Time is Money: The Most Expensive Time on Earth

Cost of a Nanosecond in U.S. Electronic Trading Markets 2017…$50,000+

and a little bit about why market 'bubbles' are actually 'balloons'!

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Think Differently

TIME = $ = ?

? = $50,000+

Executive Summary

In electronic trading

Time = Money

& prices update very very quickly

cost of being 1 nanosecond late

=

$50,000+

prices update too fast for traditional technology

but not AI

Abstract

If time is money, then what is the world's most 'expensive' time? How much is it? Where is it? Why hasn't anybody attempted to price it?

We propose the world's most expensive time is found in electronic trading markets. Further, we propose the US Equities electronic trading markets, are the world's most expensive and fastest.

We believe, during peak periods, prices update so quickly, that they are impossible to trade, even with the world's fastest trading systems.

That is, unless Machine Learning/Artificial Intelligence, is employed to predict these prices in advance (which is for a later paper).

1.0 Introduction

Time is money is infamous, the world all over. It transcends languages and cultures. It's as old as commerce itself.

Time has 'differing' value; is the founding principle of capitalism. It's also the great equalizer and 'counter' ideology, in communism; all time has 'equal' value. Time is money, forms the basis, for all human's exchanging their labor, in return for compensation.

So how much does time cost? How much is the most expensive time? What and where is it?

Richest, Priciest, Fastest, Biggest
We know how much money the richest person in the world makes, how much the top athletes and most famous celebrities earn. We even know, how much our time, is worth, especially when it's wasted!

We also know, how much the most expensive gems, metals, watches, paintings, fastest cars, biggest houses, and yachts cost, but what does the most expensive time cost?

Time Equals Money!
If ever there is an industry, where time, literally, equals money, it's the electronic trading industry. Whether it's the electronic trading of stocks, derivatives, bonds, currencies or commodities; time is money. Electronic prices change in fractions of a second and fortunes can be made, or lost, in less than the blink of an eye. Therefore, time, equals money.

However, how much money, can be made, or lost, in a fractional second, is not published. For whatever reason, nobody is pricing this electronic time.

In order to answer these questions we used U.S. Equities stock data (with nanosecond timestamps) from a number of the busiest trading days in 2017. We analyzed each stock's change in price, cost and 'speed' (update frequency!). The name of the Exchange will be made public at a later date.

Industry Literature
If you were to survey current literature from the electronic trading industry, you would learn that electronic trading time is measured in fractions of seconds; milli (thousandths), micro (millionths) and nanoseconds (billionths of a second).

From this literature, you would also learn, prices update at extremely fast 'speeds' ('light-speed'* according to some), but you wouldn't learn, how fast these prices update.

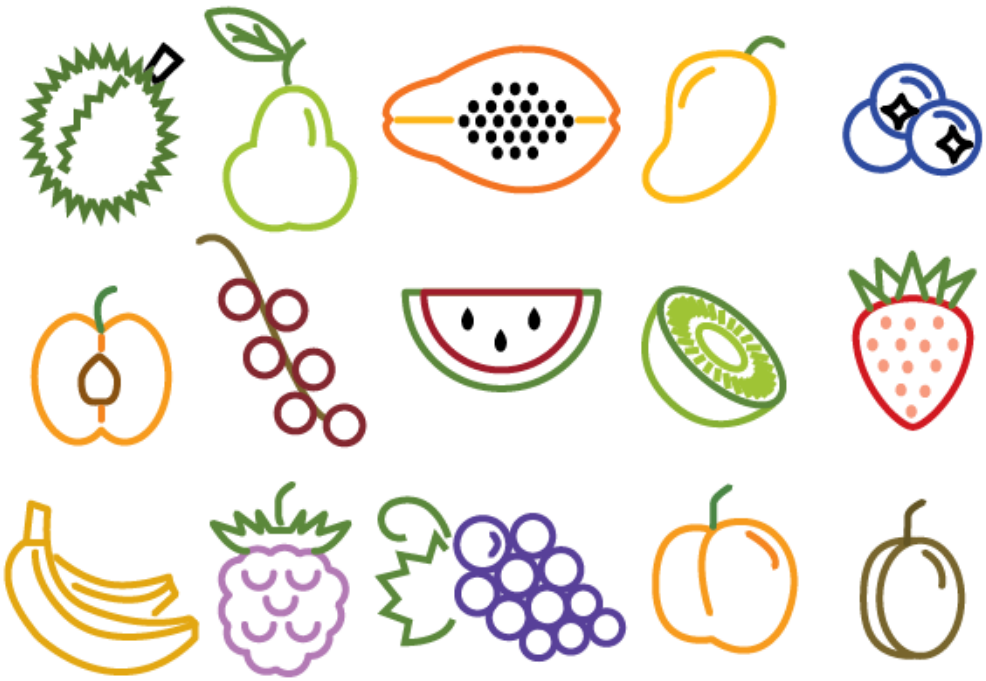
Similarly, you would be told trading time is very expensive, but you wouldn't be told, how expensive.

