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**Lending Club's Note Trading
Platform Facade:
An Examination of Peer-to-Peer
(P2P) Lending Secondary
Market Inefficiency**



Honors Thesis

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Department: Economics & Finance

Advisor: Tony Caporale, Ph.D.

April 2018

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Abstract

The original objective of the study was to monitor and analyze the inefficiencies in Lending Club's Peer-to-Peer (P2P) secondary market, in order to exploit these inefficiencies for a risk-free return. Upon a three-month examination and analysis of the secondary market, the findings indicate that arbitrage conditions do not exist as a result of the observed volume of the marketplace being vastly lower than initially believed. Only 0.44% of note listing instances on Lending Club's secondary market over the three-month period resulted in successful trades. As a consequence, investors assume a purported level of liquidity that is never met, thus they may incur a higher level of risk than initially estimated on the primary market at the time of issuance.

Dedication and Acknowledgements

Sincere thanks to Dr. Tony Caporale for his advisement and encouragement throughout the thesis process. Additionally, I would like to extend thanks to Dr. Donald Wynn for his contribution to the data analysis and guidance throughout the development of this publication. Lastly, I would like to dedicate this publication to my parents, as they have been instrumental throughout the process, both in their pinpoint editing precision and encouragement.



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Introduction to Peer-to-Peer Lending

Peer-to-Peer (P2P) lending is a method of providing credit to individual borrowers through a pooled investment of individual investors. Generally, P2P loans are sought by borrowers as an unsecured personal loan and are funded by investors looking to invest in alternative assets for the purpose of either speculation, in the case of risky borrowers, or long-term investment, in the case of highly credit-worthy borrowers. This type of lending has gained significant market share over the past decade, with many investors moving from traditional financial instruments in favor of more speculative alternatives. As an example of magnitude, Lending Club, the largest P2P marketplace in the United States, issued over \$33.5 billion in loans from 2010 through 2017, according to their website. Although this amount is a blip on the radar compared to the grand scale of traditional financial instruments, such as bond and equity markets, the growth of alternative financial assets, specifically P2P loans, warrants more targeted academic research of the industry and market.

The process by which P2P loans are funded is similar in nature to crowd-funding services where one individual (the borrower) places a request for a loan on Lending Club's marketplace and then investors pledge a chosen amount to the origination of the loan. Each investor in the loan receives a note upon origination with principal equal to the amount pledged and a stated amortization schedule of principal repayment and interest over the life of the loan. As a result of this derivation of many notes from a single loan, many identical notes in the marketplace exist, all representing a partial share of the same loan. Theoretically, these notes are identical assets, therefore the value of each should be equal. One exception to this rule is that the principal amount may vary, thus causing the value of a particular note to differ from the rest of the identically characterized note pool; however, this is rare as the standard, and minimum, pledged amount is \$25, which most investors follow to limit their cash invested in a single note as a means of diversification.

Traditionally, Lending Club investors lent money to borrowers with the understanding that monthly interest and principal payments would be received over the life of the loan (36 to 60 months), thus forfeiting liquidity for the length of the term. As a result, investors had no method of selling off a note when in need of liquidity or if the

note's risk level changed. For example, a borrower's credit score may go down over the life of the loan, thus increasing the probability of loan default, as well as the possibility of loss for the investor. In response to this, Lending Club created a secondary market where investors may list notes held in their account and purchase notes listed by other investors. This marketplace is hosted by a third-party brokerage, FOLIOfn Inc., and is referenced as 'FOLIOfn'. In addition to providing liquidity, this secondary market enables investors to speculate on notes after their origination, which creates a new wave of investment opportunities. For instance, an investor may attempt to profit by purchasing notes where the borrower's FICO score has decreased, thus causing original investors to place notes on the secondary market at a discount. In contrast, an investor may purchase notes from the secondary market that have shown strong performance, which would likely be listed at a premium but provide a lower level of risk relative to the note's stated interest rate. These speculative investments are available because when an individual decides to list a note on the secondary market, an investor has full discretion, aside from a few parameters enforced by Lending Club (e.g. a note holder cannot list a note when the loan is in default), to list the note at any price, thus causing notes to be listed at varying premiums and discounts. As a result of these unpredictable premiums and discounts, it is observed that all notes derived from the same loan are not listed at the same premiums or discounts and are instead priced irrationally on the marketplace. This mispricing occurs because of the inefficiency of the Lending Club secondary market, as note holders seemingly place notes at a premium or discount without any reference to the fair market value of the note in relation to its pool of identical notes. Additionally, the market lacks transparency from the investor perspective, as there is no easily accessible method for searching the available notes for one particular loan, which restricts the gathering of relevant note information for any particular pool of notes. This lack of transparency, coupled with irrational decision making, causes notes that are identical to be priced at vastly different premiums and discounts.

