

# TESTING ASSET PRICING THEORY ON 600 YEARS OF STOCK RETURNS

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# Motivation

- Present-value formula is one major insight from financial economics
- Simply stated: the price of a risky asset should equal the expected future cash flows discounted at the required rate of return
- However testing this formula requires a good understanding of the statistical process underlying cash flows
- Difficult to study:
  - ▶ with short time-series (think about disaster risk à la Rietz-Barro)
  - ▶ with technological change that affects uncertainty in growth rates and risk (think about technological revolutions à la Pastor-Veronesi)

# The present research

- What we do:
  - ▶ Study the most ancient stockholding corporation:  
**The Bazacle Mills of Toulouse from 1372 to 1946**
  - ▶ Document its emergence, structure, and operations
  - ▶ Collect and study stock prices and dividends over seven centuries
- Contribution: Almost complete price and dividend data from 1532 onward
  - ▶ Very long time series
  - ▶ Stable corporate governance (up to 1815)
  - ▶ Stable technology (up to 1888)
  - ▶ Several important disasters present in the data

# Why it is interesting (to us ;-)

- Document the longest-lived corporation
- Study what governance structure enables a corporation to last for centuries?
- Test the present value relation
- Measure what stocks return over centuries
- Determine whether stocks protect against inflation over very long time periods?



## Partial literature review

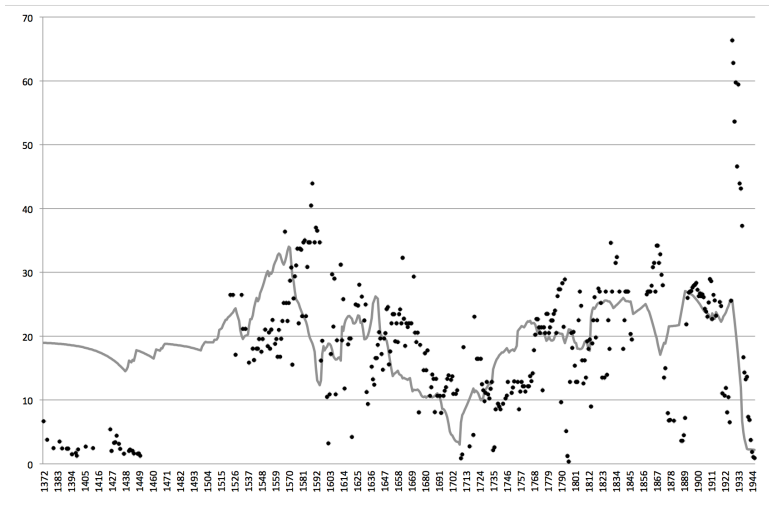
- Long-term financial series: Golez-Koudijs, LeBris-Hautcoeur, Dimson-Marsh-Staunton, Goetzmann-Jorion, Goetzmann-Li-Rouwenhorst, Goetzmann-Renneboog-Spaenjers
- History of capitalism and corporate governance: Gelderblom-deJong-Jonker, Malmendier
- Present-value tests: Chen, vanBinsbergen-Koijen, Chen-Da-Priestley
- Empirical asset pricing: Parker-Julliard, Rietz, Barro, Bansal-Yaron, Gosh-Julliard
- On the Bazacle Mills: Sicard (1954, 2015), *The Origins of Corporations. The Mills of Toulouse in the Middle Ages.*

Sicard (1954, 2015) is up for sale



# Preview of the results

Bazacle company's stock price and present value of subsequent realized dividends using 5% discount rate - Kilograms of silver - Figure in spirit of Shiller (1981)



# Agenda

- 1 The “Honor del Bazacle”
- 2 Data
- 3 Present-value relationship
- 4 Econometric methodology
- 5 Empirical results

# The “Honor del Bazacle”

The Bazacle Mills, in Toulouse (map from Melchior Tavernier, 1631)



# The “Honor del Bazacle”

The Bazacle Mills of Toulouse (Collignon map, 1642)



## The “Honor del Bazacle”

### The Bazacle Mills of Toulouse (Collignon map, 1642)



# The “Honor del Bazacle”

## Important dates

- 1071: Archive (St. Raimon hospital) mentions Bazacle Mills
- 1177: First dam, first disputes
- 1248: 12 shore mills at the Bazacle
- 1372: **Merge into one company**
- 1531: New corporate statutes
- 1888: Turned into hydro-electricity
- 1910: Listed on the Paris Bourse
- 1946: **Nationalized in EDF** (listed in 2005)
- **2015: Bazacle plant still produces electricity**



