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IMF WORLD ECONOMIC OUTLOOK
GLOBAL GROWTH ESTIMATES
AND ITS RELATIONSHIP WITH
EQUITY RETURNS

BY RODRIGO MORALES, CFA, CAIA, CMT

We are in that time of the year when the World Economic Outlook (WEO) report is discussed in every financial newspaper and the media. Around the world the latest updates in growth estimates are being discussed and the best economists are there to explain the reasons and details of the new global growth numbers.

This is probably the economic report that gets more attention globally and is published twice a year, but how does it relate to the market? It is common to read financial analysts mentioning the latest downgrade or upgrade in global economic growth by the IMF as one of the reasons for an investment thesis as it sounds logical and rational. Nevertheless, markets often give us counterintuitive outcomes so it would be useful to analyze the relationship between these downgrades/upgrades and the actual changes in the market.

The International Monetary Fund (IMF) has a useful database with the historical forecasts of the WEO reports. We analyzed the relationship between the global economic growth forecasts (change over 1 period) and the S&P 500 (subsequent 1 and 2-quarter returns), until the next WEO report is published, from 1990 until 2016. That gives us 52 observations to work with. We also analyzed this relationship using the MSCI All Country World Index as a dependent variable (subsequent 1 and 2-quarter returns); again, until the next WEO report is published.

We found that these changes don’t explain much of the returns of the index ($R^2 \sim 0.05$). Maybe this result was expected by some analysts. However, what surprised us is the fact that the relationship between the 2 variables is negative and statistically significant. Thus, whenever the IMF has upgraded (downgraded) its global growth forecasts, we have subsequently seen lower (higher) returns in the S&P 500. This relationship holds when 2 subsequent periods are used as the independent variable. We show the scatterplots below in Graph 1.
The relationship also holds for the MSCI All Country World, as shown in Graph 2. It is worth mentioning that in this case the level of explanation is a little better, with an $R^2 \approx 0.09$.

An anecdotic fact of this relationship is the outlier shown in an ellipse in the graphs above. This happened in the middle of the Global Financial Crisis in 2009 when the IMF, in an unprecedented move, cut its global growth forecast by more
than 4%. This is an exceptional downgrade followed by one of the most impressive subsequent 2-quarter returns in both the S&P 500 and the MSCI All Country World Index, increasing more than 30% and 40%, respectively.

We can also look at this relationship during the last 6 years in Graph 3. As the same time as the IMF global growth economic forecasts have gone down persistently, the S&P 500 has gone up almost without a pause.

These results show us the importance of analyzing the empirical evidence and avoiding the temptation of taking for granted some arguments, in spite of their logical and rational sounding. Markets don’t necessarily respond as economic intuition would predict since there is an unknown quantity of factors driving their returns.

Rodrigo Morales, CFA, CAIA, CMT, is the Head of Systematic Strategies at Profuturo, a Scotiabank Pension Fund based in Peru with more than USD 10 billion in AUM. Previously, Rodrigo worked as the Head of Tactical Asset Allocation and as a Senior Analyst of Global Strategies in the same company. He has also worked as a fixed income and equity trader, always in the Pension Fund industry. After graduating from Universidad del Pacifico in 2008, he obtained the CFA designation in 2011, the CAIA designation in 2012 and the CMT designation in 2014.
Are you CMT Ready?

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These interactive courses will be presented by our two resident CMTs as live webinars, with recordings available until the exams.

Presenters
Mathew Verdouw, CMT, CFTe

For over 20 years, Mathew has been building the Technical Analysis software that is Optuma. Programming the models has given Mathew intimate knowledge on the theories of Technical Analysis. Working with CMTs all over the world has provided the practical implementation of how they’re used. Mathew completed his CMT designation in 2013.

Carson Dahlberg, CMT

Starting as an advisor for Morgan Stanley, then a trader at Wachovia, Carson discovered the effectiveness of Technical Analysis in managing opportunities, risk, and emotions. Carson has previously taught CMT Prep courses. He serves on the MTA board, and is Chief Market Strategist for Optuma. Carson completed his CMT designation in 2008.

Enrollments open September 1
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FUNDAMENTAL LINE INDICATORS FOR INVESTORS

BY MARTHA STOKES, CMT

Editor’s note: This article was originally published by Proactive Advisor Magazine and is reprinted here with permission. Subscriptions to Proactive Advisor Magazine are available to financial professionals at no charge.

Fundamental analysis is the foundation of stock investing and continues to be the number one source of data for selecting stocks by giant institutions, market professionals, managers of small funds, and retail investors. However, the quality of fundamental data and the timeliness of that data are not the same for each of these market participant groups.

The retail investor often receives data from financial reports after the information has already been acquired by institutions and market professionals.

Major institutions—responsible for the largest mutual and pension funds—have the resources, talent, and power to investigate companies well ahead of any reports issued by a firm to the general public. Though it may appear that technical patterns lead or predict the market, they merely show information that the giant and large institutions already have—current data on the state of financials, company conditions, as well as other factors. (See my Proactive Advisor Magazine article from March 17, 2016, “Identifying the buying/selling patterns of large institutions and why it matters.”)

The result is a huge discrepancy between when retail investors and institutions buy or sell a stock.

One advantage that retail investors now have is that fundamental data is available in a graphical form from many sources. This is possible due to advances in both data collection and software. Skilled technical analysts use market data for analyzing the technical, or price and volume action, of a stock over time.

Fundamental line indicators are drawn by a computer on a stock chart to show what the fundamental data was for that period of time. There are hundreds of pieces of fundamental data that can be graphed in this manner.

The following example for the Walt Disney Company (DIS: NYSE) includes three commonly used fundamental line indicators in the chart windows below the price trend.

PRICE TREND FOR DISNEY (DIS) VS. KEY INDICATORS
Using these indicators can be a huge benefit to technical analysts and investors of all levels, allowing them to see graphically over time what has been going on with the fundamentals of a company. Using graphs to show the data patterns can help investors make better decisions about when to buy, hold, or sell.

The Disney chart shows that institutions once held over 73% of all the outstanding shares. Now that number has dropped to 58%, which is significant. The “percentage shares held by institutions” (PSHI) data comes from the monthly report that all institutions are required to submit to the Securities and Exchange Commission.

**Earnings (EPS) percent change** data can also be drawn as a fundamental line indicator over time. Earnings percent change shows the percentage of change in EPS over time. There is a lower percentage for DIS over recent periods that is coincident with a lower stock price.

The relationship between the data seen on the graph and stock chart is important, as most technical analysts would tell you this looks to be a topping action. This means that institutions have been rotating out of DIS for some time, even while “uninformed” retail investors have been buying, unaware of the institutions’ sell sentiment.

**Revenue growth rate** is another fundamental line indicator. It reveals that DIS has had a fair amount of inconsistency in revenues, with a marked decline in 2015. That is likely the cause of the institutional rotation that has continued throughout

*Source: TechniTrader technical analysis using a TC2000 chart, courtesy of Warden Bros*
2016. When there is more selling by the larger lot institutions against smaller lot retail investor buying, there is more pressure on the stock price to move down.

The fundamental data is irrefutable, as it is from the audited financial records of the company being studied. The chart merely reflects the changes in a graphical format that is easier to interpret and understand than just looking at earnings reports.

Summary

Investors of all levels can now use fundamental data in their stock chart analysis, providing a graphical perspective of what has been going on with the company in the recent past. This is also often reflected in the stock price and can aid investors in deciding when to buy, hold, or sell. This is an important tool for investors to learn to use. All too often, small lot retail investors and managers of small funds are buying when they should be selling, and selling when they should be buying.

Martha Stokes, CMT, is the co-founder and CEO of TechniTrader and a former buy-side technical analyst. Since 1998, she has developed over 40 TechniTrader stock and option courses. She specializes in Relational Analysis for stocks and options, and Market Condition Analysis. An industry speaker and writer, Ms. Stokes is a member of the Market Technicians Association and earned the Chartered Market Technician designation with her thesis, "Cycle Evolution Theory."
The MTA is proud to announce the availability of a new jointly published literature review entitled Technical Analysis: Modern Perspectives. We are delighted to collaborate with the CFA Institute Research Foundation on this project and its goal of dispelling myths surrounding the professional practice of technical analysis. You can read the paper at https://www.mta.org/ta/technical-analysis-modern-perspectives/

Recent research has addressed the role of technical analysis in the broader context of financial markets and begins to trace the linkages among behavioral economics, individual actors in financial markets, and the role of technical analysis in studying the behavior of individual actors. The efforts stemming from the job analysis and revision of the CMT curriculum led to a refined articulation of our discipline and strengthened our position with respect to the broader investment industry. This paper clarifies and solidifies our emphasis on objectivity and risk management in the investment process.

