Appendix B. Study of higher twist effects.

The CTEQ6 PDF's are constructed by fitting next-leading order PQCD predictions, to experimental data for short-distance processes. There is a systematic theoretical error in the use of the NLO approximation. For example, in the case of DIS data, higher-order corrections and higher-twist contributions to $F_2(x, Q^2)$ are neglected in the theoretical model.

There have been several studies of the effect of higher-twist contributions to $F_2(x, Q^2)$. For data with small Q, the higher-twist effects may be significant. In our global analysis we only use DIS data points with $Q > 2\,\mathrm{GeV}$, but this cut does not ensure that higher-twist terms are negligible. One approach to reducing the higher-twist contribution would be to impose a higher cut on Q. Another approach, which has been studied in other PDF analyses `**[cite: MRST, Botje, Alekhin; the references are at the end]**` is to introduce a phenomenological higher-twist factor with adjustable parameters, and include the parameters as global fitting parameters. We have carried out a study of higher-twist using the latter approach.

The parametrized form for the higher-twist term is

$$F_2(x, Q^2) = F_2^{NLO}(x, Q^2)\left(1 + \frac{H(x)}{Q^2}\right) \tag{1}$$

where

$$H(x) = h_0 + h_1 x + h_2 x^2 + h_3 x^3 + h_4 x^4. \tag{2}$$

The five parameters $\{h_0, \ldots, h_4\}$ are determined by minimization of χ^2_{global} along with the other model parameters, hence using the data to determine the higher-twist effects. For simplicity, and following the earlier higher-twist studies, we have assumed that $\{h_0, \ldots, h_4\}$ are the same for all DIS processes.

Table 1 shows the results of our higher-twist study. The first column is the standard fit CTEQ6M, with no higher twist, i.e., $h_k = 0$. The second column is the best fit with higher-twist corrections. Figure X is a graph of the optimal function $H(x)$. The global χ^2 is slightly lower with the higher-twist correction, but the reduction $\Delta\chi^2_{\mathrm{global}} = -27$ does not represent a great improvement of the fit. Table 1 also lists the values of χ^2/N for individual DIS experiments.

Note that the reduction of χ^2_{global}, from inclusion of higher twist, comes mainly from an improved fit to the BCDMS data on μp and μd DIS. The

	CTEQ6M	Higher-twist fit
$\chi^2_{\rm global}$	2064.	2037.
χ^2/N		
BCDMS proton	1.09	1.05
BCDMS deuteron	1.10	1.03
H1 A	1.05	1.06
H1 B	1.02	1.02
ZEUS	1.21	1.22
NMC	1.61	1.59
CCFR F2	1.60	1.75

Table 1: Comparison of χ^2's for DIS measurements, with and without a phenomenlogical higher-twist correction.

HERA experiments are not affected by the higher-twist correction. The NMC experiment, which, like BCDMS, has data points at low values of Q, is fit only slightly better by including the higher-twist factor $H(x)$. The CCFR measurements of $F_2(x,Q)$ are in fact driven to a worse fit if the higher-twist correction is included.

Because the NMC data has a large χ^2 per point compared to other DIS experiments, we have also studied whether a higher-twist function $H_{\rm NMC}(x)$ can be found that makes χ^2/N smaller for the NMC experiment. The best fit for the NMC data, keeping the PDF's unchanged but optimizing the higher-twist correction to the NMC data, has $\chi^2/N = 1.57$. The associated function $H_{\rm NMC}(x)$ is somewhat different from the best global $H(x)$—more strongly negative for $x < 0.5$. However, the best fit for NMC is a not a good fit to the other DIS experiments, with $\chi^2_{\rm global} = 2077$. We find that it is not possible to significantly improve the fit to the NMC data by a higher-twist correction without damaging the fit to other DIS data.

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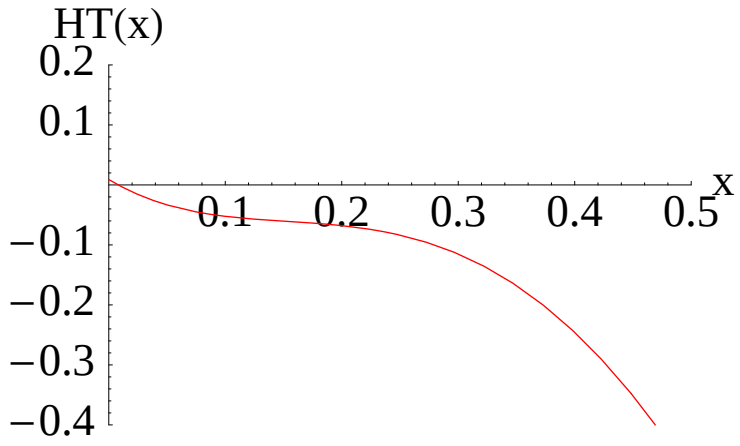

Figure 1: The function $H(x)$ for the phenomenological higher-twist correction to DIS.