# The “Honor del Bazacle”

The Bazacle Mills, in Toulouse



# The “Honor del Bazacle”

## Corporate form

### A shareholding company

- Owners (*pariers*) are not millers and own shares (*uchaux*)
- Shares are transferable without the consent of other shareholders
- Shareholders have limited liability
- 1/16 of the grain is retained and paid directly (*partisons*) to shareholders in proportion to the number of shares held
- If a shareholder cannot or does not want to contribute to mills' expenses, his or her shares are sold via forced auctions

# The “Honor del Bazacle”

## Corporate governance

### Corporate statutes of 1531

- A yearly general assembly (*Cosselh general dels senhors paries am gran deliberacio*)
  - ▶ votes on a financial contribution to Mills' expenses (*talha*)
  - ▶ approves board of directors (*regents*) composition: 8 shareholders in charge for one year
- Board chooses:
  - ▶ 2 accounts' auditors among shareholders
  - ▶ a *conterôlle* (chief executive)
  - ▶ a treasurer
  - ▶ a syndic for legal affairs
  - ▶ 6 new members at the end of the year (staggered board)

# Data

## Stock prices

- Before 1450, data from notaries (P. Wolff via G. Sicard)
- After 1530, data from registers of partisons or registers of pariers:
  - ▶ Each page corresponds to a shareholder and transactions are recorded in the margins (similar to real estate registers)
- Transactions are also mentioned during the 15th century but prices are recorded only from 1530 onwards
- Late 19th century onward, regional or national press

The parier is Jean de Bernuy (one share was bought from king Francis I)



# Data

## Stock prices

- Pariers could trade portions of a share and we corrected for this
- Uchaux existed up to 1888

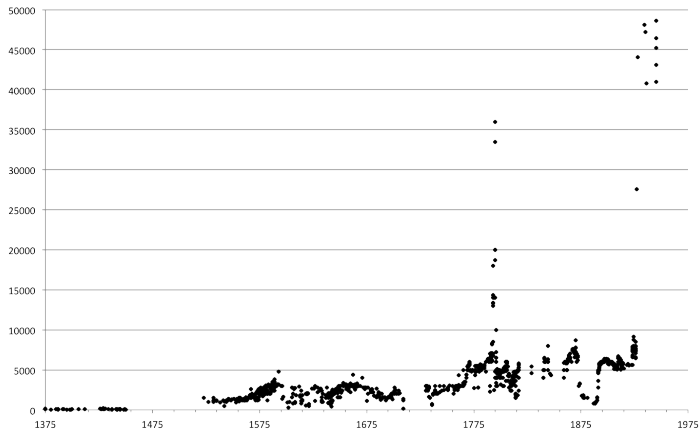
Year	1372	1374	1384	1535	1714	1804
Uchaux	80	88	96	100	128	136

- In 1889, each uchau is divided into 4 shares
- In 1910, merger with Société Toulousaine d'Electricité to create the Société Toulousaine du Bazacle
  - ▶ Each shareholder from the Bazacle receives 70 francs per share and 6 shares of the new company
- In 1929, stock split: 2.5 for 1

# Data

Stock prices in Livres/Assignats/Francs:

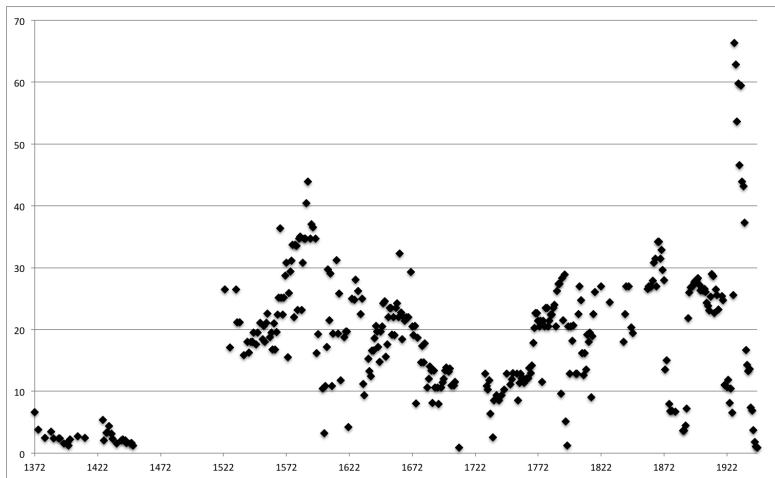
Inflation and disasters (in 1595: -90%, in 1639: -69 %, 1709: -92 %, 1815: -70 %)



