

Applied Mathematics

CALIFORNIA STATE UNIVERSITY, NORTHRIDGE

ASSET BUBBLE DETECTION USING THE FLOREN-ZMIROU  
ESTIMATOR

A thesis submitted in partial fulfillment of the requirements  
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Applied Mathematics

by

Jaspreet Kaur

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The thesis of Jaspreet Kaur is approved:

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Dr. Stephen Breen

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Date

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Dr. Vladislav Panferov

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Date

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Dr. Jorge Balbás, Chair

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Date

## Dedication

Jas' dedication

## Acknowledgements

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## ABSTRACT

### ASSET BUBBLE DETECTION USING THE FLOREN-ZMIROU ESTIMATOR

By

Jaspreet Kaur

Master of Science in Applied Mathematics

We will study non parametric estimator Floren Zmirou in local real time on compact domain with stochastic differential equation which has unknown drift and diffusion coefficients. Once we will have volatility from floren zmirou. We will obtain volatility function then we will interpolate with cubic spline to see the behavior of the function.

## Chapter 1

### Introduction

1. Market forces exhibit stochastic behavior.
  - Stochastic behavior operates in a probabilistic sense[18].
  - Uncertainties in market value [6].
  - Intrinsic value type 1, 2 and 3 bubbles[12].
  - Extrinsic value(bubble)[17, 16].
  - Uncertainties(risks) in financial portfolios, and sectors of markets(e.g .com bubble, housing bubble)JAPBIIM
2. To minimize risk in portfolio against bubble, one would need to detect when a bubble exists in an asset[8].
3. In this paper, we use a non-parametric estimator Floren Zmirou to detect or determine type 3 bubbles in an asset.
4. Further testing is needed to determine if this method is valuable in minimizing portfolio risk against type 3 bubble.

#### 1.1 Previous Work on Asset Bubble Detection

- Identify other means to detect or determine asset bubble.

[7] paper covers variance bounds testing and malformed time series as a method of detection and detection difficulty respectively. [21] panel data test and cointegration are used to detect bubbles in housing prices.[24] RKHS theory is used to detect asset bubbles.[13] used a bootstrapping methodology to indicate type 3 bubbles in the Nasdaq price index and Case-Shiller house price index. [27] use a Kalman filter to estimate a bubble and then use a state space model with Markov switching to model the survivability of a bubble, switching between collapsing and surviving states.

## Chapter 2

### Background on Asset Bubble Detection Using the Floren-Zmirou Estimator

#### 2.1 Background of Portfolio Theory

1. Objective portfolio theory to minimize risk given.
2. An expected return on assets[20].
3. Key definitions.
  - Portfolio has set of asset in manners which minimize the risks.
  - Primary way to manage portfolio with the aim of distributing risk.
  - Market Price- current price
  - Fundamental Price- Intrinsic price.
  - The bubble is the difference between market and fundamental price.
  - The fluctuation of asset price is volatility of asset.
4. Our thesis problem consists detecting type 3 bubble within market price[19]

#### 2.2 Mathematical Background of Portfolio Theory

1. Random Variable [1]
2. [3]
  - moment Generator function of random variable.
  - Expected value of an random variable.
  - Variance of a random variable
3. Sigma Algebra[5]
4. [10]
  - Probability space
  - Stochastic Process
  - Wiener process
  - Martingale
5. fundamental prices a stochastic process[14, 22]
6. Market Price as a stochastic process[14, 22]
7. Asset Bubble[7]
8. Volatility[7]
9. SDE[9]
10. Euler Maruyama[14]
11. Floren Zmirou[?]
12. Theorem strict local martingale iff [?]
13. Test: using FZ to estimate sigma and then testing integral.



## Chapter 3

### Implementation of Asset Bubble Detection Using the Floren-Zmirou Estimator

#### 3.1 Stradgery

1. minute to minute stock price data[11].
2. Nasdaq Stock.
3. calculate grid points/ usable grid points-breen notes
4. Floren Zmirou estimation- ref to chapter 2
5. Bubble test on FZ estimation- explain
  - MVT on floren zmirou derivative
6. Bubble test spline of Floren zmirou derivative  
[25]intro natural cubic spline spline on Floren Zmirou bubble

#### 3.2 Implementation

1. verbal explanantion sage python- floren zmirou, spline, bubble testing.
2. verbal explanantion google- minute to minute