The interest of the CFA Institute Research Foundation to co-publish with the MTA sends a strong message about the increased utility and complimentary nature of technical analysis within the fundamental community.

We encourage you to read the paper and if you feel so inclined, share this with your colleagues, clients, and professional contacts. We have established a simple landing page to direct those parties: https://www.mta.org/ta/technical-analysis-modern-perspectives/
COMMON MISTAKES OF MOMENTUM INVESTORS

BY GARY ANTONACCI

Editor’s note: this was originally posted at DualMomentum.net by Gary Antonacci, a featured speaker at the MTA’s 2015 Annual Symposium.

Like most investors, those using momentum are often guilty of chasing performance. In fact, momentum requires that we do this. But it should be done in a disciplined and systematic way. Performance chasing should not be due to myopia, irrational loss aversion, or other psychological biases.

Behavioral Challenges

It is not always easy adhering to a disciplined approach. If you are not vigilant, emotions can get the better of you. Even Daniel Kahneman, the father of behavioral economics, admits to being influenced by behavioral heuristics.

We may forget our strategy’s long-term expected outperformance when we experience uncomfortable drawdowns. The survival instinct kicks in strongly then. Recency bias can make us feel the drawdown will never end.

We may also have to deal with regret aversion when our portfolio underperforms. This will happen sooner or later. No strategy outperforms all the time. Occasional benchmark underperformance is the price we pay for possible protection from severe bear markets.

Myopia

Those who look at performance frequently do not do as well as those who are less concerned with short-term performance. When someone asks me how my models are doing this year, I know they do not have a good understanding of momentum being a long-term approach. Last May a dual momentum investor sent me an email saying his wife’s account in REITs was outperforming his momentum account. He then closed his account and invested in REITS himself. Since then, REITs have declined more than 10%, while momentum has gone up almost the same amount. This scenario has happened more frequently than you might think.

It is important to keep the big picture in mind. We should wait at least a full bull and bear market cycle before evaluating the performance of a dual momentum strategy. Do your homework so you understand whatever investment approach you select. Then relax, and enjoy the journey.
Accepting Lower Risk Premia

The other serious mistake momentum and other investors make is not understanding the real goal of investing. We should invest in a way that offers us the highest expected return while limiting our risk exposure. Limiting downside exposure is important so we do not panic under stress and do stupid things.

The stock market has had two bear markets over the past 20 years. Each time stocks lost more than half their value. Because of this, investors have been extra cautious. Many have tried to use broad diversification to reduce their portfolios' drawdown exposure.

If you select non-correlated assets, you can achieve some reduction in volatility and drawdown. But your expected return is the weighted average return of all your assets. That is where the problem lies. Assets with lower expected returns will reduce your portfolio's return.

![Annualized real returns on major asset classes (%)](chart)

Bonds have done well over the past 15 years. But longer term, their real return is less than one-third the real return of stocks. Given how low interest rates are now, there is not much room for bonds to appreciate further. In fact, current interest rates predict low bond returns in the years ahead.
Bonds are also not as low-risk as you might think. Since 1900, the worst real return drawdown was 73% for stocks and 68% for bonds. As we see below, stocks and bonds can sometimes have severe drawdowns simultaneously.
Bonds not only create a drag on our performance. They also may not reduce our risk exposure when we most need them to do so.

Some advisors recommend alternative assets, like commodities, with little or no expected real return. This is because such assets are generally (but not always) less correlated to equities. They can therefore reduce portfolio volatility. But the addition of low-return alternative assets can create an even more serious drag on portfolio performance.

What momentum investors should remember is absolute momentum does a much better job of reducing drawdown. Because of this, trend following absolute momentum lets us keep more of our assets in equities where we can receive more risk-premium.

**Using Stocks and Sectors**

My first research paper released in 2011 analyzed equity momentum with individual stocks, sectors, style attributes, and regions. I showed that momentum works best when applied to geographically diversified equity indices. Last year Geczy and Samonov (2015) applied momentum to stocks, stock sectors, geographic equity indices, bonds, commodities, and currencies. They also found equity indices performed best. This is without considering the issues of scalability and trading costs associated with individual stocks. (See my last blog post for more on this). Yet most articles about momentum and most momentum funds still use stocks instead of stock indices. Broadly diversified, low cost stock indices do not get the respect they deserve.
Some momentum investors still adhere to the old paradigm of extensive diversification. They hold more assets than they need for optimal portfolio growth. I posted an article and mentioned on my website’s FAQ page that the long-run performance of sector rotation is not as good as momentum with broad stock indices. But I still get plenty of emails asking me about sector rotation and the use of other higher risk or lower return assets.

Preference for Complexity

Investors and advisors seem to prefer complexity over simplicity. Many must believe that elaborate models and more diversified portfolios perform better than simpler approaches. My research shows this is not the case. I tried adding factor-based indices and additional asset classes to my dual momentum models. My models worked best using just broad-based indices for U.S. stocks, non-U.S. stocks, and short or intermediate bonds.

Advisors may prefer complexity to justify their fees. It could be challenging to charge fees for putting clients in an S&P 500 index fund. Robo-advisors are the latest slice and dice diversification strategy for those who think more is better.

Non-Optimal Portfolio Construction

Some portfolios suffer because investors rely on well-known measures like the Sharpe ratio for selecting assets. The Sharpe ratio divides excess returns by the standard deviation of those returns. It is an efficiency measure telling you how much return you might expect per unit of volatility. But unless returns are normally distributed (they almost never are), the Sharpe ratio is not a good indicator of tail risk. Nor is it a good indicator of the amount of wealth you might accumulate or your chance of future investment success.[1]

Wiecki et al. (2016) looked at 818 algorithmic trading strategies at Quantopian, a research boutique. Using data from 2010 through 2015, they found that the Sharpe ratio offered little value in predicting out-of-sample performance. This was also true of similar metrics such as the information ratio, Sortino ratio, and Calmar ratio.

You can increase the Sharpe ratio of most portfolios by simply adding more bonds. But your expected rate of return and accumulated wealth will in most cases suffer.

Here is an example showing the performance of the S&P 500 index compared to a balanced portfolio with 60% in the S&P 500 index and 40% in the Barclays Capital U.S. aggregate bond index. The data is from the start of the bond index in January 1976 until November 2016. It represents a possible 40 year holding period of someone saving for retirement.
The difference in annual return of 1.2% gives a 54% increase in ending wealth over this 40-year span. Which portfolio would you rather have? In this example, the most desirable portfolio may depend on you or your risk tolerance. The 60/40 portfolio has a less painful worst drawdown.

Here are the results adding the simple Global Equities Momentum (GEM) model featured in my book and in an earlier blog post. GEM uses relative momentum to switch between U.S. and non-U.S. stock indices, and absolute momentum to switch into aggregate bonds when stocks are weak. GEM’s single parameter, the look back period, was discovered in 1937. GEM uses a combination of relative and absolute momentum. Both have shown good results on over 200 years of back data. [2]
When I analyze investment opportunities, my primary criteria are a high CAGR combined with a tolerable level of risk exposure. CAGR represents the geometric growth rate of one’s capital. [4] It takes volatility into account. If two strategies have the same average return, the one with lower volatility will have a higher CAGR.

But like the Sharpe ratio, CAGR does not measure tail risk. Extreme downside exposure can cause you to exit positions prematurely screaming in pain or cursing your investment advisor. That is why I also consider drawdown.

Worst drawdown is only a single point in time, but it can give you a pretty good idea about tail risk. I also examine the distribution of returns and look at all the other drawdowns. Keep in mind that your worst drawdown may lie ahead still. Having a simple, robust approach that performs well over a long period may reduce that risk.

**Impatience**

It is important to remain focused on what is important – accumulating wealth while protecting yourself from severe bear markets. Once you have a good investment strategy, you need to be patient so it can do its work for you. Warren Buffett said the stock market is a mechanism for transferring wealth from the impatient to the patient. This applies to momentum as well as other investors.


[3] I also have an enhanced version of GEM that I license to a few investment professionals.

[4] For econ geeks, CAGR is consistent with logarithmic utility. The Sharpe ratio represents quadratic utility, unless returns are normally distributed. See Friedman and Sandow (2004) and Levy (2016).
Gary Antonacci has over 35 years’ experience as an investment professional focusing on underexploited investment opportunities. His innovative research on momentum investing was the first place winner in 2012 and the second place winner in 2011 of the prestigious Wagner Awards for Advances in Active Investment Management given annually by the National Association of Active Investment Managers (NAAIM).