# Data

Stock prices converted from Livres/Assignats/Francs into kilograms of silver

Disasters (in 1595: -90%, in 1639: -69 %, 1709: -92 %, 1815: -70 %)



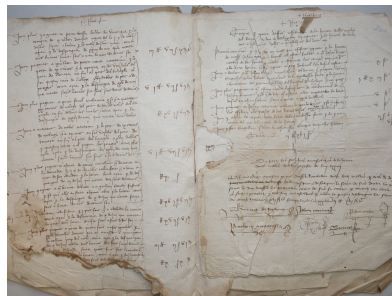
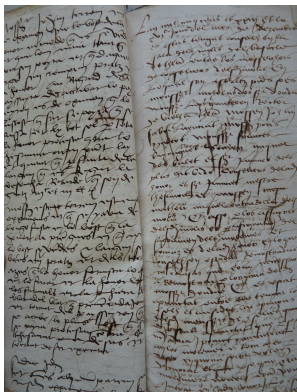


- The partisons, paid in wheat at several times during the year, were collected from the registers of partisons (about 4,000 partisons)
- Financial contributions to the Mills' annual expenses, talha, come from three sources:
  - ▶ Sometimes mentioned in partisons registers
  - ▶ General assembly registers
  - ▶ Accounting registers (it is the first receipt for the honor)
- $\text{Net Dividend} = \text{Partison} - \text{Talha}$
- Beginning in the 18th century, there is no more talha (some partisons are sold for the benefit of the Mills)
- Standard dividend after 1843

# Data

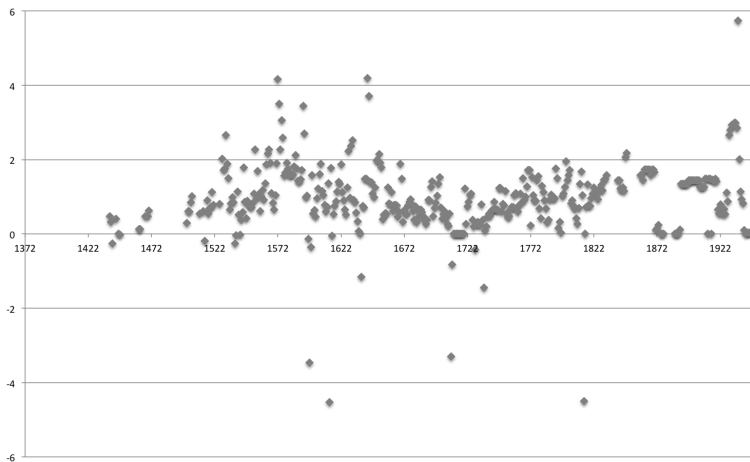
Examples of dividends sources:

General assembly register from 1522 and accounting document from 1469



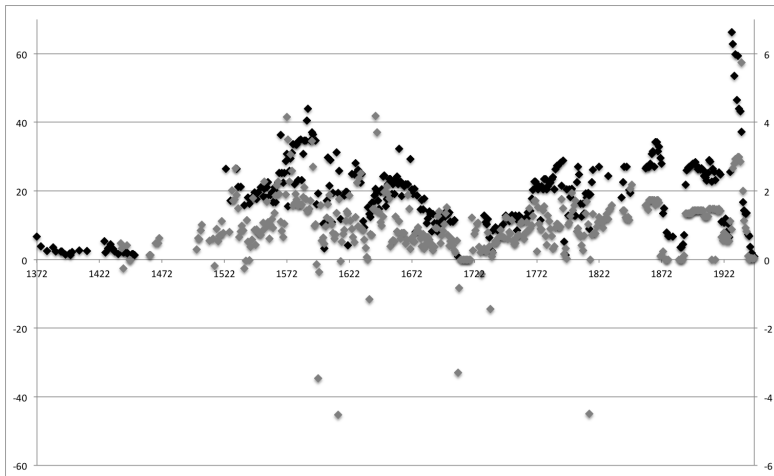
# Data

Net Dividends in kilos of silver



# Data

Prices and Net Dividends in kilos of silver



# Data

## Descriptive statistics

Data in Silver	Dividend Yield		Capital Gain		Price Change	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
<b>1372-1946</b>	5.16%	7.55%	15.48%	122.36%	30.72	6697
Obs. (p-value)	327	(0.00)	295	(0.03)	295	(0.94)
<hr/>						
<b>1372-1531</b>	4.94%	6.11%	-2.70%	36.68%	-271.48	1168
	3	(0.16)	11	(0.81)	11	(0.44)
<b>1532-1888</b>	5.14%	8.16%	18.44%	134.86%	75.25	6366
	270	(0.00)	232	(0.04)	232	(0.86)
<b>1889-1946</b>	5.29%	3.34%	6.13%	58.86%	-104.05	8640
	54	(0.00)	52	(0.45)	52	(0.93)

