Very long term historical investment return data - what can we learn from looking back 200-750 years into history?

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Actuarial Teachers & Researchers Conference

Liverpool – 27th June 2019

Overview

Why is it important to understand historical returns?

- Investment assumptions and projections

What do we already know about historical returns?

- Brief review of the last 500 years
- What issues does it highlight?

What's new in this presentation?

- An application of actuarial theory and techniques together with historical commodity price data to synthetically create new historical investment return data going back 220-750 years using data from the US, England and the EU.

Summary & conclusions

References & appendices

Why is history important?

- Historical returns are a significant element of bases that actuaries use for investment assumptions and projections
  - This is challenging because actuaries often need to make assumptions for investment returns for 10, 20, 50+ years into the future.
  - Given the limited amount of historical return information, confidence intervals that might be created for these assumptions will likely be very wide.
  - If we take the sample data as *t-distributed* – there's low degrees of freedom.
- How relevant is historical data?
  - Economic conditions have varied significantly over the centuries and they can just as easily vary in the future. We implicitly assume this away. Why?
  - Taking a comparison with weather forecasters
    - They don't make forecasts based on just a few days or weeks data.
    - They consider that they can only forecast 3-6 days with reasonable accuracy
    - They have an advantage over actuaries due to faster feedback loops
  - This raises issues around Solvency II and PRIIPs
    - Should they be using more historical data? Yes!

What do we know?

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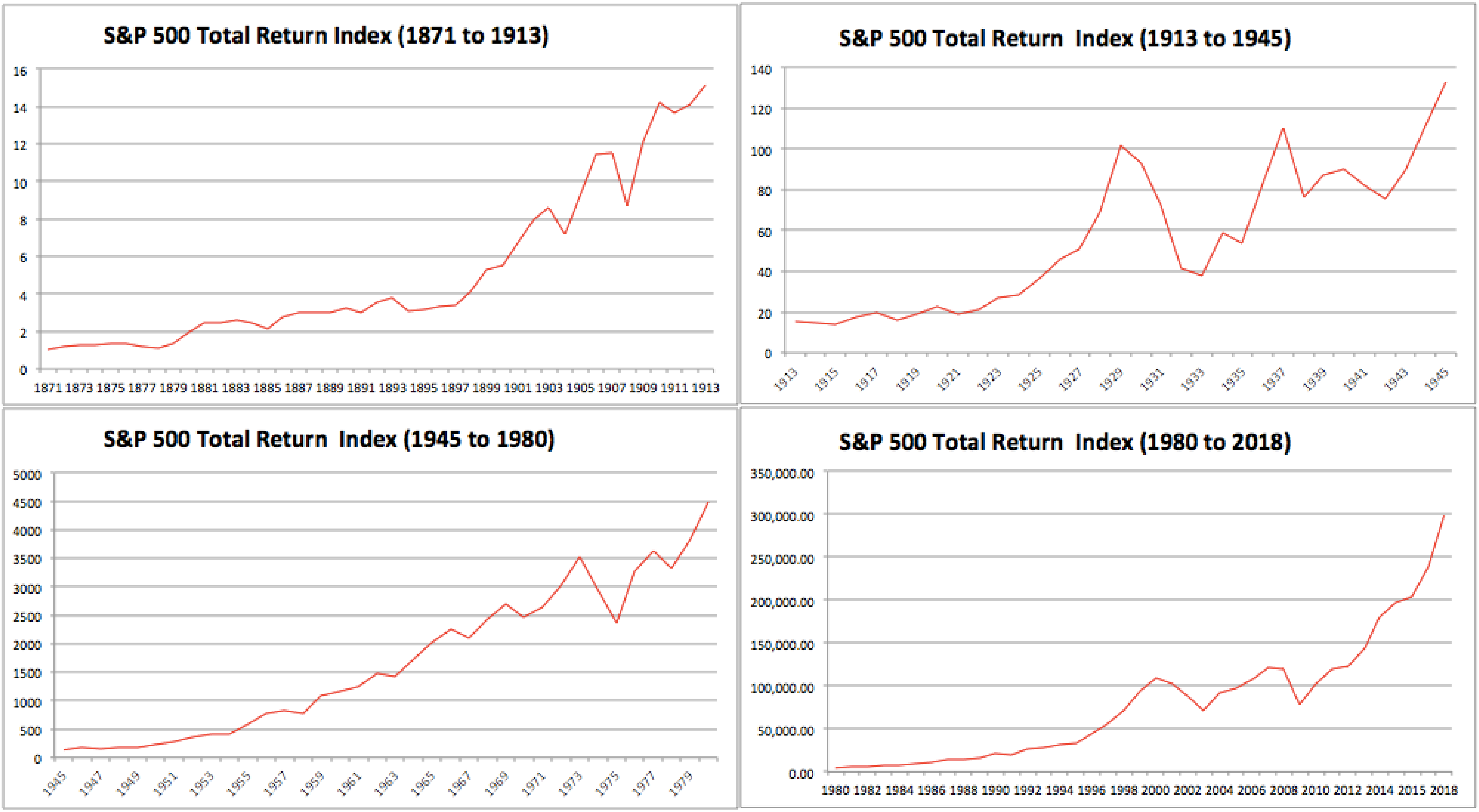
US Equity Annual Returns 1871 to 2018 (each chart starts from the end of the previous one)



Source: Samuel H. Williamson, 'S&P Index, Yield and Accumulated Index, 1871 to Present,' MeasuringWorth, 2018.

What do we know?

S&P Total Return Index - 1871 to 2018 - Summary Statistics

	Annual returns	Annualised rolling 10-year returns	Annualised rolling 20-year returns	Annualised rolling 50-year returns	Annualised rolling 70-year returns
Geometric average	**8.954%**				
Standard deviation	**17.9%**	4.98%	3.25%	1.86%	1.42%
Skew	**-12.5%**	19.6%	19.6%	64.1%	5.8%
Minimum	-42.9%	-1.91%	3.00%	5.52%	6.14%
Maximum	54.8%	19.41%	17.32%	13.29%	11.59%
25th percentile	-1.0%	5.6%	7.0%	7.8%	8.4%
50th percentile	10.6%	8.1%	8.0%	9.4%	9.5%
75th percentile	21.3%	13.2%	11.4%	10.4%	10.5%
Interquartile range	22.3%	7.5%	4.4%	2.7%	2.1%
Standard deviation / geometric average		56%	36%	21%	16%

	Multi-period 7 year returns	**Multi-period 21 year returns**	**Multi-period 49 year returns**	**Multi-period 73 year returns**
Geometric average	82%	605%	6681%	54607%
Standard deviation	66%	498%	5401%	149548%
Skew	90%	178%	-167%	not defined
Min	12%	258%	2137%	13167%
Max	257%	1620%	11932%	224660%
Standard deviation / geometric average	80%	82%	81%	274%
	df=20	df=6	df=2	df=1
95% Confidence Interval - start	-56%	-612%	-16560%	-1845556%
95% Confidence Interval - end	220%	1823%	29921%	1954769%
99.5% Confidence Interval - start	-126%	-1543%	-69414%	-18986051%
99.5% Confidence Interval - end	291%	2753%	82776%	19095265%

What do we know?

What if we add historical returns from pre-1871?

Data from Goetzmann (2000) on US stock returns in 1800s

- Show lower returns
- Added variation

Belgian stock returns available from 1833 to 2018

- Lower average returns (despite inclusion of hyperinflation due to WWI & WWII)
- Plus higher standard deviation => wider confidence intervals
- Also, US = rising hegemonic power, fast growing and innovative v Belgium 'old world'

Data from Neal (1990) for English stock returns in 1700s.

- Shows returns from Bank of England, East India Company and South Sea Company
- Show annual average geometric capital returns in the range 0.2% to 0.8% p.a.

Lower economic growth rates before the Industrial Revolution

What do we know?

When making investment assumptions for the future based only on recent historical data, an implicit and questionable assumption is being made that the average productivity improvements of the last two centuries will continue into the future.

- Economic productivity growth was approximately 30 times slower before the Industrial Revolution (Clark 2009).

Productivity growth may improve or it may slow down.

- Ralph Waldo Emerson noted that, "*Every step of civil advancement makes every man's dollar worth more*" (taken from his essay "*Wealth*")
- Civil regression likely makes every man's €, $ or £ worth less.

Do we risk spurious selection by not considering the issue of future productivity growth in our equity investment assumptions? This is an area that requires further research.

