VALUATION OF FUTURES

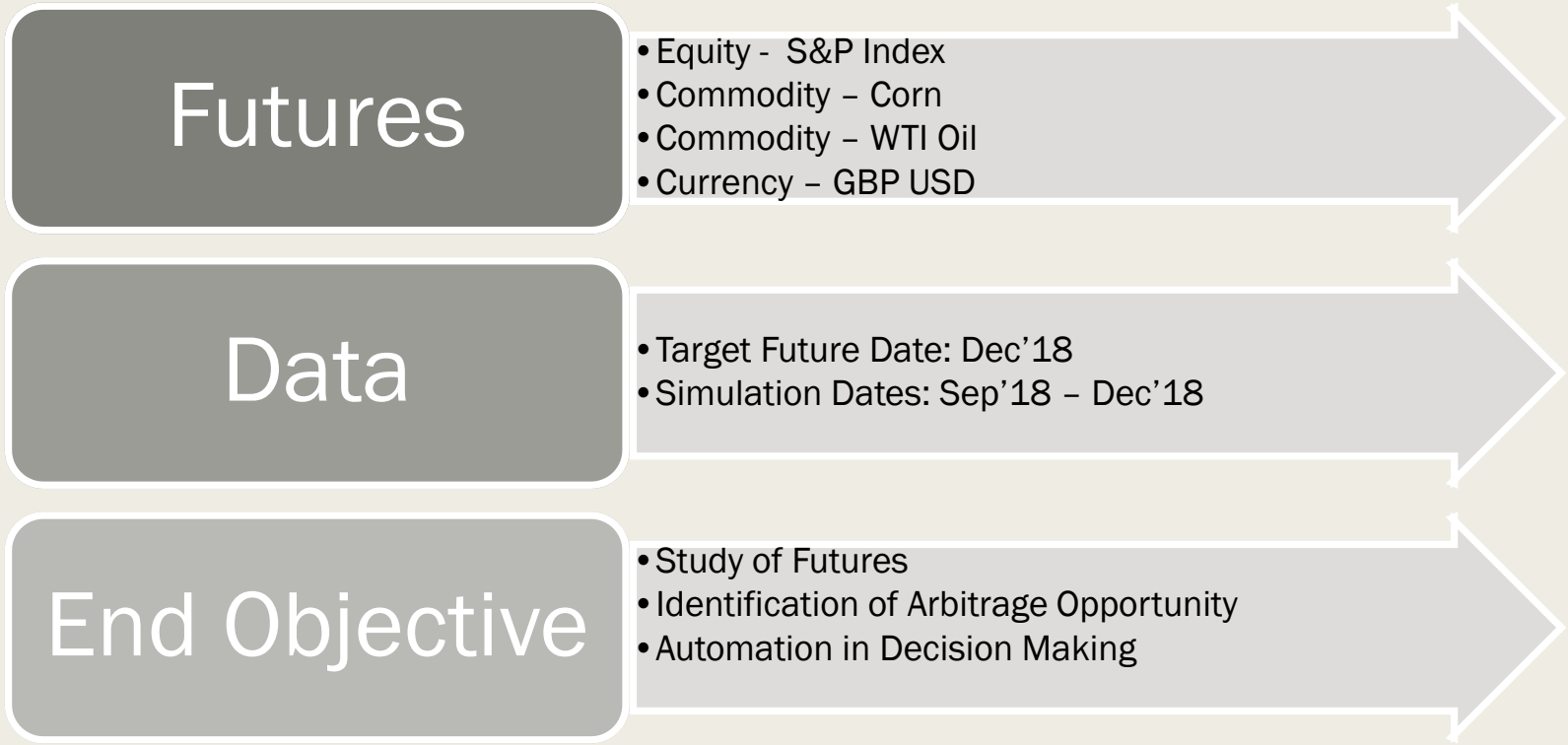
Arbitrage Opportunities – Hedging Strategies

Team Members (**DMKRT**):
Deepak Punjabi
Muktanidhi Dhotrad
Kartheek Manavarthi
Rohit Khurana
Tanmay Sah

