Session 6: Financial market returns

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Goals

- The importance of returns
- The distribution of returns
- Value at Risk (VaR)

The importance of returns

Prices and returns

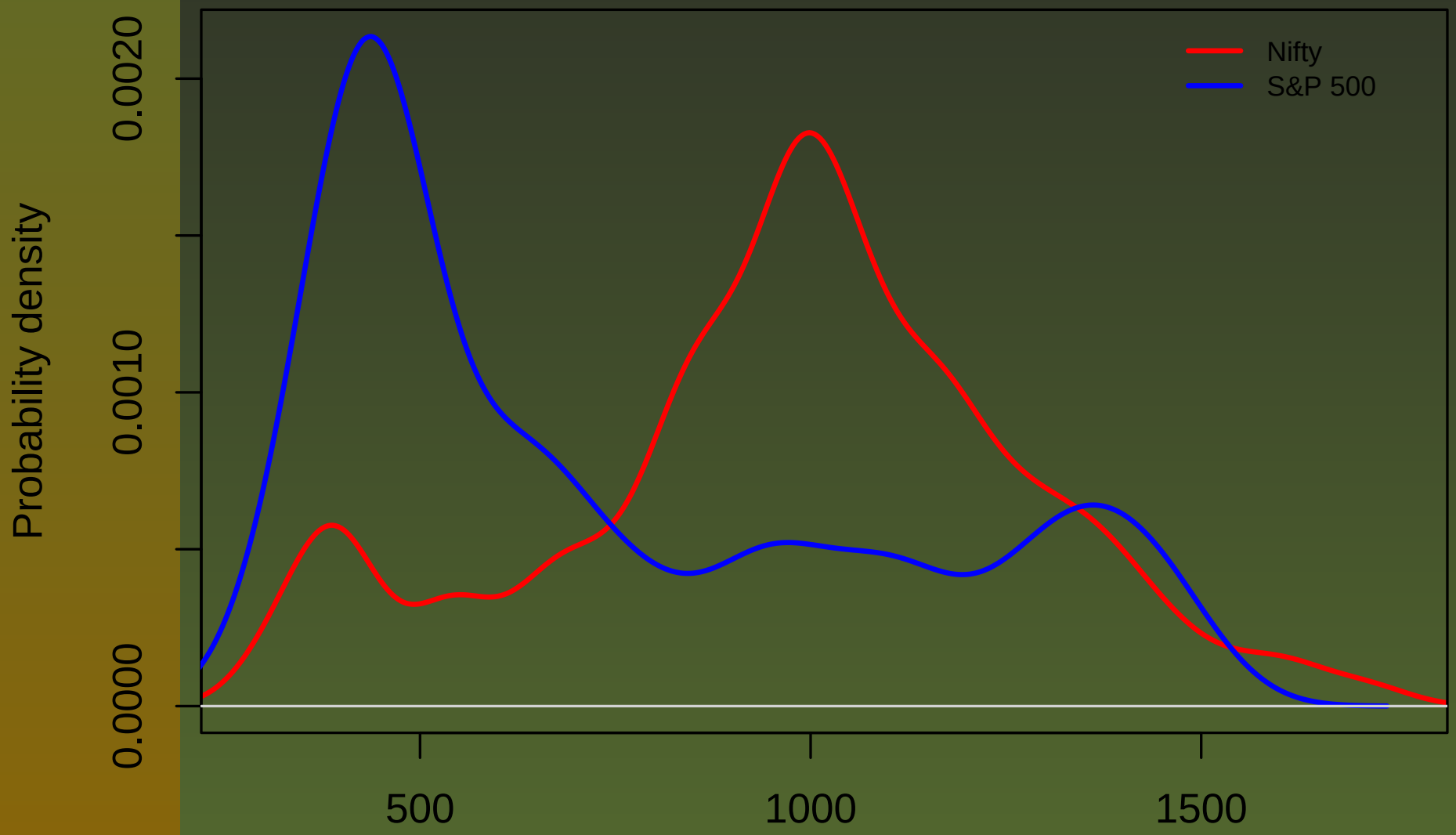
- All of us know the time-series of prices p_t.
- Finance requires a major shift in focus away from prices to the time-series of *returns*. For right now,