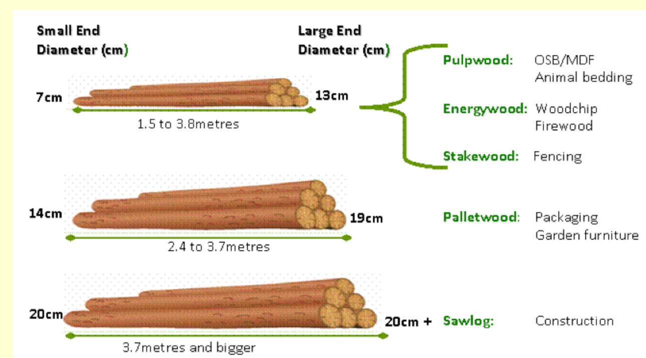
What’s new?

Which asset class?

- Forestry Investment!

Forestry Investment 101…

- How does it work?
- Forestry valuations…
  - Growth and yield models and forestry management tables
  - Discounted Cash Flow models – Faustmann in 1800s
- Analogy with Inflation-Linked Corporate Bonds

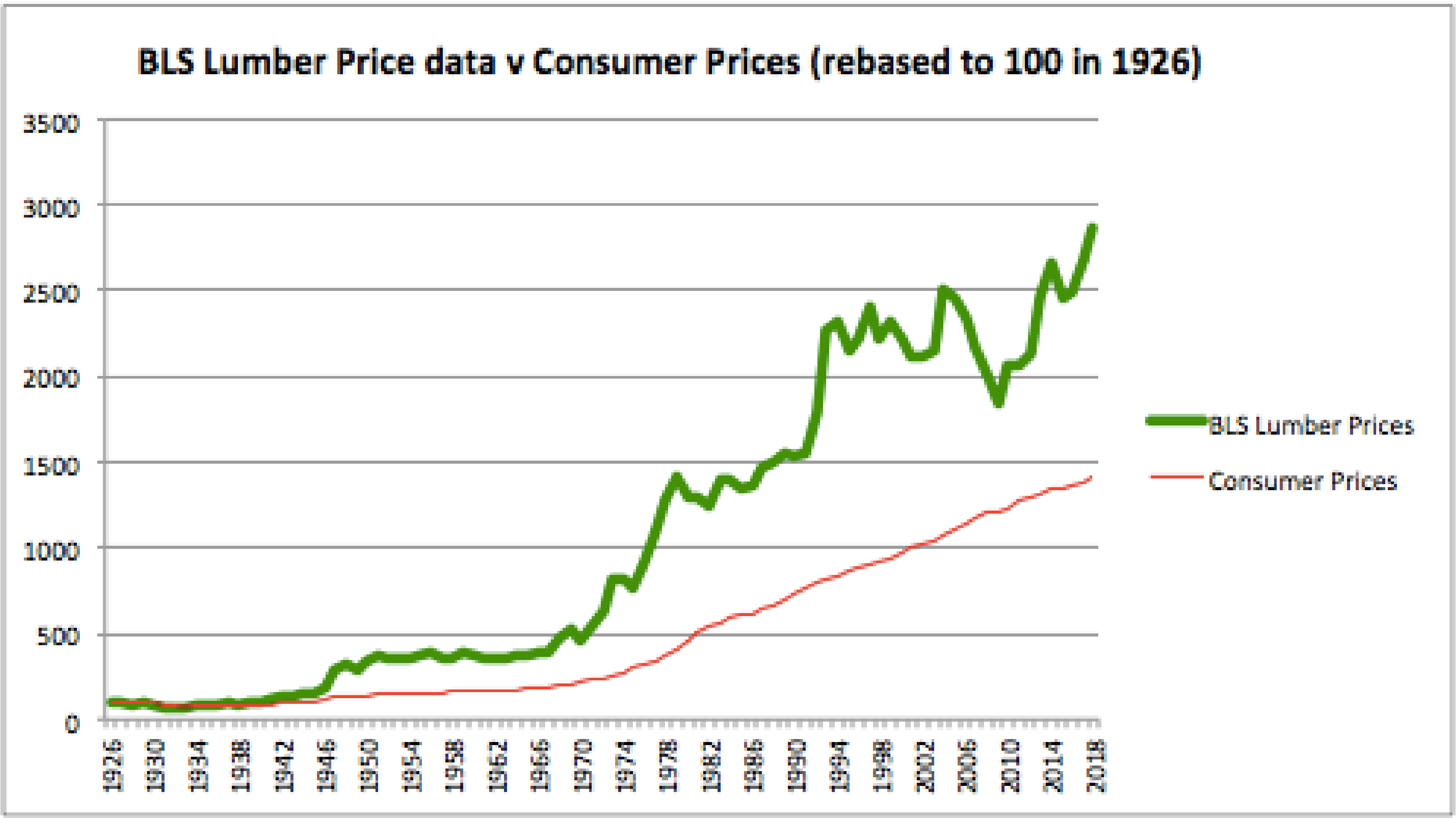


Actuarial model of forest value…

- $Value_t = Value_{t-1} \times (1+R) \times (1+TPinf_t)$
- R = real return, $TPinf_t$ = timber price inflation year t
- Timber prices versus lumber prices

What's new?

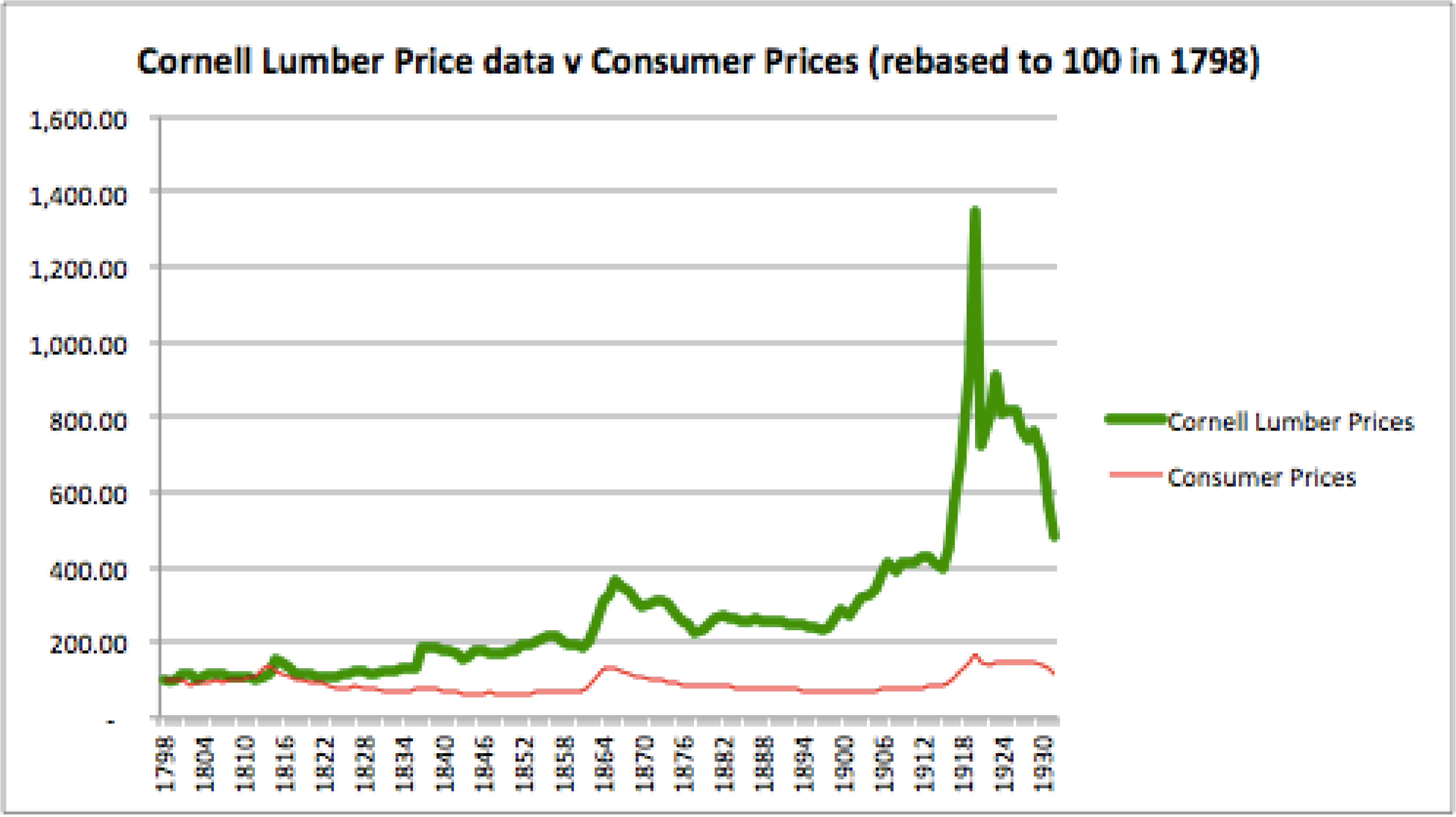
How do lumber prices compare to CPI? (US data)



US lumber prices versus consumer prices from 1926 to 2018. Source: US Bureau of Labor Statistics

What's new?

