June 2018

# Finding Alpha

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# INVESTING IN RECREATIONAL MARIJUANA

SIMON XIONG                                                              JULY 5, 2018

**Latest Update on Marijuana Legalization**

On Thursday, June 21, 2018, Bill C-45, which legalizes the sale and distribution of marijuana for recreational purposes, officially passed Parliament and received Royal Assent. This was one of the last major hurdles to legalization, which will take effect on October 17, 2018. With legalization on the horizon, how can investors get involved in this emerging industry?

**History of Marijuana Legalization In Canada**

**1923:** The Liberal government introduced an Act to Prohibit the Improper Use of Opium and other Drugs with an amendment that added cannabis to the list of proscribed drugs. As a result, Canada became one of the first countries to make smoking pot illegal, with the US following suit 14 years later. With the passing of Bill C-45, Canada will also be one of the first countries to make marijuana legal again.



Chart 4
**Raw versus smoothed estimated volume of consumption, 1960 to 2015**

- - - - Total tonnes consumed          —— Blended trend of tonnes consumed
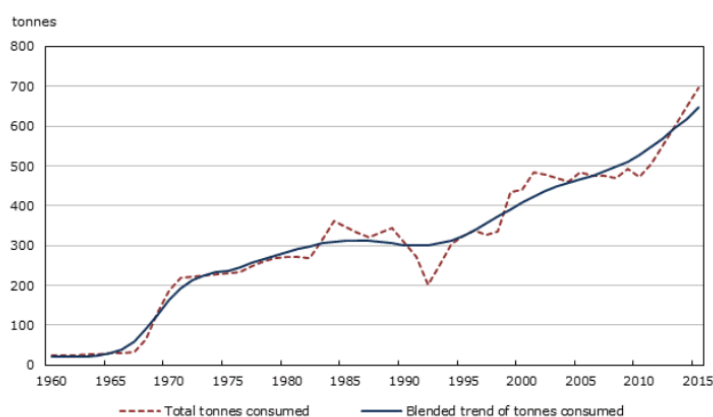
**Source:** Statistics Canada, authors' calculations.

**1960s:** Despite becoming illegal in 1923, cannabis use did not gain popularity in Canada until the 1960's with the rise of the psychedelic "hippie" movement in the US. In 1962 the RCMP reported only 20 criminal cases connected with cannabis. In 1968, that number had risen to 2300 and by 1972 there were nearly 12000 cannabis convictions in Canada.

**2015:** The liberal party, led by Justin Trudeau, won a majority government in the federal election. One of their promises was to legalize marijuana in order to discourage criminal activity surrounding the drug. Trudeau stated he would begin the process shortly after taking power and that legalization could happen anywhere from a month to "a year or two".

**2017:** On April 13, 2017, the liberal government introduced the Cannabis Act, also known as Bill C-45, which would effectively legalize marijuana for recreational purposes nationwide.

**2018:** After months of debate and consultation with provincial and indigenous governments, Bill C-45 passed the Senate's final vote on June 19, 2018, by a vote of 52 to 29 and received royal assent on June 21, 2018. Trudeau announces that recreational sales of marijuana will begin on October 17, 2018.

1. Aiello, R. (2018, June 20). *Timeline of key events in marijuana bill's passage through Parliament.* Retrieved June 23, 2018, from https://www.ctvnews.ca/politics/timeline-of-key-events-in-marijuana-bill-s-passage-through-parliament-1.3958662
2. Schwartz, D. (2014, May 06). *A Canadian mystery: Why was pot criminalized in 1923? | CBC News.* Retrieved June 23, 2018, from http://www.cbc.ca/news/health/marijuana-was-criminalized-in-1923-but-why-1.2630436
3. Rough, L. (2017, July 06). *The History of Cannabis in Canada.* Retrieved June 23, 2018, from https://www.leafly.com/news/canada/history-cannabis-canada
4. Elliott, J. (2015, September 30). *Liberals 'committed' to legalizing marijuana: Trudeau.* Retrieved June 23, 2018, from https://www.ctvnews.ca/politics/election/liberals-committed-to-legalizing-marijuana-trudeau-1.2588260
5. Kilpatrick, S. (2017, April 13). *Highlights from the Liberals' pot-legalization bills.* Retrieved June 23, 2018, from https://www.thestar.com/news/canada/2017/04/13/highlights-from-the-liberals-pot-legalization-bills.html

**Details About Legalization**

To help us understand the emerging Canadian marijuana market, we'll take a look at some of the details of legalization. On October 17, 2018, Canadians adults will be allowed to buy marijuana online or in provincially-regulated retail stores. Adults will also be allowed to grow up to four marijuana plants at home, and to carry up to 30 grams of cannabis in public.

