Shedding Light on Common Misconceptions

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Today, we go back to financial products 101 and discuss payoff, P&L and financial exchange rate diagrams, the risk of short options and a long call option with a negative time value. The reason is that I regularly experience confusion and misconception, thus it is time to clarify. Furthermore, there are reasons why different market participants look at financial products from a different angle.

1. Payoff vs. P&L

As an example, we consider a GBP call USD put option with strike K=1.3000. At university we learn how the payoff is visualized in a diagram. We put the GBP/USD spot S_T (the price of a British pound in USD) at maturity on the x-axis and the payoff $\max(S_T - K, 0)$ on the y-axis. This is the payoff diagram in green shown in Figure 1, commonly referred to as the hockey-stick.

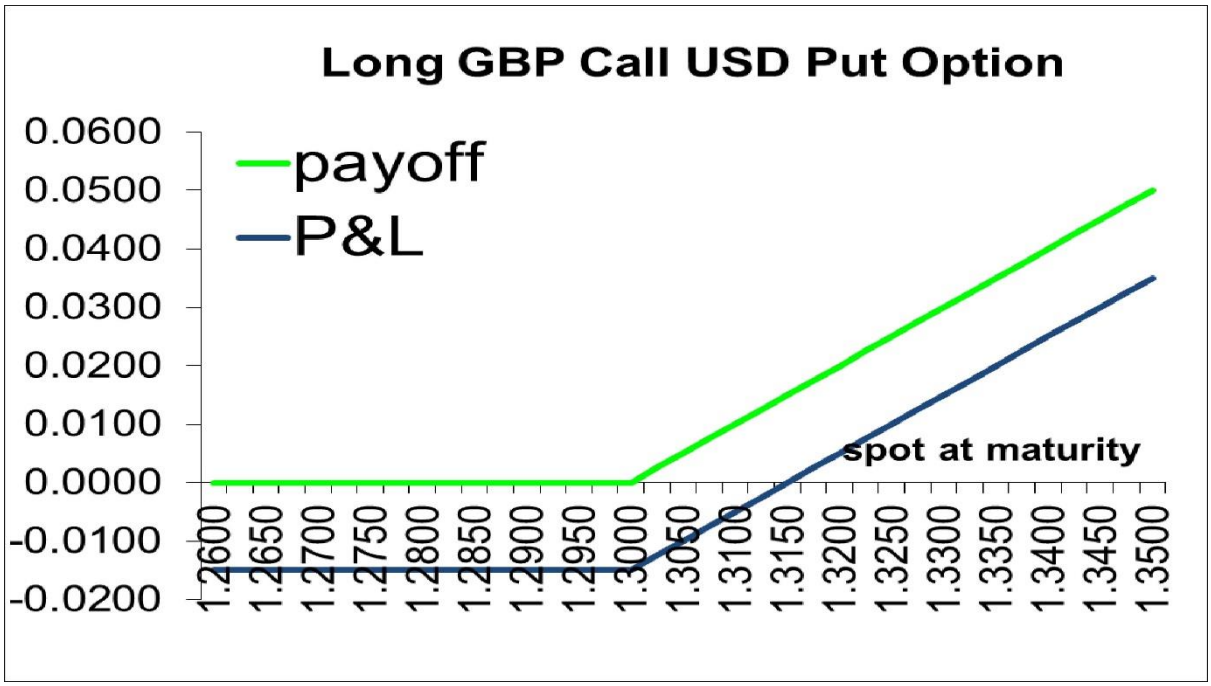

Figure 1: Payoff and P&L diagram of a GBP call USD put option

But then some people say, this doesn't take into account the initial option premium. This is correct, but fully intended, as the payoff is a product feature - independent of its value. We can take the premium of 150 USD pips into account and plot a *P&L-diagram* in blue in Figure 1. This shows that the final spot price must be 150 pips above the strike to break even, i.e. to recuperate at least the initial option premium from exercising the GBP call.

The P&L diagram is typically considered by investors, whereas the payoff diagram is used to understand the product, calculate the intrinsic value and the expected value, which will then lead to the option premium.

