

# Limits to arbitrage: bubbles, financial crises, and systemic risk

Svetlana Bryzgalova

*sabryzgalova@gmail.com*

September 20, 2013

# Introduction

Throughout the whole mankind history, bubbles and crashes have been our longstanging companion.

Bubbles often quietly build up following some sort of innovation (technological or financial), and then dramatically burst, exacerbating existing informational frictions or incentives missalignment.

Minsky phase classification:

- Displacement - new technology, increased profit expectations
- Boom phase: low volatility, credit expansion, increase in investment
- Euphoria: high trading volume in the overvalued asset
- Profit taking: sophisticated traders close their positions
- Panic phase: fast asset sale, often accelerated by margins and capital requirements, followed by amplification and spillover effects

## A brief history of ... bubbles?

Overview: Garber (2000), Graeber (2011), Shiller (2000), Allen and Gale (2007), Reinhart and Rogoff (2009).

- Mesopotamia: farmers deep in debt threatened social order, the practice of "*cleaning the slate*"
- Greece (Solonic reforms of 594 BC): prohibited using people as collateral, released enslaved defaulted farmers
- Dutch tulip mania (1634-1637), the Mississippi Bubble (1719-1720), the South Sea Bubble (1720)
- Northern European financial crisis (1763): high leverage between Amsterdam, Hamburg and Prussia, following the spread of bills of exchange, triggered asset fire sale and contagion over other countries.
- US banking crises: 1837, 1857, 1873, 1884, 1893, 1914, 1929, 1979...
- Scandinavia, Japan, Asia, Mexico, Russia, Argentina

# A brief history of ... bubbles?

## Recent events

- US housing bubble (2007-2008), feeding on mortgage securitization and low interest rates environment, would have led to a collapse of major financial institutions, if not for the massive bailout operation.
- Sovereign debt crisis: Greece, Ireland, Italy, Portugal, Spain, following a lending boom during the early 2000s.

# A brief history of ... bubbles?

## Recent events

- US housing bubble (2007-2008), feeding on mortgage securitization and low interest rates environment, would have led to a collapse of major financial institutions, if not for the massive bailout operation.
- Sovereign debt crisis: Greece, Ireland, Italy, Portugal, Spain, following a lending boom during the early 2000s.

## Every cloud has a silver lining:

- 1907 crisis led to the creation of FRS, the Great Depression - to Glass-Steagall Act (deposit insurance).
- Financial turmoil of 2007-2008 triggered a substantial revision of capital requirements for banks (en route to Basel III)

## Wile. E. Coyote effect



## Identification

If bubbles are defined through a substantial deviation from the fundamental price of the asset, then the key question is,

**What is the fundamental price of an asset?**

## Identification

If bubbles are defined through a substantial deviation from the fundamental price of the asset, then the key question is,

### **What is the fundamental price of an asset?**

Hard to test, since most attempts will be subject to Roll's critique: you are testing a joint hypothesis of market efficiency and statistical process



## Identification

If bubbles are defined through a substantial deviation from the fundamental price of the asset, then the key question is,

### **What is the fundamental price of an asset?**

Hard to test, since most attempts will be subject to Roll's critique: you are testing a joint hypothesis of market efficiency and statistical process

Garber (2000): Dutch tulip mania, Mississippi and the South Sea company bubbles could be explained through fundamentals

## Identification

If bubbles are defined through a substantial deviation from the fundamental price of the asset, then the key question is,

### **What is the fundamental price of an asset?**

Hard to test, since most attempts will be subject to Roll's critique: you are testing a joint hypothesis of market efficiency and statistical process

Garber (2000): Dutch tulip mania, Mississippi and the South Sea company bubbles could be explained through fundamentals

Pastor and Veronesi (2006): if the productivity of new technology is uncertain, and is slowly recognised by agents through learning, bubbles occur.

In some cases, however, mispricing seems evident.

## The curious case of 3Com and Palm

- On March, 2 (2000) 3Com sells 5% of Palm shares in IPO and plans to spin off the rest in 9 months
- 1 share of 3Com owns 1.5 shares of Palm
- Price of Palm share: \$95, so the price of 3Com should be at least 142?

## The curious case of 3Com and Palm

- On March, 2 (2000) 3Com sells 5% of Palm shares in IPO and plans to spin off the rest in 9 months
- 1 share of 3Com owns 1.5 shares of Palm
- Price of Palm share: \$95, so the price of 3Com should be at least 142?
- Wrong: it's only \$81
- Negative equity of 3Com: excluding Palm, the company value is only -\$60.

Exception? Let's take a look at another example.