To legally sell cannabis, businesses must first apply to become a licensed producer, an expensive and time-consuming process that can take more than a year to complete. As of March 31, 2017, Health Canada had received 1,630 applications for licences and approved 43, representing a success rate of just 2.6% (Israel, 2017). Stringent regulatory requirements create a high barrier of entry to the marijuana market, which gives established producers an advantage.

The retail and distribution of marijuana will be government-regulated and varies from province to province. In Ontario, LCBO will be the legal retailer of cannabis with roughly 150 stores to be opened by 2020, while British Columbia will allow sales from private stores but require them to get their supply of cannabis from the government's wholesale distribution system (Crawley, 2018). Both Ontario and BC have chosen to use Shopify for their online and mobile sales portals, giving Shopify a monopoly over the provinces' online cannabis sales channels (Drew, 2018).

**Investment Opportunities**

Canada legalized medical marijuana nationwide back in 2001, which has allowed the Canadian cannabis industry to become more mature than in the US where only 29 states allow the use of medical marijuana. With legalization of recreational marijuana on the horizon, the Canadian cannabis industry is well-positioned to capture this emerging market.

(TSX:WEED) Canopy Growth Corp is the largest marijuana grower in Canada with a market cap of $8.72 billion CAD. The company has significant production capacity and has secured supply agreements with 3 Canadian provinces with more provinces likely to join.



*Figure 2.1:* *LCBO will be the legal retailer of marijuana in Ontario.*

This position will allow Canopy Growth to hit the ground running when recreational marijuana position will allow Canopy Growth to hit the ground running when recreational marijuana becomes legal later in the year.

In addition, Canopy Growth is targeting the international medical marijuana market. 22 countries outside of Canada have legalized medical marijuana with 14 other countries potentially legalizing within the next few years. With 8 growing sites across 7 countries, Canopy Growth is looking to capitalize on the fast-growing international medical marijuana market that is potentially eight times larger than Canada's total marijuana market.

6. Statistics Canada. (2018, February 02). *Economic Insights Experimental Estimates of Cannabis Consumption in Canada, 1960 to 2015. Retrieved June 23, 2018, from https://www150.statcan.gc.ca/n1/pub/11-626-x/11-626-x2017077-eng.htm*

7. Israel, S. (2017, April 29). *'Not for the faint of heart': Why getting a marijuana producer licence is a long shot. Retrieved June 23, 2018, from https://www.cbc.ca/news/business/health-canada-marijuana-licence-applications-1.4090035*

8. Crawley, M. (2017, September 08). *Ontario unveils pot plan, including online ordering, 150 stand-alone stores | CBC News. Retrieved June 23, 2018, from http://www.cbc.ca/news/canada/toronto/province-cannabis-plan-1.4280484*

9. Drew, R. (2018, February 12). *Shopify will manage online cannabis sales in Ontario | CBC News. Retrieved June 23, 2018, from https://www.cbc.ca/news/canada/ottawa/ontario-shopify-marijuana-online-shopping-1.4531228*

10. Speights, K. (2018, June 23). *Better Marijuana Stock: Canopy Growth Corporation vs. Scotts Miracle-Gro. Retrieved June 23, 2018, from https://www.fool.com/investing/2018/06/23/better-marijuana-stock-canopy-growth-corporation-v.aspx*

**WEED STOCK CHART**

1d   1m   3m   1y   5y   max

***Figure 3.1:*** *Canopy Growth has returned over 400% in the past year.*

(TSX:ACB) Aurora Cannabis is the second largest producer in Canada with a market cap of $5.61 billion CAD. The company focuses on being a very efficient producer with its Aurora Sky project, a technologically innovative growth facility that will significantly drive down the cost of production.

Aurora Cannabis made several major acquisitions this year including CanniMed Therapeutics Inc. for $1.1 billion in March and MedReleaf for $3.2 billion in May. These acquisitions allow the company to greatly expand its production capacity to take advantage of its more efficient production processes. However, the company has had to issue a large number of stocks to fund these acquisitions, which have diluted existing shareholders.

(TSX:SHOP) Shopify is the clear winner for online distribution as both Ontario and BC have chosen the company to host their online sales channels with other provinces likely to follow suit. Shopify's technology will also be used in physical stores for point-of-sale systems and for digital screens displaying product and health information (Drew, 2018).