# Present-value relationship

## Present-value formula

$$P_t = \mathbb{E}_t [M_{t+1} (D_{t+1} + P_{t+1})]$$

- $M_{t+1}$  is the stochastic discount factor at date  $t + 1$
- $D_{t+1}$  is the dividend distributed at date  $t + 1$
- $P_{t+1}$  is the post-dividend price at date  $t + 1$
- This equation derives from an investor's first order condition when maximizing expected utility from consumption (see e.g. Cochrane, 2005)

# Present-value relationship

## Derivation of the pricing formula

- Dividends follow an ARMA(1,1) process:

$$D_{t+1} = \alpha + \beta D_t + \gamma \varepsilon_t^D + \varepsilon_{t+1}^D$$

- Stochastic discount factor is time varying:

$$M_{t+1} = \frac{1}{1+r} \left( 1 + \varepsilon_{t+1}^M \right)$$

- The risk correction  $\pi_t = -\text{Cov}_t(\varepsilon_{t+1}^M, \varepsilon_{t+1}^D)$  is auto-regressive:

$$\hat{\pi}_t = \pi_t - \mathbb{E}(\pi_t) = \delta \hat{\pi}_{t-1} + \varepsilon_t^\pi$$

## Pricing formula

$$P_t = \frac{1+r}{1+r-\beta} \frac{\alpha}{r} - \frac{1+r+\gamma}{1+r-\beta} \frac{\mathbb{E}(\pi_t)}{r} + \frac{\beta}{1+r-\beta} D_t + \frac{\gamma}{1+r-\beta} \varepsilon_t^D - \frac{1+r+\gamma}{(1+r-\beta)(1+r-\delta)} \hat{\pi}_t$$

# Empirical results

## Estimating and testing the model

- We estimate the dividend and pricing equations via MLE:

**GLS on dividends:**  $D_{t+1} = 181 + 0.80D_t - 0.35\varepsilon_t^D + \varepsilon_{t+1}^D$

**GLS on stock prices:**  $P_t = 14,682 + 3.9D_t - 1.84\varepsilon_t^D - 0.81\hat{\pi}_t$

- We test and cannot reject two theoretical predictions using the Delta method:

**Price reactions to dividends and dividend shocks:**  $\frac{\beta}{b} - \frac{\gamma}{c} = 0$

**Expected dividends:**  $\frac{\alpha}{1-\beta} - \frac{\mathbb{E}[P_t] - a}{b} = 0$



# Term-structure of the risk premium

Our model implies a decreasing term-structure for the risk premium

- We estimate an average risk premium at around 10%
- Normal given the high volatility of consumption and the high correlation of returns with consumption
- The one-year risk premium is estimated around 15%
- The 50-year risk premium is close to zero

# Graph of the risk premium over different horizons

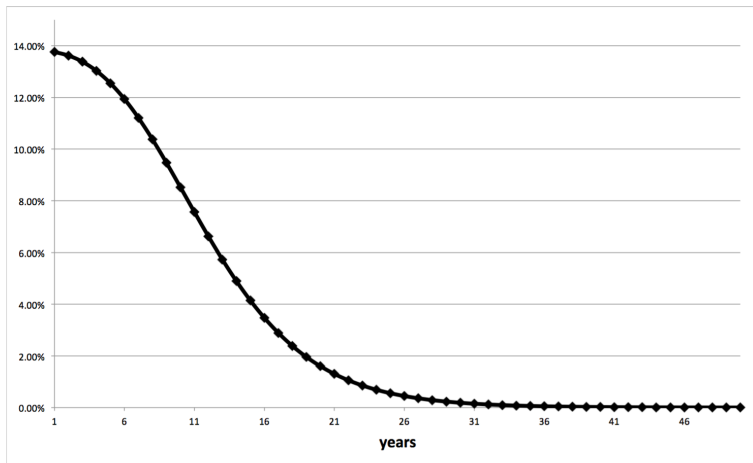


Figure 8: Term structure of the risk premium.

This Figure shows the term structure of the risk premium for the parameters estimated over the full 1441-1946 period.

# Summary

- Study Bazacle Company of Toulouse, founded in 1372 and still alive
- Rotating staggered board with flexible governance
- Present-value formula cannot be rejected
- Risk premium is much lower for long than short horizons
- The shares of the Bazacle company have been an excellent hedge against inflation