How do lumber prices compare to CPI? (US data)



US lumber prices versus consumer prices from 1798-1926. Source: Cornell University & Williamson (2019)

What's new?

How do US lumber prices compare to US CPI?

- Lumber prices increased on average **1.12% p.a.** faster than consumer prices from 1798-2018.
- The geometric average increase in lumber prices was 2.51% compared to a geometric average increase in consumer prices of 1.39% (arithmetic averages 3.06% and 1.55% respectively).
- The breakdown of the 1.12% difference is as follows:
  - From 1798 to 1848 it was 1.96% p.a.,
  - From 1848 to 1898 it was 0.6% p.a.,
  - From 1898 to 1948 it was 2.59% p.a.,
  - From 1948 to 1998 it was 0.03% p.a., and
  - From 1998 to 2018 it was -0.88%.

What’s new?

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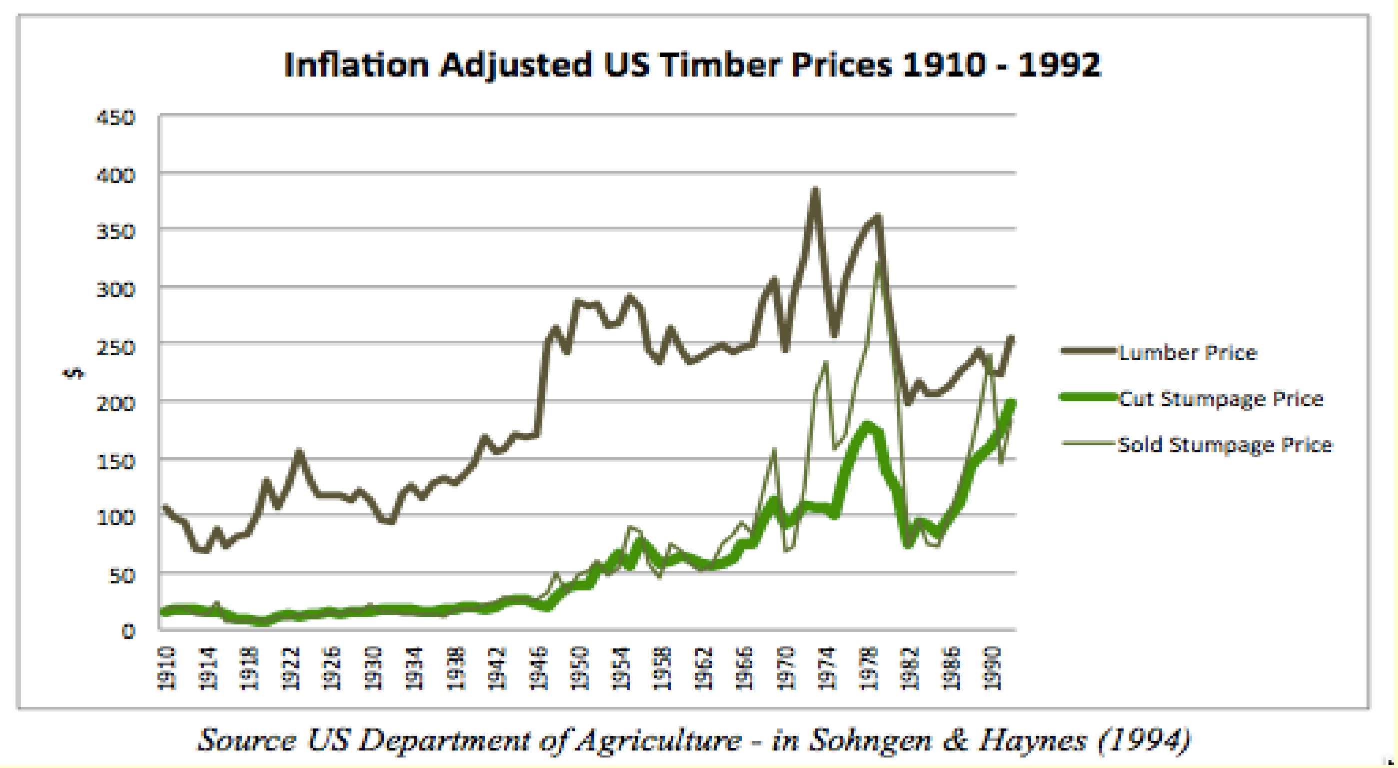
How do US timber prices compare to US lumber prices?

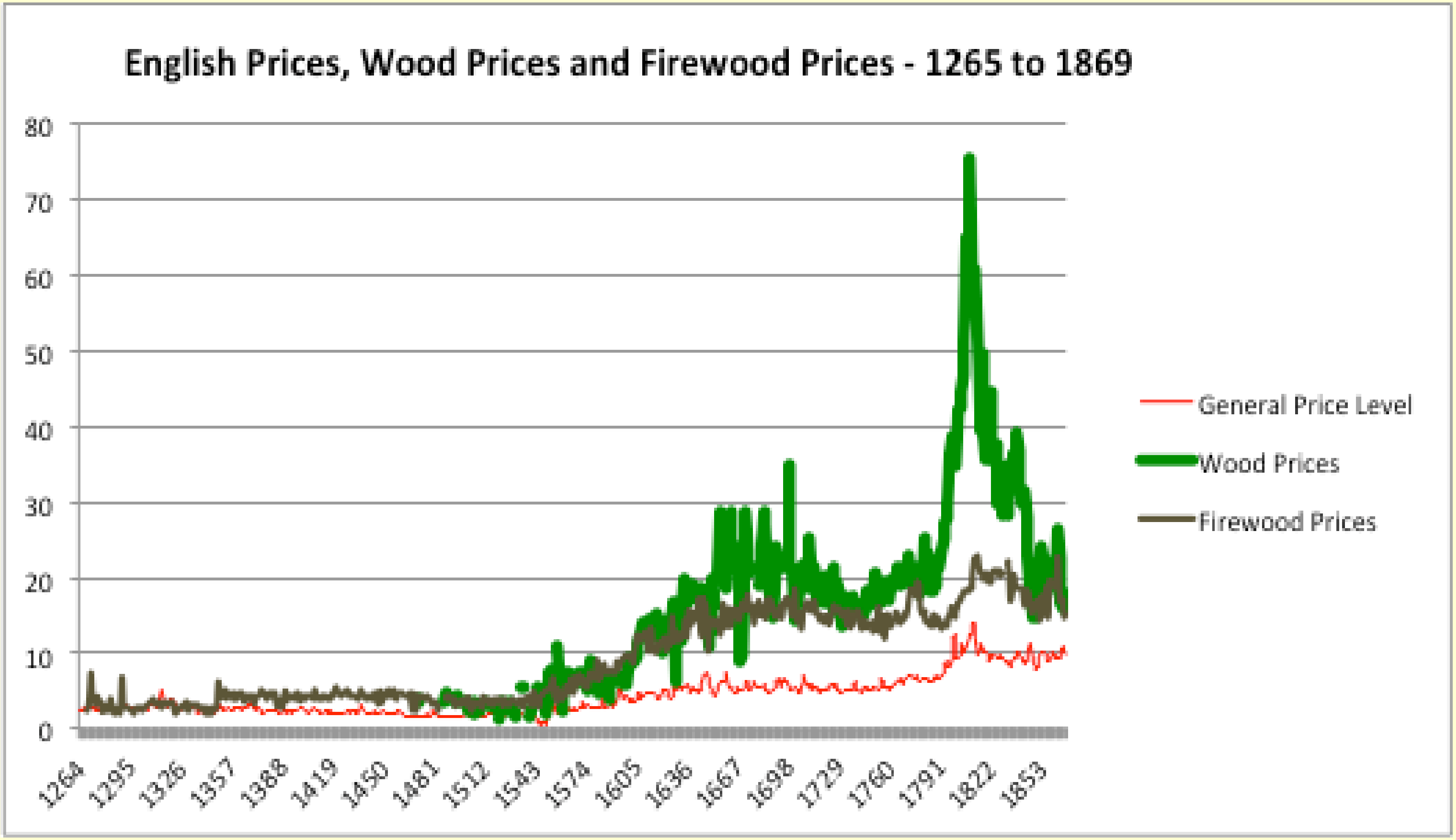


Timber prices increased by **2% p.a.** faster than lumber prices.

