1 Purpose

nag_jumpdiff_merton_greeks (s30jbc) computes the European option price together with its sensitivities (Greeks) using the Merton jump-diffusion model.

2 Specification

```c
#include <nag.h>
#include <nags.h>

void nag_jumpdiff_merton_greeks (Nag_OrderType order, Nag_CallPut option,
                          Integer m, Integer n, const double x[], double s, const double t[],
                          double sigma, double r, double lambda, double jvol, double p[],
                          double delta[], double gamma[], double vega[], double theta[],
                          double rho[], double vanna[], double charm[], double speed[],
                          double colour[], double zomma[], double vomma[], NagError *fail)
```

3 Description

nag_jumpdiff_merton_greeks (s30jbc) uses Merton’s jump-diffusion model (Merton (1976)) to compute the price of a European option, together with the Greeks or sensitivities, which are the partial derivatives of the option price with respect to certain of the other input parameters. Merton’s model assumes that the asset price is described by a Brownian motion with drift, as in the Black–Scholes–Merton case, together with a compound Poisson process to model the jumps. The corresponding stochastic differential equation is,

$$\frac{dS}{S} = (\alpha - \lambda k)dt + \sigma dW_t + dq_t.$$  

Here $\alpha$ is the instantaneous expected return on the asset price, $S$; $\sigma^2$ is the instantaneous variance of the return when the Poisson event does not occur; $dW_t$ is a standard Brownian motion; $dq_t$ is the independent Poisson process and $k = E[Y - 1]$ where $Y - 1$ is the random variable change in the stock price if the Poisson event occurs and $E$ is the expectation operator over the random variable $Y$.

This leads to the following price for a European option (see Haug (2007))

$$P_{\text{call}} = \sum_{j=0}^{\infty} \frac{e^{-\lambda T} (\lambda T)^j}{j!} C_j(S, X, T, r, \sigma'_j),$$

where $T$ is the time to expiry; $X$ is the strike price; $r$ is the annual risk-free interest rate; $C_j(S, X, T, r, \sigma'_j)$ is the Black–Scholes–Merton option pricing formula for a European call (see nag_bsm_price (s30aac)).

$$\sigma'_j = \sqrt{z^2 + \delta^2 j},$$

$$z^2 = \sigma^2 - \lambda \delta^2,$$

$$\delta^2 = \frac{\gamma \sigma^2}{\lambda},$$

where $\sigma$ is the total volatility including jumps; $\lambda$ is the expected number of jumps given as an average per year; $\gamma$ is the proportion of the total volatility due to jumps.

The value of a put is obtained by substituting the Black–Scholes–Merton put price for $C_j(S, X, T, r, \sigma'_j)$. 

Mark 25
The option price \( P_{ij} = P(X = X_i, T = T_j) \) is computed for each strike price in a set \( X_i, \) \( i = 1, 2, \ldots, m \), and for each expiry time in a set \( T_j, j = 1, 2, \ldots, n \).

### 4 References


Merton R C (1976) Option pricing when underlying stock returns are discontinuous Journal of Financial Economics 3 125–144

### 5 Arguments

1. **order** – Nag_OrderType
   
   *Input*
   
   *On entry:* the \( \text{order} \) argument specifies the two-dimensional storage scheme being used, i.e., row-major ordering or column-major ordering. C language defined storage is specified by \( \text{order} = \text{Nag RowMajor} \). See Section 3.2.1.3 in the Essential Introduction for a more detailed explanation of the use of this argument.
   
   *Constraint:* \( \text{order} = \text{Nag RowMajor} \) or \( \text{Nag ColMajor} \).

2. **option** – Nag_CallPut
   
   *Input*
   
   *On entry:* determines whether the option is a call or a put.
   
   \( \text{option} = \text{Nag Call} \)
   
   A call; the holder has a right to buy.
   
   \( \text{option} = \text{Nag Put} \)
   
   A put; the holder has a right to sell.
   