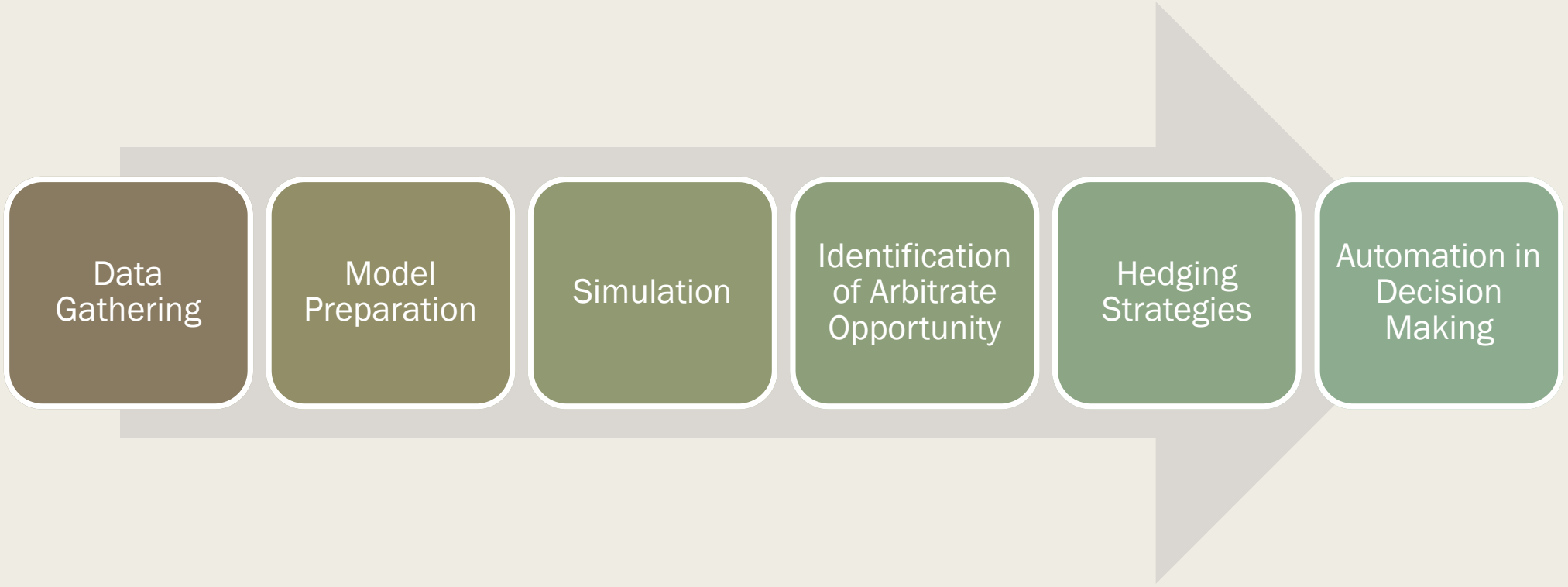
IDEA OF THE PROJECT

To value and analyse if there’s any arbitrage opportunity i.e. an opportunity to make profit on the actual future price and calculated price, on the futures.

