# SEALED COLLECTIBLE CARD GAME PRODUCT AS STANDALONE INVESTMENT AND PORTFOLIO DIVERSIFIER

**George Langelett, South Dakota State University**
**Zhiguang Wang, South Dakota State University**

## ABSTRACT

*As an uncorrelated asset class, collectibles have potential to diversify a traditional stock-bond portfolio. The challenge with analyzing investment in collectibles is their non-homogeneity and lack of liquidity. We overcome this challenge by analyzing the most standardized products within collectibles -- brand new sealed booster boxes. The purpose of this research is to examine how the prices of sealed boxes are determined and if sealed boxes could be a useful asset for portfolio diversification. We collect a rich dataset of Magic the Gathering (MTG) collectible card game, including 109 unique sets of cards and 2031 temporal observations from 2015 to 2020. We find that sealed booster boxes had on average a 21% annual return and a low correlation with the S&P 500 index during the sample period. Sealed booster boxes carry nearly zero market beta in the Fama-French 3-factor model. By including sealed MTG products in a traditional stock-bond portfolio, the efficient frontier of the portfolio expands favorably to achieve a better return-risk tradeoff.*

## INTRODUCTION

Based on the risk/return tradeoff, Markowitz's modern portfolio theory suggests risk-averse investors attempt to maximize returns on a given level of market risk (Lintner 1965). On the inverse, investors may also create a portfolio of assets to minimize risk to achieve a targeted rate of return. Diversification of assets is a critical component in the construction of a portfolio that minimizes risk. A variety of asset classes are often used to diversify a portfolio including bonds, cash, precious metals, real estate, and commodity contracts. In the effort to diversify a portfolio, two asset classes are often overlooked, art and collectibles. As uncorrelated asset classes, artwork and collectibles could hold value in risk management through portfolio diversification. The purpose of this study is to better understand the potential of a particular collectible, brand new, factory sealed boxes of a trading card game, as a standalone investment and as part of a portfolio.

Collectibles have become an important alternative investment vehicle. As of spring 2022, the two largest hobbies for collectible cards are sports cards and tradeable card games (TCG), including Pokémon, and Magic the Gathering (MTG). Sports cards are collected by fans of professional sports, including baseball, football, hockey, basketball, soccer, golf, and NASCAR.

The market for sports cards was estimated to be $13.8B in 2019 and is projected to reach $98.75B in 2027 (https://manometcurrent.com/sports-trading-card-market-size-and-forecast-2028).

The most valuable cards in each sport are the rookie cards in "Gem Mint" state condition of fan-favorite athletes. By contrast, the estimated market for tradable TCG's was $11.1B in 2020, with an estimated annual growth rate of 15.9% from 2021 to 2027, and $31.3B in 2027 (www.marketwatch.com). In this paper, we studied one specific TCG's valuation and its benefit to portfolio management.

However, the nature of collectible investments is different from traditional financial investments in four aspects: non-homogeneity, lack of liquidity, physical nature, and greater susceptibility to fads. First, unlike a stock or bond, art and collectibles are non-homogenous products by nature and valuation of collectibles often requires a high level of expertise. The value of most collectibles may change dramatically based on condition. Unfortunately, the desirability of collectibles is often tainted by problems with asymmetric information. The advertised condition of a collectible versus its actual state may deviate significantly when purchased sight-unseen. Rare art and many forms of collectibles are extremely specialized, and valuations are subjective. Second, art and collectibles are less-liquid assets than equities or bonds. Often, collectibles become more valuable based on rarity, uniqueness, and condition. This creates an innate deficiency. A sample of one or only a few pieces does not represent a market for the average portfolio manager; rather by nature, it is a niche market for specialists who have expertise in the valuation of rare collectibles and antiquities. Third, collectibles, unlike stocks or bonds, usually require a physical location to store, and protection from fire, moisture, and theft. Therefore, storage costs may need to be included in ROI (return on investment) calculations. Finally, collectibles are susceptible to fads that create bubbles which financially devastate participants when they implode. Two well-known fads were beanie babies and the market for baseball cards during the early 1990's. Valuation of an item, with a finite number of pieces in existence, and an emotional attachment by certain collectors becomes problematic. Collectible markets are vulnerable to investor FOMO (fear of missing out) sentiment.

Prior literature has studied financial returns from a variety of collectibles, the behavior of collectors, and the nature of collectible investments. Regarding the returns, prior research finds that collectibles produce a wide range of returns and are often susceptible to booms and busts. The collectible subjects include wine by Cardell et al. (1995) and Masset and Weisskopf (2010), automobiles by Martin (2016), art by Bialowas et al. (2018), violins by Ross and Zondervan (1989), vinyl albums by Cameron et al. (2020), paintings by Korteweg et al. (2016), sports cards by Regoli et al. (2007), among others. Regarding the behavior of collectors, researchers (McInish and Srivastava, 1982; Pearman et al., 1983; Formanek, 1994; Kleine et al., 2020) find that collectors buy collectibles for both financial gains and enjoyment. Lastly, a few researchers find similarities between collectible investments and capital assets. Goetzmann (1995) and Goetzmann and Spiegel (1995) find that risks and returns from collectible investments decrease as more pricing information is available and more participants enter the market. Angello (2016) even finds that paintings follow the traditional CAPM (capital asset pricing model). Hughes

(2022) provided an excellent study on the value of individual collectible game cards and found that rarity of the cards has a positive impact on their values based on two select sample boxes.

