Single Pin Barrier Option

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1 Input to Function

Description	*Symbol*	*min*	*max*	*Reasonable range*
Underlying price	S	0^+	$+\infty$	
Strike price	X	0^+	$+\infty$	
Barrier level	H	0^+	$+\infty$	
Continuous risk-free interest rate till t_1	r_1	0^+	$+\infty$	
Continuous secondary rate till t_1	q_1	0^+	$+\infty$	
Volatility till t_1	σ_1	0^+	$+\infty$	
Time to barrier observation	t_1	0^+	$< T_2$	
Continuous risk-free interest rate till T_2	r_2	0^+	$+\infty$	
Continuous secondary rate till T_2	q_2	0^+	$+\infty$	
Volatility till T_2	σ_2	0^+	$+\infty$	
Time to option maturity	T_2	$> t_1$	$+\infty$	
Put or Call		–	–	"P", "C"
Up or Down	*indicator*	–	–	"U", "D"
In or Out		–	–	"I", "O"

Table 1: Inputs for Single Pin Barrier Option pricing function

2 Formula

The value of a *single pin barrier* option is given by

$$\boxed{\phi S e^{-q_2 T_2} N_2\left(\eta h_1, \phi b_1; \eta\phi\rho\right) - \phi X e^{-r_2 T_2} N_2\left(\eta h_2, \phi b_2; \eta\phi\rho\right),}$$

where

$$h_1 = \frac{\ln\frac{S}{H} + \left(r_1 - q_1 + \frac{\sigma_1^2}{2}\right) t_1}{\sigma_1\sqrt{t_1}} \qquad h_2 = h_1 - \sigma_1\sqrt{t_1}$$

$$b_1 = \frac{\ln\frac{S}{X} + \left(r_2 - q_2 + \frac{\sigma_2^2}{2}\right) T_2}{\sigma_2\sqrt{T_2}} \qquad b_2 = b_1 - \sigma_2\sqrt{T_2}$$

$$\rho = \frac{\sigma_1\sqrt{t_1}}{\sigma_2\sqrt{T_2}}.$$

ϕ	Option Type	η	Barrier Type
-1	Put	-1	Up-and-out/Down-and-in
1	Call	1	Down-and-out/Up-and-in

3 Properties of Instrument

A single pin barrier option, is an option with a barrier applicable only at one point, time t_1, during the option's life.

An up-and-in, or down-and-out, single pin barrier option has vanilla payoff, provided the spot rate is *above* the barrier level at time t_1. For a down-and-in or up-and-out single pin barrier option, the payoff is vanilla provided the spot rate is *below* the barrier level at time t_1.