Gary is author of the award-winning book, Dual Momentum Investing: An Innovative Approach for Higher Returns with Lower Risk. His research introduced the investment world to dual momentum, which combines relative strength price momentum with trend following absolute momentum. He is recognized as a foremost authority on the practical applications of momentum investing.

Gary received his MBA degree from the Harvard Business School. He serves as a consultant and public speaker on asset allocation, portfolio construction, and advanced momentum strategies. You can learn more about Gary and dual momentum investing at [http://optimalmomentum.com](http://optimalmomentum.com)
The 2016 Market Technicians Association Educational Foundation (MTAEF) Annual Fundraiser was held on October 26th at The Yale Club of New York City. This yearly event is an important source of funding that contributes to the foundation's ongoing efforts to establish, support, and continually enhance both accredited courses and research in the field of Technical Analysis on campuses around the globe.

This year the record number of supporters in attendance were treated to a full evening of events. Highlights included an informative panel discussion by panel members Jim Cramer, Jeff DeGraff, Steve Blitz and Jason Trennert, a silent auction and the presentation of the prestigious Mike Epstein Award for 2016 to Dr. Edward J. Zychowicz, CFA, CMT of Hofstra University.

Each year at the fundraiser, the Mike Epstein Award is presented to a prominent member of the academic community in recognition of that individual's many years of successfully advocating for the inclusion of Technical Analysis in both the curriculum offered, as well as the research being conducted, in the world of academia.
The award was established by the foundation in 2009 to honor Mike Epstein's legacy of long term sponsorship of Technical Analysis in both academia and financial industry practice. Prior winners include academic luminaries such as Dr. Andrew Lo of MIT, Dr. Hank Pruden of Golden Gate University, Professor Bruce Kamich of Baruch College and Julie Dahlquist and Charles Kirkpatrick, co-authors of the landmark college textbook, *Technical Analysis: The Complete Resource for Financial Market Technicians*.

This year's award honored Dr. Zychowicz in recognition of his tireless efforts over many years to incorporate Technical Analysis into both the academic curriculum at Hofstra University as well as his extensive personal catalog of published research. The scope of his research interests include Behavioral Finance, Technical Analysis, Socially Responsible Investing and Sustainability. He has also taught a Technical Analysis course at the graduate level. During the presentation ceremony, foundation board member Lawrence Laterza cited how Dr. Zychowicz has expanded the perspective of young minds through his dedication to blending academic theory with the realities of being a practitioner in the financial industry. It was also noted how his initiatives have served to support the foundation's efforts to increase the awareness and acceptance of Technical Analysis in both the halls of academia and the libraries of published research.
Editor’s note: This article was originally posted at KeithSelover.net and is reprinted here with permission. It is presented as an example of the new software tools available for technical analysis and includes a sample of the code required to back the widely-used RSI indicator. The article also highlights a number of resources available to analysts and is a primer for those wanting to learn more about programming. To learn more, please visit KeithSelover.net.

The above chart was generated in Python. It’s the result of backtesting a basic algorithmic trading strategy that makes use of the Relative Strength Index (RSI). In this tutorial I’ll walk through implementing and graphing a simple strategy. The tutorial should provide a framework that will allow coders to swap out code segments to include strategies and indicators of their preference. It’s meant more to model the beginnings of a customizable backtesting platform than a successful strategy.
**Libraries**

There is a small set of backtesting libraries to choose from, but I used Zipline as the backbone for backtesting strategies. Zipline also underpins Quantopian, an algorithmic trading platform and community that allows traders to plug their algorithms into a polished interface. I chose not to use Quantopian because I wanted the freedom to work outside of their framework, but everything I’ve done thus far could likely be done in Quantopian with ease.

The python wrapper for TA-Lib allows users to painlessly calculate technical indicators.

All of the plotting was done with the old standard: Matplotlib.

**A Strategy-Independent Dashboard**

Creating a separate class to run these strategies allows you to swap and compare algorithms easily. This “dashboard” class is used primarily to import libraries, establish a timeframe, and select a security. The security used as an example is ExxonMobil, which has had its fair share of ups and downs in the given timeframe.

Creating the ‘algo’ object involves references to a second class where the strategy is actually held. The details of that class are discussed later.

```python
# All the necessary libraries
import talib as ta
import pandas.io.data as web
import matplotlib.pyplot as plt
from matplotlib.dates import date2num
from matplotlib.patches import Rectangle
import matplotlib.pyplot as plt
import matplotlib.dates as mdates
import numpy
import warnings
from datetime import datetime
import logbook
from logbook import Logger
log = Logger('Algorithm')
import pytz
from zipline.algorithm import TradingAlgorithm
from zipline.utils.factory import load_from_yahoo
from zipline.api import order, symbol, get_order, record
import pylab as pl
warnings.filterwarnings("ignore")
# Choosing a security and a time horizon
logbook.StderrHandler().push_application()
start = datetime(2012, 9, 1, 0, 0, 0, 0, pytz.utc)
end = datetime(2016, 1, 1, 0, 0, 0, 0, pytz.utc)
sec = 'XOM'
data = load_from_yahoo(stocks=[sec], indexes={}, start=start,
```
data = data.dropna()
algo = TradingAlgorithm(initialize=RSI_Strategy.initialize, handle_data=RSI_Strategy.handle_data, analyze=RSI_Strategy.analyze)
results = algo.run(data)

Implementing a Strategy

Before I go through the individual functions, here’s the class in its entirety:

```python
from datetime import datetime, timedelta
class RSI_Strategy:
    def initialize(self):
        self.test = 1
        self.stock = symbol(sec)
        self.RSI_upper = 65
        self.RSI_lower = 35
        # Flag for when the RSI is in the overbought region
        self.RSI_OB = False
        # Flag for when the RSI is in the oversold region
        self.RSI_OS = False
        self.buy = False
        self.sell = False
    def handle_data(self, context, data):
        try:
            trailing_window = data.history(self.stock, 'price', 35, '1d')
        except:
            return
        crossover_flag = False
        RSI = ta.RSI(trailing_window.values, 14)
        # Setting flags
        if(RSI[-1] > self.RSI_upper):
            self.RSI_OB = True
        elif(RSI[-1] < self.RSI_lower):
            self.RSI_OS = True
        if(RSI[-1] < self.RSI_upper and self.RSI_OB):
            self.RSI_OB = False
            crossover_flag = True
        elif(RSI[-1] > self.RSI_lower and self.RSI_OS):
            self.RSI_OS = False
            crossover_flag = True
        # Trading Logic
        if(crossover_flag and RSI[-1] < 50 and not self.buy):
```
context.order_target(context.stock, 100)
context.buy = True

if(crossover_flag and RSI[-1] > 50 and not context.sell):
    context.order_target(context.stock, -100)
    context.sell = True

if(context.buy and RSI[-1] >= 50):
    context.order_target(context.stock, 0)
    context.buy = False
    context.sell = False

if(context.sell and RSI[-1] <= 50):
    context.order_target(context.stock, 0)
    context.buy = False
    context.sell = False

# Recording Results
record(security=data[symbol(sec)].price,
       RSI = RSI[-1],
       buy = context.buy,
       sell = context.sell)

def analyze(context, perf):
    fig = plt.figure()

    # Set up a plot of the portfolio value
    ax1 = plt.subplot2grid((8,1), (0,0), rowspan=3, colspan=1)
    perf.portfolio_value.plot(ax=ax1)
    ax1.set_ylabel('Portfolio Value ($)')

    # Set up a plot of the security value
    ax2 = plt.subplot2grid((8,1), (3,0), rowspan=3, colspan=1, sharex=ax1)
    data.plot(ax=ax2)
    ax2.set_ylabel(sec + ' Value ($)')

    # Find transaction points
    perf_trans = perf.ix[[t != [] for t in perf.transactions]]
    buys = perf_trans.ix[[t[0]['amount'] > 0 for t in perf_trans.transactions]]
    sells = perf_trans.ix[[t[0]['amount'] < 0 for t in perf_trans.transactions]]