You would, however, be informed that prices update so quickly and expensively, that if trading firms do not continuously invest in the latest and fastest technologies, they should probably get out of the trading business. As, according to trading literature, there are no profits, for the slow; only higher costs and missed trading opportunities.

Trading Fruit Analogy (5 Fruit a day!)
Imagine you went to the world's largest fruit market (where each fruit represents a different company's share stock). In this market, thousands of different types of fruits, are bought and sold, at any given moment.

You can either buy fruit, if available. Or you could try sell them your fruit, if anybody was interested in buying that particular fruit, at that moment in time.

The maximum amount of fruit (Size), the market is willing to sell to you, or buy from you, can also change at any given moment in time.



Each fruit's prices, for buying from the market (the Ask price) and for selling to the market (the Bid price) are clearly displayed, but these prices change with varying frequency, sometimes in less than a blink of an eye, sometimes the length of a yawn.

Your strategy at the market is quite straightforward; buy low and sell high. However, timing this market is tricky.

If you are late, by as little as a blink of an eye and buy at too ‘high’, or sell at too ‘low’ a price, this will be very expensive.

This market is further unique, in that, you can sell a fruit you don’t own. This is known as going ‘short’ (selling high and buying low). This strategy is employed with the purpose of selling fruit at a high price first, but buying at a lower price later, before delivery of the fruit is required. Timing this strategy wrong, can be very, very expensive.

Cost Models

The model employed for calculating peak nanosecond costs, is conservative. It makes sure that the same fruit Size is available, at both old and new price quotes. If a larger Size is available at the new quote, the smaller (old quote) size is used, as it makes for an ‘apples to apples’ comparison, which is ‘fairer’.

Buying Unicorn Fruit

Let’s say you have to buy Unicorn** fruit, as much as currently available. The price of Unicorn fruit is quite expensive, approximately, $270,000 each.

At peak periods, the price of Unicorn fruit, increases by thousands of dollars per fruit! If you ‘blinked’, were a nanosecond late and bought a lot of Unicorn fruit, at the ‘wrong’ time (like after a big price increase) it would cost you significantly extra.

On this occasion you are late to the market by a nanosecond, so it will cost you extra.

As the price of Unicorn fruit increased by $2450, from $267,550 to $270,000.

However, it turns out, you are quite fortunate, as Unicorn fruit is rare (only 1 or 2 Unicorn fruits are typically sold, at any given time).

As only 1 Unicorn fruit (Size) was available (at both, the old and new prices), the extra total cost to you, for this late trade, was only $2450.

Bananas

You head to the Bananas section, where the current price is $15.46 and 4000 (Size) are currently available to buy, but you blink!

The price now increases by $3.54 per Banana and is now $19.00. The amount of Bananas on sale is 5000 (Size).

Your new transaction, based on the old Size of 4000 Bananas, costs you an extra $14,160.

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Selling Fruit

You now have to sell your Oranges, so you visit the Oranges section, where the price of selling Oranges to the market is currently $ [redacted] and the market is willing to buy up to [redacted] Oranges (Size). Which is exactly how many Oranges you have to sell.

You try to hurry, but you blink! The price decreases by $[redacted] per Orange and is now $ [redacted] and [redacted] (Size).

On this trade you lose a total of $ [redacted] for selling [redacted] Oranges, one nanosecond 'too late'.

Berkshire Hathaway Unicorn Fruit

In our trading fruit analogy, the Unicorn fruit, represents Berkshire Hathaway***, the world's most expensive stock. If you were to buy or sell Berkshire Hathaway at the 'wrong' moment in time and its share price increased or decreased dramatically, this could be considered, the most expensive time on Earth.

However, we don't believe this is the 'true', most expensive, cost, of being late, to the market by a nanosecond.

SNAP Bananas Are Quite Expensive

Bananas**** in this case represent shares of Snap Inc, trading one nanosecond late, would have cost an extra $14,160. Which is quite expensive, but still not the most expensive nanosecond.

XXXXXX Oranges The Most Expensive?