   *Constraint:* \( \text{option} = \text{Nag Call} \) or \( \text{Nag Put} \).

3. **m** – Integer
   
   *Input*
   
   *On entry:* the number of strike prices to be used.
   
   *Constraint:* \( m \geq 1 \).

4. **n** – Integer
   
   *Input*
   
   *On entry:* the number of times to expiry to be used.
   
   *Constraint:* \( n \geq 1 \).

5. **x** – const double
   
   *Input*
   
   *On entry:* \( x[i-1] \) must contain \( X_i \), the \( i \)th strike price, for \( i = 1, 2, \ldots, m \).
   
   *Constraint:* \( x[i-1] \geq z \) and \( x[i-1] \leq 1/z \), where \( z = \text{nag\_real\_safe\_small\_number} \), the safe range parameter, for \( i = 1, 2, \ldots, m \).

6. **s** – double
   
   *Input*
   
   *On entry:* \( S \), the price of the underlying asset.
   
   *Constraint:* \( s \geq z \) and \( s \leq 1.0/z \), where \( z = \text{nag\_real\_safe\_small\_number} \), the safe range parameter.

7. **t** – const double
   
   *Input*
   
   *On entry:* \( t[i-1] \) must contain \( T_i \), the \( i \)th time, in years, to expiry, for \( i = 1, 2, \ldots, n \).
   
   *Constraint:* \( t[i-1] \geq z \), where \( z = \text{nag\_real\_safe\_small\_number} \), the safe range parameter, for \( i = 1, 2, \ldots, n \).
8: \textbf{sigma} – double \hspace{1cm} \textit{Input}

\textit{On entry:} \(\sigma\), the annual total volatility, including jumps.
\textit{Constraint:} \(\text{sigma} > 0.0\).

9: \textbf{r} – double \hspace{1cm} \textit{Input}

\textit{On entry:} \(r\), the annual risk-free interest rate, continuously compounded. Note that a rate of 5\% should be entered as 0.05.
\textit{Constraint:} \(r \geq 0.0\).

10: \textbf{lambda} – double \hspace{1cm} \textit{Input}

\textit{On entry:} \(\lambda\), the number of expected jumps per year.
\textit{Constraint:} \(\lambda > 0.0\).

11: \textbf{jvol} – double \hspace{1cm} \textit{Input}

\textit{On entry:} the proportion of the total volatility associated with jumps.
\textit{Constraint:} \(0.0 \leq \text{jvol} < 1.0\).

12: \textbf{p[m \times n]} – double \hspace{1cm} \textit{Output}

\textit{Note:} where \(P(i, j)\) appears in this document, it refers to the array element
\[
\begin{align*}
\text{p}[(j - 1) \times m + i - 1] & \text{ when order = Nag_ColMajor;} \\
\text{p}[(i - 1) \times n + j - 1] & \text{ when order = Nag_RowMajor.}
\end{align*}
\]

\textit{On exit:} \(P(i, j)\) contains \(P_{ij}\), the option price evaluated for the strike price \(x_i\) at expiry \(t_j\) for \(i = 1, 2, \ldots, m\) and \(j = 1, 2, \ldots, n\).

13: \textbf{delta[m \times n]} – double \hspace{1cm} \textit{Output}

\textit{Note:} the \((i, j)\)th element of the matrix is stored in
\[
\begin{align*}
\text{delta}[(j - 1) \times m + i - 1] & \text{ when order = Nag_ColMajor;} \\
\text{delta}[(i - 1) \times n + j - 1] & \text{ when order = Nag_RowMajor.}
\end{align*}
\]

\textit{On exit:} the \(m \times n\) array \text{delta} contains the sensitivity, \(\frac{\partial P}{\partial S}\), of the option price to change in the price of the underlying asset.

