$$= \frac{1}{\left(\frac{q^{1-n}}{x q^{N-n}}\right)_m \left(-x q^{N-n}\right)^n q^{\binom{n}{2}}} = \frac{1}{\left(q^{1-N} x^{-1}\right)_n \left(-x q^{N-n}\right)^n q^{\binom{n}{2}}}$$

Therefore,

$$\frac{(q)_N}{(q)_{N-n}} \cdot \frac{\left(\frac{c}{ab}\right)_{N-n}}{\left(\frac{c}{ab}\right)_N} \left(\frac{c}{ab}\right)^n$$

$$= \frac{\left(q^{-N}\right)_m \left(-q\right)^n \left(\frac{c}{ab}\right)^n}{\left(q^{1-N} a b c^{-1}\right)_m \left(-\frac{c}{ab}\right)^n}$$

$$= \frac{\left(q^{-N}\right)_n q^n}{\left(q^{1-N} a b c^{-1}\right)_m}.$$

Hence

$$\sum_{n=0}^{N} \frac{(a)_n (b)_n \left(q^{-N}\right)_n q^n}{(c)_n \left(a b c^{-1} q^{1-N}\right)_n (q)_n} = \frac{(c/a)_N (c/b)_N}{(c)_N (c/ab)_N}$$

(Jackson's q-analog of Saalschütz's Thm).

Now let

$$a = q^{-M+m}, \quad b = q^{m+n+1}, \quad c = q^{m+1}$$

$$\sum_{r=0}^{N} \frac{\left(q^{-M+m}\right)_r \left(q^{m+n+1}\right)_r q^r \left(q^{-N}\right)_r}{\left(q^{m+1}\right)_r \left(q^{-N-M+m+n+1}\right)_r (q)_r} = \frac{\left(q^{M+1}\right)_N \left(q^{-n}\right)_N}{\left(q^{m+1}\right)_N \left(q^{M-n-m}\right)_N}$$

We use

$$\left(q^{-N}\right)_r = \frac{(q)_N}{(q)_{N-r}} (-1)^r q^{r(r-1)/2 - rN}$$