In addition, the provincial government plans to use Shopify's platform for inventory, accounting, and human resources operations. With its reputation as a Canadian tech darling, Shopify will likely attract more investment from the Canadian government, which will help maintain its tremendous growth over the past couple years.

**Conclusion**

With legalization finally taking effect later this year, recreational marijuana is poised to become a multi-billion dollar market. Although distribution will be regulated by the government, investment opportunities exist in marijuana producers like Canopy Growth and Aurora Cannabis. In addition, Shopify is well-positioned to profit after being chosen by the governments of Ontario and BC to be their online distribution channel for recreational marijuana.

11. Frenette, J. (2017, October 25). *Canopy Growth Corp. vs. Aurora Cannabis Inc.: Which Stock Is Better Positioned to Soar Once Legalization Day Arrives?* Retrieved June 23, 2018, from https://www.fool.ca/2017/10/25/canopy-growth-corp-vs-aurora-cannabis-inc-which-stock-is-better-positioned-to-soar-once-legalization-day-arrives/

12. Paradza, B. (2018, May 29). *Aurora Cannabis Inc. (TSX:ACB): Could This Be the Best Stock News Release for the Month?* Retrieved June 23, 2018, from https://www.fool.ca/2018/05/29/aurora-cannabis-inc-tsxacb-could-this-be-the-best-stock-news-release-for-the-month/

13. Jagielski, D. (2018, June 16). *Aurora Cannabis Inc. (TSX:ACB) Acquires Another Company: Why This Is Good News for Investors.* Retrieved June 23, 2018, from https://www.fool.ca/2018/06/16/aurora-cannabis-inc-tsxacb-acquires-another-company-why-this-is-good-news-for-investors/

# AT&T – TIME WARNER MERGER

**SHIRLEY XIAO**                                                      **JUNE 27, 2018**

**Merger Timeline**

AT&T, one of the largest satellite TV and wireless companies in the U.S., is acquiring Time Warner, one of the world's largest media entertainment companies for an equity value of $USD 85.4 billion.

The deal was first announced in October 2016 after unanimous approval from the boards of both companies. In November 2017, the U.S. Department of Justice sued AT&T to block its acquisition of Time Warner in an effort to limit corporate power in the fast-evolving media landscape (Merced & Kang, 2017). The merger finally gained regulatory approval in mid-June 2018 after a lengthy battle with the Justice Department.

**Merger Rationale**

**Competition from Streaming Alternatives**

The media industry is going through structural change. Customers are cutting the cord and becoming more selective about their entertainment consumption choices. An increasing number of streaming alternatives such as Netflix, Amazon Prime Video, and the shift of customers from traditional media are forcing traditional content distributors to rethink their business models.

Competition from emerging technology companies is the main reason why AT&T and Time Warner decided to merge. The industry has been in a frenzy over the past few years. The stock price of Netflix over the past 5 years has significantly outperformed that of AT&T, Comcast, Time Warner, etc., proving that AT&T is facing huge competitive pressures from Netflix. The stock price of Netflix has continuously increased by approximately 1194% from 30.16 per share to 390.39 per share in the past five years whereas the stock price of AT&T fluctuated and dropped by 11.8% from June 2013 to June 2018.
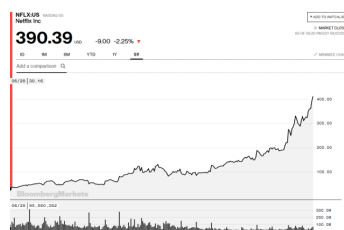


**Graph 1:** *Netflix Stock Performance 2013–2018*
**Source:** *Bloomberg*

**Graph 2:** *AT&T Stock Performance 2013–2018*
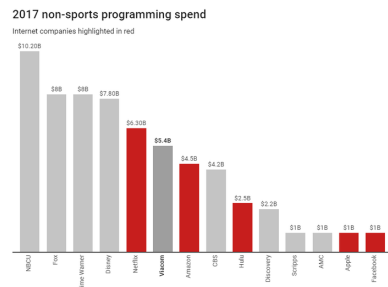**Source:** *Bloomberg*

**Premium Content**

Offering better content to customers is one of the goals AT&T wants to achieve to make itself more competitive in the market. Content is the key factor to attract new customers, as well as earning and keeping customer loyalty in the media industry. This is shown by the crazy amounts of spending and investment in new content in the industry. In 2017, NBCUniversal spent the most on non-sports programming at $10.2 billion followed by Fox and Time Warner, which both spent about $8 billion on video content. Netflix spent about $6.3 billion on content in 2017 and planned to increase the budget to $8 billion in 2018 (Molla, 2018).