Inflation adjusted timber prices paid to timber growers increased by an inflation-adjusted 3.1% p.a. - compared to an inflation-adjusted lumber price increase of 1.1% p.a.

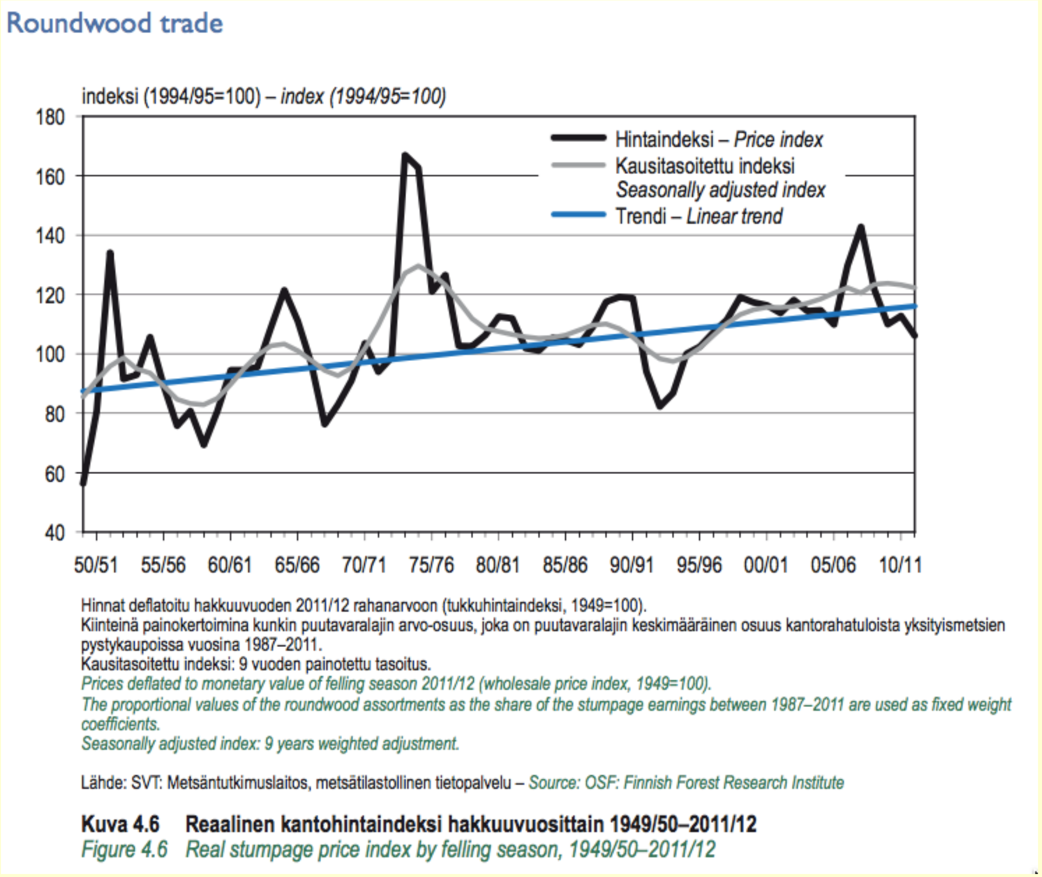
What's new?

Older data from Allen (2001) and Clark (2007)…



What's new?

Consistent picture so far with European data…



Looking for European collaborators to gather more European timber price data. If interested, please contact me at colm.fitzgerald@ucd.ie?

What's new?

Timber prices summary:

- Much more stable pattern over the centuries than equities
- Increasing by > 1% p.a. over CPI for last 220 years in the US
- Timber prices increasing by about 2% p.a. over lumber prices

Real returns on forestry investment

- Real returns assumed fixed at 5%
  - Historical basis for the assumption
    - Fitting of model to actual US forestry returns (from NCREIF and John Hancock data back to 1960)
    - Data from academic literature on forestry investment (Phillips (1999) suggests 4.5-7% and O'Connor & Kearney (1993) suggests 6.6%)
    - Industry viewpoint ("a 5% real return objective... Is reasonable")
    - Suggest that 5% is a conservative assumption
  - It is also fixed at commencement for duration of investment

The FITR Index

The Forestry Investment Total Return (FITR) Index

- FITR index was constructed as follows:

$FITR\ Index_1$ @ 1871 set to = 1

$FITR\ Index_t$ = $FITR\ index_{t-1}$

x 1.05 (real return)

x annual change in Cornell lumber prices

x 1.02 (timber v lumber p.a.) for t = 1872 - 1926

$FITR\ Index_t$ = $FITR\ index_{t-1}$

x 1.05 (real return)

x annual change in BLS lumber prices (series WPU081)

x 1.02 (timber v lumber p.a.) for t = 1927 0 2018

The FITR Index

The Forestry Investment Total Return (FITR) Index

- Limitations
  - The model is based on how returns ought to behave, based on an assessment of intrinsic values, rather than how they actually behave in the short term
    - Aim to be good medium to long term rather than short term proxy.
    - Many forestry funds calculate their annual returns based on valuation measures that are based on smoothed timber prices, e.g. some smooth over a five-year period and some over ten-year periods. This means that correlation between the model annual returns and direct measures of annual forestry returns will be only moderately positive. To illustrate this, the correlation coefficient between the US lumber price component of the US Producer Price Inflation (PPI) index, and the ten-year average of the same US lumber prices from 1987 to 2018 is only 37%.
    - Over time actual forest returns should revert towards how they ought to behave.
  - There is a basis risk in the model due to the smoothing used from using annual PPI lumber prices (these are used due to their ease of availability) and smoothing by forestry funds.

The FITR Index

The Forestry Investment Total Return (FITR) Index

- Limitations
  - Actual annual returns can vary from the model for other reasons also:
    - Realized gains from selling timber when timber prices have spiked during a year can add to returns.
    - Timber supply usually contracts when prices fall, but selling timber when timber prices are in a trough in a year can reduce returns.
    - Gains from changes in land value can impact returns but the impact is usually small. Healey et al (2005) estimate that only 6% of the total return from forestry is from the land value, or more precisely the land value changing relative to timber prices, so the impact is smaller still. Even so, exogenous changes to land prices could impact returns, due to, for example, changes to competing land uses resulting in a significant change in its value.
    - New wood products can increase the demand for timber (e.g. the emergence of OSB and the demand for bioenergy) and new substitutes can reduce the relative demand for timber in the short to medium term.
    - Forestry management costs can be greater or less than expected.
    - Losses can arise from unscrupulous agents, negligence and fraud.
    - Taxation or legislation changes can significantly impact returns.
  - In the model, all of these are assumed to average out over time in a well-diversified portfolio if it is prudently managed, but they will limit the extent to which the model will track actual forestry returns in the short term.