Project Scope



Project Methodology



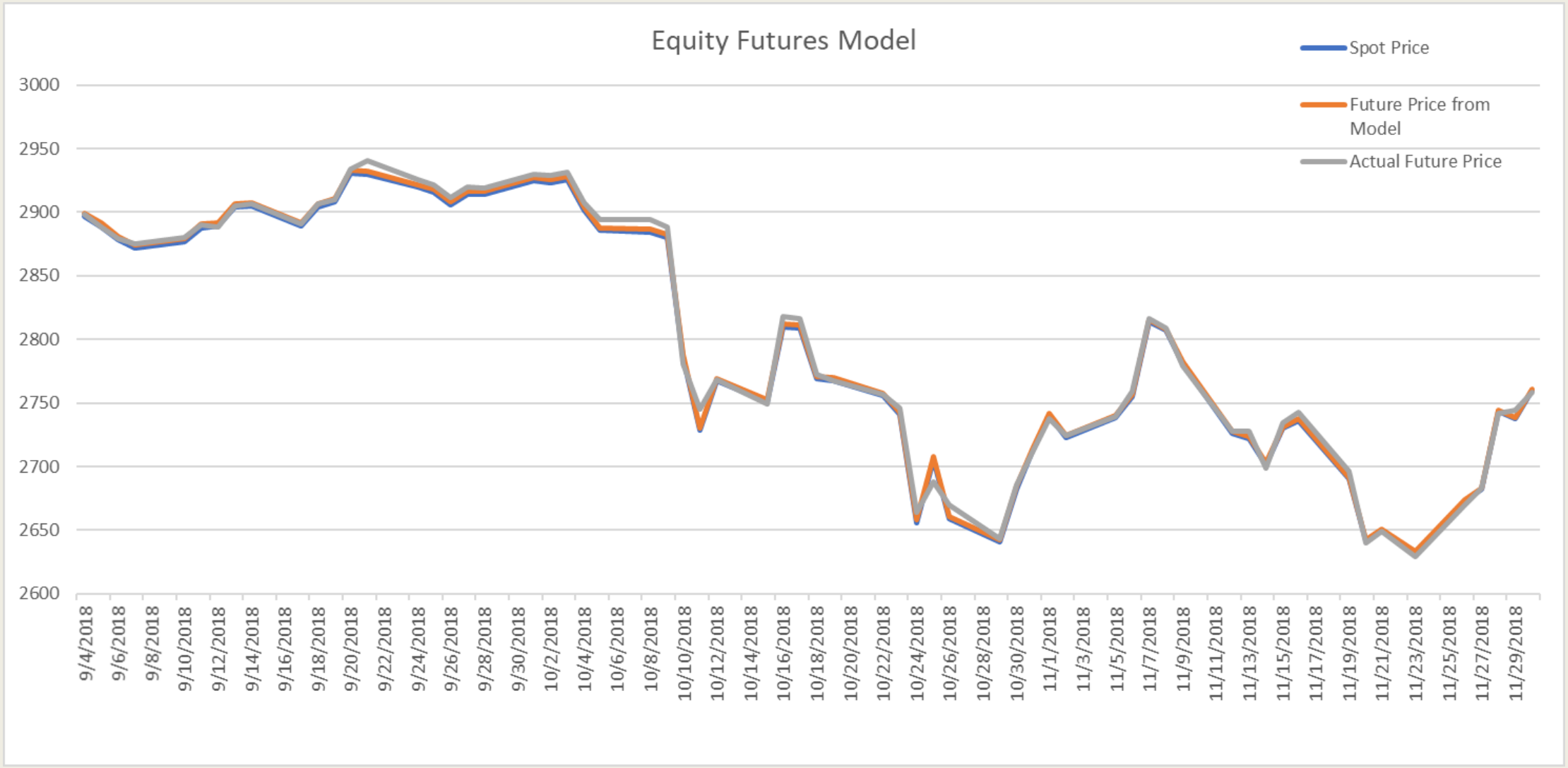
Assumptions

- Borrowing rate is assumed to be the country specific risk-free rate.
- Storage costs are continuously compounded and are assumed to be similar for both Corn and Oil.
- Convenience yield for corn is assumed to be zero, calculated to be 11% for Crude oil.
- Dividend yield was annualized and retrieved from Yahoo Finance for S&P 500.
- Interest rates presented are annually compounded continuously.
- Day Count: Day/ 360

EQUITY (S&P) FUTURES

Equity	S&P 500 Futures			
Time Period	86	Today is Sept 20th 2018 and looking for Dec'18 delivery S&P Futures		
Inventory Cost (considering this is paid at the end of year)	NA	USD per unit at end of year		
Spot Price	2915.56	Current Index level	mean (Spot Price)	
Income	0	USD	2799.715072	
Risk Free Rate rf	0.0212		Standard Deviation (Spot Price)	
Borrowing Rate r	0.0212	Assumption : Lending and borrowing rate are the same	94.58579986	
Dividend yield q	0.0176		mean (Actual Future Project)	
Cost of inventory u	NA		2,802.44	
Cost of Cary (r+u-y)	NA		Std. Deviation (Actual Future Project)	
Futures Price =So*exp((r-q)*T)	2918.06846	Assumption : payment being made at the end of the period	96.01719443	
Market Future Price (Fo)	2922.75			
Observation				
1. Here	Fo>(So)exp((r-q)*T)			
2. Therefore this is	Contango			
3. Aribtrage				
To take advantage of this opportunity, an arbitrageur can implement the following strategy:-				
	a. Borrow an amount So at the risk-free rate and use it to purchase underlying stocks equivalent to spot level of index for immediate delivery			
	b. Short a futures contract on index			