#### 3.3 Algorithm and psuedocode

## **Chapter 4**

### **Examples of Asset Bubble Detection**

#### 1. 1 example of asset bubble detection

- stock
- day of data
- table of grid points
- identify usable grid points.
- floren zmirou graph
- spline graphs together
- bubble test.
- Conclusion

## **Chapter 5**

### **Future Work on Asset Bubble Detection and Conclusion**

#### **5.1 Future Work**

1. Identify this only detects bubble when sigma square is certain to make equation 3 explode.
2. when uncertainty arises, extrapolation is need to identify bubbles e.g rkhs, etc[24, 27]
3. Further examination of testing historical examples of type 3 bubbles is needed to determine assurance of tests and methodology.
4. testing on longer periods of time(e.g 1 week instead of a day)and faster rates of data(e.g.seconds to seconds) stock price data instead of minute to minute [24]

#### **5.2 Conclusion**

1. cegurgitate
2. what you did

## References

- [1] Theodore Wilbur Anderson. An introduction to multivariate stsisical analysis. 1954.
- [2] VK Bhalla. *Investment Management*. S. Chand, 2008.
- [3] Herman J Bierens. *Introduction to the mathematical and statistical foundations of econometrics*. Cambridge University Press, 2004.
- [4] Richard L Burden and J Douglas Faires. Numerical analysis. 2001. *Brooks/Cole, USA*.
- [5] Donald L Cohn. *Measure theory*, volume 1993. Springer, 1980.
- [6] E Robert Fernholz. *Stochastic portfolio theory*. Springer, 2002.
- [7] Robert P Flood and Robert J Hodrick. Asset price volatility, bubbles, and process switching. *The Journal of Finance*, 41(4):831–842, 1986.
- [8] Danielle Florens-Zmirou. On estimating the diffusion coefficient from discrete observations. *Journal of applied probability*, pages 790–804, 1993.
- [9] Thomas C Gard. *Introduction to stochastic differential equations*. M. Dekker New York, 1988.
- [10] Crispin W Gardiner et al. *Handbook of stochastic methods*, volume 3. Springer Berlin, 1985.
- [11] Google, June 2014.
- [12] Benjamin Graham, David Le Fevre Dodd, and Sidney Cottle. *Security analysis*. McGraw-Hill New York, 1934.
- [13] Luciano Gutierrez. Bootstrapping asset price bubbles. *Economic Modelling*, 28(6):2488–2493, 2011.
- [14] Desmond J Higham. An algorithmic introduction to numerical simulation of stochastic differential equations. *SIAM review*, 43(3):525–546, 2001.
- [15] Robert Jarrow, Younes Kchia, and Philip Protter. Is there a bubble in linkedin’s stock price? *arXiv preprint arXiv:1105.5717*, 2011.
- [16] Robert A Jarrow, Philip Protter, and Kazuhiro Shimbo. Asset price bubbles in complete markets. In *Advances in mathematical finance*, pages 97–121. Springer, 2007.
- [17] Robert A Jarrow, Philip Protter, and Kazuhiro Shimbo. Asset price bubbles in incomplete markets\*. *Mathematical Finance*, 20(2):145–185, 2010.
- [18] Douglas Kennedy. *Stochastic financial models*. CRC Press, 2010.
- [19] Cheng-Few Lee and John Lee. *Handbook of quantitative finance and risk management*. Springer, 2010.
- [20] Harry M Markowitz. *Portfolio selection: efficient diversification of investments*, volume 16. Yale University Press, 1970.
- [21] Vyacheslav Mikhed and Petr Zemčík. Testing for bubbles in housing markets: A panel data approach. *The Journal of Real Estate Finance and Economics*, 38(4):366–386, 2009.
- [22] Bernt Øksendal. *Stochastic differential equations*. Springer, 2003.
- [23] Philip E Protter. *Stochastic Integration and Differential Equations: Version 2.1*, volume 21. Springer, 2004.
- [24] Philip Protter Robert A. Jarrow, Younes Kchia. How to detect an asset bubble. *Journal of Computing*, 2011.

- [25] Walter Rudin. *Principles of mathematical analysis*, volume 3. McGraw-Hill New York, 1976.
- [26] W.A. Stein et al. *Sage Mathematics Software (Version x.y.z)*. The Sage Development Team, 2014.  
<http://www.sagemath.org>.
- [27] Guojin Chen Cheng Yan. A financial engineering approach to identify stock market bubble. *Systems Engineering Procedia*, 2:153–162, 2011.