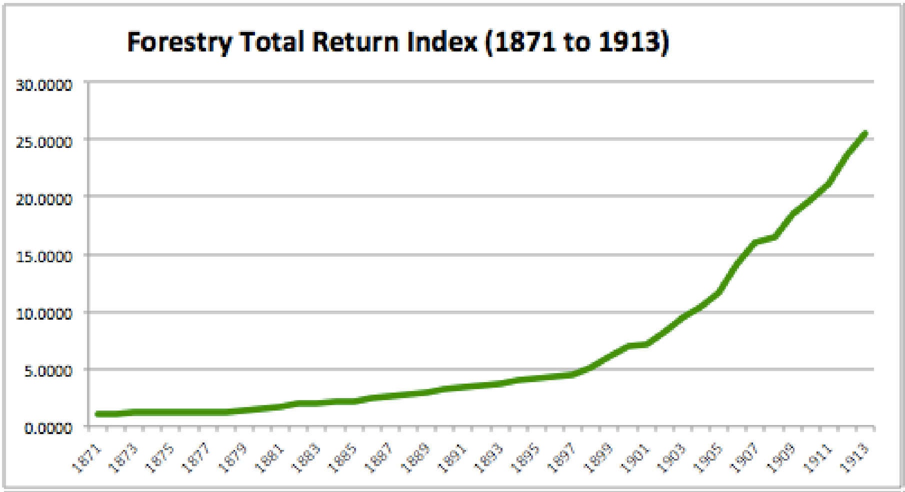
The FITR Index

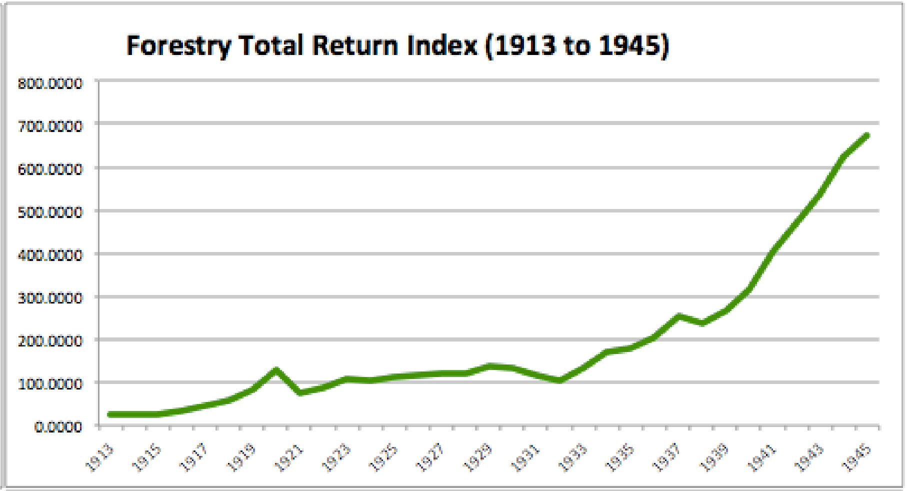
The Forestry Investment Total Return (FITR) Index

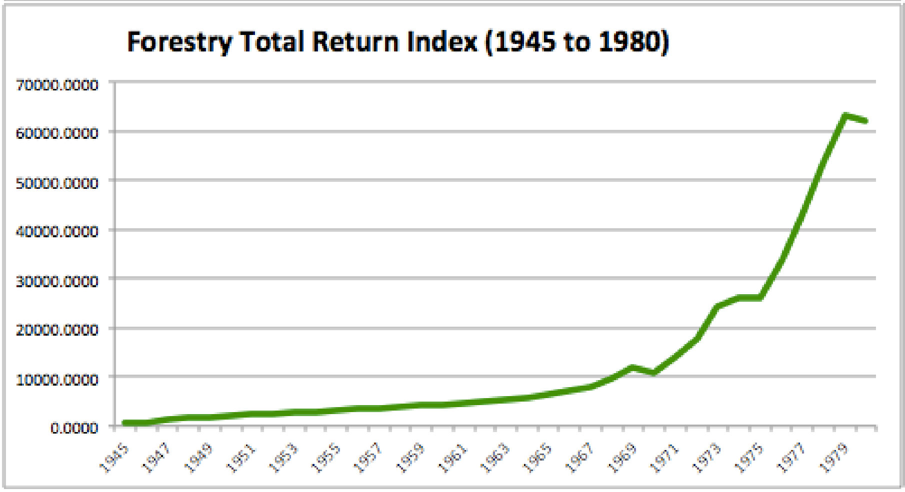
- Limitations
  - Technology changes, genetic improvements, improvements in forestry management practices and other factors can lead to higher quality tree growth resulting in straighter and more valuable timber than expected. In the model, it is assumed that such changes occur gradually over time and that they will continue at the same rate in the future. This is a challengeable assumption but one necessary for the model in the absence of research showing the direct impact of such changes on timber prices and a model to predict future changes.
  - There is usually a wide window in which a forest can be harvested so there is an option value from being able to delay the harvest. This option value is not included in the model.
  - The extra costs of investing, those not considered in the DCF assessments of real return, e.g. arising from payments to agents like management charges on pooled investment vehicles, can reduce returns, just as pooled investment in equities can cost more over time than direct holdings.