$$r_t = 100 \left(\frac{p_t}{p_{t-1}} - 1 \right)$$

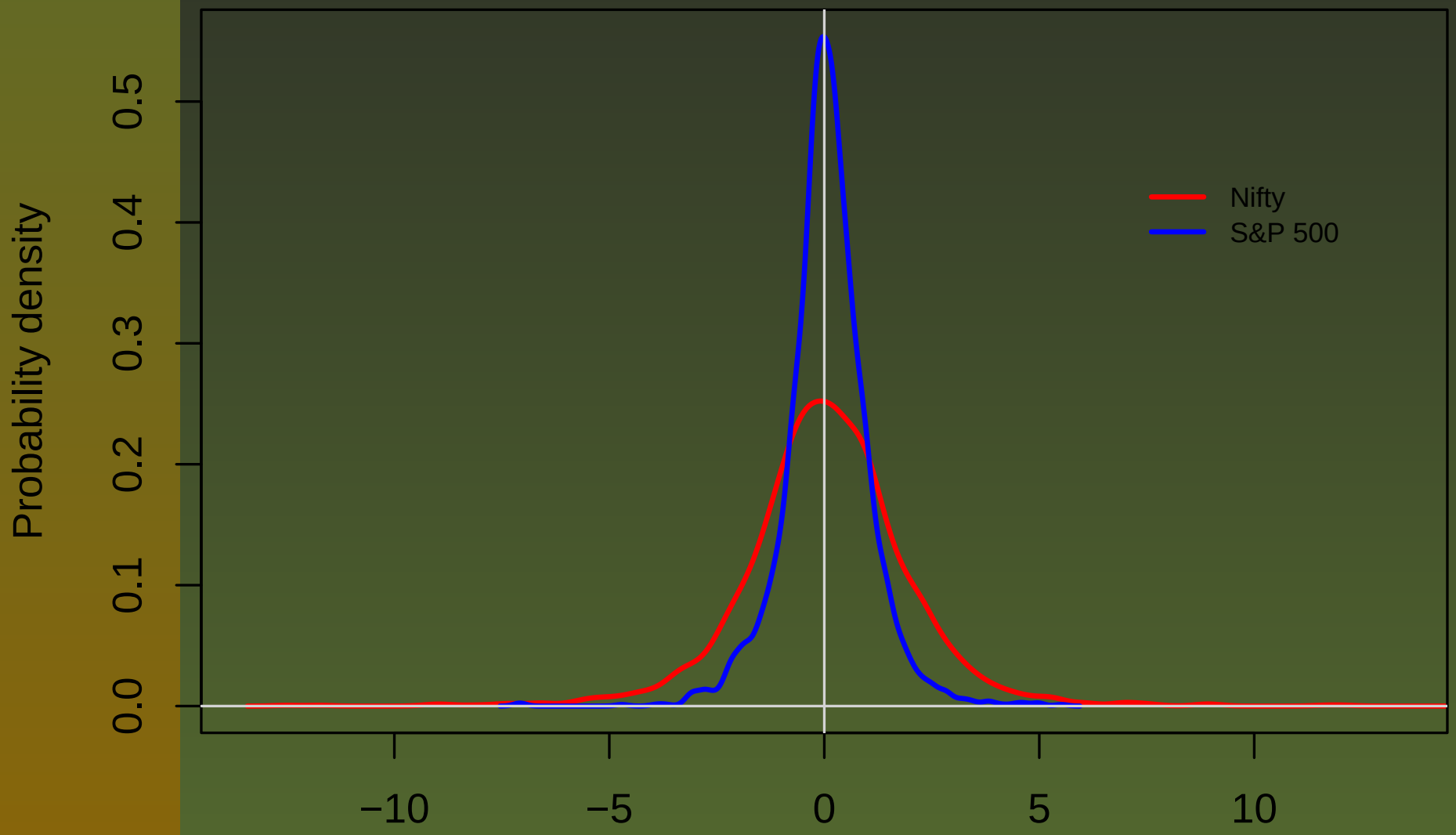
Why returns is the right way to think about finance

- Prices are not comparable across products.
- Prices can move dramatically for non-informative events: e.g. stock split.
- *Most asset prices trend up, and it is not meaningful to talk about the distribution of something that is not stationary*.

Distribution of Nifty and S&P500 prices



Comparability comes by shifting to returns



The concept of returns is general!

- Returns of equities, equity indexes, currencies, commodities: all are obvious.
- Interest rates: Shift from thinking about interest rates to *returns* on bonds.

The distribution of returns

What do we know about prices

- Prices can move up and down,
- But they can’t become negative.
- There can be very large positive moves.
- But the returns can’t be worse than -100%.