$$F_0 = (S_0)e^{(r-q)*T}$$

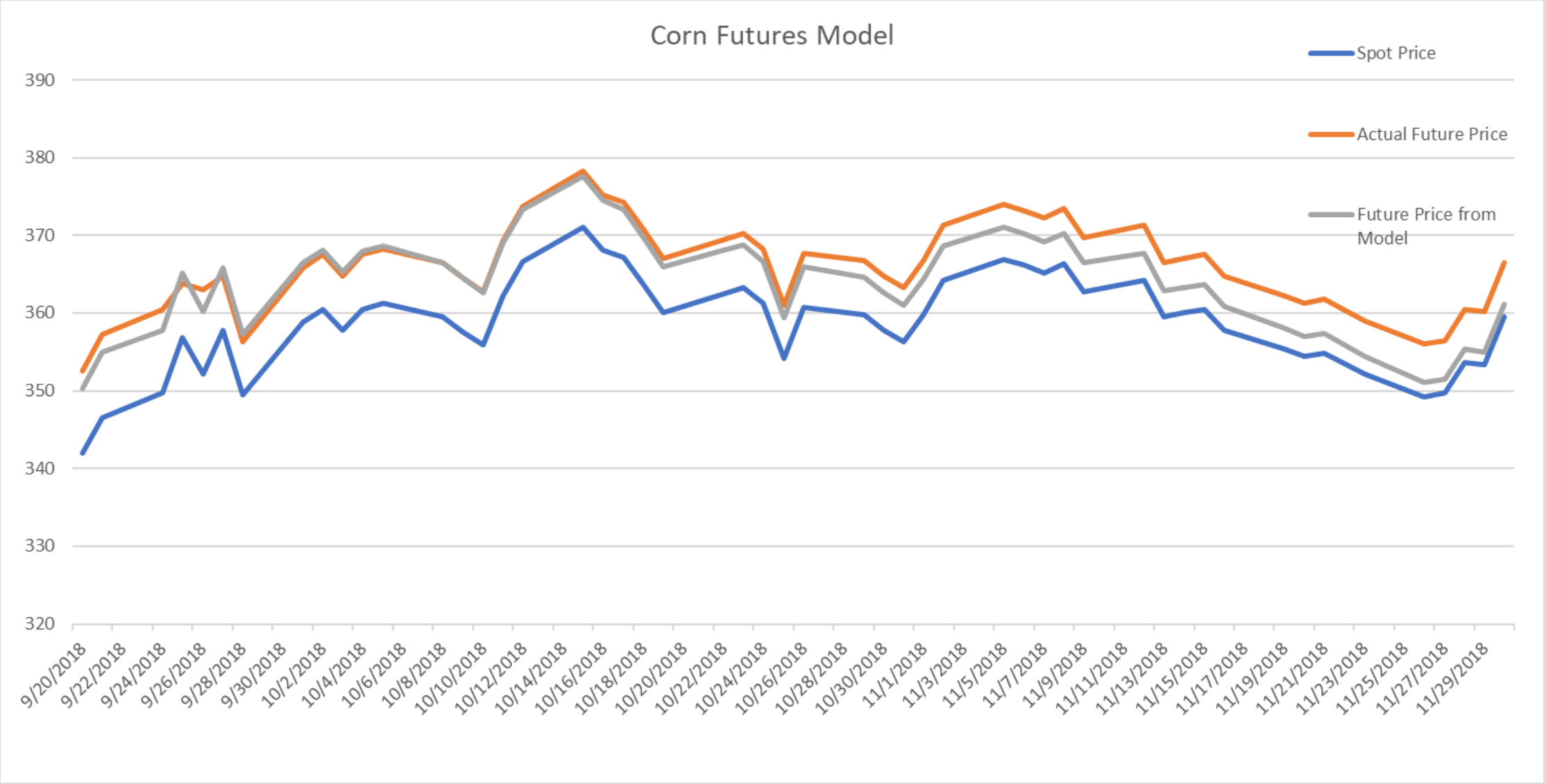


F_0 = Theoretical Future Price, S_0 = Current Spot Price, **r** = Borrowing Rate, **q** = Dividend Yield, **T** = Time