1. Kang, C., & Merced, M. J. (2017, November 20). *Justice Department Sues to Block AT&T-Time Warner Merger. Retrieved June 27, 2018, from* https://www.nytimes.com/2017/11/20/business/dealbook/att-time-warner-merger.html
2. T:*New York Stock Quote – AT&T Inc.* (2018, June 27). *Retrieved June 27, 2018, from* https://www.bloomberg.com/quote/T:US
3. NFLX:*NASDAQ GS Stock Quote – Netflix Inc.* (2018, June 27). *Retrieved June 27, 2018, from* https://www.bloomberg.com/quote/NFLX:US
4. Molla, R. (2018, February 26). *Netflix spends more on content than anyone else on the internet – and many TV networks, too. Retrieved June 27, 2018, from* https://www.recode.net/2018/2/26/17053936/how-much-netflix-billion-original-content-programs-tv-movies-hulu-disney-chart

2017 non-sports programming spend
Internet companies highlighted in red

**Graph 3:** *Non-sports programming spending of main media companies in 2017*
**Source:** *Recode*

As a content distributor, acquiring an existing leading content creator would be a great way for AT&T to provide premium content to consumers. With the content from Time Warner, AT&T is able to provide premium content from a portfolio that combines leading movies and shows from Warner Bros., HBO and Turner, along with more targeted digital content from Bleacher Report, Boomerang, FilmStruck and AT&T's investment in Otter Media, among others (Business Wire, 2018).

The returns on attractive content are clear; blockbuster legacy franchises such as the Avengers and Black Panther consistently make billions of dollars for Disney. Therefore, better content is expected to generate more profits for AT&T.

**Concern and Impact**

**Reduced Competition**
One of the biggest arguments against the AT&T-Time Warner merger is that it would reduce competition and the merger will allow AT&T to use Time Warner's media assets to raise costs and put pressure on freedom of content creation. However, they argued that it would be a vertical merger and would not harm customers. AT&T stated that AT&T and Time Warner do not compete; their combination would not alter the competitive landscape in either the telecommunications or entertainment industries. Instead, AT&T argued that consumers would benefit given the amount of competition and alternatives available.

**Vertical Merger:** A vertical merger is a merger between two companies that operate at separate stages of the production process for a specific finished product.

Moreover, AT&T stated that consumers will be able to gain more from the merger between AT&T and Time Warner as the new entity might offer new services, such as new content offerings on mobile from Time Warner's media library, early access to Game of Thrones episodes, or targeted advertising that comes with better information on what consumers watch (Anand, 2016).

**Consolidation Trends in Media Industry**
The deal between AT&T and Time Warner is likely to spur yet more consolidation among media companies as the approval of the deal flashes a green light for mergers and acquisitions. The industry is seeing a flurry of consolidation activity at the moment as the communications industry is trying to combat stiff competition through M&A. For example, Disney and Comcast are bidding for key film and TV assets of 21st Century Fox. Disney offered $52.5 billion to acquire 21st Century Fox in 2017 followed by Comcast offering $65 billion for the acquisition in 2018 challenging Disney. Recently, Disney raised the offer to $71.3 billion. (Baysinger, 2018) The merger between AT&T and Time Warner is a signal of the start of a new era in the media space.

5. Business Wire. (2018, June 14). *AT&T Completes Acquisition of Time Warner Inc.* Retrieved June 27, 2018, from https://finance.yahoo.com/news/t-completes-acquisition-time-warner-234300947.html
6. Anand, B. (2016, October 28). *AT&T, Time Warner, and What Makes Vertical Mergers Succeed.* Retrieved June 27, 2018, from https://hbr.org/2016/10/att-time-warner-and-what-makes-vertical-mergers-succeed
7. Baysinger, T. (2018, June 20). *Disney vs Comcast: Why the Bidding War for Fox Has Only Just Begun.* Retrieved June 27, 2018, from https://www.thewrap.com/disney-vs-comcast-why-the-bidding-war-for-fox-is-just-heating-up/

# EMERGING MARKETS SLOWDOWN

**FRANK SHI**                                                              **JULY 4, 2018**

*On June 20, 2018, Morgan Stanley Capital International (MSCI) announced that Saudi Arabia will be classified as an Emerging Market, thereby increasing investor access to one of the fastest growing economies in the Middle East. This article is aimed at introducing Emerging Markets and its characteristics.*

The goal is investing is to get returns and make money. Investors care about Emerging Markets because EM investments gain higher returns than Developed Markets. Simply put, an Emerging Market is a nation's financial market that is in progress of becoming a Developed Market, which are characterised by well-established exchanges and regulatory bodies, high liquidity in debts, and high GDP per capita. Examples of a Developed Market include Canada, the US, Hong Kong, Japan, and numerous countries in Western Europe.