The right parametrisation

$$r_t = 100 \log_e(p_t/p_{t-1})$$

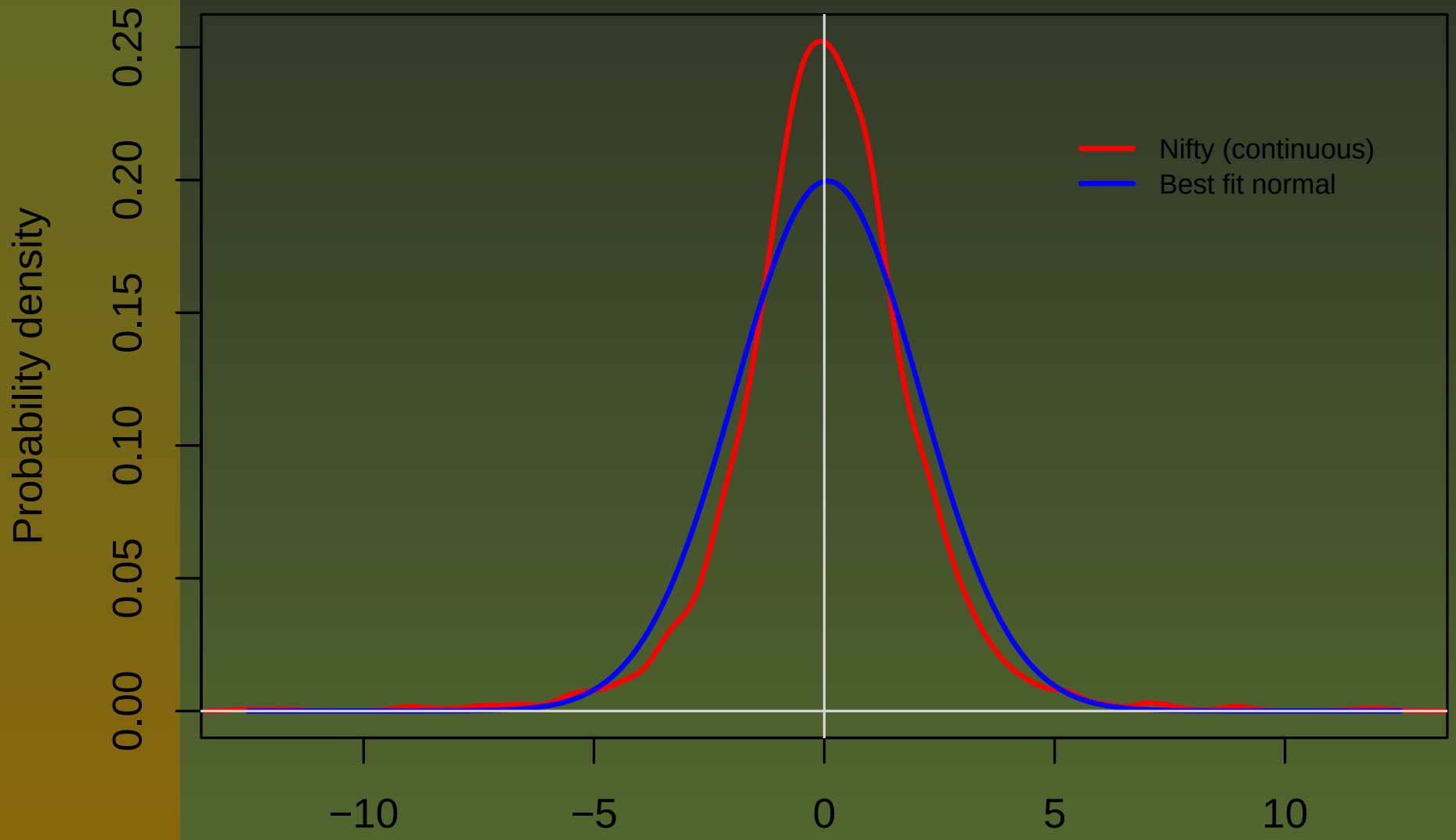
- If $p_t \to 0$, then $r_t \to -\infty$.
- If there is a massive upswing in prices, $r_t \to +\infty$.
- *Fact:* p_t/p_{t-1} is roughly lognormal; r_t is roughly normal.

Raw versus continuously compounded returns

- *Fact:* As $x \to 0, \log_e(1+x) \approx x$, so for small values of returns, $\log_e(1+r) \approx r$. Example: $\log_e(1.03) = .0295588$.
- This can all be confusing!! 3% or 1.03 or 0.02955 or 2.955. Choose one way of measurement (2.955) and rigidly stick to it.
- For weekly or monthly returns, values of r are bigger, so whether you log or not makes more of a difference. For small time horizons it matters less.