2. Payoff vs. Effective Exchange Rate

There is yet another illustration of the same GBP call, and this is especially interesting for a corporate treasurer, who uses the GBP call as a hedge to convert a USD amount into a GBP amount. This treasurer will want to know his *Effective Exchange Rate*, i.e. the exchange rate that applies to his cash flow at maturity taking the GBP call into account. The treasurer has a worst case of 1.3000 USD per GBP. If GBP-USD ends up below this worst case, i.e. the strike of the GBP call, then he can sell USD in the spot market at a better rate and let the option expire. His final exchange rate is hence equal to the spot. This is $\min(S_T,K)$, exhibited in Figure 2.

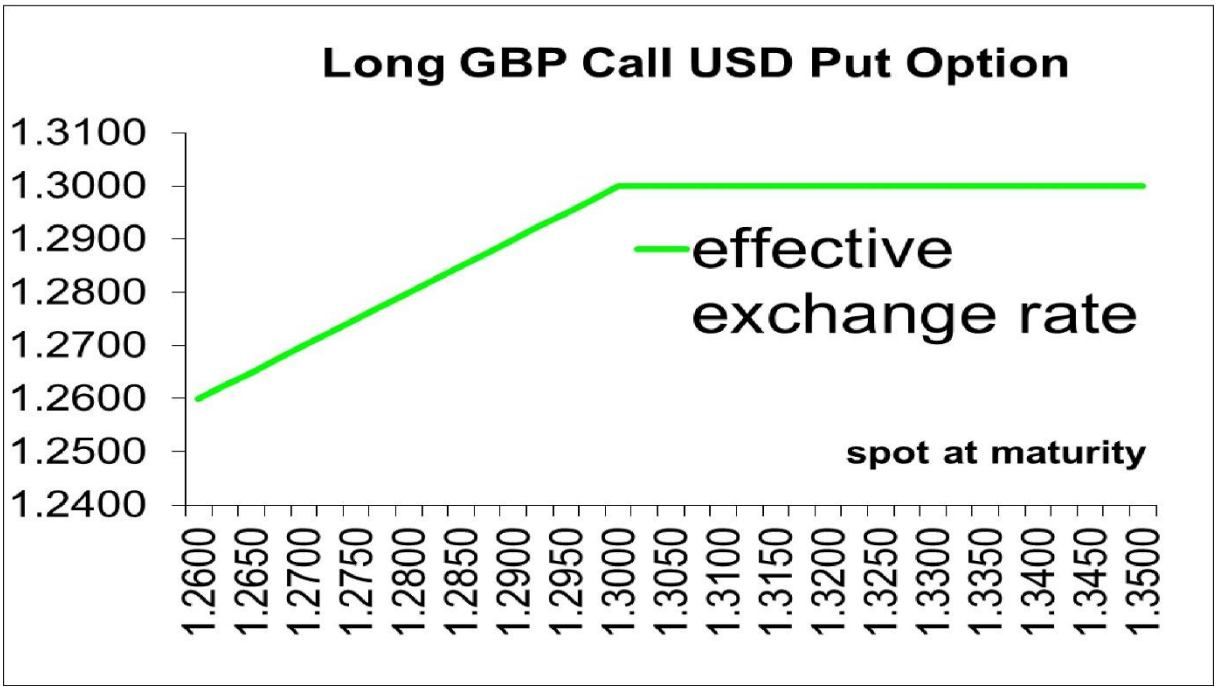

Figure 2: Effective Final Exchange Rate of a GBP call USD put with Strike 1.3000

This Effective Final Exchange Rate diagram looks like a short GBP put, but is actually a visualization of a long GBP call. All in all, we have three diagrams for the GBP call USD put that focus on different points of view.

3. Risk of short call vs. short put options

And while we are at it, I often read and am told that short puts are less risky than short calls. Everybody normally agrees with this as for a short put, the crowd will agree that the loss of a put option is limited to the strike price, whereas the maximum potential loss of a call is infinite.

This is a suspicious lack of symmetry, isn't it? To clarify, the FX view can help: **The maximum potential loss depends on the currency in which you measure it.** Consider the short GBP put USD call in Figure 3. Students – and market participants of other asset classes – typically put (unconsciously) USD on the y-axis and think that the loss is bounded by the strike price.