**Which are the Emerging Markets?**

There is no set standard to determine which nations are considered a Developed Market or an Emerging Market, but institutions like the International Monetary Fund (IMF), S&P, and the MCSI provide authoritative classifications. Figure 1 presents the MCSI's Market Classification, which contains a list of Developed Markets and Emerging Markets. As an aside, the frontier markets are a level lower than Emerging Markets in terms of financial infrastructure and economy.



**Figure 1.** *MSCI Market Classification as of June 20, 2018*
**Source:** *MSCI*

It is worth noting that, as seen in Figure 1, including a nation's stock index into the Emerging Market Index effectively makes that nation an Emerging Market. The same is true for Developed Markets and Frontier Markets. S&P and the IMF have a slightly different classification than the MSCI, but the sizes of the lists are all around 20, and several countries like China, India, and Brazil appear on almost all lists of Emerging Markets.

**Review: Why are Emerging Markets a hot topic?**

Over the last two years, Emerging Market investments have been more profitable than those in Developed Markets. The following charts illustrate this quite well:



**Figure 2.** *iShare MSCI Emerging Market ETF and S&P 500 returns starting from Jan. 2017 to Mar. 2018*
**Source:** *TradingView*



**Figure 3.** *iShare MSCI Emerging Market ETF and S&P 500 returns starting from Jan. 2016 to Jan. 2017*
**Source:** *TradingView*

1. Baltaji D. E., Ozsoy, T. (2018 May 23). Lira Heads for Crisis Mode on Eve of Erdogan's Election Speech. Retrieved from https://www.bloomberg.com/news/articles/2018-05-23/turkey-heads- toward-a-currency-crisis-as-lira-goes-into-freefall
2. Campos, R., Hunnicutt, T. (2018 June 20). Argentina and Saudi Arabia to be added to MSCI emerging markets index. Retrieved from https://www.reuters.com/article/us-funds-msci/argentina-saudi- arabia-to-be-part-of-msci-emerging-markets-index-idUSKBN1JG3AN
3. Curran, E., Tu, L. (2018 May 22). Emerging-Market Stress Just Begun as Record Debt Wall Looms. Retrieved from https://www.bloomberg.com/news/articles/2018-05-23/emerging-market-stress- just-beginning-as-record-debt-wall-looms

In the figures above, the blue line represents the percent growth of the iShare MSCI Emerging Market Fund (NYSE: **EEM**), which tracks investment returns of large and medium-sized Emerging Market Equities, from January 2017 to March 2018. The orange line represents the growth of the S&P 500 in the same timeframe. The comparison here is relevant because S&P 500 is a good representation of large-sized companies in a Developed Market.

Emerging Markets have consistently outperformed the S&P 500 throughout 2016 and 2017, even during the market correction in February 2018. With overall greater economical volume than the developed economies, perhaps the result is unsurprising? However, if we draw the chart from 2013, the result is quite different.
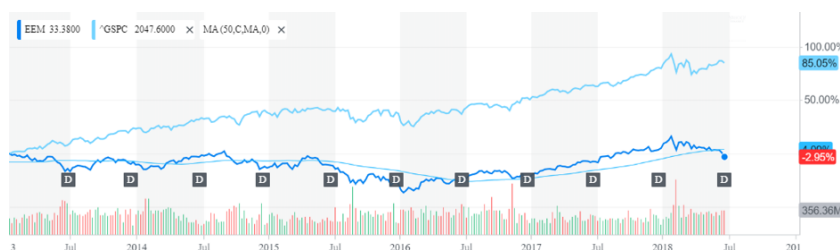


*Figure 4. iShare MSCI Emerging Market ETF and S&P 500 returns starting from Jan. 2013 to current Source: Yahoo Finance*

Figure 4 illustrates that if someone invests $100 at the start of 2013 (instead of the start of 2016 as we did in Figure 3), the S&P will give you a positive return of +$85.05 in June 2018 while the EEM yields a negative return of -$2.95 over the same timeframe. This is a staggering difference. In fact, if we look at the yield from January 2015 until now, the S&P 500 outperforms the EEM by about 10%, so the Emerging Markets have only experiencing growth since the beginning of 2016. Included below are some of the characteristics of Emerging Markets that might offer some insight.

