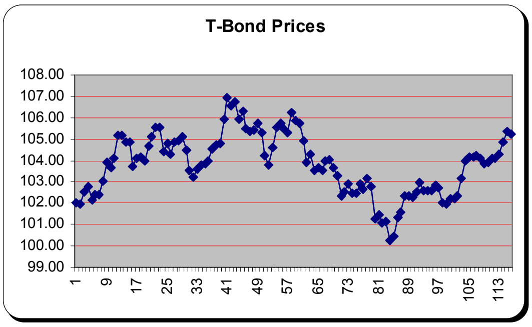
5.2.8 Example Histograms: T-Bond Implied & Historical Volatility – "Statistical Smoothening"

All of the examples thus far have concentrated on market prices, but of course, statistical analysis can be applied to "anything". Figure 5.2 – 17 a) and b) show a history of implied volatilities[130] for options on T-Bond Futures, and one possible histogram from that data.

Implied volatilities[131] are related to standard deviations, and so this analysis is actually examining the statistical properties of a "standard deviation". In other words, this statistical analysis is examining the properties of a (kind of) "statistic".



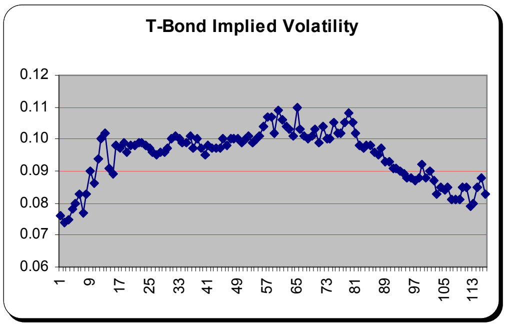
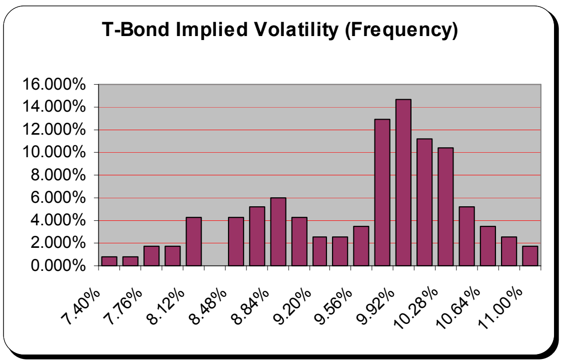


Figure 5.2 – 17. a) History of T-Bond Futures prices, and b) of implied volatilities for ATM calls on T-Bond Futures.



Bin	*Frequency*	*Cumulative %*
7.40%	1	.86%
7.58%	1	1.72%
7.76%	2	3.45%
7.94%	2	5.17%
8.12%	5	9.48%
8.30%	0	9.48%
8.48%	5	13.79%
8.66%	6	18.97%
8.84%	7	25.00%
9.02%	5	29.31%
9.20%	3	31.90%
9.38%	3	34.48%
9.56%	4	37.93%
9.74%	15	50.86%
9.92%	17	65.52%
10.10%	13	76.72%
10.28%	12	87.07%
10.46%	6	92.24%
10.64%	4	95.69%
10.82%	3	98.28%
11.00%	2	100.00%

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[130] Technically, implied volatilities are a "kind of price" since the values are "reversed out of" or "implied by" quoted options prices. Nevertheless, they are closely related to the standard deviation of returns, in this case returns as expected by the Log-Normal/Root2 model buried inside the Black-Scholes equation. [1] provides a thorough introduction, and [8] provides detailed analysis. An alternative way of thinking about implied volatilities is that they are to options prices what internal rates of returns are to bond prices; in both cases these are proxies for value or price, but now on a kind of "relative" or "speed" basis.

[131] Once again, implied volatilities, while "related" to the standard deviation of returns/prices, are not "basic statistical measures" in the usual or traditional sense. They are purely an artefact of a "model assumption" as discussed in Chapters 11 - 13, and in [1] and [8]. To this end, please be extremely careful not to confuse model implied statistical measures with "actual" or "empirical" statistical measures.

Figure 5.2 – 18. Histogram of implied volatilities for ATM calls on T-Bond Futures.

Characterising the statistical properties of the histogram in Figure 5.2 – 18 can be approached as before. For example, what are the implied volatility levels (or width) as defined by the 5- and 95-percentiles, given the histogram data in Figure 5.2 – 18? The answer is in Footnote[132], but try it yourself first.

Notice that, the implied volatility history and its histogram is "better behaved" than the price histories seen earlier. This is generally true when examining the "statistics of statistics". Rather like the observation that "averages of prices" are always "smoother" than the prices themselves, statistics of statistics are often "smoother" than the underlying process as well, and for a similar, though slightly more abstract reasons (some of which are discussed in Section 5.2.3 in connection with the effect of pre-processing to Diffs).

Figure 5.2 – 19. 20-year NIKKIE Index history with 30-day and 60-day historical volatilities.

Historical vs. implied volatility is examined in quite some detail in later Chapters and books, but Figure 5.2 – 19 is provided as an additional illustration. The 20-year NIKKIE

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[132] Answer: ignoring for the moment any refinement via interpolation, the lower 5%ntile mostly closely corresponds to 5.17%, which occurs at an implied volatility of 7.94%. Similarly, the upper 5%ntile (i.e. the 95%ntile) is found closest to an implied volatility of 10.64%. Therefore, the 90%-width defined by these choices is 10.64-7.94 = 2.7%. In other words, 90% of the implied volatilities (by these boundaries) are in a range 2.7% wide, whereas a comparable calculation on the Futures prices puts the width near 7%, and the contrast can be much more dramatic than that. Moreover, the implied volatilities tend to be heavily mean reverting to a "flat" or "trend free" central value, whereas the prices require quite complex de-trending. So what's the catch, why not just "forecast implied vols" and make a fortune? Chapters 11 - 13 and especially [4], [8] and [8.a] provide much discussion on this matter.

Index history is accompanied by two "historical volatility" series[133]. Historical Volatility (HV) is calculated directly from the dataset using traditional "standard deviation" methodologies (see Section 5.3, and [1] and [8]), unlike implied volatility (which is related to stochastic model assumptions). Again, notice that the HV's are "well behaved" compared with the price history. Take, for example, the last 10-years of data. Here, the HV is quite "flat" and in a relatively narrow range (approximately 10% in volatility terms, and approximately 60% in absolute terms). Compare this to the price history over the same period, which has an absolute range approaching 300%, and with pronounced trending effects.

One implication is that statistical results may be more amenable to forecasting (as opposed to the prices or underlying values themselves). For example, this situation suggests that while an option trader may have quite a difficult time forecasting, say, T-Bond Futures prices, she may have an easier time forecasting implied or historical volatilities. This is partially responsible for the (relatively) wide interest in methods such as GARCH. These issues, however, are well and truly a part of the modelling matters left for later Chapters and books (see [1] and [8]).

> Caveat: Have we forgotten anything here? Remember to be in the habit of relating everything back to P&L. For example, the analysis above compares the range or variability of prices vs. variability volatilities. The discussion concludes that prices are much more "volatile" than "volatilities". However, what is the value of a "point of volatility" vs. a "point of price". As it happens, the cash value of a point of volatility is a function of a number of factors. The value of a point of volatility can be quite substantial, and so when presented with such comparisons, it is often useful to relate the two measures back to a common footing to see how "your money" is affected. [1] provides introductory discussion on this matter, and [8] and [8.a] provide very detailed treatment.

[133] A little care about the terminology; a historical volatility calculation usually only results in a single "historical volatility value", here graphs show "histories of historical volatilities"