14: \textbf{gamma[m \times n]} – double \hspace{1cm} \textit{Output}

\textit{Note:} the \((i, j)\)th element of the matrix is stored in
\[
\begin{align*}
\text{gamma}[(j - 1) \times m + i - 1] & \text{ when order = Nag_ColMajor;} \\
\text{gamma}[(i - 1) \times n + j - 1] & \text{ when order = Nag_RowMajor.}
\end{align*}
\]

\textit{On exit:} the \(m \times n\) array \text{gamma} contains the sensitivity, \(\frac{\partial^2 P}{\partial S^2}\), of \text{delta} to change in the price of the underlying asset.

15: \textbf{vega[m \times n]} – double \hspace{1cm} \textit{Output}

\textit{Note:} where \text{VEGA}(i, j)\) appears in this document, it refers to the array element
\[
\begin{align*}
\text{vega}[(j - 1) \times m + i - 1] & \text{ when order = Nag_ColMajor;} \\
\text{vega}[(i - 1) \times n + j - 1] & \text{ when order = Nag_RowMajor.}
\end{align*}
\]

\textit{On exit:} \text{VEGA}(i, j), contains the first-order Greek measuring the sensitivity of the option price \(P_{ij}\) to change in the volatility of the underlying asset, i.e., \(\frac{\partial P_{ij}}{\partial \sigma}\), for \(i = 1, 2, \ldots, m\) and \(j = 1, 2, \ldots, n\).
On exit: THETA(i, j), contains the first-order Greek measuring the sensitivity of the option price \( P_{ij} \) to change in time, i.e., \(-\frac{\partial P_{ij}}{\partial t}\), for \( i = 1, 2, \ldots, m \) and \( j = 1, 2, \ldots, n \), where \( b = r - q \).

17: \textbf{rho} \([m \times n]\) – double

Note: where RHO(i, j) appears in this document, it refers to the array element

\[ \text{rho}[(j - 1) \times m + i - 1] \text{ when order} = \text{Nag\_ColMajor}; \]
\[ \text{rho}[(i - 1) \times n + j - 1] \text{ when order} = \text{Nag\_RowMajor}. \]

On exit: RHO(i, j), contains the first-order Greek measuring the sensitivity of the option price \( P_{ij} \) to change in the annual risk-free interest rate, i.e., \(-\frac{\partial P_{ij}}{\partial r}\), for \( i = 1, 2, \ldots, m \) and \( j = 1, 2, \ldots, n \).

18: \textbf{vanna} \([m \times n]\) – double

Note: where VANNA(i, j) appears in this document, it refers to the array element

\[ \text{vanna}[(j - 1) \times m + i - 1] \text{ when order} = \text{Nag\_ColMajor}; \]
\[ \text{vanna}[(i - 1) \times n + j - 1] \text{ when order} = \text{Nag\_RowMajor}. \]

On exit: VANNA(i, j), contains the second-order Greek measuring the sensitivity of the first-order Greek \( \Delta_{ij} \) to change in the volatility of the asset price, i.e., \(-\frac{\partial \Delta_{ij}}{\partial \sigma^2} = -\frac{\partial^2 P_{ij}}{\partial \sigma^2 \partial \sigma^2}\), for \( i = 1, 2, \ldots, m \) and \( j = 1, 2, \ldots, n \).

19: \textbf{charm} \([m \times n]\) – double

Note: where CHARM(i, j) appears in this document, it refers to the array element

\[ \text{charm}[(j - 1) \times m + i - 1] \text{ when order} = \text{Nag\_ColMajor}; \]
\[ \text{charm}[(i - 1) \times n + j - 1] \text{ when order} = \text{Nag\_RowMajor}. \]

On exit: CHARM(i, j), contains the second-order Greek measuring the sensitivity of the first-order Greek \( \Delta_{ij} \) to change in the time, i.e., \( \frac{\partial \Delta_{ij}}{\partial \tau} = \frac{\partial^2 P_{ij}}{\partial \tau \partial \tau}\), for \( i = 1, 2, \ldots, m \) and \( j = 1, 2, \ldots, n \).