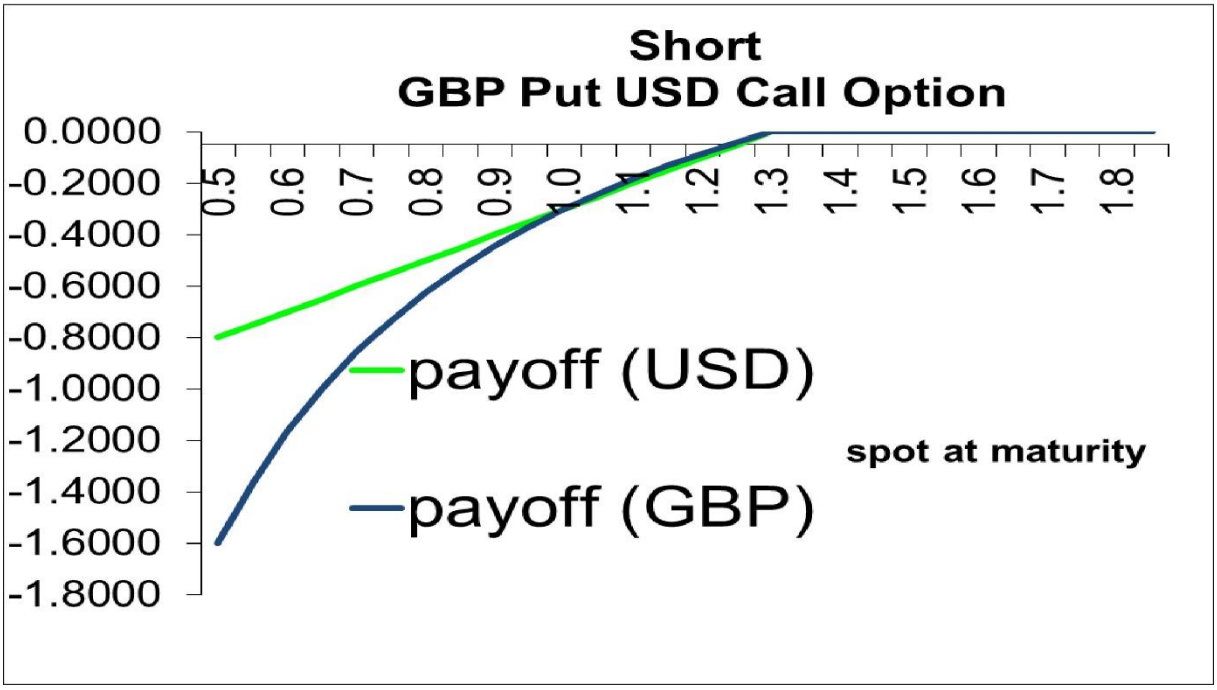

Figure 3: USD Payoff vs. GBP Payoff of a short GBP put USD call

However, if we measure the potential loss in GBP – and there are quite a few banks with this approach in London – the payoff becomes $-\max(K-S_T)/ S_T$, which converges to negative infinity as spot goes to zero, indicated by the blue curve.

Note that this payoff is just the one of a vanilla put, there is nothing exotic about it, and it is not a quanto put. It all comes back to my favorite question in FX markets: **"which currency?"** With GBP on the y-axis, the payoff of a vanilla put is no longer linear.

Your homework is to plot and compare the payoffs in USD and GBP of a short GBP call USD put, with the goal to find out that the maximum potential loss of a short GBP call is -1 GBP, i.e., finite when measured in GBP. This is rather intuitive, because the maximum you need to pay as an option writer is the call currency amount, which is 1 GBP. **It is just not true that short calls are more risky than short puts.**

4. Long Call Option with Negative Time Value

In general derivatives textbooks the value of a call option is often presented as the sum of the intrinsic value $\max(0,S_T-K)$ and the time value as illustrated in Figure 4.

