerned with obtaining approximate solutions while maintaining reasonable bounds on errors. Unfortunately, there is no universal numerical method which could be used to efficiently solve all problems of this type. In fact, there are tremendously many numerical methods for solving different types of PDEs, and all those methods are featured with individual limitations in performance, stability, and accuracy — mostly depending on the problem details. Therefore, carefully selecting and developing numerical methods for particular applications has been the only way to build the most efficient PDE solvers in the ongoing practice.

RBF-FD is a numerical method that is developed to efficiently solve partial differential equations. RBF-FD, as its name suggests, is a finite difference type of a method from the radial basis function family. Such methods are mainly developed for numerical approximation of differential operators which is a crucial building block for many solvers partial differential equations (PDEs).

This manuscript is organized in the following way.

# 2. Financial Derivatives

Across the financial markets of the world, financial derivatives are traded in substantial volumes. According to the reports of BIS, the estimated total notional value of these financial instruments has been above half a quadrillion of USD during the current decade. That value is about the order of magnitude larger than the total world gross domestic product (GDP). The main reason for this astronomical market size is that there are numerous financial derivatives in existence, available for almost every type of investment asset.

## 2.1 Futures

## 2.2 Options

# 3. Option Pricing

Talk about stochastic and deterministic formulation.

## 3.1 Market Models

State, motivate and explain the models used in BENCHOP.

## 3.2 Pricing Methods

Talk about all the method groups from BENCHOP.

# 4. Radial Basis Function generated Finite Difference Methods

Similar to explanation in our papers, a bit of history and the method evolution throughout the papers.

## 4.1 Choosing Shape Parameters

## 4.2 Constructing Node Layouts

## 4.3 Smoothing Payoff Functions

# 5. Outlook and Further Development

Sumarize.

# References


[1] Peter Flynn. *Formatting information. A beginner's introduction to typesetting with LaTeX*. 3rd edition, 2005. http://www.ctan.org/tex-archive/info/beginlatex/beginlatex-3.6.pdf.

[2] Patrik W. Daly Helmut Kopka. *A Guide to LaTeX 2$_\varepsilon$*. Addison-Wesley Professional, 4th edition, 2003.

[3] Frank Mittelbach, Michel Goossens with Johannes Braams, David Carlisle, and Chris Rowley. *The LaTeX 2$_\varepsilon$ Companion*. Addison-Wesley Professional, 2nd edition, 2004.

[4] Tobias Oetiker, Hubert Partl, Irene Hyna, and Elisabeth Schlegl. *The Not So Short Introduction to LaTeX 2$_\varepsilon$*. 4.14th edition, 2004. http://www.ctan.org/tex-archive/info/lshort/english/lshort.pdf.

[5] Paul W. Abrahams with Karl Berry and Kathryn A. Hargreaves. *TeX for the Impatient*. Addison-Wesley Professional, 2003. http://www.tug.org/ftp/tex/impatient/book.pdf.

# Acknowledgment

Wohoo!