20: \textbf{speed} \([m \times n]\) – double

Note: where SPEED(i, j) appears in this document, it refers to the array element

\[ \text{speed}[(j - 1) \times m + i - 1] \text{ when order} = \text{Nag\_ColMajor}; \]
\[ \text{speed}[(i - 1) \times n + j - 1] \text{ when order} = \text{Nag\_RowMajor}. \]

On exit: SPEED(i, j), contains the third-order Greek measuring the sensitivity of the second-order Greek \( \Gamma'_{ij} \) to change in the price of the underlying asset, i.e., \( \frac{\partial \Gamma'_{ij}}{\partial S} = \frac{\partial^3 P_{ij}}{\partial S^3}\), for \( i = 1, 2, \ldots, m \) and \( j = 1, 2, \ldots, n \).

21: \textbf{colour} \([m \times n]\) – double

Note: where COLOUR(i, j) appears in this document, it refers to the array element

\[ \text{colour}[(j - 1) \times m + i - 1] \text{ when order} = \text{Nag\_ColMajor}; \]
\[ \text{colour}[(i - 1) \times n + j - 1] \text{ when order} = \text{Nag\_RowMajor}. \]

On exit: COLOUR(i, j), contains the third-order Greek measuring the sensitivity of the second-order Greek \( \Gamma_{ij} \) to change in the time, i.e., \( \frac{\partial \Gamma_{ij}}{\partial \tau} = \frac{\partial^3 P_{ij}}{\partial \tau \partial \tau \partial \tau}\), for \( i = 1, 2, \ldots, m \) and \( j = 1, 2, \ldots, n \).
22:  \texttt{zomma[m x n]} – double \textit{Output}

\textbf{Note:} where \texttt{ZOMMA}(i, j) appears in this document, it refers to the array element
\begin{align*}
\texttt{zomma[(j-1) x m + i - 1]} & \text{ when } \texttt{order} = \texttt{Nag\_ColMajor}; \\
\texttt{zomma[(i-1) x n + j - 1]} & \text{ when } \texttt{order} = \texttt{Nag\_RowMajor}.
\end{align*}

\textit{On exit:} \texttt{ZOMMA}(i, j), contains the third-order Greek measuring the sensitivity of the second-order Greek $\Gamma_{ij}$ to change in the volatility of the underlying asset, i.e., \( \frac{\partial^3 \Gamma_{ij}}{\partial \sigma^3} = \frac{\partial^2 \Gamma_{ij}}{\partial \sigma^2 \partial \sigma} \), for \( i = 1, 2, \ldots, m \) and \( j = 1, 2, \ldots, n \).

23:  \texttt{vomma[m x n]} – double \textit{Output}

\textbf{Note:} where \texttt{VOMMA}(i, j) appears in this document, it refers to the array element
\begin{align*}
\texttt{vomma[(j-1) x m + i - 1]} & \text{ when } \texttt{order} = \texttt{Nag\_ColMajor}; \\
\texttt{vomma[(i-1) x n + j - 1]} & \text{ when } \texttt{order} = \texttt{Nag\_RowMajor}.
\end{align*}

\textit{On exit:} \texttt{VOMMA}(i, j), contains the second-order Greek measuring the sensitivity of the first-order Greek $\Delta_{ij}$ to change in the volatility of the underlying asset, i.e., \( \frac{\partial \Delta_{ij}}{\partial \sigma} = \frac{\partial^2 \Gamma_{ij}}{\partial \sigma \partial \sigma} \), for \( i = 1, 2, \ldots, m \) and \( j = 1, 2, \ldots, n \).

24:  \texttt{fail} – \texttt{NagError} \textit{Input/Output}

The NAG error argument (see Section 3.6 in the Essential Introduction).

6 \ Error Indicators and Warnings

\textbf{NE\_ALLOC\_FAIL}

Dynamic memory allocation failed.
See Section 3.2.1.2 in the Essential Introduction for further information.

\textbf{NE\_BAD\_PARAM}

On entry, argument \enquote{value} had an illegal value.