    # Plot the colored box of the final transaction if the time period ends with an open position
    if(len(buys) != len(sells)):
        if(len(buys) > len(sells)):
            upper_lim = len(sells)
            last_point = mdates.date2num(buys.index[upper_lim])
            col = 'g'
        elif(len(sells) < len(buys)):
            upper_lim = len(buys)
            last_point = mdates.date2num(sells.index[upper_lim])
            col = 'r'

        end_d = mdates.date2num(end)
        width = mdates.date2num(end) - last_point
        rect = Rectangle((last_point, width), color=col, alpha = 0.3)
        ax2.add_patch(rect)

    else:
        upper_lim= len(buys)
Zipline provides a series of helpful backtesting functions, three of which are utilized above: ‘context’, ‘handle_data’, and ‘analyze’. The ‘context’ function initializes the algorithm. It also serves as a good place to store any variables you want to be local to the algorithm. Initializing them in ‘handle_data’ instead means they’d be re-initialized at each iteration your algorithm goes through. This is particularly important for flag variables like “RSI_OB” or “RSI_OS”

```
def initialize(context):
    context.test = 1
    context.stock = symbol(sec)
    context.RSI_upper = 65
    context.RSI_lower = 35
    #Flag for when the RSI is in the overbought region
```
context.RSI_OB = False
#Flag for when the RSI is in the oversold region
context.RSI_OS = False
context.buy = False
context.sell = False

The ‘handle_data’ function is where the strategy is really built. To provide a brief overview: the algorithm makes a trade when the RSI leaves either of the extreme regions (overbought or oversold, as indicated by the shaded regions of the RSI). It buys the security when the RSI exits the ‘oversold’ period (defined in the ‘context’ function as anything under 35), and shorts the security when the RSI exits the ‘overbought’ period (anything over 65). As soon as the RSI hits 50, the algorithm closes whichever position is took and moves to cash.

The biggest flaw of the strategy is that it doesn’t recognize when the security has re-entered the overbought or oversold regions. You’ll notice it takes its biggest losses when the RSI re-enters those regions before hitting 50. A simple solution for this would be to move to cash if the the RSI enters into an extreme region while a position is open. Since this algorithm is meant to be more demonstrative than actionable, adding in this extra layers would really just serve to make the code more confusing and uninterpretable.

The first chunk of the ‘handle_data’ function determines whether the function is in extreme territory, or if it has just crossed back into the “normal” 35-65 ranged. The second chunk takes a position if the security has moved out of an extreme, or moves to cash if the RSI has settled back to 50.

def handle_data(context, data):
    try:
        trailing_window = data.history(context.stock, 'price', 35, '1d')
    except:
        return
    crossover_flag = False
    RSI = ta.RSI(trailing_window.values, 14)

    #Setting flags
    if(RSI[-1] > context.RSI_upper):
        context.RSI_OB = True
    elif(RSI[-1] < context.RSI_lower):
        context.RSI_OS = True
    if(RSI[-1] < context.RSI_upper and context.RSI_OB):
        context.RSI_OB = False
        crossover_flag = True
    elif(RSI[-1] > context.RSI_lower and context.RSI_OS):
        context.RSI_OS = False
        crossover_flag = True

    #Trading Logic
if(crossover_flag and RSI[-1] < 50 and not context.buy):
    context.order_target(context.stock, 100)
    context.buy = True
if(crossover_flag and RSI[-1] > 50 and not context.sell):
    context.order_target(context.stock, -100)
    context.sell = True
if(context.buy and RSI[-1] >= 50):
    context.order_target(context.stock, 0)
    context.buy = False
    context.sell = False
if(context.sell and RSI[-1] <= 50):
    context.order_target(context.stock, 0)
    context.buy = False
    context.sell = False

#Recording Results
record(security=data[symbol(sec)].price,
       RSI = RSI[-1],
       buy = context.buy,
       sell = context.sell)

The ‘analyze’ function is used after the algorithm has run. The “perf” variable in its function header stands for the performance of the algorithm. This function is used to report and plot the results of the algorithm. The three paneled image shown at the top of the post was created here. Most of the plotting is relatively straight-forward, with the exception of creating those green and red long/short rectangles on the second graph. Since it’s possible that the algorithm ends its backtest with an open short or long position, the ‘analyze’ function has to account for that before plotting the rest of the rectangles.

def analyze(context, perf):
    fig = plt.figure()

    #Set up a plot of the portfolio value
    ax1 = plt.subplot2grid((8,1), (0,0), rowspan=3, colspan=1)
    perf.portfolio_value.plot(ax=ax1)
    ax1.set_ylabel('Portfolio Value ($)')

    #Set up a plot of the security value
    ax2 = plt.subplot2grid((8,1), (3,0), rowspan=3, colspan=1, sharex=ax1)
    data.plot(ax=ax2)
    ax2.set_ylabel(security + ' Value ($)')

    #Find transaction points
    perf_trans = perf.ix[[t != [] for t in perf.transactions]]
    buys = perf_trans.ix[[t[0]['amount'] > 0 for t in perf_trans.transactions]]
    sells = perf_trans.ix[[t[0]['amount'] < 0 for t in perf_trans.transactions]]

    #Plot the colored box of the final transaction if the time period ends with an open position
    if(len(buys) != len(sells)):
if(len(buys) > len(sells)):
    upper_lim = len(sells)
    last_point = mdates.date2num(buys.index[upper_lim])
    col = 'g'
elif(len(sells) < len(buys)):
    upper_lim = len(buys)
    last_point = mdates.date2num(sells.index[upper_lim])
    col = 'r'
end_d = mdates.date2num(end)
width = mdates.date2num(end) - last_point
rect = Rectangle((last_point, 60), width, 40, color=col, alpha = 0.3)
ax2.add_patch(rect)
else:
    upper_lim= len(buys)

short_patch = mpatches.Patch(color='r', alpha = 0.3, label='Short Holdings')
long_patch = mpatches.Patch(color='g', alpha = 0.3, label='Long Holdings')
plt.legend(handles=[long_patch, short_patch])
plt.setp(plt.gca().get_legend().get_texts(), fontsize='8')

#Plot the colored box of all other transactions
for i in range(0,upper_lim):
    buy_d = mdates.date2num(buys.index[i])
    sell_d = mdates.date2num(sells.index[i])
    if(buy_d < sell_d):
        col = 'g'
        width = sell_d - buy_d
        rect = Rectangle((buy_d, 60), width, 40, color=col, alpha = 0.3)
    else:
        col = 'r'
        width = buy_d - sell_d
        rect = Rectangle((sell_d, 60), width, 40, color=col, alpha = 0.3)
        ax2.add_patch(rect)

#Plot the RSI with proper lines and shading
ax3 = plt.subplot2grid((8,1), (6,0), rowspan=2, colspan=1, sharex=ax1)
ax3.plot(perf['RSI'])
ax3.fill_between(perf.index,perf['RSI'],context.RSI_upper,
                 where = perf['RSI'] >= context.RSI_upper, alpha = 0.5, color='r')
ax3.fill_between(perf.index,perf['RSI'],context.RSI_lower,
                 where = perf['RSI'] <= context.RSI_lower, alpha = 0.5, color = 'g')
ax3.plot((date2num(perf.index[0]),date2num(perf.index[-1])),(context.RSI_upper,context.RSI_upper), color='r', alpha = 0.5)
ax3.plot((date2num(perf.index[0]),date2num(perf.index[-1])),(context.RSI_lower,context.RSI_lower),color='g', alpha = 0.5)
ax3.grid(True)
ax3.set_ylabel('RSI')

OB_patch = mpatches.Patch(color='r', alpha = 0.5, label='Overbought')
OS_patch = mpatches.Patch(color='g', alpha = 0.5, label='Oversold')
plt.legend(loc = 'upper left',handles=[OB_patch, OS_patch])
plt.setp(plt.gca().get_legend().get_texts(), fontsize='8')
plt.tight_layout()
Keith Selover is currently a senior at New York University’s Leonard N. Stern School of Business, studying Finance and Computer Science. He is an incoming analyst at Waterfall Asset Management. This blog serves as a portfolio of short data-related programming projects. Contact Keith at keith.selover@gmail.com.
CALL FOR NOMINATION

The Market Technicians Association (MTA) is a dynamic association focused on building a strong community of market professionals, maintaining the highest ethical standards in the industry, and promoting the use of technical analysis in the investment process. Participating in the leadership of an organization like the MTA can be a deeply rewarding experience. It is an opportunity to work closely with industry leaders, to significantly further the mission of the MTA, and to have a real impact on technical analysis in the financial industry. You will also find the experience to provide great opportunities to improve yourself both personally and professionally.

So what is actually involved in serving on the MTA Board? What qualities should you look for when nominating other members? Is this a good role for you personally? Here are the expectations of MTA Board members, which I have boiled down to the “5 P’s.” An MTA Board member should be:

1) Passionate- have a passion for technical analysis and furthering the mission of the MTA

2) Positive- encourage a positive and collaborative debate and discussion with a diverse group of volunteer leaders

3) Present- able to participate in regular conference calls, as well as attend the Annual Symposium and other events as needed.