## Creating Computers and Ubid

Ubid, specializing on internet auctions, was a subsidiary of Creative Computers

- March, 12 (1998) CC decides to sell 20% of Ubid shares in IPO
- 6 months later CC is trading at \$22.75 per share, and Ubid is trading at \$35.6875

## Creating Computers and Ubid

Ubid, specializing on internet auctions, was a subsidiary of Creative Computers

- March, 12 (1998) CC decides to sell 20% of Ubid shares in IPO
- 6 months later CC is trading at \$22.75 per share, and Ubid is trading at \$35.6875

A hedge fund, Strategic Capital Management LLC decided to exploit apparent mispricing, initiating a **convergence trade** by

- buying CC and
- selling short Ubid

in the hope that the price should correct itself.

## Creating Computers and Ubid

Ubid, specializing on internet auctions, was a subsidiary of Creative Computers

- March, 12 (1998) CC decides to sell 20% of Ubid shares in IPO
- 6 months later CC is trading at \$22.75 per share, and Ubid is trading at \$35.6875

A hedge fund, Strategic Capital Management LLC decided to exploit apparent mispricing, initiating a **convergence trade** by

- buying CC and
- selling short Ubid

in the hope that the price should correct itself.

Convergence trades were also the basis for many strategies or Long-Term Capital Management, possibly the most well-known hedge fund in history.

## Creating Computers and Ubid

Ubid, specializing on internet auctions, was a subsidiary of Creative Computers

- March, 12 (1998) CC decides to sell 20% of Ubid shares in IPO
- 6 months later CC is trading at \$22.75 per share, and Ubid is trading at \$35.6875

A hedge fund, Strategic Capital Management LLC decided to exploit apparent mispricing, initiating a **convergence trade** by

- buying CC and
- selling short Ubid

in the hope that the price should correct itself.

Convergence trades were also the basis for many strategies or Long-Term Capital Management, possibly the most well-known hedge fund in history.

**Both went bankrupt with a bang!**



## Imperfect prices

Apparent mispricing is a sure sign of people being irrational?

## Imperfect prices

Apparent mispricing is a sure sign of people being irrational?

**Wrong! Rationality or market efficiency has nothing to do with it.  
Market frictions can explain nearly all of it.**

## Imperfect prices

Apparent mispricing is a sure sign of people being irrational?

**Wrong! Rationality or market efficiency has nothing to do with it.  
Market frictions can explain nearly all of it.**

Jensen (1978) EMH: prices reflect information to the point where the marginal benefits of acting on information (i.e. the potential profits to be made) do not exceed marginal costs.

## Imperfect prices

Apparent mispricing is a sure sign of people being irrational?

**Wrong! Rationality or market efficiency has nothing to do with it.  
Market frictions can explain nearly all of it.**

Jensen (1978) EMH: prices reflect information to the point where the marginal benefits of acting on information (i.e. the potential profits to be made) do not exceed marginal costs.

We will consider several type of frictions that lead to temporary price distortions and match other stylized facts:

- synchronisation problem: 1 investor cannot burst the bubble
- short sale restrictions and capital constraints
- delegated investment and investment distortion
- heterogeneous beliefs

## Informational frictions

Brunnermeier (2001):

- asymmetric information with common priors, but
- the existence of a bubble is *not a common knowledge* ("I know it's a bubble, but do others know that?")

# Informational frictions

Brunnermeier (2001):

- asymmetric information with common priors, but
- the existence of a bubble is *not a common knowledge* ("I know it's a bubble, but do others know that?")
- Morris, Postwaite, Shin (1995): the size of the bubble depends on the depth of such beliefs
- general set of conditions for a finite period bubble to exist
- prices are not fully revealing in equilibrium
- short sale constraint for at least some states of the world

## Informational frictions

Brunnermeier (2001):

- asymmetric information with common priors, but
- the existence of a bubble is *not a common knowledge* ("I know it's a bubble, but do others know that?")
- Morris, Postwaite, Shin (1995): the size of the bubble depends on the depth of such beliefs
- general set of conditions for a finite period bubble to exist
- prices are not fully revealing in equilibrium
- short sale constraint for at least some states of the world

General consensus in the literature: asymmetric info + other market frictions (like short-sale restrictions) are enough for a bubble to persist.