As a result of these note pricing divergences from any understood fair market value, an investor has the opportunity to acquire the same asset at a variety of different price points, thus theoretically providing an opportunity for arbitrage to be performed. If the arbitrage condition held true, an individual investor would be able to profit by

purchasing underpriced notes and re-listing these notes at a fair market value. This thesis examined the unique condition of Lending Club's secondary marketplace in hopes of acting on this theoretical arbitrage condition. Throughout the data collection and initial analysis, it was discovered that the volume of trading on Lending Club's secondary market, FOLIOfn, was insufficient to provide conditions necessary for arbitrage. As a result, the discussion of this thesis transitioned to the lack of liquidity provided by the marketplace and how this lack of liquidity poses a threat to investors.

Peer-to-Peer Secondary Market Arbitrage

Although the results of the data collection and analysis proved that the secondary marketplace lacked the conditions to perform arbitrage, this section outlines the initial layout of the trading strategy that would have been performed in such conditions.

By tracking Lending Club's secondary market, FOLIOfn, it is possible to derive the fair market value of each pool of notes associated with a loan and act upon this knowledge for profit. After deriving the fair value of each note on the marketplace, it would be possible to purchase notes priced below fair value and immediately trade them at fair value to gain a marginal return. This strategy works in theory; however, to derive a fair value for any given note, an investor must have knowledge of a note's previous trading activity. The initial problem was that the only data available from Lending Club was the current listings of the secondary market at any given time, making it impossible to observe the actual historical trading activity. Additionally, it can be theorized that notes priced at a premium far away from the observable median never sell, thus using them as estimates for the fair value of notes among their identical set is erroneous. Because of these limitations, it was necessary to gather more data from the secondary market in order to build a dataset whereby a fair market value for any particular set of identical notes might have been derived. This dataset was built by tracking the activity of the open listings of the secondary market at one-hour intervals and comparing the current and previous hours, which allowed for an assumption to be made that a note was placed and removed, or 'fell out' of the dataset, between the hours. If a note fell out, it is

understood to either have been traded or pulled from the market by its current holder as a result of listing expiration, re-pricing, or manual removal.

The objective was to derive the fair value for each pool of identical notes by recording every instance of a note's fall out. From tracking this, it was possible to associate each instance with the execution of a trade, whereby the premium or discount that the note traded at was observed. By recording these instances, it was then possible to derive the fair value for each pool of identical notes associated with every loan originated on Lending Club. After each pool of identical notes was assigned a fair value, this value would be used in the open marketplace to search for notes priced below their pool's fair value. By utilizing a weighted-average that emphasizes recent trades, an automated trading platform would have been deployed to purchase currently available notes that are underpriced relative to their pool's derived fair value and then re-listed at the fair value. In doing so, a marginal profit would have been obtained and the arbitrage condition proven true.

If the arbitrage condition was proven to exist and the trading was successful, the opportunity to profit would diminish over time as a result of shrinking note pricing divergences due to increased market efficiency. In order to continue reaping profits from this strategy, the pool of identical notes would need to be expanded through combining similar loans into pools of similar notes. Although straying from arbitrage, as the notes in a similar combined pool are not identical assets, the pools would exhibit characteristics that cause them to trade identically. These pools would have been created by performing machine learning through K-Means Clustering on the characteristics of every loan originated through Lending Club based on the trading patterns tracked from the secondary market. By clustering loans with similar characteristics and then refining those clusters based upon each note's trading activity, pools of almost-identical notes would have been developed. The previously defined arbitrage technique would then have been performed on these new pools of almost-identical notes, thus theoretically generating profits from individual note mispricing relative to the fair value of almost-identical pools. This pool enlargement would have allowed for a proprietary expansion of the theorized arbitrage condition that is believed to exist within the secondary market

and provide opportunities to reap continued profits from incongruent secondary market note pricing.

To summarize, the original purpose of this thesis was to track Lending Club's secondary market for P2P notes, in order to derive the fair value for each set of identical notes. Upon finding this fair value for each pool of notes, arbitrage would have been attempted by algorithmically purchasing notes that are priced below this threshold and placed back on the market at their fair value. If this strategy was successful, and the arbitrage condition held true, the set of identical notes related to a single loan would have been expanded to include all loans of similar characteristics as defined by a K-Means Clustering algorithm, which would have been refined through adjusting the set of variables and the number of the clusters, thus providing a trading strategy that could exist in perpetuity, regardless of arbitrage condition.

Data Analysis Results

As displayed in Table 1, every note movement on Lending Club's secondary market, FOLIOfn, was recorded from June 1, 2017 to August 20, 2017. Throughout this time frame, there were a total of 18,731,474 note listings that resulted in either a note being traded, removed from the marketplace, or listed but disposition not determined due to the methodology employed to categorize the movement. From this analysis, it can be determined that 16,705,880 notes were removed from the marketplace because of expiration, re-pricing, or manual removal. 83,265 notes were confirmed traded, whereby the notes moved accounts. Additionally, 1,942,329 notes were not able to be determined as a result of the methodology employed, which requires at least two instances of a note being listed. As a consequence, all notes that remained listed at the end of the study, as well as those only listed on the marketplace a single time, comprise this undetermined category; however, there is no reason to assume these notes would stray far from the observed mean likelihood that a note is traded.