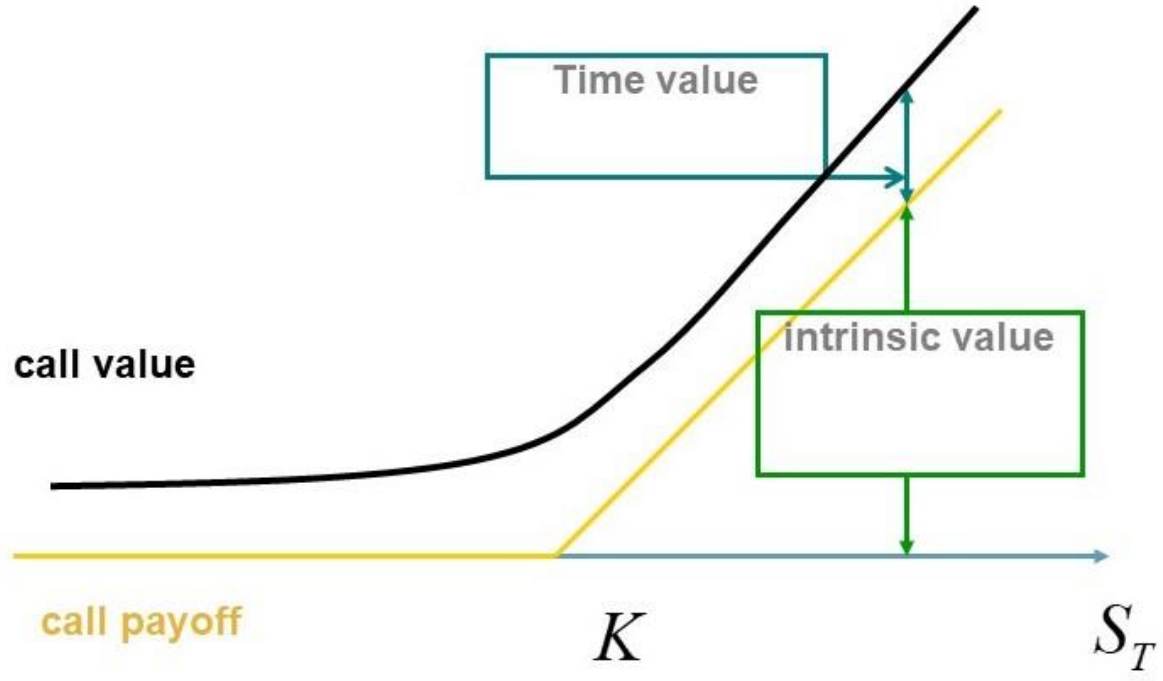

Figure 4: payoff and value function of a call option

One question I like to ask is if the time value can ever be negative. Since most of the time I get "no" as an answer, with the additional reasoning that otherwise the holder of the call option would exercise earlier, let me clarify today: In FX context options are normally of European exercise style, which means that the holder can only exercise them on the maturity date. American options that allow exercise during the live time as well are more common in equities.

The best way to understand the reason is to consider FX options in their traditional way as hedging instruments for corporate treasurers. A corporate treasurer would normally not buy an American option, because (a) it would be unnecessarily expensive compared to the same European option and (b) the cash flow to be hedged is normally not available before maturity. Consequently, unless you say otherwise, FX options are of European exercise style.

That clarified, how can a European call option have a negative time value? We can recycle our knowledge about American options and argue that the American option would only be exercised early if the foreign interest rate is significantly larger than the foreign interest rate. For the equity options fans this is equivalent to a call on a dividend paying stock. A real-live example is a 1Y USD call JPY put, which I have priced in Eikon, see Figure 5.

Figure 5: USD/JPY 1Y USD call priced in Eikon's FX Option Calculator

With spot at 110, strike at 90, the intrinsic value is 20 JPY per USD, so 20M JPY on a notional of 1M USD. Not being able to exercise early means losing the USD interest rate of 2.10%, so the price of the USD call is lower than this intrinsic value. It is shown as about 17M JPY in Eikon (although it is interesting that the bid price seems higher than the offer price, food for thought). The graph shows in fact that the value function crosses the intrinsic value (=payoff) if the option is deep enough in the money (ITM).

For the Greeks, we spot that the USD call option is long gamma (as any long vanilla option is long gamma), see the blue curve in Figure 5. This option is also long theta in the deep ITM region. Thus, the trader with this option in his book will make money by delta hedging it and at the same time make money as time passes. Where is the catch?

This is not an Eikon bug: a negative time value implies a long theta position, because the value function will have to converge to the payoff, so the ITM part of the value function will increase towards the payoff as time passes. The catch is that the deep ITM call is very similar

to a long USD/JPY forward contract, whose dominating risks are the change of spot and carry, the difference between the USD and the JPY interest rate.

As a general summary: any FOR call DOM put option with a backwardation in the FOR/DOM forward curve will show this feature of a negative time value, be long theta and long gamma. Some derivatives textbooks or common misconceptions need to be updated.