In our Oranges, or XXX, analogy, the BID share price of a stock of XXX Inc. fell by [redacted], trading one nanosecond late, would have resulted in a loss of [redacted]

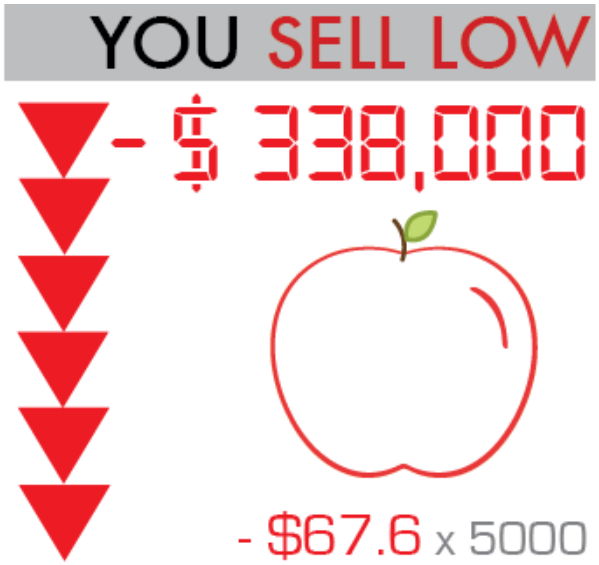
This $[redacted] loss, is considered, the true, peak cost of a nanosecond (for this particular day).

Cost Models
The next peak cost for selling Apples to the market, uses a less conservative calculation model, it uses the new quote's Size, rather than the old quote's Size.

Really Bad Timing Selling Apples - $338K
If you happened to have a lot of Apples and decided to sell a few thousand at the wrong time, it could cost you hundreds of thousands!

The price of Apples fell by $67.6 in one nanosecond, the new quote's Size was 5000.

If you sold your apples at the wrong time, you would have lost $338,000.



'Wrong' and 'Right' Time
If it's possible to be late one nanosecond and buy at the 'wrong' moment in time, it's also possible to buy at the 'right' moment in time, where the price, actually moves in your favour.

For example, if you were buying fruit from the market and the price suddenly dropped, this would be good for you.

Likewise if you were selling your fruit to the market and the value of your fruit suddenly increased, this would also be good for you.

On the same day, as a missed nanosecond, cost over $50,000. It was also possible to be a nanosecond 'late' and actually benefit financially.

Buy Late, OK

If you bought shares of COH (Cochlear Limited), at the 'right' time, one nanosecond later, you could have saved $11,100, from the drop in price.

Sell Late, OK

Likewise, if you were selling shares of BIDU (Baidu Inc), it would also be better, to be a nanosecond late, as the increase in price at the new quote, would have resulted in an extra profit of $12,700.

'Right/Wrong/Correct' Nanosecond

Determining the 'right' or 'wrong' time can be complicated; buying and selling at the 'correct' nanosecond time, requires much skill. Since, luck is for amateurs;-)

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*I don't actually describe market movements as light-speed. Since, light-speed is not actually a measurement of time (nor are parsecs). The 'speed' bit should, actually, give it away. As speed is, a 'distance', per unit time measurement. A more appropriate measure, of 'price change' time, is 'frequency', this is measured in hertz (Hz), which is a 'rate', per unit time measurement.

**The rare, cousin, of Dragon fruit and the Dodo fruit.

***Run by the legendary Warren Buffet, who incidentally will charge you $2.68 million for his time, or more precisely, his lunch time. All of which he nicely donates to the charity Glide. People of wealthy means, used to pay more, but I guess times are tough in these austere days. Where's trickle down economics when you need it!

****On a fruit related note; you might be eating bananas 'wrong'. Did you know that monkees and other, expert banana eating, animals, eat bananas, 'stem-side down'. Whereas, 'smarter', evolved humans, typically eat them the 'wrong' way, 'stem-side up'. For many years I was eating them wrong, until my father informed me of this (but only, when I was an adult!). I initially thought, he was joking. Turned out, I was definitely wrong and had been peeling bananas, incorrectly, for many years. His laugher, was not in jest, but in amusement, which I had also mistaken.

2.0 Price, Cost and Speed

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3.0 Results

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4.0 Conclusions

Think differently - Time equals money and is absolutely quantifiable. In order to 'Think AI', it is important to be able to re-examine the obvious. The true value of AI, is not in employing the most technical AI algorithm, but in applying AI, in the most useful manner.

AI is already advanced enough, to solve many of the world's important problems.

Electronic trading time is tricky. Time is relative! One trading firm's 'wrong' nanosecond, is another trading firm's 'right' nanosecond. Sometimes, you could be late and it could be very expensive, at other times, being a nanosecond late, could be profitable.

If you 'short' the market, time, can become even more challenging to master!