\textbf{NE\_INT}

On entry, \texttt{m} = \enquote{value}.
Constraint: \texttt{m} $\geq$ 1.

On entry, \texttt{n} = \enquote{value}.
Constraint: \texttt{n} $\geq$ 1.

\textbf{NE\_INTERNAL\_ERROR}

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please contact NAG for assistance.

An unexpected error has been triggered by this function. Please contact NAG.
See Section 3.6.6 in the Essential Introduction for further information.

\textbf{NE\_NO\_LICENCE}

Your licence key may have expired or may not have been installed correctly.
See Section 3.6.5 in the Essential Introduction for further information.

\textbf{NE\_REAL}

On entry, \texttt{jvol} = \enquote{value}.
Constraint: \texttt{jvol} $\geq$ 0.0 and \texttt{jvol} < 1.0.

On entry, \texttt{lambda} = \enquote{value}.
Constraint: \texttt{lambda} $>$ 0.0.
On entry, \( r = \langle \text{value} \rangle \).
Constraint: \( r \geq 0.0 \).

On entry, \( s = \langle \text{value} \rangle \).
Constraint: \( s \geq \langle \text{value} \rangle \) and \( s \leq \langle \text{value} \rangle \).

On entry, \( \sigma = \langle \text{value} \rangle \).
Constraint: \( \sigma > 0.0 \).

**NE_REAL_ARRAY**

On entry, \( t[i] = \langle \text{value} \rangle \).
Constraint: \( t[i] \geq \langle \text{value} \rangle \).

On entry, \( x[i] = \langle \text{value} \rangle \).
Constraint: \( x[i] \geq \langle \text{value} \rangle \) and \( x[i] \leq \langle \text{value} \rangle \).

### 7 Accuracy

The accuracy of the output is dependent on the accuracy of the cumulative Normal distribution function, \( \Phi \), occurring in \( C_i \). This is evaluated using a rational Chebyshev expansion, chosen so that the maximum relative error in the expansion is of the order of the *machine precision* (see `nag_cumul_normal (s15abc)` and `nag_erfc (s15adc)`). An accuracy close to *machine precision* can generally be expected.

### 8 Parallelism and Performance

`nag_jumpdiff_merton_greeks (s30jbc)` is threaded by NAG for parallel execution in multithreaded implementations of the NAG Library.

Please consult the X06 Chapter Introduction for information on how to control and interrogate the OpenMP environment used within this function. Please also consult the Users’ Note for your implementation for any additional implementation-specific information.

### 9 Further Comments

None.

### 10 Example

This example computes the price of two European calls with jumps. The time to expiry is 6 months, the stock price is 100 and strike prices are 80 and 90 respectively. The number of jumps per year is 5 and the percentage of the total volatility due to jumps is 25\%.

The risk-free interest rate is 8\% per year while the total volatility is 25\% per year.