# Synchronisation problem

Abreu, Brunnermeier (2003)

- no single trader can burst the bubble
- trade-off between riding it and trying to liquidate first
- competition vs coordination
- in the equilibrium they ride it for some time, prolonging the mispricing

Empirical evidence on riding the bubbles:



# Synchronisation problem

Abreu, Brunnermeier (2003)

- no single trader can burst the bubble
- trade-off between riding it and trying to liquidate first
- competition vs coordination
- in the equilibrium they ride it for some time, prolonging the mispricing

Empirical evidence on riding the bubbles:

- Hedge funds heavily invested in tech companies between 1998 and 2000, instead of correcting overpriced assets (Brunnermeier and Nagel, 2004)

# Synchronisation problem

Abreu, Brunnermeier (2003)

- no single trader can burst the bubble
- trade-off between riding it and trying to liquidate first
- competition vs coordination
- in the equilibrium they ride it for some time, prolonging the mispricing

Empirical evidence on riding the bubbles:

- Hedge funds heavily invested in tech companies between 1998 and 2000, instead of correcting overpriced assets (Brunnermeier and Nagel, 2004)
- Hoare's bank was profitably riding the South Sea Bubble (Temin and Voth, 2004)

# Synchronisation problem

Abreu, Brunnermeier (2003)

- no single trader can burst the bubble
- trade-off between riding it and trying to liquidate first
- competition vs coordination
- in the equilibrium they ride it for some time, prolonging the mispricing

Empirical evidence on riding the bubbles:

- Hedge funds heavily invested in tech companies between 1998 and 2000, instead of correcting overpriced assets (Brunnermeier and Nagel, 2004)
- Hoare's bank was profitably riding the South Sea Bubble (Temin and Voth, 2004)
- Not everybody's lucky: Issac Newton went bankrupt, "*I can calculate the motions of the heavenly bodies, but not the madness of people*"

## Delegated investment

Most people do not manage their own investments

Shleifer and Vishny (1997):

- temporary losses may lead to fund outflow, so managers often have to liquidate positions when mispricing is the largest

## Delegated investment

Most people do not manage their own investments

Shleifer and Vishny (1997):

- temporary losses may lead to fund outflow, so managers often have to liquidate positions when mispricing is the largest
- managers are induced to focus on short term gains and often forgo long-term opportunities

Sato (2009):

- relative performance measures exacerbates negative effects

Allen and Gale (2000):

- investors borrow debt from the bank to buy stocks and a risk-free asset
- bank has no control over how the loan is actually invested

## Delegated investment

Most people do not manage their own investments

Shleifer and Vishny (1997):

- temporary losses may lead to fund outflow, so managers often have to liquidate positions when mispricing is the largest
- managers are induced to focus on short term gains and often forgo long-term opportunities

Sato (2009):

- relative performance measures exacerbates negative effects

Allen and Gale (2000):

- investors borrow debt from the bank to buy stocks and a risk-free asset
- bank has no control over how the loan is actually invested
- limited liability: they enjoy the upside and care less about the downside risk

## Delegated investment

Most people do not manage their own investments

Shleifer and Vishny (1997):

- temporary losses may lead to fund outflow, so managers often have to liquidate positions when mispricing is the largest
- managers are induced to focus on short term gains and often forgo long-term opportunities

Sato (2009):

- relative performance measures exacerbates negative effects

Allen and Gale (2000):

- investors borrow debt from the bank to buy stocks and a risk-free asset
- bank has no control over how the loan is actually invested
- limited liability: they enjoy the upside and care less about the downside risk
- risk shifting: people increase demand on the risky asset, driving its price higher than the fundamental value

# Heterogeneous beliefs

Survey papers: Hong and Stein (2007), Xiong (2012)

- Different priors result in heterogeneous beliefs
- combined with short sale restrictions explains mispricing



# Heterogeneous beliefs

Survey papers: Hong and Stein (2007), Xiong (2012)

- Different priors result in heterogeneous beliefs
- combined with short sale restrictions explains mispricing
- while optimists drive the market price even higher, pessimists have no means to counter it

# Heterogeneous beliefs

Survey papers: Hong and Stein (2007), Xiong (2012)

- Different priors result in heterogeneous beliefs
- combined with short sale restrictions explains mispricing
- while optimists drive the market price even higher, pessimists have no means to counter it
- Scheinkman and Xiong (2003) also demonstrate how bubbles generate high trading volume and price volatility
- volume and volatility decreasing in the supply of the risky asset (Hong, Scheinkman and Hong, 2006)

# Heterogeneous beliefs

Survey papers: Hong and Stein (2007), Xiong (2012)

- Different priors result in heterogeneous beliefs
- combined with short sale restrictions explains mispricing
- while optimists drive the market price even higher, pessimists have no means to counter it
- Scheinkman and Xiong (2003) also demonstrate how bubbles generate high trading volume and price volatility
- volume and volatility decreasing in the supply of the risky asset (Hong, Scheinkman and Hong, 2006)
- Both are consistent with the internet stock bubble (March 2000, onward)

# Heterogeneous beliefs and credit

# Heterogeneous beliefs and credit

Geanakoplos (2010)

- optimists can borrow from pessimists against the collateral to invest into a risky asset

# Heterogeneous beliefs and credit

Geanakoplos (2010)

- optimists can borrow from pessimists against the collateral to invest into a risky asset
- in the downturn more asset will be held by pessimists, hence, further price reduction

Simsek (2011)

- how much pessimists are willing to lend to optimists?
- examines the structure of informational discord (do we agree upon the best or worst scenarios?)