Mastering, sub-second time, at milli or microsecond levels is difficult enough, mastering time at nanosecond levels requires extraordinary skill.

Electronic Markets and AI
Electronic trading markets output vast quantities of data, which are well suited for Machine Learning and Artificial Intelligence. These data sets can be easily combined and combed for patterns.

The larger challenge, in searching for specific patterns in financial data, is correctly selecting sets of input data (primary, secondary, tertiary) and employing a domain model that will 'coax' the desired answers out.

If you want to predict movements in electronic markets you must first have some 'basic' numbers, such as the cost of time.

In addition to measuring how much prices increase/decrease, how fast these prices move and how frequently they move, must also be calculated.

This Research…
This research calculated the cost of time at nanosecond level precision and provided 'concrete' numbers for prices, costs and update speeds, where there were previously none.

It priced the most 'expensive' movements of US Equity stocks and it measured how fast prices update during peak periods. In addition, it provided some suggestions as to how this research should be further expanded and could be used.

Based on analysis of US Equities market data, at peak periods the cost of a nanosecond in the US Equities market was approximately $[redacted],000 dollars. If you were to multiply this

number ‘up’ to a one second cost, this would equal $ trillion dollars. Which is more money, than the net worth of every single individual on this planet combined, multiples times over!

Peak prices, costs and speeds are important to quantify, but

the US Equities market move at nanosecond speeds, peak periods the market updates at rates of approximately

This is phenomenally fast. The majority of electronic stock markets update at much slower speeds; typically microseconds or milliseconds, some older exchanges, even take whole seconds to update.

Trading Systems Will Always Be Behind the Market

Even if trading firms invested in the fastest hardware/software available and co-located at the execution venue, they would be unable to process a venue’s market data and send an order back into the execution venue’s matching system, in less than nanosecond

Therefore, at regular periods, stock prices are updating faster than they can be traded. Trader firms, even high frequency ones, will always be behind the market.

Machine Learning/Artificial Intelligence will Disrupt Low Latency

While new hardware acceleration technology will reduce latency further, It is more than probable, that trading firms, will always be ‘slower’ than the market.

However, Machine Learning and Artificial Intelligence will disrupt low latency trading,

Spending Quantitatively on Technology

Ultimately, how many quotes a firm is unable to trade and the additional cost per trade, will be dependent on each individual firm’s latency.

Trading firms should analyze the peak and average speeds of the Symbols they trade, as well as the peak and average, increases in costs, of those symbols, to model and quantify, their optimal trading speeds.

Minimum Daily Profit Opportunities

These total numbers can be used to model 'minimum' or 'basic' trading profit opportunities on any given day and compared with a firm's profit for that day.

Each price movement, a firm was technically capable of trading (quick enough), but chose not to, represents a 'theoretical' missed profit opportunity.

If firms are not fast enough, these missed opportunities can also be modeled as a latency cost (or tax), paid on Symbols traded. Particularly where price slippage (change in price) occurred as a result of trading 'slowly'.

Maximum Daily Profit Opportunities

If in addition to a simple 'long' trading strategy

When Game Theory Meets Video Games and AI – Max Profits vs Perfect Scores

All traders are versed in game theory and maximum profit opportunities, but few have probably thought about, combining them with 'perfect score' theory in video games.

Recent developments in reinforcement learning

Digital Accidents, Cyber Crime and Financial Losses

These profit/cost numbers can also be used to model trading losses from outages as a result of system failures or cyber crimes. System failure and cyber crime outages can be unpredictable in length from minutes to even days!

As more insurance companies decide to offer cyber intrusion coverage policies, more accurate cost data will be required to model any potential financial losses.

What if a trading firm is over-optimistic regarding it's trading prowess and submits claims for higher losses when an outage occurs? What if the market was actually 'quieter' that day and the losses were unrealistic?

In addition,

Future Work, Markets and Balloon Theory
In future work, we will analyze data from other exchanges/markets.

We will also talk about ‘balloon’ theory and why it is more useful than traditional ‘bubble’ based market modeling. While balloons and bubbles both ‘pop’; there are critical differences. Balloons, unlike bubbles, are ‘bi-directional’; they can let air out.

This air, or more precisely, these

Other Charities & Social Causes

IN ADDITION TO RAISING MONEY FOR THESE CAUSES, WE WOULD LIKE TO PROMOTE THEIR IMPORTANT WORK.