Looking at real-world returns

Nifty returns : how 'normal' are they?



Mean and standard deviations as summary statistics

	Nifty	S&P 500	INR/USD
μ_{price}	973.4384	742.0828	39.4443
σ_{price}	300.4205	363.6260	5.9551
μ_{returns}	0.0705	0.0622	0.0216
σ_{returns}	1.9984	1.0008	0.2817
1^{st} Quartile	-0.9762	-0.4214	-0.0280
Median	0.0507	0.0622	0.0216
3^{rd} Quartile	1.1000	0.5719	0.0560

An across-markets view

	2003-04 vol
Nifty	1.43
COSPI	1.47
1-year ZC bond	0.32
10-year ZC bond	0.47
GOI bond index	0.27
Gold	0.92
Silver	1.42
INR/USD	0.19
INR/EUR	0.77

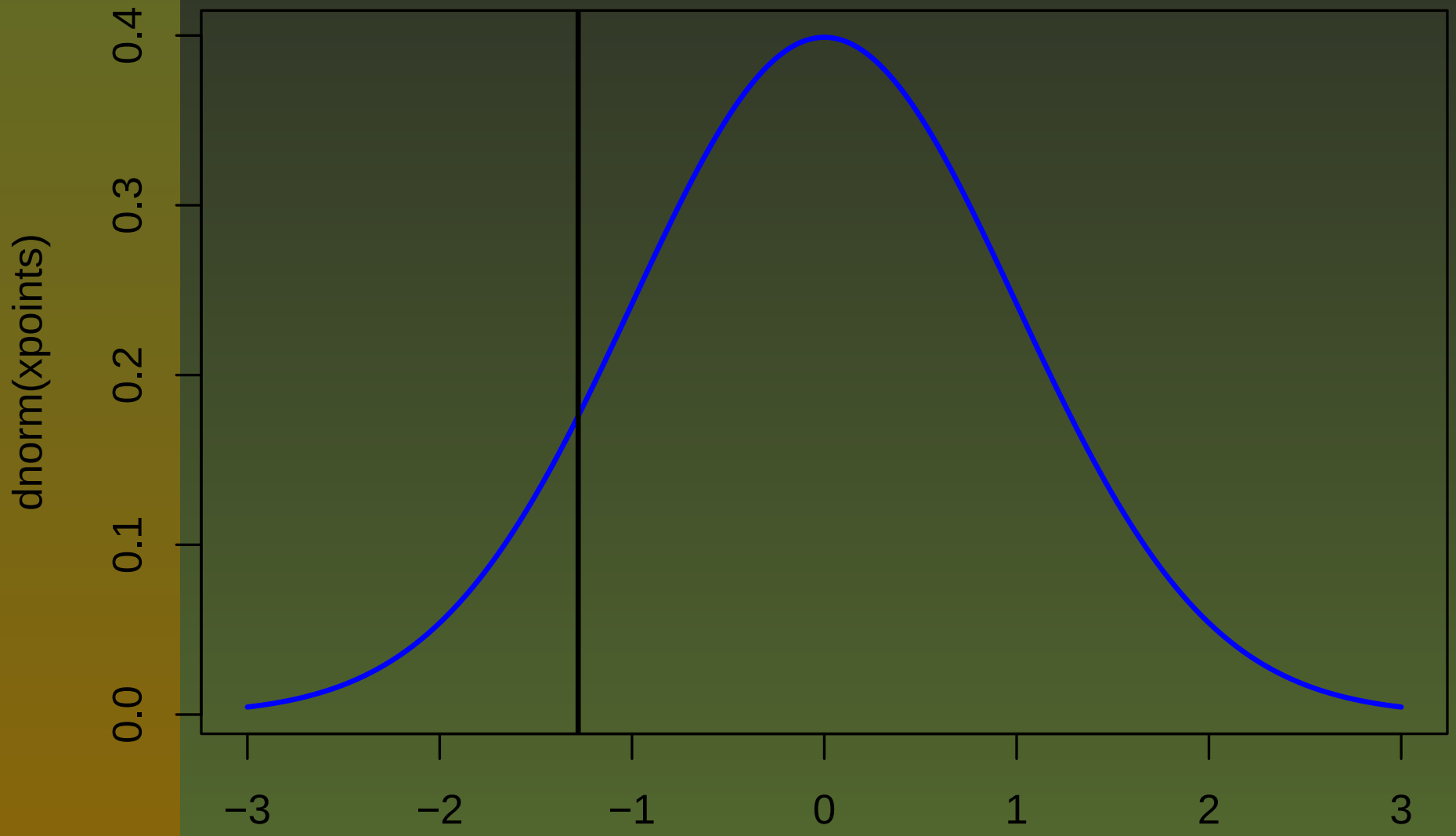
Value at Risk (VaR)