Fostel and Geanakoplos(2013)

- financial innovation (securitization, tranching) facilitates lending, hence, exacerbates the bubble

# Heterogeneous beliefs and credit

## Geanakoplos (2010)

- optimists can borrow from pessimists against the collateral to invest into a risky asset
- in the downturn more asset will be held by pessimists, hence, further price reduction

## Simsek (2011)

- how much pessimists are willing to lend to optimists?
- examines the structure of informational discord (do we agree upon the best or worst scenarios?)

## Fostel and Geanakoplos(2013)

- financial innovation (securitization, tranching) facilitates lending, hence, exacerbates the bubble
- however, instruments matter: e.g. Credit Default Swaps allow pessimists to bet against the assets
- empirical evidence: the introduction of ABX index on subprime securitization contributed to a mortgage market collapse.

## What of capital constraints?

Shortselling the assets requires fulfilling capital margins, haircuts and collateral conditions. In the downturn that requires either posting more capital (which is costly and not always possible) or liquidating a part of position, often exacerbating marker swings.

Recall the case of Ubid and CC.



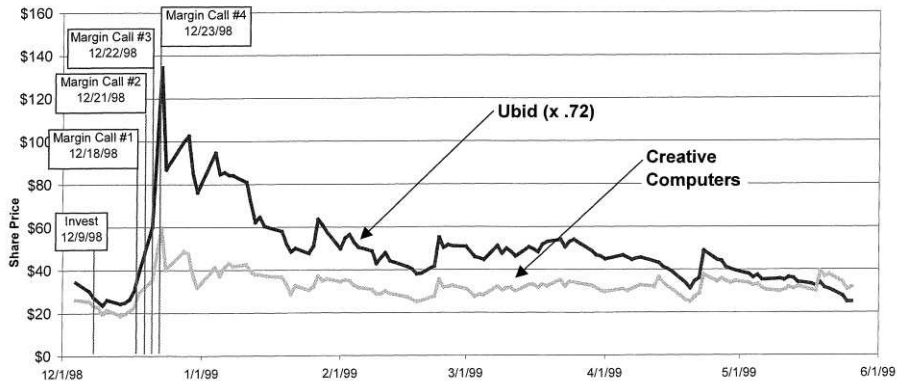
## What of capital constraints?

Shortselling the assets requires fulfilling capital margins, haircuts and collateral conditions. In the downturn that requires either posting more capital (which is costly and not always possible) or liquidating a part of position, often exacerbating marker swings.

Recall the case of Ubid and CC. Our assumptions (quite realistic):

- 50% initial margin is required on short positions and you can borrow against 50% of your long position
- 30% maintenance margin on short positions
- 25% maintenance margin on long positions

# Evolution of stock prices



Source: Chabakauri, Mueller(2013)

## Danielsson, Shin (2003) *Endogenous risk*

- Suppose you long asset A, and short asset B.
- Following margin requirements, you have to liquidate a part of your portfolios, putting upward pressure on asset B and downward - on asset A.
- This exacerbates already negative price movements, and forces you to face new margin requirement

Example: dual-listed company, Royal-Dutch Shell

- summer of 1997: Royal Dutch traded at 8-10% premium relative to Shell
- LTCM invested \$2.3bln in the convergence trade
- July 1998: following other losses, the fund liquidated this position, with the premium increased to 22%, suffering major losses.

J.M.Keynes

*"Markets can stay irrational longer than you can stay solvent"*

## Carry traders

- Different countries have different interest rate

## Carry traders

- Different countries have different interest rate
- Borrow in a country with low interest rates, convert it to a currency with high interest rates and earn a profit
- Interest rates difference, accounting for the FX fluctuations, are my profits

## Carry traders

- Different countries have different interest rate
- Borrow in a country with low interest rates, convert it to a currency with high interest rates and earn a profit
- Interest rates difference, accounting for the FX fluctuations, are my profits
- Still statistically profitable and widely used

### WHY?

**Margin constraints and high leverage (50-150): historical profits are remuneration for the tail risk of bankruptcy and costs of hedging.**

Model and evidence: Brunnermeier, Nagel, Pedersen (2008), Jurek (2011).

Carry traders are responsible for the Yen crash of October, 1998, after they had to liquidate their positions on Yen-USD trades. Yen crash of March, 2010 was also triggered in a similar way.

# Conclusions

- There is a huge difference between ex-ante and ex-post analysis
- What looks obvious ex-post, often could not be the optimal decision given the initial information set
- Financial markets are extremely efficient and when reflecting information, however
- The nature of this information and market frictions matter
- Sensible regulation should understand the source of these frictions and eliminate them