Amnesty International
Big Issue
Code Chix
Care International
Charity Water
Code First Girls
Days For Girls
Fight Against Slavery
First Code Academy
Free The Children
Girls Not Brides
Glide
Great Ormond Street
Gurls Talk
Habitat for Humanity
Human Rights Watch
Kode with Kloss
Made By Survivors
Malala Fund
Minds Matter
One Girl
Orbis Flying Eye Hospital
Pencils of Promise
Pencils for Kids
Pens for Kids
Population Services International
Shaukat Khanum Cancer Hospital
Shelter
St Jude Hospital
The Hunger Project
The Women's Coding Collective
Tostan
Trussell Trust
War Child
Women Aid
World Food Programme
Women on Wings
Women's Refugee Commission
World Toilet Organization
Women Who Code

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Artificial Intelligence will fundamentally change the way we think

A for AI... the era after... 'A for Apple'

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THANK YOU;-]

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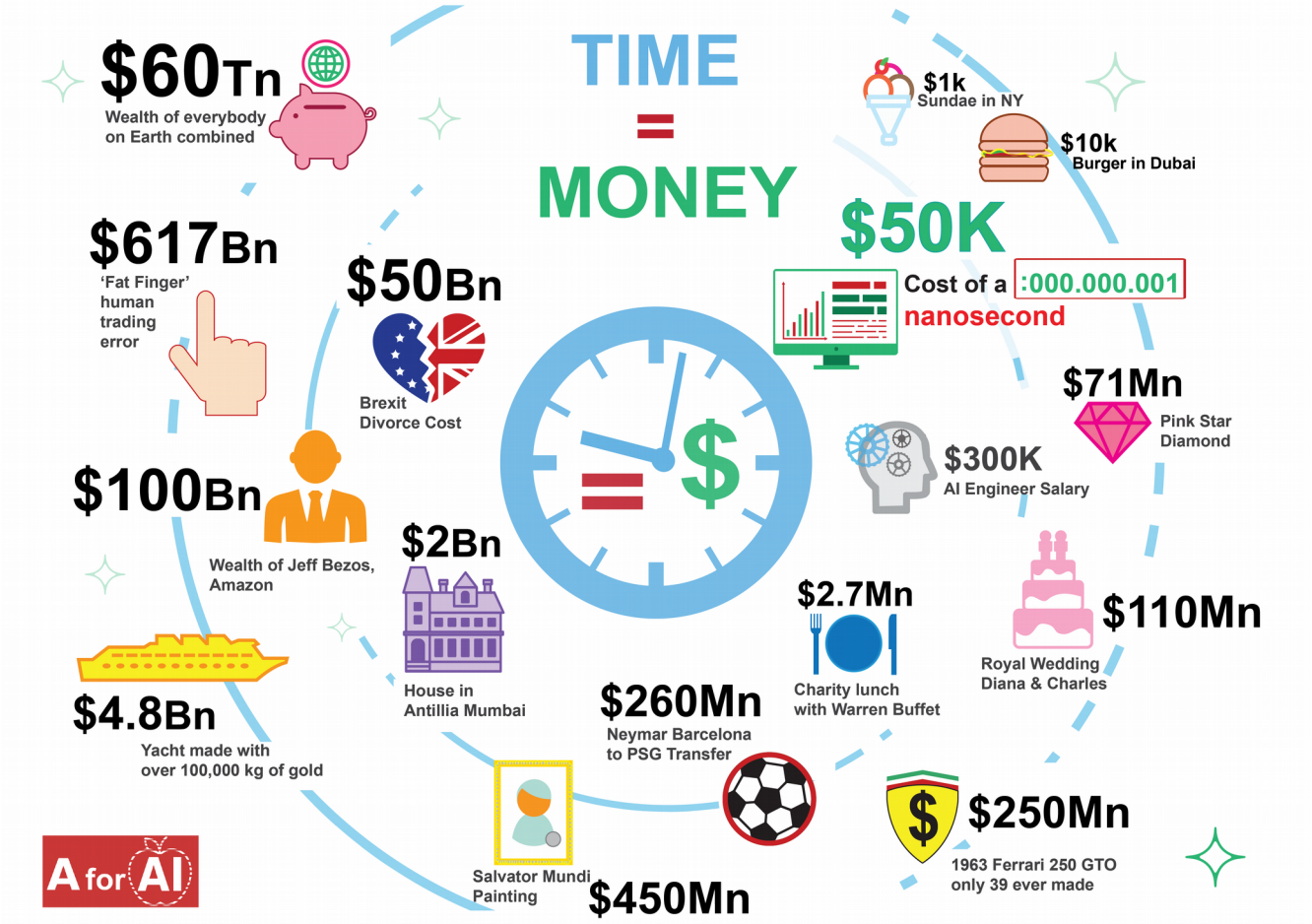

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