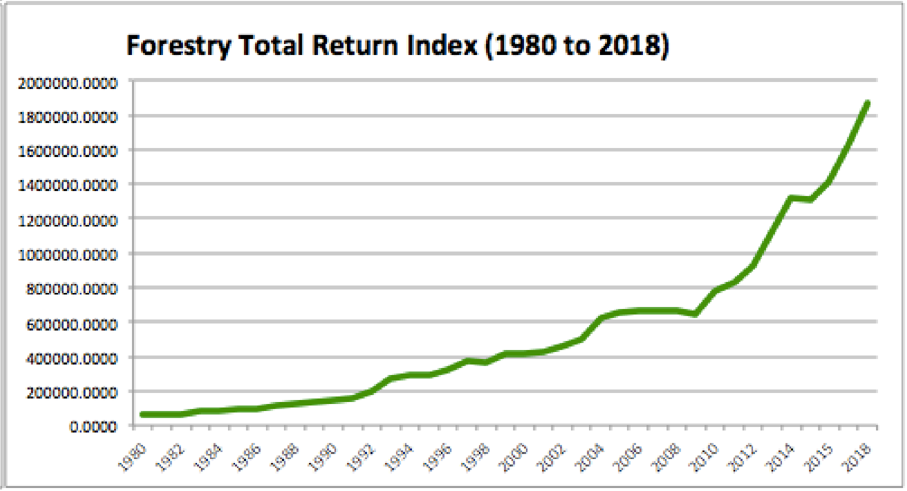
The FITR Index

The Forestry Investment Total Return (FITR) Index



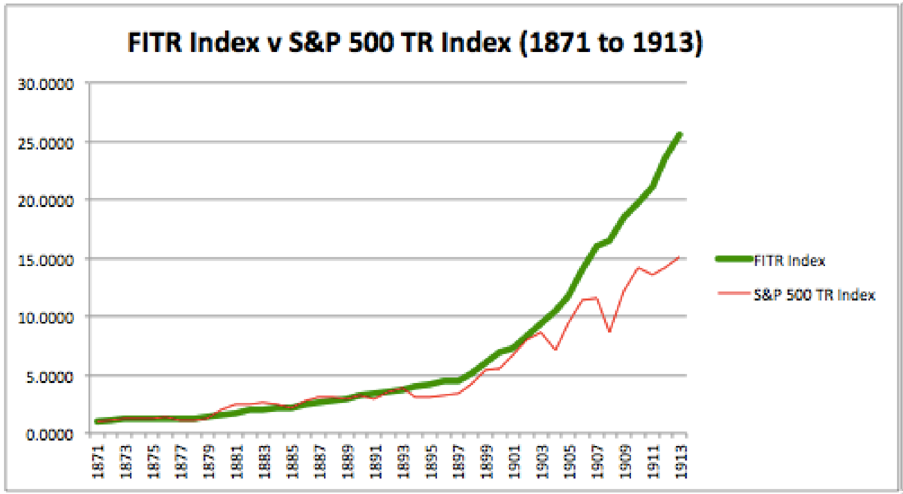


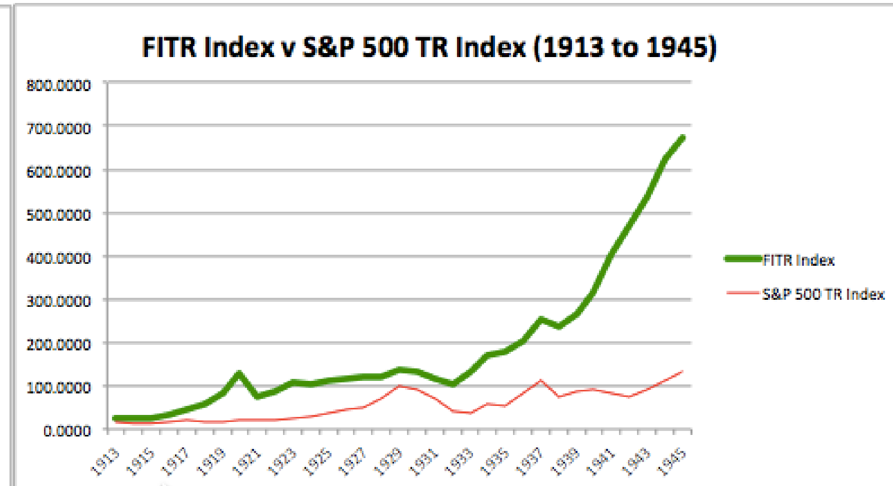


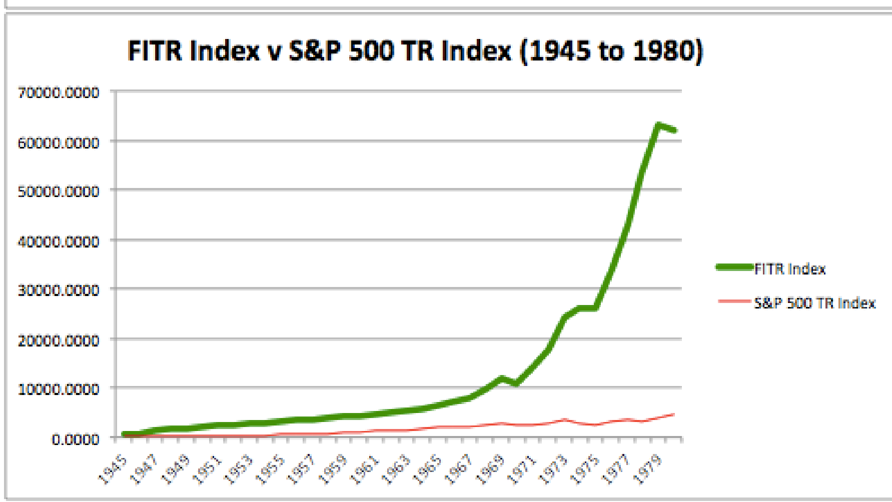


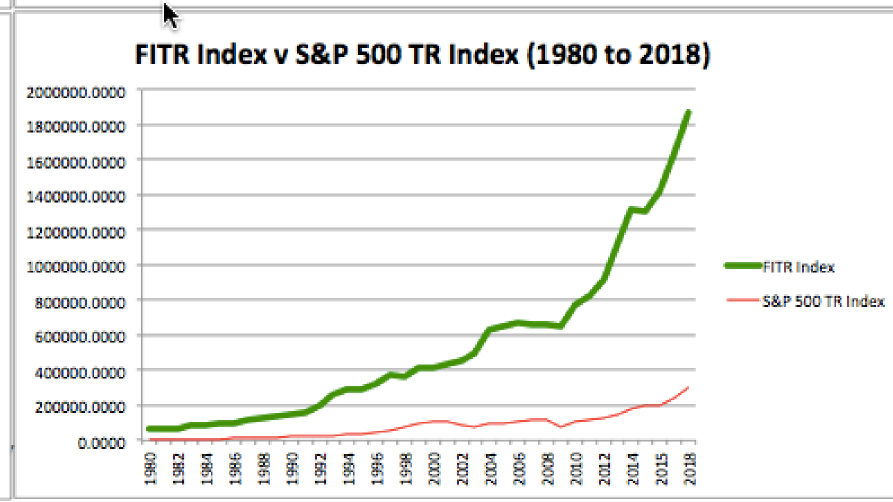
The FITR Index

The FITR Index versus the S&P Total Return Index



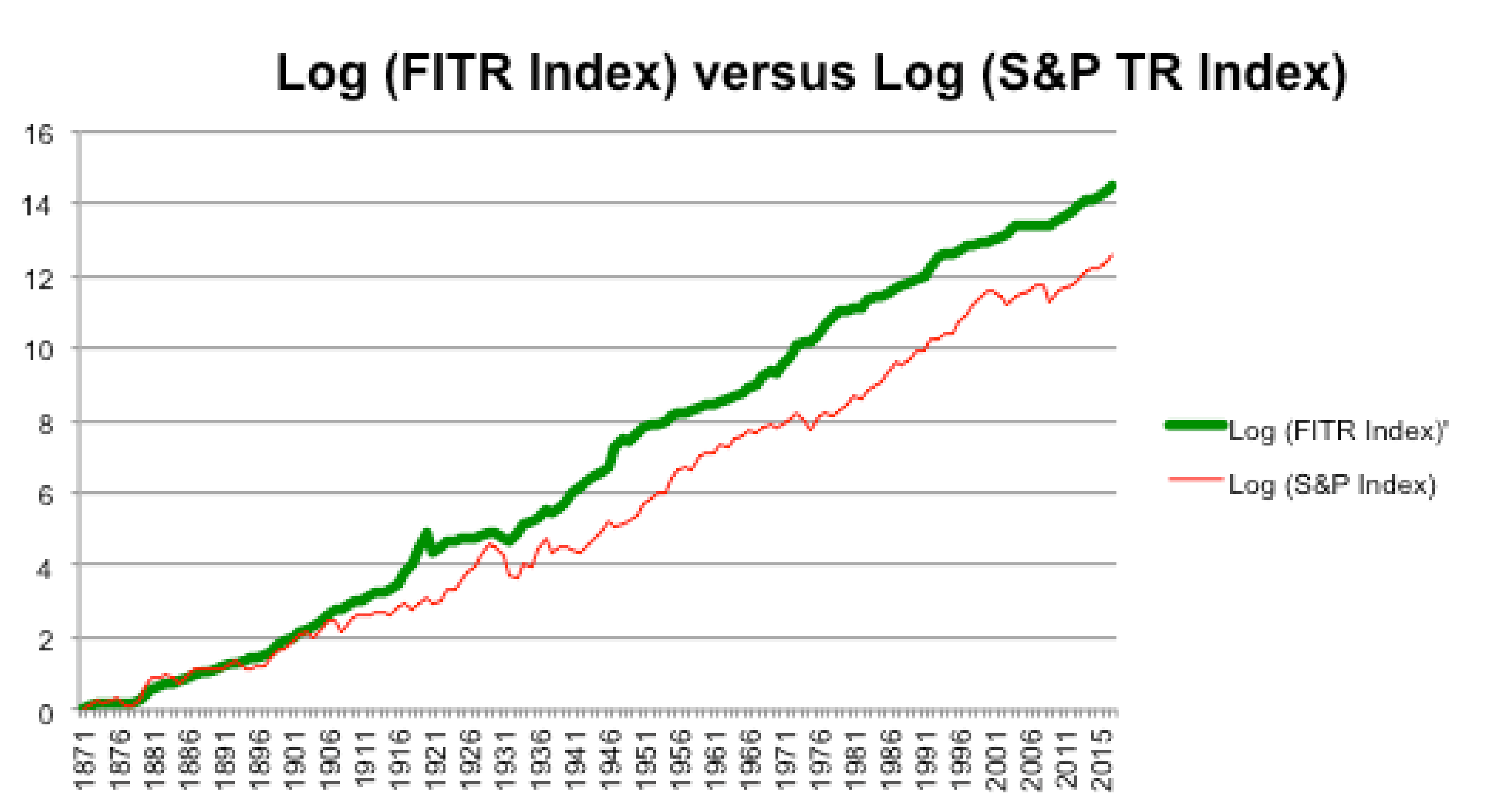






The FITR Index

The FITR Index versus the S&P Total Return Index



The FIT Index

Forestry Investment Total Return (FITR) Index - 1871 to 2018 - Summary Statistics

	Annual returns	Annualised rolling 10-year returns	Annualised rolling 20-year returns	Annualised rolling 50-year returns	Annualised rolling 70-year returns
Geometric average	**10.323%**				
Standard deviation	**12.4%**	4.37%	2.73%	1.33%	0.84%
Skew	**88.2%**	51.8%	51.8%	18.6%	-10.4%
Minimum	-42.3%	0.26%	4.59%	8.32%	8.96%
Maximum	71.1%	21.99%	17.26%	13.81%	12.70%
25th percentile	3.8%	7.2%	8.7%	10.5%	10.9%
50th percentile	8.9%	9.7%	10.1%	11.3%	11.5%
75th percentile	15.8%	13.4%	12.8%	12.1%	12.0%
Interquartile range	12.0%	6.2%	4.2%	1.6%	1.1%
Standard deviation / geometric average		42%	26%	13%	8%

	Multi-period 7 year returns	Multi-period 21 year returns	Multi-period 49 year returns	Multi-period 73 year returns
Geometric average	99%	787%	12320%	136754%
Standard deviation	97%	512%	3363%	149045%
Skew	181%	129%	-39%	not defined
Min	-8%	252%	9033%	67162%
Max	407%	1788%	15739%	277944%
Standard deviation / geometric average	98%	65%	27%	109%
	df=20	df=6	df=2	df=1
95% Confidence Interval - start	-104%	-465%	-2151%	-1757015%
95% Confidence Interval - end	302%	2039%	26792%	2030523%
99.5% Confidence Interval - start	-208%	-1423%	-35062%	-18839838%
99.5% Confidence Interval - end	406%	2997%	59703%	19113347%