CORN FUTURES

Commodities	Corn Futures		
Time Period	86	Today is Sept 20th 2018 and looking for Dec'18 delivery Corn Futures	Days to 15th of Calendar date
Inventory Cost (considering this is paid at the end of year)	0.04	USD per unit at end of year	
Spot Price	3.45	USD per bushel	
Income	0	USD	
Risk Free Rate rf	0.0212		
Borrowing Rate r	0.0212	Assumption : Lending and borrowing rate are the same	
Convinience yield y	0		
Cost of inventory u	0.08	per annum per bushel	
Cost of Cary (r+u-y)	0.1012		
Futures Price (So)exp((r+u-y)*T)	3.53442203	Assumption : payment being made at the end of the period	
Market Future Price (Fo)	3.54		
Observation			
1. Here	Fo>(So)exp((r+u-y)*T)		
2. Therefore this is	Countango		
3. Aribtrage			
To take advantage of this opportunity, an arbitrageur can implement the following strategy:-			
	a. Borrow an amount So at the risk-free rate and use it to purchase one unit of the commodity and pay storage costs at the end of contract.		
	b. Short a futures contract on one unit of the commodity.		

$F_0 = (S_0)e^{(r+u-y)*T}$

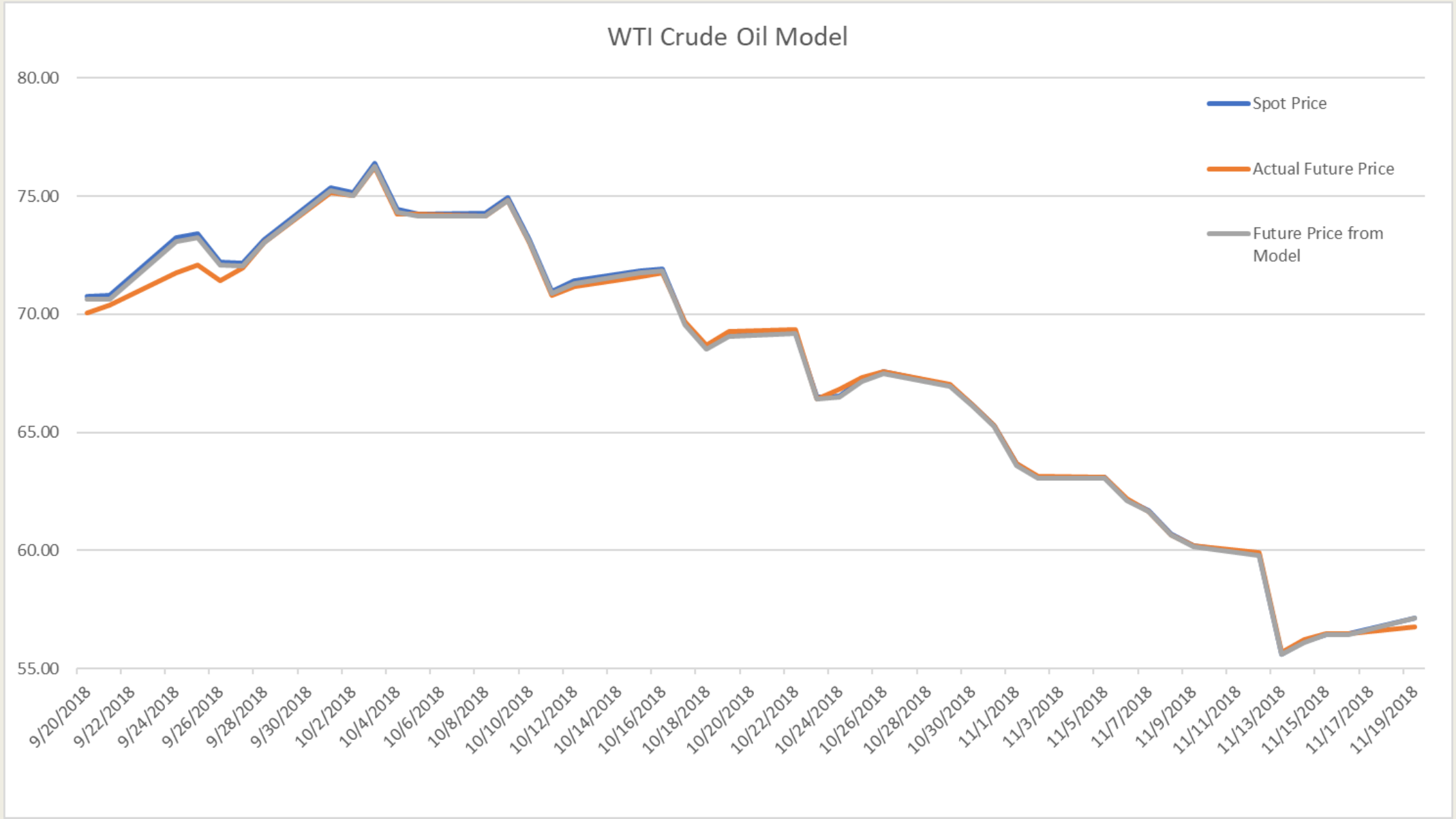


F_0 = Theoretical Future Price, S_0 = Current Spot Price, **r** = Borrowing Rate, **u** = Cost of Inventory, **y** = Convenience Yield, **T** = Time

WTI Crude oil futures

Commodities	Oil Futures		
Time Period	86	Today is Sept 20th 2018 and looking for Dec'18 delivery Corn Futures	Days to 15th of Calendar date
Spot Price	70.77	USD per barrel	
Income	0	USD	
Risk Free Rate rf	0.0212		
Borrowing Rate r	0.0212		
Convinience yield y	0.11	Theoritically I can't be found because it is subjective. We have calculated using Futures Price formula. We take average of y	
Cost of inventory u	0.08		
Cost of Cary (r+u-y)	-0.0088		
Futures Price (So)exp((r+u-y)*T)	70.621382		
Market Future Price (Fo)	70.06		
Observation			
1. Here	Fo <(So+U)exp((r+u-y)*T)		
2. Therefore this is	Backwardation		
3. Aribtrage			
To take advantage of this opportunity, an arbitrageur can implement the following strategy:-			
	a. Borrow an amount Fo at the risk-free rate and use it to purchase one unit of the futures commodity.		
	b. Short a spot contract on one unit of the commodity.		