**Currently in Emerging Markets**

On paper, equities in Emerging Markets sound like a good investment. After all, developing countries like China, India, Brazil, or Mexico experience higher GDP growth than developed economies like those of the US or Europe. However, there are other issues in developing countries that bring more risk and volatility than Developed Markets.

**1. State interference**

Companies in Emerging Markets usually experience more state interference than those in developed economies, exposing Emerging Markets to risks of poor economic policies run by the government.

State interference can take several forms, such as significant presence of state-owned companies in certain sectors, significant government subsidies in the private sector, or the state's interference in financial and economic policies. Heavy state interference is unattractive because ultimately, protectionism is unfriendly to foreign investors, as companies which rely heavily on state protection or subsidies are no longer globally competitive once the state is in trouble and can no longer sustain its protection.

Another risk factor is state interference in economic policies such as currency manipulation and interest rates. Perhaps the most recent example of poor economical management is Turkey's currency crisis in May 2018, partially caused by presidential interference in central bank monetary policies towards interest rates. Turkish lira has fallen more than 14% since the beginning of May this year.

**2. Foreign debt and vulnerability to foreign influences**

Since the Federal Reserve in the US has increased the federal interest rate by 0.25% on June 14, it is becoming increasingly expensive to borrow from the US. This is important because many nations that are Emerging Markets hold USD denominated debts, which means that a foreign nation must first convert their revenues (in their local currency) into USD in accordance to the foreign exchange rate first before paying the USA. If the nation's local currency is devalued because of poor economic policies, this leads to trouble to pay off the debts. According to Bloomberg, a record 249 billion USD worth of US dollar bonds are due to mature until the end of 2019.
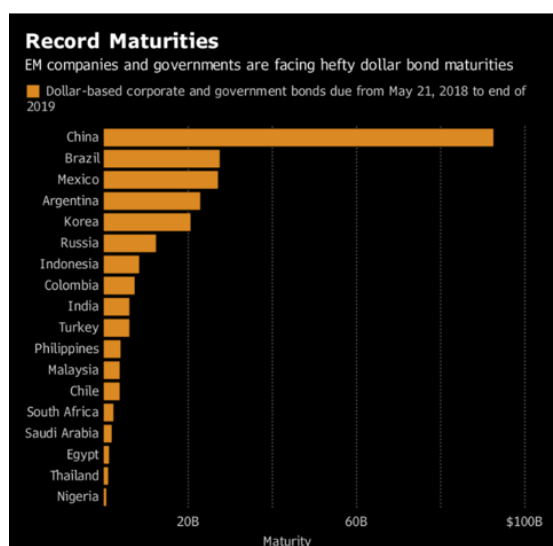
4. Wilson, C., Schaber, O. (2018 June 18). *Investors Are Bailing from Emerging-Market ETFs*. Retrieved from https://www.bloomberg.com/news/articles/2018-06-18/etfs-say-pain-is-not-over-for- emerging-markets-as-investors-bail

**Record Maturities**
EM companies and governments are facing hefty dollar bond maturities
■ Dollar-based corporate and government bonds due from May 21, 2018 to end of 2019

China
Brazil
Mexico
Argentina
Korea
Russia
Indonesia
Colombia
India
Turkey
Philippines
Malaysia
Chile
South Africa
Saudi Arabia
Egypt
Thailand
Nigeria

20B      60B      $100B
Maturity

***Figure 5.*** *Emerging Market Nations USD Debt*
*Record Maturities*
***Source:*** *Bloomberg*

ETF: Open-ended mutual fund trusts that hold the same stocks in the same proportion as those included in a specific stock index. ETFs are designed to mimic the performance of a specified index

Index: A measure of the market as measured by a basket of securities. Fund managers and investors use a stock index to measure the overall direction and performance of the market

USD denominated debts: Debts that needs to be repaid in US dollars

Mature: A debt is said to mature when it is due to be paid back

Opening interest: The total number of open or outstanding options or futures contract that exist at a given time

Vulnerability to foreign debt has had serious consequences in the past. International investors lose faith in a nation that is struggling to repay its debts, thus removing capital from the nation's market and refusing to lend to local businesses. Consequently, economical growth slows down. If the nation's government is unable to finance its foreign debts, we say that its government has gone into sovereign default. Rating agencies will warn against investing in the nation, halting foreign investment. Local investors and consumers alike usually withdraw large amount of capital and convert them into a more stable currency, since the defaulting government usually depreciates the local currency to satisfy debt payments.