4) Prepared- eager to pursue a deep understanding of the organization, its structures, and strategic plans for the coming years.

5) Proactive- be an active participant in discussions, bringing past experiences from inside and outside the MTA to help further the organization

For the fiscal year commencing July 1, 2016, two (2) At-large Director positions are up for consideration for a 3-year term. Members, Honorary Members and Emeritus Members in good standing are invited to submit recommendations for consideration no later than January 27, 2017, and can be submitted via e-mail to nominations@mta.org. Individuals may nominate themselves or others. If you have any questions, please contact Tyler Wood at Tyler@mta.org.
OPTION PRICING METHODS IN THE LATE 19TH CENTURY

BY GEORGE DOTSIS

Editor’s note: this paper is available at SSRN.com and highlights the history of options pricing models. It demonstrates the long history of quantitative models in the markets and the relevance of history to market analysts. The complete paper, with all citations, can be read at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2831362.

Abstract: This paper examines option pricing methods used by investors in the late 19th century. Based on the book called “PUT-AND-CALL” written by Leonard R. Higgins in 1896 and published in 1906 it is shown that investors in that period used routinely the put-call parity for option conversion and static replicating of option positions, and had developed no-arbitrage pricing formulas for determining the prices of at-the-money and slightly out-of-the-money and in-the-money short-term calls and puts. Option traders in the late 19th century understood that the expected return of the underlying does not affect the price of an option and viewed options mainly as instruments to trade volatility.

Introduction

Although trading and product innovation in derivative markets increased almost exponentially over the last four decades, option markets existed for centuries prior to the modern era. Mixon (2009) examines equity option data from an over-the-counter market in US during the 1870s and concludes that: “Traders in the nineteenth century appear to have priced options the same way that twenty-first-century traders price options. Empirical regularities relating implied volatility to realized volatility, stock prices, and other implied volatilities (including the volatility skew) are qualitatively the same in both eras...... empirical regularities regarding implied volatility are qualitatively the same in the nineteenth and twenty-first centuries. In both eras, implied volatility typically exceeded realized volatility, was substantially serially correlated, featured significant comovement among stocks, and was higher for stocks with relatively high realized volatility. An implied volatility skew is present and displays significant common movement in both eras. The empirical regularities and pricing behavior are clearly not a function of modern theoretical advances”. This is a fascinating result that leads naturally to the following question: What type of pricing techniques did investors in the late 19th century use?

Kairys and Valerio (1997) use the same data as Mixon (2009) and argue that options were expensive relative to the Black and Scholes (1973) model. However, even with today’s standards, certain options (e.g., out-of-the-money puts) may seem expensive relative to the Black and Scholes model. Moore and Juh (2006) examine daily data for warrants traded on the Johannesburg Stock Exchange between 1909 and 1922 and find that options were fairly priced. They argue that investors had an intuitive grasp of the determinants of derivative pricing. Historical evidence suggests that trading in standalone
equity options first begun in the Amsterdam bourse in the 17th century (see Gelderblom and Jonker (2005) and Poitras (2009)). According to Moore and Juh (2006) books such as Higgins (1906), which was available in the early twentieth century, provided a theory of derivatives pricing based mainly on an intuitive understanding of the determinants of option prices, but option traders at that time did not have available an exact option pricing formula.

In this paper I show that option traders in the late 19th century not only had an intuitive grasp of the main determinants of option prices but they have also developed no-arbitrage pricing formulas for determining their prices. The option pricing formulas are described in a book called “PUT-AND-CALL” written by Leonard R. Higgins in 1896 and published in 1906. Higgins was an option trader in London and in his book he describes option pricing methods and option strategies used in the late 19th century in the City of London. In the preface of the book Higgins writes: “The writer of the following pages feels that, in publishing this little book on Options, he may be telling many of his professional friends what they already know perhaps better than the author”. Therefore, one can safely conclude that the methods described in Higgins’s book were common knowledge amongst professional option traders in London. In the chapter “OPTION DEALING ABROAD” Higgins writes (p. 58) that “London is the par excellence the option market of the world” and mentions that large transactions of option trading are also done in the French (Paris) and German (Berlin) markets. In this chapter he provides a vocabulary in English, French and German with terms related to options trading. For example, he says that (p. 59). “In Germany the put-and-call is treated somewhat differently from the London method. It is called Die Stellage for which no English equivalent can be found, but which corresponds with the American expression "straddle \". The term “put-and-call” which is used repeatedly in Higgins’s book and it is also the title of the book corresponds to an at-the-money-forward (ATMF) straddle. From Higgins’s book it appears that in the late 19the century there was an active option market in Paris, London, Berlin and New York and a network of sophisticated option traders both in Europe and US who probably shared the same methodologies and pricing techniques. The book is available on line here: https://archive.org/details/putandcall00higguoft.

Based on Higgins’s book it appears that option traders in the late 19th century understood perfectly well the put-call parity relationship, used methods of static replication, understood that the expected return of the underlying does not affect the price of an option and viewed options mainly as a vehicle for trading volatility. The pricing approach described in Higgins book could be summarized as follows: First, traders were pricing short-term ATMF straddles (30, 60 or 90 days to maturity. The prices of the ATMF straddles were set equal to the risk-adjusted expected absolute deviation (Higgins uses the term average fluctuation) of the underlying price from the strike price at expiration. The expectation of the absolute deviation was based on historical estimates plus a risk premium for future uncertainty as well as some other markups. Given the ATMF straddle prices as reference points Higgins is using a linear approximation formulae based on put-call parity to price slightly out-of-the-money (OTM) and slightly in-the-money (ITM) put and call options (in Higgins’s book the ITM and OTM options are called “fancy options”). I show that the approximation used by Higgins is analogous to a first order Taylor expansion around the ATMF straddle price. Higgins acknowledges (p. 36) that the pricing methodology
described in his book could not be be used when the strike price was set well above or well below the price of the underlying. Higgins also uses the same approximation formula to price “repeat contracts”. The holder of a repeat contract had the right to repeat several times the Sotiropoulos and Rutterford (2014) also discuss the approach of Higgins with respect to the ATMF straddle, and correctly point out that the straddle is used as an “anchor” for pricing other options. However, they do not show how Higgins’s method can be viewed through the lenses of modern option pricing techniques. Haug and Taleb (2011) and Haug (2009) also refer to Higgins’s book and his knowledge of the put-call parity but they do not analyze his pricing methodology. I show that Higgins’s approximation for pricing repeat contracts works quite well when compared to prices obtained from a modified version of the Black and Scholes model.

Modern theories of option pricing based on deductive reasoning and frictionless perfect market hypothesis provide exact pricing mechanisms for the full cross section of call and put option prices. From Higgins’ book it appears that option traders in the late 19th century used inductive reasoning and interpolation techniques and were able to determine quite accurately the prices of ATM and slightly OTM and ITM short-term calls and puts. The pricing methodology described in Higgins’s book shares many similarities with the pricing methods used today and that can explain the findings of Mixon (2009) that empirical regularities and behavior of options prices are qualitatively the same in the nineteenth and twenty-first centuries. Higgins’s book shows that practitioners had developed methods for determining option prices, well before the introduction of the continuous-time stochastic processes paradigm by Black-Scholes-Merton that revolutionized the area of contingent claim analysis.

The remainder of the paper proceeds as follows. In the next Section I provide a brief history of the development of option contracts from antiquity until the late 19th century. In Section 3 the option pricing methods described in Higgins’s book are presented and the last section concludes.

A short history of the development of option contracts from antiquity until the late 19th century

A widely cited example of an early development of the concept of a contingent claim is the story of Thales in Aristotle’s Politics. In Book I, Chapter 11 of Politics, Aristotle tells the story of Thales of Miletus (624-547 BC), one of the seven sages of the ancient world.

“Thales, so the story goes, because of his poverty was taunted with the uselessness of philosophy; but from his knowledge of astronomy he had observed while it was still winter that there was going to be a large crop of olives, so he raised a small sum of money and paid round deposits for the whole of the olive-presses in Miletus and Chios, which he hired at a low rent as nobody was running him up; and when the season arrived, there was a sudden demand for a number of presses at the same time, and by letting them out on what terms he liked he realized a large sum of money, so proving that it is easy for philosophers to be rich if they choose, but this is not what they
care about. Thales then is reported to have thus displayed his wisdom, but as a matter of fact this device of taking an opportunity to secure a monopoly is a universal principle of business; hence even some states have recourse to this plan as a method of raising revenue when short of funds: they introduce a monopoly of marketable goods.”