Defining VaR

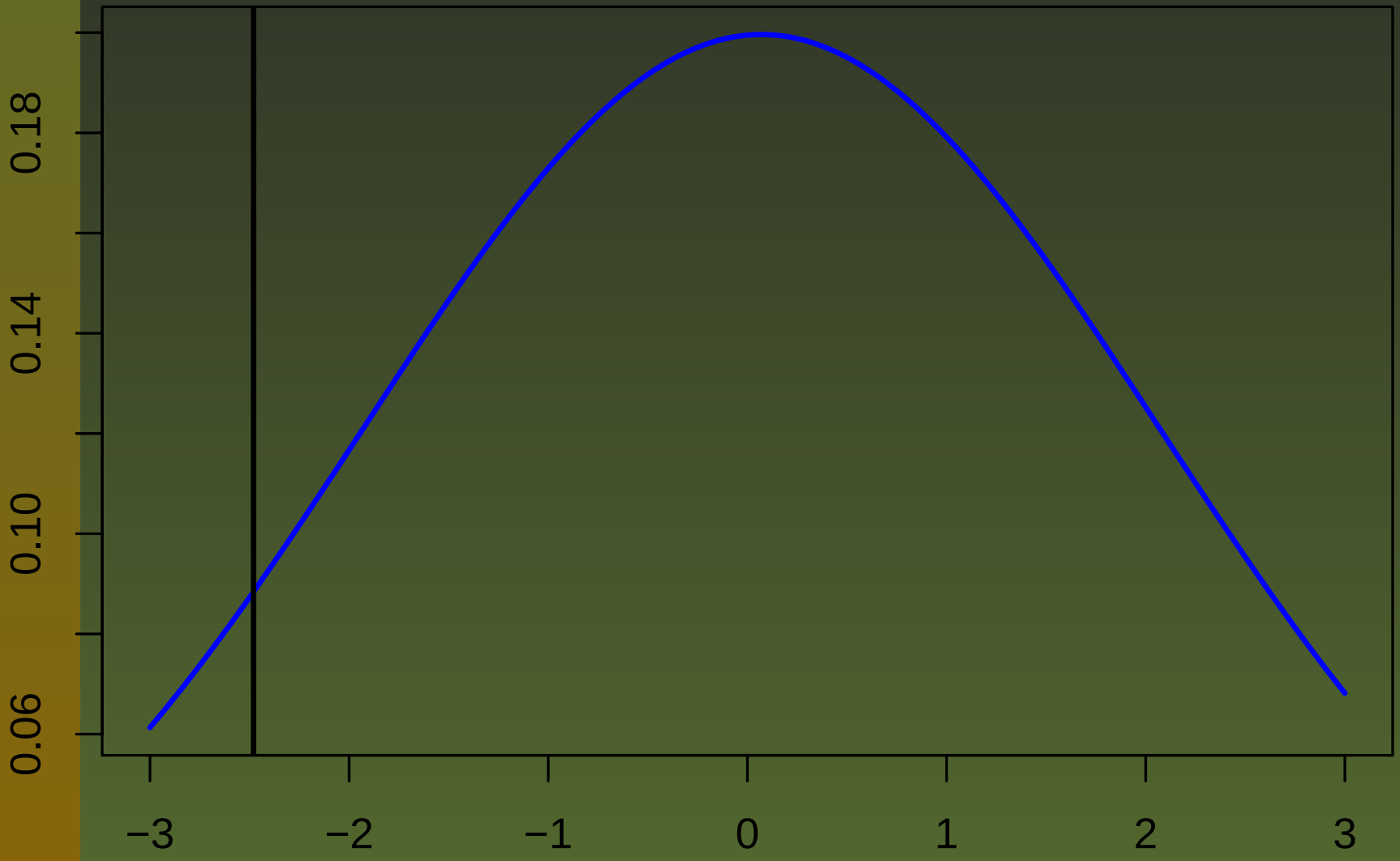
- Suppose $r_t \sim f(r)$.
- VaR v is a r_t defined in the following manner: VaR is the value v at a p level of significance using the equation