Table 1. Note listing statistics

	Listing Result			Total
	Not Traded	Traded	Undetermined	
Count of Listings	16,705,880	83,265	1,942,329	18,731,474
Sum of Principal \$ Amount	\$ 483,417,987	\$ 2,173,101	\$ 57,570,715	\$ 543,161,802
First Listing Date	6/1/17	6/1/17	6/1/17	
Last Listing Date	8/20/17	8/20/17	8/20/17	
% of Total Principal	89.00%	0.40%	10.60%	100.00%
% of Total Count	89.19%	0.44%	10.37%	100.00%

Data Capture and Analysis Methodology

To accomplish the analysis of Lending Club's secondary market, FOLIOfn, a database was created to record the information of every note listing between June 1, 2017 to August 20, 2017. The data was retrieved directly from the secondary market, stored in a database built in MySQL, and hosted on an Amazon Web Services RDS instance, which allowed for continuous network availability and the ability to automatically scale in size to support newly appended data.

The hourly data collection process involved the retrieval of open listings from FOLIOfn, which was accomplished through a Python script running on a local Linux machine. This script ran hourly through the use of Cron, which is a command-line utility used to schedule tasks, and sent a request to FOLIOfn's current listings endpoint. This open endpoint provided a complete set of open listings in a Comma Separated Value (CSV) file, which was stored in a Python Pandas dataframe. This dataframe was compared to the previous hour's dataframe, thus allowing the Python script to determine which listings were already in existence, which listings were new within the hour, and which listings no longer existed on the marketplace. Listings that were available in the previous hour's dataframe, but not the current dataframe, were determined to have been removed from the marketplace through the process of a trade, listing expiration, repricing, or manual removal. These instances were recorded and appended to the AWS-hosted MySQL database.

After the completion of the data recording, there were 18,713,474 listings stored in the AWS MySQL database. A MySQL script was written in order to assign each listing as a trade, not a trade, or indeterminate. This script compared each listing's 'OrderId' field, a unique identifier, to a future listing's 'OrderId' of the same note, which allowed for tracing an individual note's movements across the marketplace. Because the 'OrderId' field changes when a note moves from one account to another, it can be determined that a listing where the next occurrence's 'OrderId' of the same note is different than its 'OrderId' constitutes a trade. If the 'OrderId' field remains the same after observing a new listing of the same note, it can be determined that this listing is not a trade. A limitation of this algorithm is that a listing's result cannot be determined if there is not a future listing of the same note, thus every final listing instance of a note cannot be determined. This limitation describes the 1,942,329 listings that could not be determined as either a trade, expiration, re-pricing or manual removal.

Implications of Analysis and Results

Lending Club investors assume the credit and liquidity risk associated with funding P2P loans on the platform. Through the existence of a secondary market on FOLIOfn, Lending Club is able to promote an alternative to long-term investment, whereby the investor has the option to trade a portfolio of notes, as a means of providing liquidity. As this analysis proves, the assumed liquidity of the secondary market far exceeds the observed levels. As such, investors lack a proper marketplace to trade their portfolio of notes before maturity, which increases the risk associated with their primary market investment. This analysis leaves open for exploration the question of whether investors underestimate liquidity risk as a result of believing that the option to trade notes post-issuance on the secondary market exists. If this is the case, then investors are taking on more risk than initially thought, thus diminishing the value of these investments. Ultimately, this lack of liquidity is misleading to investors, as it purports an option for secondary market trading that rarely exists, and needs to be addressed by Lending Club so that it can be better understood by investors.

Limitations and Further Research

The research and analysis performed for the thesis have limitations as a result of the data collection method and indicator used to define a trade on FOLIOfn's secondary marketplace. Due to the private nature of Lending Club and FOLIOfn data, this analysis was performed independently and without direct assistance from either of these entities. The data collection was performed by downloading the data from FOLIOfn's open listings every hour, with few exceptions, such as down time due to local network outages, which leaves open the possibility that specific note listing instances may not have been captured by the program. Additionally, by using an algorithm to define the end result of note listings, the possibility exists that not all indicators of a successful trade were confirmed. These limitations result in a dataset that may not be perfectly congruent with Lending Club's private data; however, this dataset is the outcome of primary research and analysis that was performed using an indicator, the accuracy of which was confirmed by a Lending Club employee. Specifically, the 'OrderId' field used to describe the movement of a note listing from one user account to another, thus indicating a successful trade, was verified in a phone call to Lending Club's investor relations team.

As described, this study was limited by the difficulties associated with data collection, as a result of the privacy of the data involved. Further research on this topic, utilizing data directly from Lending Club and FOLIOfn is necessary to confirm the findings and obtain a more complete set of results.

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