According to Aristotle's description Thales had bought a call option on the rental price of oil-presses; the right to rent oil pressures at predetermined price. However, Aristotle’s description is vague as to whether Thales would still have to rent the oil pressures should the favorable oil crop had not materialized. Poitras (2009) correctly argues that if Thales had the obligation to rent the oil pressure regardless of rental market conditions the agreement could also be interpreted as a forward contract with down payment. Aristotle’s story may well be fictitious, however he used the parable of Thales to emphasize that those who possess superior information can establish monopolies and produce large profits.

A real example of a contingent claim that was used widely in antiquity and especially in ancient Greece, was the sea loan or bottomry loan. These loans were early forms of structured products with embedded options. Bottomry loans were loans made to merchants and ship owners for financing the transportation of goods using the vessel and/or the cargo as collateral. The payment of the loan was contingent upon the successful arrival of the ship at the destination harbor. In the event of a shipwreck, the borrower did not bear any liabilities with respect to the repayment of the loan. Bottomry loans were not plain loans since the lender was exposed to risk of the voyage nor a type of partnership since the return of the loan was fixed and know in advance. Using Merton's (1974) formulation for the valuation of corporate debt the bottomry loan can be viewed as risky debt on vessel/cargo value. The creditors had implicitly sold a put option on the value of the vessel and the cargo. The interest rate charged on a bottomry loan embedded a premium that reflected the probability of a shipwreck event. Due to the implicit put option, bottomry loans are often refereed as early forms of ship insurance. Although there are no explicit records regarding the actual yields on bottomry loans, Cohen (1992) examines sources from Demothsenes and Lysias and argues that yields probably varied between 12.5% and over 100%. Hoover (1926) describes in detail the contractual characteristics and the evolution of bottomry loans from ancient Greece to the Roman era and to medieval Genoa. Bottomry loans assume that at the maturity of the loan in the event of the shipwreck the creditor takes over any value left from the ship and the cargo (V) and if the vessel reaches its destination successfully the creditor receives the face value of the loan (B). The payoff to the creditor is min(V,B) = B-max(B-V,0), a risk-free bill and a short position in a put option. Options were an important financial innovation that contributed significantly to the development of commerce and trade.

Basking and Miranti (1997) and Cohen (1992) provide a compelling explanation based on asymmetric information and information costs as to why these contingent claim contracts were so widely used in maritime trade. They argue that these type of arrangements minimized investor's information requirements. If the bottomry loans did not embed the cancellation provision, lenders would have to spend time and effort to collect accurate information with respect to the financial viability of the borrowing merchants. Cohen (1992) also argues based on the Lakritos case (Demosthenes Against Lacritus) that in the event of shipwreck, lender’s compensation would require costly, complex, and time-consuming legal
efforts rendering the collection of debt quite uncertain. The bottomry loan is an early example of security for maritime financing whose design minimized information costs and asymmetric information.

According to the historical evidence (see Gelderblom and Jonker (2005), Poitras (2009)) exchange trading in standalone equity options first begun in the Amsterdam bourse in the 17th century. In the Amsterdam bourse there was an active market of derivative contracts on the stock of the Dutch East Indies Company (VOC from the Dutch Vereenigde Oost-Indische Compagnie). The Dutch East Indies Company was founded in 1602 (and dissolved in 1799) after the Dutch government granted the company a 21-year trade monopoly on spice trade. The Dutch East Indies Company was an early form of a limited liability company and the first public company in world’s economic history to perform an IPO with issuing negotiable shares sold to the wider public. According to Szpiro (2011), VOC shares were used routinely as loan collaterals. VOC shares were highly valued as collaterals and that contributed significantly to the reduction in interest rates with beneficial effects in commerce financing. However, lenders were exposed to default risk in the event of a significant drop in the value of the collateral. To insure themselves against such losses, they would enter put option positions to have the right to sell the VOC shares at a predetermined price. Again, the introduction of stock option contracts can, at least partially, be attributed to the existence of information asymmetries between borrowers and lenders and information costs. Should lenders did not have the ability to hedge collateral value they would have to collect additional information with respect to other assets owned by the borrower. Petram (2011) examines actual options transactions data on VOC shares and finds that call options were also routinely used for speculative reasons. Josef de la Vega (1688) and Isaac de Pinto (1762) are the primary sources regarding option trading in the Amsterdam bourse. Poitras (2009) shows that both de la Vega and de Pinto had an intuitive grasp of the put-call parity since they both knew how to covert call prices to put prices and vice versa. However, the put-call parity relationship is not explicitly formulated neither in de la Vega nor in de Pinto.

Stock and option trading gradually moved to London after the Great Revolution and in 1773 the London Stock Exchange was formally established. Houghton (1694) provides a detailed description of equity options trading in London (see Poitras (2009) for a thorough analysis of Houghton' book). At that time derivative trades were often called “time trades” or “time bargains” or “jobbing” trades (see Harrison (2003)). Murphy (2009) examines actual option price data for the period from January 1692 to mid-1695 from the ledgers of a financial broker named Charles Blunt. Call and put options (call options were called refusals in the late seventeenth century) could be exercised at any time before expiration (American-style) with physical delivery of the underlying security. The majority of the options were at-the-money with 6- months to expiration. Murphy (2009) finds that Blunt’s clients used options for both risk management and speculative purposes and option prices were more or less consistent with basic pricing rules. Out-of-the-money options were less expensive than at-the-money and in-the-money options, short-term options were less expensive than long-term options and option prices were highly sensitive to changes in market uncertainty.
Following the events of the South Sea Bubble in 1720, the English parliament in 1734 passed Sir John Barnard's Act which was a set of rules aimed to prevent stock jobbing and trade in options and forwards was forbidden. Poitras (2009) reports the main provision of the Act that states: “All contracts or agreements whatsoever by or between any person or persons whatsoever, upon which any premium or consideration in the nature of a premium shall be given or paid for liberty to put upon or deliver, receive, accept or refuse any public or joint stock, or other public securities whatsoever, or any part, share or interest therein, and also all wagers and contracts in the nature of wagers, and all contracts in the nature of puts or refusals, relating to the then present or future price or value of any stock or securities, as aforesaid, shall be null and void.” In Barnard's Act, forward trades are referred to as contracts to “deliver” or “receive” and as “wagers and contracts in the nature of wagers”, put options as contracts to put upon and call options are referred to as refusals. Harrison (2003) notes that forward trades were considered wagers because they were often contracts for difference similar to modern CFDs. According to Harrison (2003) frequent instances of short-selling banning, usually after large market drops, also occurred in the Amsterdam exchange. Following the Tulip bubble crisis in the 1630's the Dutch government also rendered time bargains unenforceable by law.

Despite the fact that “time trades” were in general unenforceable by law and often explicitly banned, the market for these contracts continued to grow during the 18th century. Harrison (2003) notes that Barnard's Act proved to be ineffective since Bills aim to ban time trades also were introduced in 1756 again in 1756 and in 1776. The 1746 and 1756 bills came under the title “a bill more effectually to prevent the infamous practice of stock-jobbing”. Clearly, benefits from time trades outweighed the potential costs from illegal actions or counterparty default risk. Poitras (2009) notes that in 1820 even though options trading was illegal under Barnard's Act, members of the London Stock Exchange tried to pass a rule to explicitly forbid Exchange members from dealing in options. The rule failed to pass and by the end of the 19th century equity options were traded using the central clearing house of London stock exchange.