Overborrowing saw the Argentine government default on their USD debt in 2000. It took the nation five years to end their default status, during which time much capital was moved abroad, and the unemployment rate rose as high as 25%.

Today's Emerging Markets are not in such dire shape, but with record foreign debts due to mature in the coming years, there are some worrying signs. According to Bloomberg, in the week immediately after the interest hike on June 14, 2.2 billion USD worth of investments were withdrawn from the iShare MSCI Emerging Market ETF, which was originally worth of 35 billion USD. This is the most since January 2014. At the same time, the iShares J.P. Morgan USD Emerging Markets ETF (NASDAQ: EMB) has seen a 524% percent in open interest this year and reached a record number of 469,313 option contracts, suggesting a volatile outlook.

## Future

Emerging Markets have given investors a good time during 2016 and 2017, but recent developments are good reasons to cause concern. Not only does US interest rate hike and record debt maturities seem unfavourable, Trump's escalating tension over trade with China, the biggest Emerging Market in the world, also imply a slowdown in growth. It remains doubtful whether Emerging Markets can be the main driver of global growth in the next year.

5. Shilling, A. G. (2018 June 20). *Emerging Markets Have Many Tools, But Few That Are Good. Retrieved from https://www.bloomberg.com/view/articles/2018-06-20/emerging-market-sell-off-won-t-be- easy-to-reverse*
6. Morgan Stanley Capital International. (2018). *MSCI announces the results of its annual market classification review. Retrieved from https://www.msci.com/market-classification*

# EUROPEAN OPTION VALUATION:
## BLACK-SCHOLES & BINOMIAL

**CAMERON COX**                                                          **JULY 7, 2018**

In the financial market, options give a buyer/owner the right – but not the obligation – to buy or sell something at a specific price at either the option's expiration date or any date before the expiration date (the former being referred to as a European Option, and the latter an American Option). From an owner's prospective, the risk of an option is limited to the premium paid for the option, which scales directly with the expected volatility of the underlying asset. So forth, the appropriate valuation of an option is an important aspect for investors and option-writers.

**Binomial**

The simplest way to be introduced to European Option valuation is to consider the Binomial Option Pricing Model, where a stock's price movement is limited to increasing or decreasing to specific predetermined values. The inputs for this model are:

- $S_0$: *The asset's price at time 0*
- $S_1$: *The asset's price at time 1 if the asset increases in value*
- $S_2$: *The asset's price at time 1 if the asset decreases in value*
- $r_f$ : *The risk-free rate available to an investor at time 0*
- X: *The strike-price that the option may be exercised at*
- T: *The time until expiration*

A European Option's price is derived by constructing a hypothetic portfolio such that the portfolio's performance can be perfectly predicted, namely holding a long position in $\Delta$ **shares** and holding a short position of 1 **call option**, where:

$$\Delta = \frac{S_1 - X}{S_1 - S_2}$$

No matter if the asset's price increases or decreases, the portfolio will hold a **risk-free** value of $S_2 * \Delta$ at *time* 1. By discounting the value of the portfolio at $r_f$, we can derive the value of the option. In particular:

$$\text{Option Price} = S_0 - e^{-r_f * T} * S_2 * \Delta$$

For example, consider the following situation where you're considering the purchase of a European Call Option that would expire in 1 year:

$S_0$: 50
$S_1$: 60
$S_2$: 45
$r_f$ : 3%
X: 53
T: 1

According to the derived formula above, the price of the call option would be $2.95. If you are not executing a separate trading strategy, this would mean you would be **in the money** if the price of the asset increased to $60. An interesting observation is that in the Binomial Option Pricing Model (one-step) an option's fair value is **independent** of its probability to transition between the two states. Applying this to an example can often be counter-intuitive to investors, as instinctively an investor might think that (within the scope of our example) if $P(S_0 \rightarrow S_1) = 95\%$ then the call option would be more expensive than if, alternatively, $P(S_0 \rightarrow S_1) = 5\%$, despite the inclusion of either piece of information having no impact on the valuation.