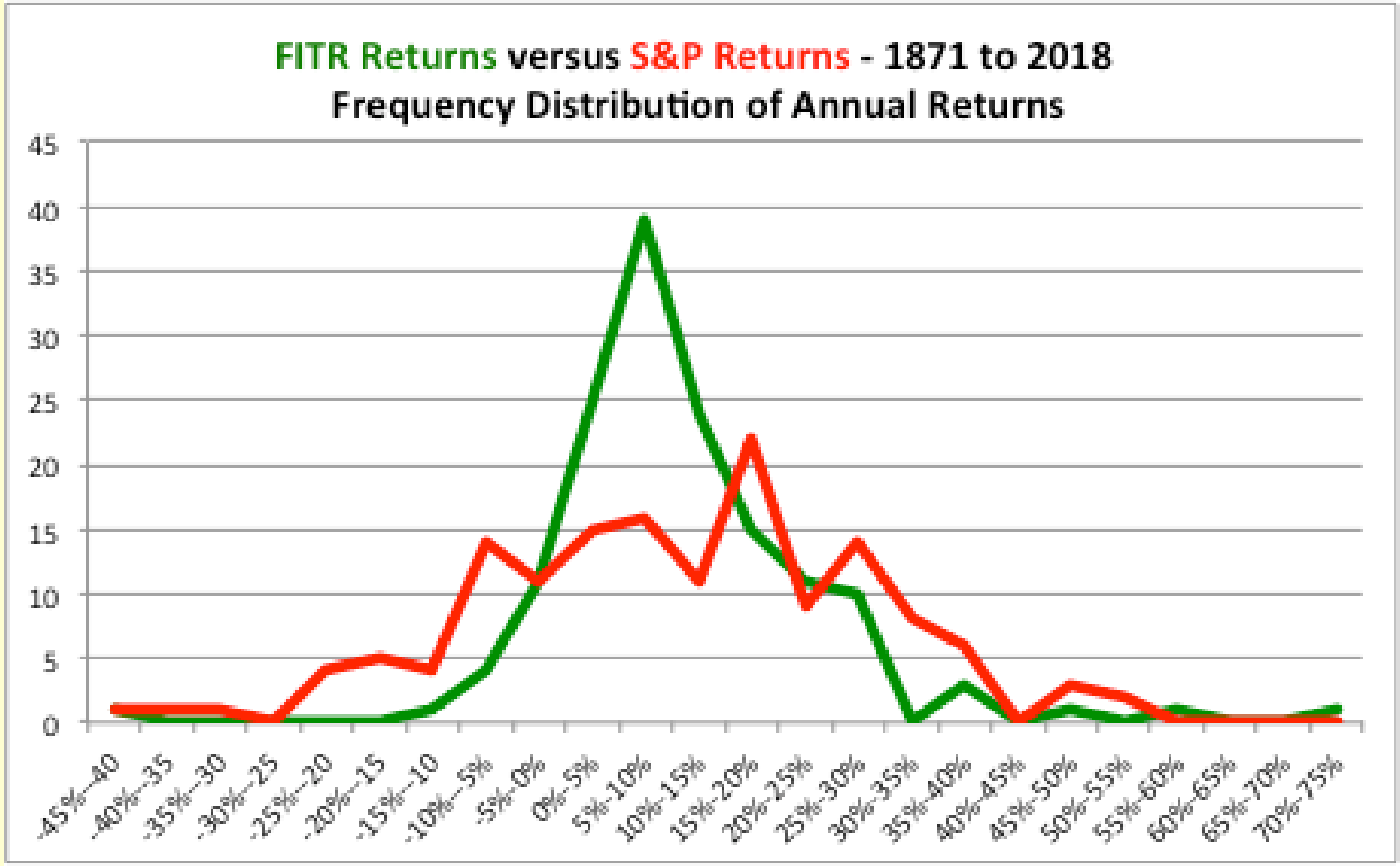
The FITR Index

Forestry Investment Total Return (FITR) Index - 1798 to 2018 - Summary Statistics

	Annual returns	Annualised rolling 10-year returns	Annualised rolling 20-year returns	Annualised rolling 50-year returns	Annualised rolling 70-year returns
Geometric average	**9.790%**				
Standard deviation	**11.598%**	3.93%	2.60%	1.73%	1.54%
Skew	**119%**	74.5%	60.0%	41.3%	17.5%
Minimum	-42.3%	0.26%	4.59%	7.50%	7.87%
Maximum	71.1%	21.99%	17.26%	13.81%	12.70%
25th percentile	3.3%	7.2%	7.9%	8.6%	8.5%
50th percentile	8.3%	8.9%	9.5%	9.4%	9.5%
75th percentile	14.6%	12.0%	11.6%	11.4%	11.6%
Interquartile range	11.3%	4.8%	3.6%	2.9%	3.1%
Standard deviation / geometric average		40%	27%	18%	16%

	Mult-period 10 year returns	Mult-period 20 year returns	Mult-period 55 year returns	Mult-period 73 year returns
Geometric average	154%	598%	17018%	94307%
Standard deviation	132%	422%	14479%	128772%
Skew	242%	178%	1%	172%
Min	34%	316%	8417%	49268%
Max	630%	1499%	34410%	277944%
Standard deviation / geometric average	86%	71%	85%	137%
	df=21	df=10	df=3	df=2
95% Confidence Interval - start	-121%	-342%	-29054%	-459797%
95% Confidence Interval - end	430%	1537%	63090%	648412%
99.5% Confidence Interval - start	-261%	-913%	-90895%	-1719956%
99.5% Confidence Interval - end	570%	2108%	124931%	1908571%

The FITR Index



The FITR Index

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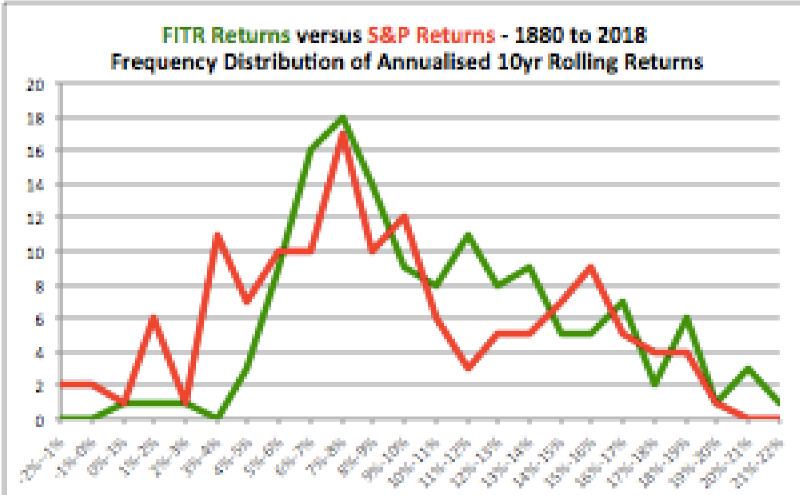
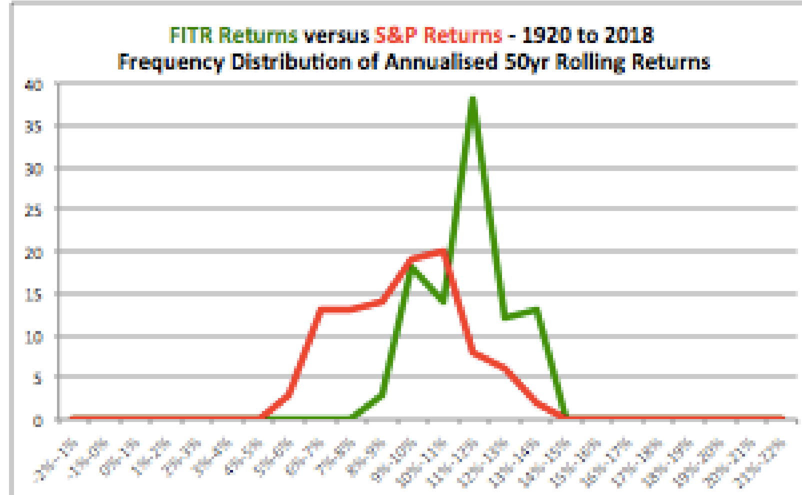
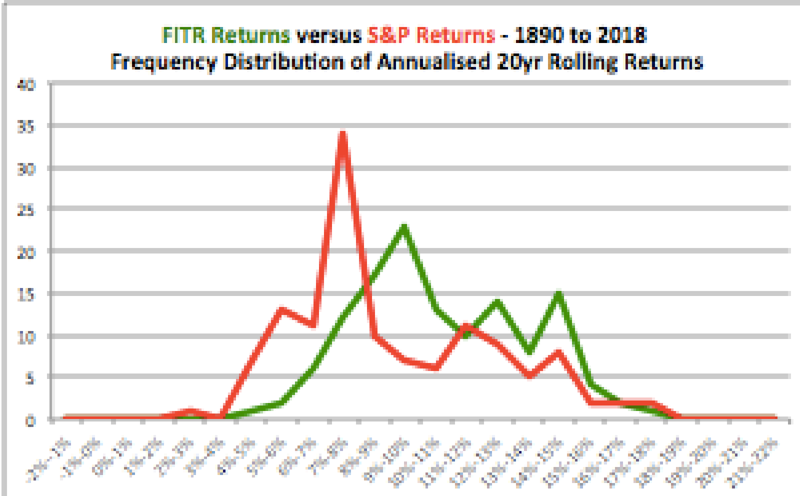
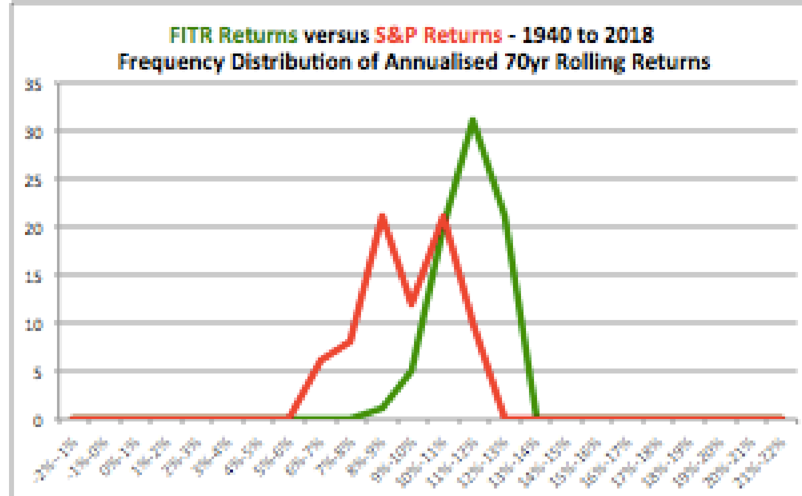