Equity option trading in US probably started in the late 18th century but according to Poitras (2009) historical recourses are scarce. An active over-the-counter market for equity options developed in New York after the civil war. Mixon (2009) notes that option trading was generally perceived as socially undesirable and a cause of extreme speculation and volatility in agricultural commodity prices and sometimes was explicitly banned by legislation. During the second half of the 19th century option transactions in Paris started to grow and in 1885 derivative contracts became legally enforceable in France (see Weber (2009)). During the 19th century options trading also spread from France to Germany. According to Higgins (p. 58) in the late 19th century the London market was par excellence the option market of the world since “nowhere the same facility for giving and taking, for operating in long and short options, and for hedging against a favourable put or call in the firm stock as that which exists in London. It rarely happens that an option is done in the Paris market for more than one month ahead, and in Berlin too the majority of such dealings are arranged for a similar period. In London two and three months’ calls are easily negotiated in the active stocks.”
THE PUT-AND-CALL by Leonard R. Higgins

The book PUT-AND-CALL was written by Leonard R. Higgins in 1896 and published in 1906. The books consist of 11 chapters and presents in a systematic way definitions of various options contracts, examples of speculation and hedging strategies and methods for pricing option contracts. From Higgins’s book it appears that in the late 19th century there was an active options market in the City London. The underlying assets described in Higgins’s book are British and American shares, British government bonds (Consols), and Spanish government bonds. Options could be exercised only at maturity (European style), they were written on the forward price of the underlying (the forward contract had the same expiry date as the option), they were dividend protected, and time to expiration ranged from 15 days up to 90 days. According to Higgins (p.1) the Committee of the London Stock Exchange recognized the legality of option dealing only when the maturity of option ranged from 15 days to 45 days. For longer maturities the Committee “will not legislate upon any dispute arising from an option transaction”. In Higgins’s book the options writer is called the "the taker" and the option buyer is called "the giver". Premiums were paid at expiration and standard options were ATMF. ITM and OTM options and repeat contracts are called "Fancy Options" in Higgins’s book.

I begin the analysis from the last chapter of the book, Chapter XI, (The Value of the Putand-Call) where Higgins explains how to price an ATMF straddle. Then I study Chapter V (The Conversion of Options), Chapter VI (The Principles Formulated), Chapter VII (The Call o' more, Put o' more), and Chapter VIII (The Call of twice more, three times more, etc,) where the author describes option conversion and static replication based on the put-call parity and uses as a starting point the price of the ATMF straddle to price fancy options.

The Value of the Put-and-Call

In Chapter VIII called “The Value of the Put-and-Call”” Higgins describes his approach for pricing ATMF straddles. According to Higgins (p. 70-71) the basic rules for finding the price of the ATFM straddle are:

“Firstly, to ascertain the past average fluctuations over a considerable period of time of the stock to be operated in.

Secondly, to consider whether there is any special influence at work calculated to modify that average result in the immediate future (such as a particular scarcity of the stock for delivery, financial strain, or probability of political complications).

Thirdly, to accept risks on approximately the same amounts of stock at regular intervals of time.

Fourthly, to add to the "average value" of the put and call an amount which will give a fair margin of profit and allowance for working expenses.
Fifthly, to make provision for possible default on the part of the giver (since the option money only becomes payable at the end of the option period), and for special contingencies, such as large differences or bad debts on option stock carried over through buying one half of the stock to convert the call into a put-and-call or loss through an unexpected rise in the money rate, none of these mischances being provided for in the "average value" tables, which have been calculated simply from the average fluctuations.

Sixthly and lastly. To be careful that, having once accepted a risk, the option shall be allowed to run to the end of the option period without being tampered with by hedging operations in the firm stock or "cutting the loss " before its time, and that at the expiry of the option the profit or loss shall be taken as final and the position be absolutely closed."

Higgins calculates past average fluctuations for various stocks. For example, in the table below, he calculates the average two months and three months' fluctuations of Louisville and Nashville shares:

<table>
<thead>
<tr>
<th>Year</th>
<th>Two Months</th>
<th>Three Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>1888</td>
<td>-</td>
<td>3.84%</td>
</tr>
<tr>
<td>1889</td>
<td>-</td>
<td>5.43%</td>
</tr>
<tr>
<td>1890</td>
<td>-</td>
<td>4.77%</td>
</tr>
<tr>
<td>1891</td>
<td>-</td>
<td>4.32%</td>
</tr>
<tr>
<td>1892</td>
<td>-</td>
<td>2.88%</td>
</tr>
<tr>
<td>1893</td>
<td>-</td>
<td>5.41%</td>
</tr>
<tr>
<td>1894</td>
<td>-</td>
<td>4.53%</td>
</tr>
</tbody>
</table>

Average, 4.45%        | Average, 5.34%

Source: Higgins (1906), Chapter VIII, p. 72.

Although not explicitly stated, Higgins calculates the average past fluctuation as the past mean absolute return which is the same as the mean absolute deviation (MAD) when the mean return is set to zero.

Under Higgins’s approach the price of the put-and-call, in the book it is denoted as p.a.c., is set equal to the past average fluctuation, plus a risk premium for future uncertainty, plus an additional markup for a profit margin, working expenses and compensation for the default probability of the option buyer (premiums were paid at expiration). Note that in Higgins’s book option prices are reported as percentages relative to the price of the underlying at the imitation of the trade.

Using modern derivatives notation, the payoff of the p.a.c. at expiration (T) can be written as:
\[ P.a.c. = \frac{ATF_{\text{call}} + ATM_{\text{put}}}{F_{t,T}} = \frac{1}{F_{t,T}} \begin{cases} S_T - F_{t,T} & \text{if } S_T \geq F_{t,T} \\ F_{t,T} - S_T & \text{if } S_T < F_{t,T} \end{cases} \]

where \( F_{t,T} \) is the forward price (with delivery at time \( T \)) of the underlying stock at the initiation of the trade at time \( t \). Therefore, at the initiation of the trade at time \( t \) the price of the put-and-call is equal to the expected absolute deviation:

\[ P.a.c.(t) = E^Q_t \left[ \frac{S_T - F_{t,T}}{F_{t,T}} \right] \]  

(2)

where \( Q \) is the risk-neutral probability measure. Brenner-Subrahmanyan (1988) show that using a Taylor expansion of the normal CDF about 0 the ATMF call option according to the Black-Scholes formula is approximately equal to:

\[ \frac{C^{BS}(\sigma)}{F_{t,T}} = e^{-r(T-t)} \sqrt{T-t} \left( \frac{1}{2} \right) \frac{1}{\sqrt{2\pi}} \]  

(3)

Using the approximation in (3) and adjusting for the fact that premiums are paid at expiration, the value of the p.a.c. is equal to:

\[ P.a.c.(t) = \frac{2}{\pi} \sigma \sqrt{T-t} \approx 0.8 \times \sigma \sqrt{T-t} \]  

(4)

where \( \sigma \) is the annualized standard deviation. Relationship (4) holds approximately even when the underlying asset follows a process with stochastic volatility:

\[ P.a.c.(t) = \frac{2}{\pi} \times E^Q_t \left[ \sigma_{t,T} \right] \]  

(5)
where is conditional risk-neutral expectation of return volatility over the time interval \([t, T]\). Carr and Lee (2007) show that the approximation in (5) is quite accurate under general market setting, especially when the correlation between volatility and returns is zero.

For the case of a normal distribution with standard deviation \(\sigma\), a well known result in statistics is that the standard deviation is equal to \(\sigma \pi = \times 2\) MAD. Under the normal distribution, the Black and Scholes approximation in (4) and the pricing equation in (2) become identical, up to an approximation error. Option traders in the late 19th century and option traders today both view the prices of ATMF straddles as risk-adjusted estimates of future stock fluctuation. The difference being that modern option traders measure stock return fluctuation using the concept of variance and standard deviation while option traders in the late 19th century measured stock return fluctuation using the mean absolute deviation.

From Higgins’s description it is evident that option traders did not consider the expected return of the underlying asset as a factor that had a direct effect on the price of the option. Using the modern option pricing approach, the expected return of the asset is eliminated from the pricing formula through dynamic delta hedging. Option traders in the 19th century arrived at the same conclusion using an approach based on intuition and experience. Traders in the late 19th century assumed that the sensitivity of the ATMF option prices with respect to the underlying was 0.5 and therefore considered ATMF straddles as “delta neutral” assets whose value depended only on the future fluctuation of the underlying. Huang and Taleb (2011) refer to Nelson (1904) who says that “Sellers of options in London as a result of long experience, if they sell a Call, straightway buy half the stock against which the Call is sold; or if a Put is sold, they sell half the stock immediately, finding that in the long run this method usually works out a profit.” Note that Nelson (his book called the “The A B C of Options and Arbitrage) refers extensively to Higgins’s book and whole sections from Higgins’s book are also included in Nelson’s book (for example the chapter “The Value of the Put-and-Call”). In the next section, it is shown how Higgins priced ITM and OTM options using a linear approximation around the price of the ATMF straddle. Through inductive reasoning option traders in the late 19th century concluded that since the expected return does not affect the price of the ATMF straddle it also does not affect the price of OTM and ITM options, since both were priced relative to the ATMF straddle.

Similar to modern equity markets, stock returns in the 19th century were also characterized by fat tails and time-varying volatility (see Mixon (2009)). Higgins does not postulate any particular distribution for stock returns. He is using a pricing method based on the empirical distribution of stock returns and any departures from normality are implicitly embedded into the estimate of future absolute deviation.