#### 10.1 Program Text

```c
#include <stdio.h>
#include <string.h>
#include <nag.h>
#include <nag_stdlib.h>

int main(void)
{
    /* Integer scalar and array declarations */
    Integer exit_status = 0;
    Integer i, j, m, n;
```
NagError fail;
Nag_CallPut putnum;
/* Double scalar and array declarations */
double jvol, lambda, r, s, sigma;
double *charm = 0, *colour = 0, *delta = 0, *gamma = 0, *p = 0;
double *rho = 0, *speed = 0, *t = 0, *theta = 0, *vanna = 0;
double *vega = 0, *vomma = 0, *x = 0, *zomma = 0;
/* Character scalar and array declarations */
char put[8+1];
Nag_OrderType order;
INIT_FAIL(fail);
printf("nag_jumpdiff_merton_greeks (s30jbc) Example Program Results\n");
printf("Merton Jump-Diffusion Model\n\n");
/* Skip heading in data file */
#ifdef _WIN32
    scanf_s("%*[\n"]);
#else
    scanf("%*[\n"]);
#endif
/* Read put */
#ifdef _WIN32
    scanf_s("%8s%*[\n"] , put, _countof(put));
#else
    scanf("%8s%*[\n"] , put);
#endif
/* nag_enum_name_to_value (x04nac).
* Converts NAG enum member name to value
*/
putnum = (Nag_CallPut) nag_enum_name_to_value(put);
/* Read lambda, sigma, r, jvol */
#ifdef _WIN32
    scanf_s("%lf%lf%lf%lf%lf%*[\n"] , &lambda, &s, &sigma, &r, &jvol);
#else
    scanf("%lf%lf%lf%lf%lf%*[\n"] , &lambda, &s, &sigma, &r, &jvol);
#endif
/* Read m, n */
#ifdef _WIN32
    scanf_s("%"NAG_IFMT"%"NAG_IFMT "%*[\n"] , &m, &n);
#else
    scanf("%"NAG_IFMT"%"NAG_IFMT "%*[\n"] , &m, &n);
#endif
#ifdef NAG_COLUMN_MAJOR
#define CHARM(I, J) charm[(J-1)*m + I-1]
#define COLOUR(I, J) colour[(J-1)*m + I-1]
#define DELTA(I, J) delta[(J-1)*m + I-1]
#define GAMMA(I, J) gamma[(J-1)*m + I-1]
#define P(I, J) p[(J-1)*m + I-1]
#define RHO(I, J) rho[(J-1)*m + I-1]
#define SPEED(I, J) speed[(J-1)*m + I-1]
#define THETA(I, J) theta[(J-1)*m + I-1]
#define VANNA(I, J) vanna[(J-1)*m + I-1]
#define VEGA(I, J) vega[(J-1)*m + I-1]
#define VOMMA(I, J) vomma[(J-1)*m + I-1]
#define ZOMMA(I, J) zomma[(J-1)*m + I-1]
#else
#define CHARM(I, J) charm[(I-1)*n + J-1]
#define COLOUR(I, J) colour[(I-1)*n + J-1]
#define DELTA(I, J) delta[(I-1)*n + J-1]
#define GAMMA(I, J) gamma[(I-1)*n + J-1]
#define P(I, J) p[(I-1)*n + J-1]
#define RHO(I, J) rho[(I-1)*n + J-1]
#define SPEED(I, J) speed[(I-1)*n + J-1]
#define THETA(I, J) theta[(I-1)*n + J-1]
#define VANNA(I, J) vanna[(I-1)*n + J-1]
#define VEGA(I, J) vega[(I-1)*n + J-1]
#define VOMMA(I, J) vomma[(I-1)*n + J-1]
#define ZOMMA(I, J) zomma[(I-1)*n + J-1]
order = Nag_ColMajor;
#else
#define CHARM(I, J) charm[(I-1)*n + J-1]
#define COLOUR(I, J) colour[(I-1)*n + J-1]
#define DELTA(I, J) delta[(I-1)*n + J-1]
#define GAMMA(I, J) gamma[(I-1)*n + J-1]
#define P(I, J) p[(I-1)*n + J-1]
#define RHO(I, J) rho[(I-1)*n + J-1]
#define SPEED(I, J) speed[(I-1)*n + J-1]
#define THETA(I, J) theta[(I-1)*n + J-1]
#define VANNA(I, J) vanna[(I-1)*n + J-1]
#define VEGA(I, J) vega[(I-1)*n + J-1]
#define VOMMA(I, J) vomma[(I-1)*n + J-1]
#define ZOMMA(I, J) zomma[(I-1)*n + J-1]
#endif
```c
order = Nag_RowMajor;
#endif
if (!charm || !colour || !delta || !gamma || !p || !rho || !speed || !t || !theta || !vanna || !vega || !vomma || !x || !zomma)
{
printf("Allocation failure\n");
exit_status = -1;
goto END;
}
/* Read array of strike/exercise prices, X */
for (i = 0; i < m; i++)
#ifdef _WIN32
scanf_s("%lf ", &x[i]);
#else
scanf("%lf ", &x[i]);
#endif
#ifdef _WIN32
scanf_s("%*[\n] ");
#else
scanf("%*[\n] ");
#endif
/* Read array of times to expiry */
for (i = 0; i < n; i++)
#ifdef _WIN32
scanf_s("%lf ", &t[i]);
#else
scanf("%lf ", &t[i]);
#endif
#ifdef _WIN32
scanf_s("%*[\n] ");
#else
scanf("%*[\n] ");
#endif
/* nag_jumpdiff_merton_greeks (s30jbc) */
/* Jump-diffusion, Merton's model, option pricing formula with Greeks */
nag_jumpdiff_merton_greeks(order, putnum, m, n, x, s, t, sigma, r,
lambda, jvol, p, delta, gamma, vega,
theta, rho, vanna, charm, speed, colour,
zomma, vomma, &fail);
if (fail.code != NE_NOERROR)
{
printf("Error from nag_jumpdiff_merton_greeks (s30jbc).\n%s\n", fail.message);
exit_status = 1;
goto END;
}
if (putnum == Nag_Call)
printf("%s\n", "European Call :");
else if (putnum == Nag_Put)
printf("%s\n", "European Put :");
print(" Spot = \%8.4f\n", s);
print(" Volatility = \%8.4f\n", sigma);
print(" Rate = \%8.4f\n", r);
print(" Jumps = \%8.4f\n", lambda);
print(" Jump vol = \%8.4f\n", jvol);
print("\n");
for (j = 1; j <= n; j++)
```
printf("\n Time to Expiry : %.8f", t[i-1]);
printf(" Strike Price  Delta  Gamma  Vega  
Theta  Rho\n");
for (i = 1; i <= m; i++)
printf("%8.4f %8.4f %8.4f %8.4f %8.4f %8.4f %8.4f\n", x[i-1],
P(i, j), DELTA(i, j), GAMMA(i, j), VEGA(i, j), THETA(i, j),
RHO(i, j));
printf(" Colour  Zomma  Vomma\n");
for (i = 1; i <= m; i++)
printf("%26.4f %8.4f %8.4f %8.4f %8.4f \n", VANNA(i, j),
CHARM(i, j), SPEED(i, j), COLOUR(i, j), ZOMMA(i, j),
VOMMA(i, j));
}