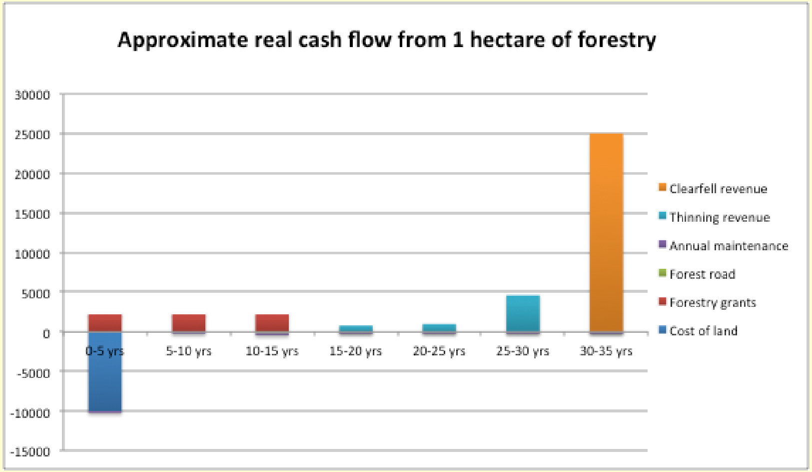


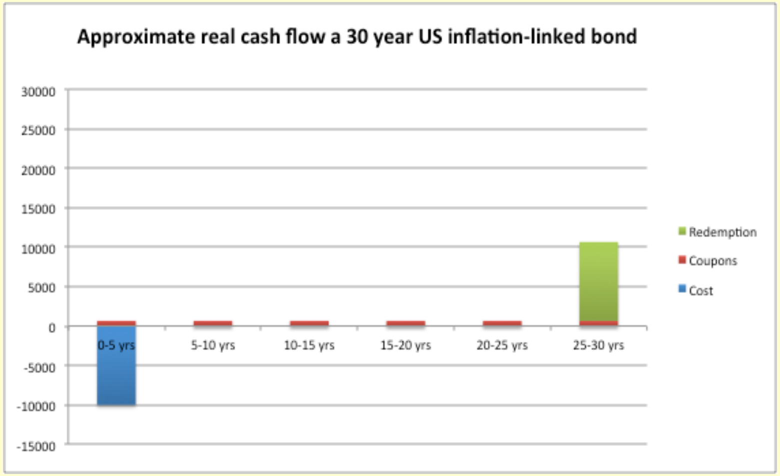




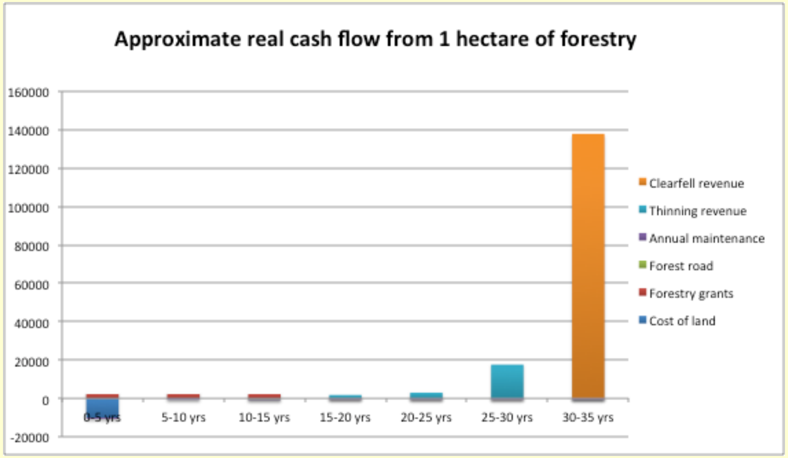
The FITR Index

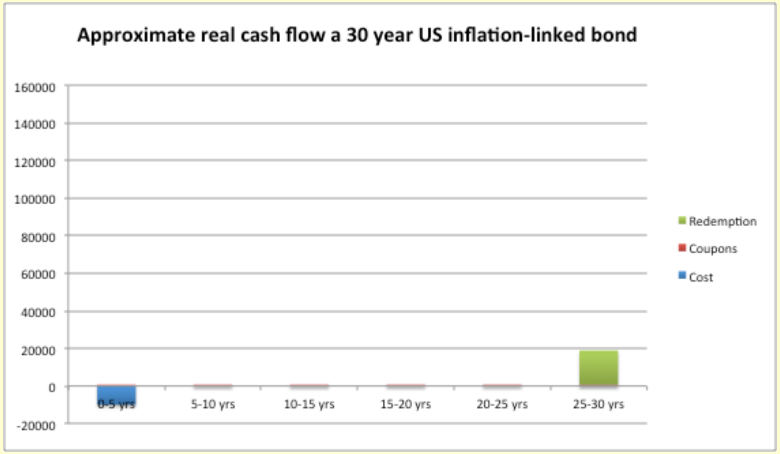
Comparison between forestry investment and US TIPS…





- TIPs real yield of 0.92% versus forestry real yield of 5%





The FITR Index

The Forestry Investment Total Return Index

- Correlations
  - The correlation between annual forestry returns and CPI inflation was 0.58 and the correlation between annual S&P total returns and CPI inflation was 0.01, practically zero correlation, with inflation over time period 1871 to 2018. (or 0.7 and 0.16 on 3yr basis).
  - This suggests that forestry is a better matching asset class for liabilities linked to inflation and indeed for earnings inflation due to it increasing faster than CPI.
  - The correlation between FITR and equity returns from 1871 to 2018 was 0.32 - a weak correlation over the long term – showing good diversification benefit.
- Matching by term and Liability Driving Investment (LDI) issues
  - Forestry is a long-term investment with infrequent reinvestment requirements
  - Suitable for investors with longer term horizons, e.g. in pensions and insurance
- Positive skew of returns
- Upside risks
- ESG benefits
- Sounds too good to be true!
- Or does virtue and patience pay?

Summary & conclusions

Forestry investment

- Better historical basis for longer-term investment horizons
- Better historical match to inflation / earnings inflation
- Superior historical performance record compared to equities.
- Significant outperformance relative to equities during times of significant inflation
  - This is important due to the issue of the increasing trend of looseness in monetary supply, e.g. QE, and the trouble that is can cause
  - Those who studied or have recent national history of hyperinflation might agree more than others
  - Forestry investments are a good hedge from an historically perspective
- ESG considerations make forestry attractive
- Agency costs are important
- Other actuarial issues

Thank you

Thank you

Questions or comments welcome…

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Appendix

Why might actuaries be relatively silent on historical data issues around Solvency II and PRIIPs?

- How and why do we react to experiences we don't like:
  - "*To continue further the analysis of non-rational opinion, it should be observed that the mind rarely leaves un-criticized the assumptions which are forced on it by herd suggestion, the tendency being for it to find more or less elaborate rationalized justifications of them.*" – Wilfred Trotter
  - "*Propaganda does not deceive people; it merely helps them to deceive themselves.*" – Eric Hoffer
  - Is this the case with Solvency II and PRIIPs?