Higgins (p.73) also provides an example on the pricing of a two month ATMF straddle whose underlying is the stock of Louisville. Higgins’s computations are shown in the table below:
According to Higgins’s calculations, given an estimate of future absolute deviation a markup of approximately 20% is added to derive the price of the ATMF straddle. A difference of 20% between historical and implied absolute deviation is in line with the size of the variance risk premium of individuals stocks in modern option markets (see, for example, Carr and Wu (2009)). Higgins (p.68) also comments on the realization of the premium and writes that the option taker “must "take the money" very many times to make it pay. It is just so with the taker of option money. Not only must he ascertain the average past behaviour of the stock he is about to deal in, but he must be careful that he can sell this risk a sufficient number of times during the year to establish the average upon which his premium is based.”

**Pricing the “Fancy Options”**

In many parts of the book Higgins is using the put-call parity for the forward values of the put and the call. Given the risk-free interest rate (r), option expiration (T-t) in years, the price of the underlying (S), the price of the call (C) paid at time T, the price of the put (P) paid at time T and strike price (X) the put-call parity at time t is given below:

\[
\frac{P}{1 + r(T-t)} + S = \frac{C}{1 + r(T-t)} + \frac{X}{1 + r(T-t)} \Rightarrow P + F = C + X
\]

(6)

Adding the call price or put price in both sides of (6), Higgins expresses the put-call parity in terms of the put-and-call as follows:

\[
P.a.c. = 2C - D \\
P.a.c. = 2P + D
\]

(7)
where \( D = F - X \), is called the “distance”. The put-and-call plays a central role in Higgins’s approach since fancy options are priced relative to the ATMF straddle. In order to price OTM and ITM call and put options Higgins is using the put-call parity relationship in (7) as follows:

\[
C = \frac{p + \Delta C + D}{2} \\
\frac{P = \frac{p + \Delta C - D}{2}}{2}
\]

(8)

In Chapter V (The conversion of Options) Higgins (p.26) provides a set of 8 rules based on the put-call parity:

1. That a call of a certain amount of stock can be converted into a put-and-call of half as much by selling one-half of the original amount.

2. That a put of a certain amount of stock can be turned into a put-and-call of half as much by buying one-half of the original amount.

3. That a call can be turned into a put by selling all the stock.

4. That a put can be turned into a call by buying all the stock.

5 and 6. That a put-and-call of a certain amount of stock can be turned into either a put of twice as much by selling the whole amount, or into a call of twice as much by buying the whole amount.

7. To sell half the stock at the option price against a call is equivalent to giving twice the amount of money for the put-and-call of half the quantity of stock at the same price.

8. If option money is given for the put, and half the amount of stock is bought against it at the option price, the dealer has practically given twice the option money for the put-and-call of half the stock - at the same price.”

It is obvious that Higgins had an insightful understanding of the put-call parity and derives various replication strategies involving long/short positions in forward contracts, long/short positions in a call or a put and long/short positions in ATMF straddles. Rules 1 and 2 are based in expression (8). Rules 3 and 4 is a standard replication strategy using forward contracts and options based on the put-call parity in (6). Rules 5, 6 are based in expression (7) and rules 7 and 8 in expression (8).

In Chapter VI (The Principles Formulated) Higgins describes his methodology for pricing ITM and OTM options. The example below (p.37) describes the pricing of an ITM and OTM call.
To return to our examples: The call at 80 costs 1½%. What is the call worth at 80½? Now, we assume that p.a.c. at 80 = p.a.c. at 80½; we know that the call must cost less at 80½ than at 80; the formula therefore is—

\[ C = \frac{\text{p.a.c.} - D}{2} = \frac{3 - \frac{1}{2}}{2} = 1 \frac{1}{8} \]

Again, what is the cost of the call at 79½ when the right price is 80 and the put-and-call 3%? The “distance” is unfavourable here to the option money risked. The formula therefore is—

\[ C = \frac{\text{p.a.c.} + D}{2} = \frac{3 + \frac{1}{2}}{2} = 1 \frac{1}{8} \]

So we see that if a stock stands at 80, and the put-and-call is 3% for a certain period at 80—

The call at 79½ would cost 1½, 

at 80 " 1½, 

at 80½ " 1½, 

Source: Higgins (1906), chapter VI, page 37.

Higgins is using the put-call parity to price slightly OTM and ITM options by assuming that the price of the ATMF straddle remains the same in strikes slightly above/below the forward price. When the option is an ITM call half the distance is added to half the price of the ATMF straddle and when the option is an OTM call half the distance is subtracted from the half the price of the ATMF straddle. Note that this approximation is equivalent to a first order Taylor expansion along the strike dimension:

\[ C_{\text{ITM/OTM}} = C_{\text{ATMF}} - \frac{1}{2}(X - F), \text{ since } C_{\text{ATMF}} = P_{\text{ATMF}} \]

and assuming that the price sensitivity with respect to the strike is -0.5.

Higgins (p. 38) understands that the approximation works well only for small deviations from the forward price (forward price is also called “the right price”) and writes “It is quite usual for options to be done for long periods, e.g., three months ahead, where the price fixed is considerably above or below the "right" price for the period; in these cases the call money is arranged on the basis of a put-and-call increased by an arbitrary amount calculated to cover the additional risk involved in taking option money with so much of the money already "run off" in one direction.”
In Chapters VII and VIII, Higgins examines the pricing of option contracts known as call o’more, put o’more, call of twice more, call of three times more etc. These were type of “repeat contracts” that were traded in options markets until the early decades of the 20th century (see Zimmermann (2009)).

The holder of a repeat contract had the right to repeat the transaction of the option n times. For example, in the case of a call option the holder had the right to buy once more (called call o’more in Higgins’ book), twice more (called the call of twice more), three times more (called the call of three time more) the amount of stock etc. In the repeat contracts the premium was paid at maturity but the premium was also added to strike price in the case of a call option and subtracted from the strike price in the case of a put option.

To fix ideas, denote as \( R_n \) the premium of a n-times repeat contract. If \( F_{tT} \), is the strike price of an ATMF option, \( c F R t T \ n + \) is the strike price of an n-times repeat call option and \( - \) is the strike price of an n-times repeat put option. The premium of an n-times repeat call option that expires at time T is equal to and the premium of n-times repeat put option is equal to the price of European call option when the price of the underlying is \( F_{tT} \), and the strike price is , is the price of European put option when the price of the underlying is F and the strike price is , \( p F R t T n - \).

Higgins writes (p.41): “From its very nature the call o' more or put o' more must of necessity be an optional bargain at a price other than the right price, seeing that the option money is included in the price at which the stock is bought or sold. Consequently, transactions of this description are not often done for long periods ahead, for the "distance" would become so large that the option would have to be very dear to compensate the taker's risk in commencing a "long shot" operation with a considerable amount of the money "run off". Call o' more bargains are therefore more freely done from day to day or for a week, one account or one month ahead.”

In Higgins’s book the premium of the n-times repeat contract corresponds to the “distance” \( D \) relative to the forward price of the underlying, and its price is equal to the price of the ATMF straddle. In the example below Higgins (p. 51) presents his approach for pricing the repeat contract.

**Conclusions**

This paper examines the option pricing methodologies describe in the book called “PUT-AND-CALL” written by Leonard R. Higgins in 1896 and published in 1906. The central object in Higgins’s approach is the price of the ATMF straddle. In the chapter “The Value of the Put-and-Call” Higgins prices the ATMF straddle as the risk-adjusted future absolute deviation. The prices of ITM, OTM options and repeat contracts are determined relative to the price of the ATMF straddle using a linear approximation based on the put-call parity, which is analogous to a first order Taylor expansion. Higgins also provides a set of rules for option conversion and static replication based on the put-call parity.
From Higgins’s book it appears that option traders in the late 19th century had developed no-arbitrage pricing formulas for determining the prices of at-the-money and slightly out-of-the-money and in-the-money short-term calls and puts. Higgins’s book is an important reference in the history of option pricing because it provides a pricing framework based on empirical rules and approximation methods for determining option prices. Higgins’s method could be taught in introductory derivatives valuation courses before the Black and Scholes and the binomial model to help students appreciate the historical development of option pricing methods and the contribution of option market practitioners. In future research it would be interesting to examine how the option market in the City of London evolved during the early decades of the 20th century and try to understand why the pricing methods developed by the practitioners in the late 19th century was largely lost and forgotten in the post 1960s era when trading in option markets and academic research in option pricing begun to flourish.