END:
NAG_FREE(charm);
NAG_FREE(colour);
NAG_FREE(delta);
NAG_FREE(gamma);
NAG_FREE(p);
NAG_FREE(rho);
NAG_FREE(speed);
NAG_FREE(t);
NAG_FREE(theta);
NAG_FREE(vanna);
NAG_FREE(vega);
NAG_FREE(x);
NAG_FREE(zomma);

return exit_status;

10.2 Program Data

nag_jumpdiff_merton_greeks (s30jbc) Example Program Data

Nag_Call : Nag_Call or Nag_Put
5.0 100.0 0.25 0.08 0.25 : lambda (jumps), s, sigma, r, jvol
2 1 : m, n
80.0
90.0 : X(I), I = 1,2,...m
0.5 : T(I), I = 1,2,...n

10.3 Program Results

nag_jumpdiff_merton_greeks (s30jbc) Example Program Results
Merton Jump-Diffusion Model

European Call :

Spot = 100.0000
Volatility = 0.2500
Rate = 0.0800
Jumps = 5.0000
Jump vol = 0.2500

Time to Expiry : 0.5000
Strike Price Delta Gamma Vega Theta Rho
80.0000 23.6090 0.9431 0.0064 8.1206 -7.6718 35.3480
90.0000 15.4193 0.8203 0.0149 18.5256 -9.9695 33.3037

Vanna Charm Speed Colour Zomma Vomma
-0.6334 0.1080 -0.0006 -0.0035 0.0315 70.6824
-0.7726 0.0770 -0.0009 0.0109 -0.0186 49.7161

Mark 25