UNIVERSITY OF CAPE TOWN

MASTER'S DISSERTATION

High-frequency correlation dynamics: Is the Epps effect a bias?

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Related Publications and Pre-prints

Much of the content in this dissertation has been submitted as a suite of pre-prints to the arXiv.org e-Print archive. The list of pre-prints include:

- **?**: "Using the Epps effect to detect discrete data generating processes". This work has been submitted to Quantitative Finance (QF) for review.

Some of the content in this dissertation has been published in peer reviewed journals. The list of publications include:

- **?**: "Malliavin-Mancino estimators implemented with non-uniform fast Fourier transforms". This work has been accepted for publication by SIAM Journal on Scientific Computing (SISC).

- **?**: "Fourier instantaneous estimators and the Epps effect". This work has been accepted for publication by PLOS ONE.

Declaration of Authorship

I, Patrick CHANG, declare that this dissertation titled, "High-frequency correlation dynamics: Is the Epps effect a bias?" and the work presented in it are my own. I confirm that:

- This work was done wholly while in candidature for a research degree at this University.

- The contents of this dissertation has not been previously submitted for a degree or any other qualification at this University or any other institution.

- Where I have consulted the published work of others, this is always clearly attributed.

- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.

- I have acknowledged all main sources of help.

Signed:

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Date:

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Abstract

Master of Science

High-frequency correlation dynamics: Is the Epps effect a bias?

by Patrick CHANG

We tackle the question of whether trade and quote data from high-frequency finance are representative of discrete connected events, or whether these measurements can still be faithfully represented as random samples of some underlying Brownian diffusion in the context of modelling correlation dynamics. In particular, if the implicit notion of instantaneous correlation dynamics that are independent of the time-scale a reasonable assumption. To this end, we apply kernel averaging non-uniform fast Fourier transforms in the context of the Malliavin-Mancino integrated and instantaneous volatility estimators to speed up the estimators. We demonstrate the implicit time-scale investigated by the estimator by comparing it to the theoretical Epps effect arising from asynchrony. We compare the Malliavin-Mancino and Cuchiero-Teichmann Fourier instantaneous estimators and demonstrate the relationship between the instantaneous Epps effect and the cutting frequencies in the Fourier estimators. We find that using the previous tick interpolation in the Cuchiero-Teichmann estimator results in unstable estimates when dealing with asynchrony, while the ability to bypass the time domain with the Malliavin-Mancino estimator allows it to produce stable estimates and is therefore better suited for ultra high-frequency finance. We derive the Epps effect arising from asynchrony and provide a refined approach to correct the effect. We compare methods to correct for the Epps effect arising from asynchrony when the underlying process is a Brownian diffusion, and when the underlying process is from discrete connected events (proxied using a D-type Hawkes process). We design three experiments using the Epps effect to discriminate the underlying processes. These experiments demonstrate that using a Hawkes representation recovers the empiricism reported in the literature under simulation conditions that cannot be achieved when using a Brownian representation. The experiments are applied to trade and quote data from the Johannesburg Stock Exchange and the evidence suggests that the empirical measurements are from a system of discrete connected events where correlations are an emergent property of the time-scale rather than an instantaneous quantity that exists at all time-scales.

Contents

Chapter 1

Chapter Title Here

1.1   Welcome and Thank You

Appendix A

Frequently Asked Questions

A.1   How do I change the colors of links?

The color of links can be changed to your liking using:

`\hypersetup{urlcolor=red}`, or

`\hypersetup{citecolor=green}`, or

`\hypersetup{allcolor=blue}`.

If you want to completely hide the links, you can use:

`\hypersetup{allcolors=.}`, or even better:

`\hypersetup{hidelinks}`.

If you want to have obvious links in the PDF but not the printed text, use:

`\hypersetup{colorlinks=false}`.