1.  *https://www.investopedia.com/terms/o/option.asp*
2.  *https://www.investopedia.com/terms/b/binomialoptionpricing.asp*
3.  *https://www.investopedia.com/terms/i/inthemoney.asp*

**Black-Scholes**

It's obvious that the Binomial Option Pricing Model is limited in its application. However, the Black-Scholes European Option Model (BS) that was developed in 1973 is widely used in the financial services world today and is regarded as one of the best ways of determining fair prices of options. The formula for the Call Option Premium is:

$$C = S_0 * N(d_1) - N(d_2) * X * e^{-r_f * T}$$

Where:

S $=$ *Current Stock Price*
$r$ $=$ *The risk-free rate*
X = *The strike-price the option may be exercised at*
T = *Time until expiration*
N ( )= *Cumulative standard normal distribution*
S = *Implied Volatility*

- *If the implied volatility is high, the market thinks the stock has potential for large price swings in either direction, just as low implied volatility implies the stock will not move as much by option expiration.*

- $d_1 = \frac{\ln\left(\frac{S_0}{X}\right) + \left(r_f + \frac{S^2}{2}\right) * T}{S * \sqrt{T}}$ and $d_2 = d_1 - s * \sqrt{t}$

The model essentially derives the value of a call option by subtracting the present value of the exercise price from the current stock's price, adjusted for the volatility of the stock.

For example, consider the following situation where you are considering the purchase of a European Call Option that would expire in 2 years:

$S_0 = 100$
$r_f = 3\%$
X = 110
T = 2
S = 25%

According to the BS model, the price of the option would be $12.56. In this case, although the investor would be **in the money** if the price of the stock rose to greater than $110, their investment in a call option would only be **profitable** if the stock rose to **$122.56** (Strike-Price + Option Price). In addition, it can be assumed[2] the investor believes the stock will be worth **at least $128.65** at it's time of expiration in two years, since their profit of $6.09 would be equivalent to investing their original $100 at the risk-free rate (100* (1+3%) –100=$6.09).

4. https://www.investopedia.com/terms/f/fairvalue.asp
5. https://www.investopedia.com/terms/b/blackscholes.asp
6. https://www.ally.com/do-it-right/investing/what-is-implied-volatility/

# NEWSLETTER TEAM

## CHIEF EDITORS

Edward wishes to share his knowledge by helping the team develop interesting financial articles. He is an avid follower of technology equities and is always looking for opportunities to execute trading strategies in his personal account. He hopes to make enough money from trading options to retire in a small house by the lake at age 25.

### EDWARD SU
**2B MATH BUS DD**

Edmund is a fourth year student in the Financial Analysis and Risk Management Program at the University of Waterloo, with CFA specialization. His interests lie in North American Equities, with a focus in the technology industry. His previous experience includes an analyst position at Tao Asset Management, where he assisted in Small Cap company valuations and structuring of asset back securities.

### EDMUND CHU
**4B FARM**

## MARKET RESEARCH ANALYSTS

Cameron is a third year student in the Financial Analysis and Risk Management program at the University of Waterloo. Cameron has experience working in Finance and Wealth Management at RBC and has pursued projects related to portfolio management and Monte Carlo simulations. When he's not studying for his CFA level 1, he enjoys relaxing with video games and playing basketball work friends.

### CAMERON COX
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Chaitanya Bhutani is currently a second-year student in the BMath/BBA double degree program jointly offered by UW and WLU. From past experience within a supply-chain oriented role in the logistics industry, he is currently seeking more diverse and finance related opportunities. In his free time he enjoys playing and watching basketball, and hitting the gym occasionally.

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**2B MATH BUS DD**

# NEWSLETTER TEAM

## FRANK SHI
### 2A FARM

*Frank is a second year student in Mathematical Finance. His goal is to find a quantitative position where he can apply the mathematical knowledge he acquired in a practical manner. He is currently looking for his first co-op position for his work term in Fall 2018.*

## SHIRLEY XIAO
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*Shirley is a third year student in the Financial Analysis and Risk Management. She has worked with two investment groups at Scotiabank and learned about Portfolio Management. She is interested the North American Fixed Income and Commodities market. In her free time, she enjoy cooking, baking, and trying different restaurants.*

## SIMON XIONG
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*Simon is a fourth year student in the Computational Mathematics Program at the University of Waterloo. He works primarily in the software industry with experience at IBM and Mixmax. In his free time, he follows the stock market and maintains a personal portfolio.*

## NEWSLETTER DESIGNER

*Jessica hopes to learn more about financial markets and economics in this role. In her free time, Jessica enjoys playing badminton, playing the ukulele and journaling.*

## JESSICA ZHAO
### 2A FARM