$$F_0 = (S_0)e^{(r+u-y)*T}$$

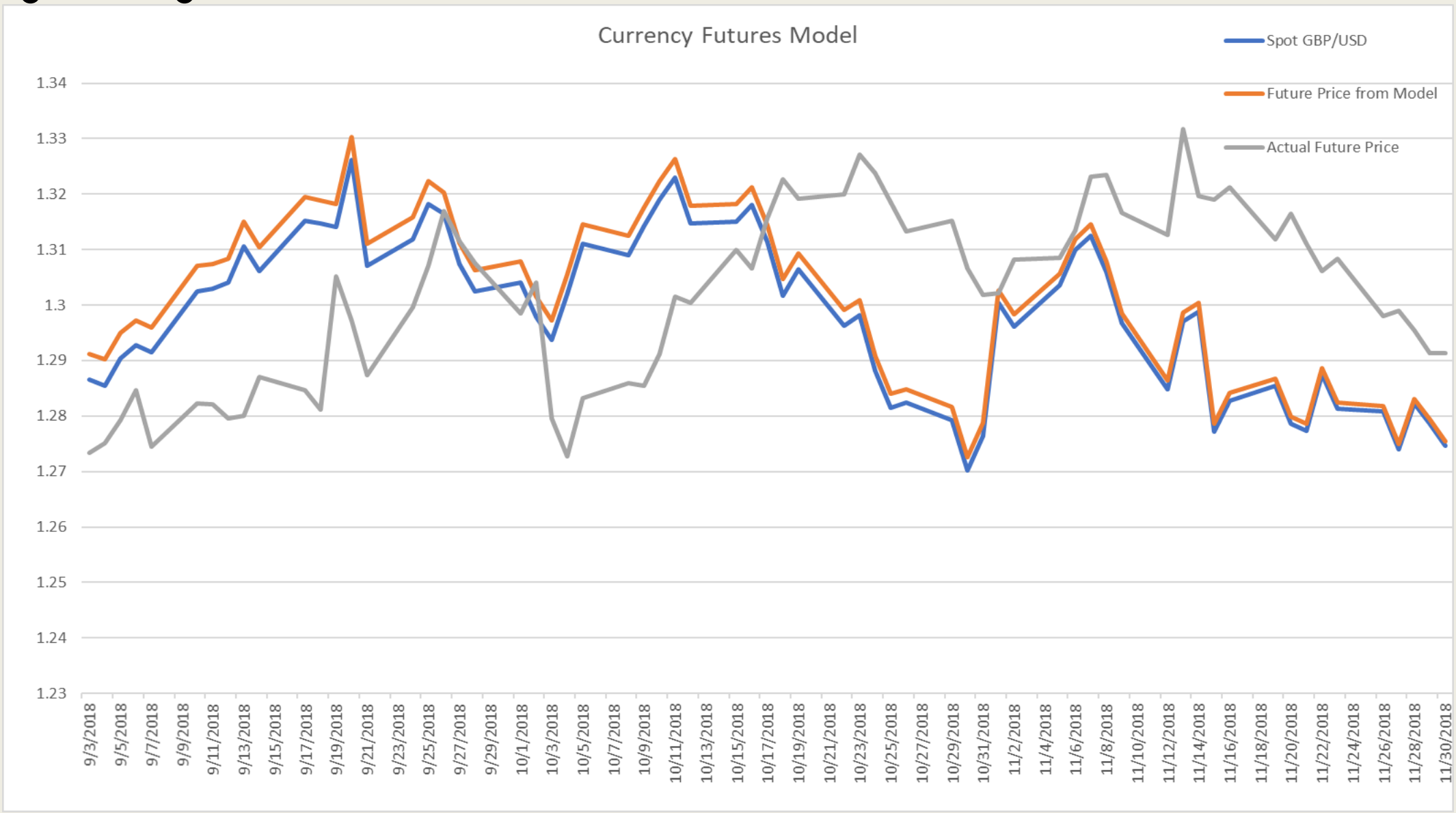


F_0 = Theoretical Future Price, S_0 = Current Spot Price, **r** = Borrowing Rate, **u** = Cost of Inventory, **y** = Convenience Yield, **T** = Time

CURRENCY FUTURES

FX Futures	FX Futures GBP/USD	
Time Period	86	Today is Sept 20th 2018 and looking for Dec'18 delivery FX Futures
Inventory Cost (considering this is paid at the end of year)	NA	
Spot Price	1.3271	USD per GBP
Income	NA	USD
Domestic Risk Free Rate (rd)	0.0212	
Foreign Rate (rf)	0.0075	
Convinience yield y	NA	
Cost of inventory u	NA	
Cost of Cary (r+u-y)		
Futures Price (So)exp((r+u-y)*T)	1.331450418	
Market Future Price (Fo)	1.332	
Observation		
1. Here	Fo<Soexp((rd-rf)*t)	
2. Therefore this is	Contango	
3. Aribtrage		
To take advantage of this opportunity, an arbitrageur can implement the following strategy:-		
	a. Borrow in the GBP, convert into USD, invest in US market	
	b. Buy forward contract to convert USD into GBP	
4. But this is not arbitrage opportunity because there are broker cost, technology costs, transactions and taxes which has not been account in above model.		