$$\int_{-\infty}^{v} f(r)dr = 1 - p$$

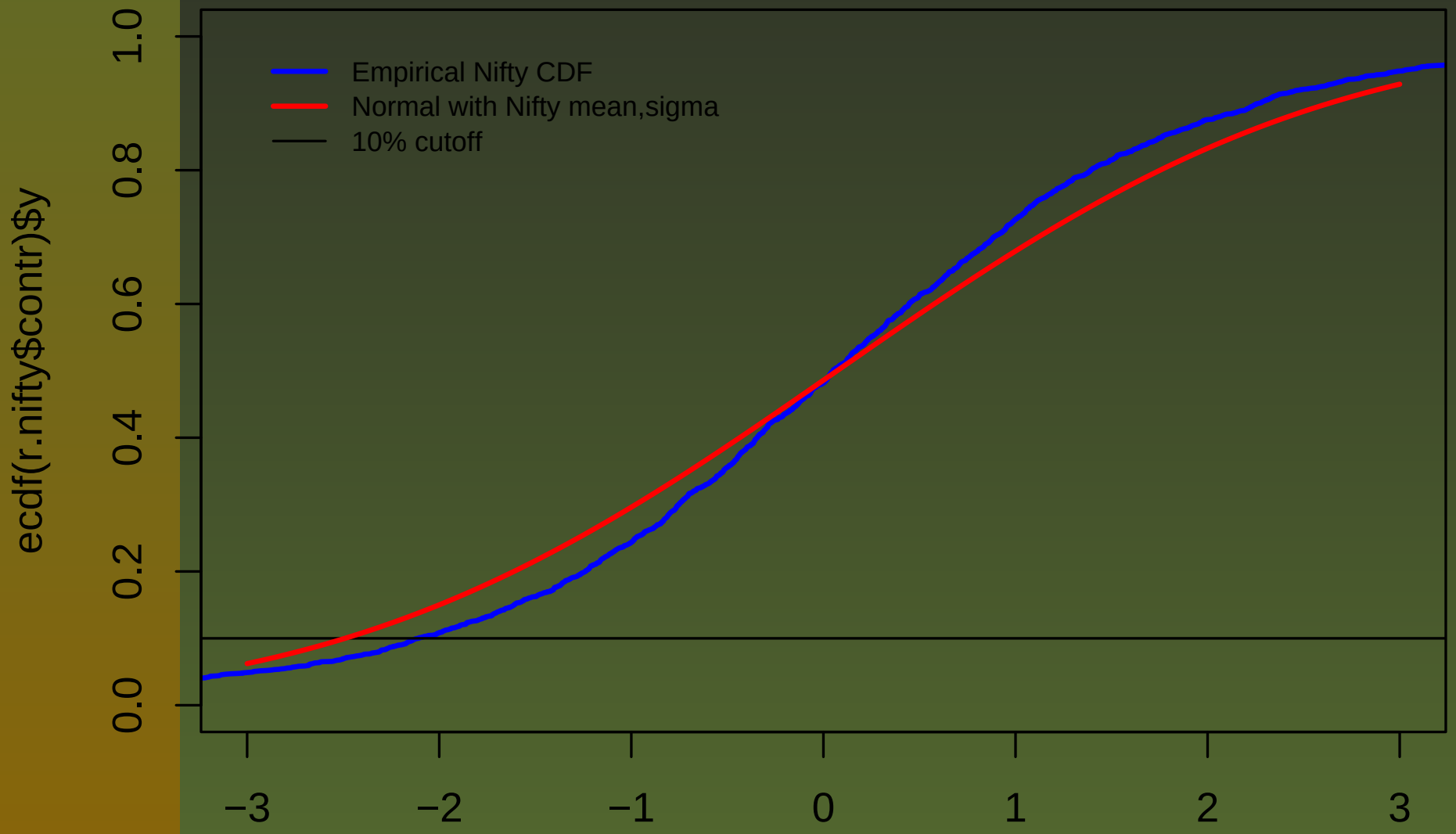
A 90% VaR on a standard normal distribution



A 90% VaR on a normal distribution with Nifty parameters



Two CDFs and the 10% cutoff



References

- http://www.economagic.com has some useful data.
- http://www.mayin.org/ajayshah
- http://www.igidr.ac.in/∼susant
- PHILIPPE JORION. *Value at Risk : The Benchmark for Controlling Market Risk.* McGraw Hill, 2000, 2nd edition