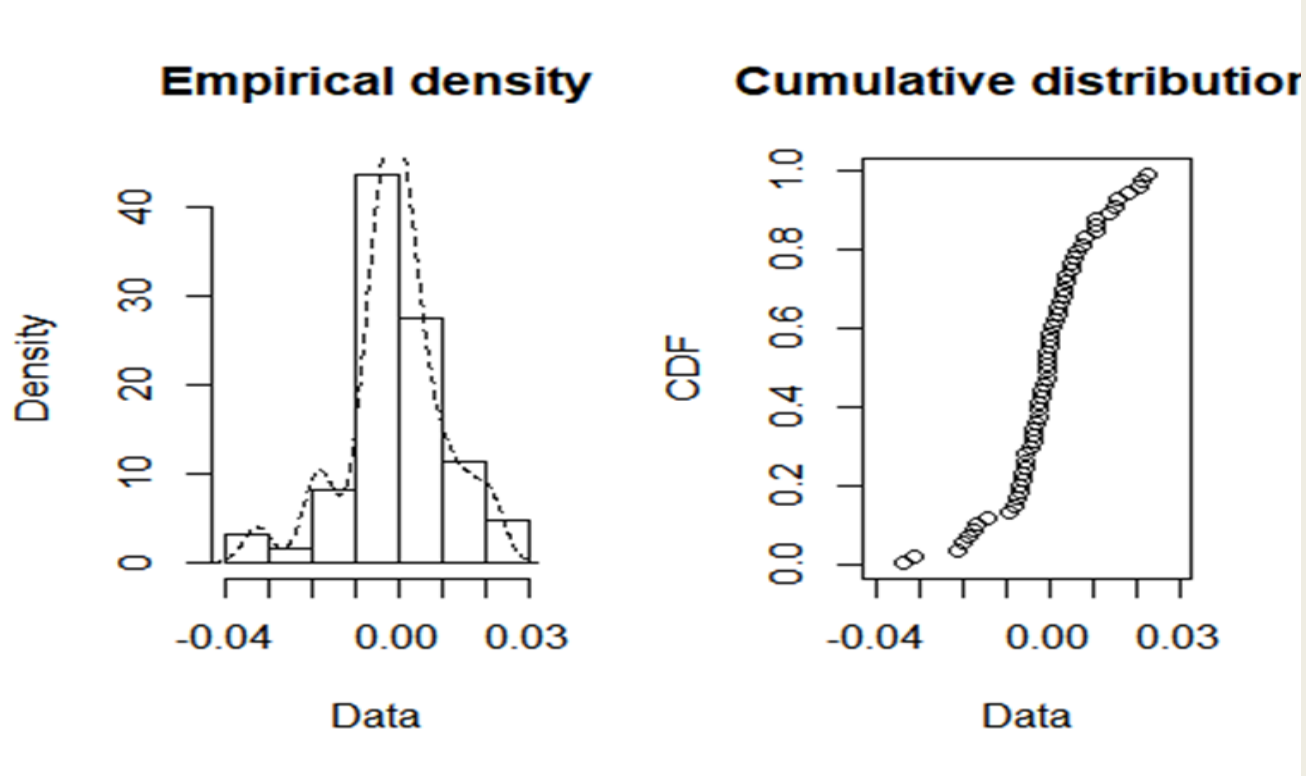
$$F_0 = (S_0)e^{(rd-rf)*T}$$



F_0 = Theoretical Future Price, S_0 = Current Spot Price, **rd** = Domestic Borrowing Rate, **rf** = Foreign Borrowing Rate, **T** = Time

Distribution

Inherent Risk



- Histogram of S&P Index

Automation in Decision Making

Pass the parameters required to determine the possibility of Hedging.
Code written in R :libraries included were openxlsx, fitdistrplus

```
#Equity(Spot, Risk Free Rate, Dividend Yield, Time To Maturity, Futures
Market Price) )
equityd(2919.56,0.022,0.0176,80,2922.75)

## [1] "Possible Arbitrage Opportunity exits. 1. Borrow"
## [2] "2919.56"
## [3] "amount at the rate"
## [4] "2.2"
## [5] "% and use it to purchase underlying stocks equivalent to spot level
of the index for immediate delivery and  \n           2. Short a futures
contract on index"
```

THANK YOU