In this paper, we focus on the investment value of sealed booster boxes of a popular collectible card game, namely Magic the Gathering (MTG), as opposed to individual game cards studied by Hughes (2022). The sealed nature underlies the ever-shrinking supply of such products. A new set of MTG is released approximately every quarter and most packs get opened soon after purchase. Therefore, the remaining supply of sealed product in each set is substantially reduced. In time the supply of sealed products will eventually go to zero. The reduction of supply over time drives investment value in sealed product of sets containing highly valuable cards that enthusiasts seek to open. Meanwhile, the lack of liquidity and potentially high price volatilities in sealed booster boxes might hinder their value as a standalone investment and their diversification benefits to a traditional portfolio of stocks and bonds.

We contribute to the literature by analyzing the valuation and portfolio diversification benefits of investing in sealed booster boxes of MTG. However, the uniqueness of collectibles mentioned above often leads to limited data for empirical research on their valuation and benefits to portfolio management. Thanks to the data aggregator such as MTG Goldfish.com, we collect daily price data from June 3, 2015 to December 21, 2020 for 109 sealed MTG booster boxes. Combined with other production information, such as original price, release date, and reserve list of the boxes, we determine the factors to the value of sealed MTG booster boxes and their return correlations within the asset class of booster boxes and with other major asset classes such as S&P 500 index and bonds. Our empirical results show that sealed MTG boxes generate an annual return of 21% and have low correlations both within and across asset classes, therefore providing significant diversification benefits to the classical portfolio.

The paper is organized as follows: section 2 reviews literature on collectible investments; section 3 details the origin of MTG game and discusses the price and expected value of a sealed MTG booster box; section 4 explains the data and model for determining the prices of sealed MTG booster boxes of 109 different sets cards over time; section 5 presents empirical results on the factors that influence the prices and the potential diversification benefits of MTG boxes; and section 6 concludes.

## LITERATURE REVIEW

Jacoby (1995) defines collectibles as examples with two defining characteristics: (1) an inanimate object and (2) incapable of assisting in any production process. But if a collectible is to be considered as a possible investment, a third characteristic is also required, either protectable or durable. Thus, by nature collectibles are essentially useless artifacts, meaning they are neither edible or used in production processes, and therefore value is derived solely from supply and demand. Because of the non-useful nature of collectibles, markets are vulnerable to extreme swings in prices whenever available supply significantly differs from quantity demand. In the following, we review the literature on collectibles as an investment, and correlation of collectibles with other asset classes.

### Collectibles as an Investment

Cardell et al. (1995) demonstrates an impressive price run-up and then a collapse in stamp collecting from 1978 through 1982, providing empirical evidence that collectibles are susceptible to extreme boom and busts in valuation. Burton and Jacobsen (1999) explain why collectibles have the potential for either extraordinarily high or low rates of return. Investors may need to be compensated in the form of high returns for holding less-liquid assets. But one could argue that non-pecuniary returns, including pride and enjoyment, compensate for low financial returns. Collectibles are susceptible to fashions and fads that substantially impact their long-term value and liquidity. Hughes (2022) found that manufacture-created rarity has a positive impact on prices for desirable cards played in a collectible card game.

Empirical studies also provide evidence of a wide range of returns in the collectible markets. Masset and Weisskopf (2010) found investment-grade wine yields higher returns and has lower volatility than equities, especially during economic crises. Likewise, Martin (2016) found from 2007- 2016 collectible automobiles yielded superior returns to traditional stock, bond, and precious metal investments. By contrast, Bialowas et al. (2018) observed that the Polish art market provided similar returns to treasury bonds and lower returns than the Polish stock market. Finally, it's possible for low or even negative returns in specific collectible markets. For example, Burton and Jacobsen (2001), found that sales commissions, insurance, and storage costs reduced gross returns of 9.4 to 11.8 percent by 3.7 percentage points. Likewise, Ross and Zondervan (1989) estimated that after insurance and transaction costs are included, Stradivarius violins realized near zero returns on investment.

### Correlation of Collectible Returns with Other Asset Classes

In order to improve the performance of one's investment portfolio, above and beyond the current distribution of holdings, any potential asset must simultaneously have a positive expected return and reduce risk by having either no or a negative correlation with other asset classes (Burton and Jacobsen, 1999). Regarding the correlation between collectibles and other asset classes, the empirical evidence has been mixed. Small et al. (2013) found that diamonds have low CAPM and Fama-French betas, and are only slightly correlated with other assets, including gold, the S&P 500, and U.S. bond prices. Likewise, Ginsburgh and Jeanfils (1995) found no long-run correlation between art and equities markets, but in the short run, financial markets performance can affect art markets. Bartholomew (1991) provided evidence that the 1987 stock market crash did not negatively impact the art market, and the art market malaise of the early 1990's was uncorrelated with the equities market.

By contrast, both Goetzmann (1993) and Chanel (1995) found that changes in equities market valuations have a measurable unidirectional impact on the art market, through the wealth effect and investor sentiment. In a meta-analysis study of collectible markets, Burton and

Jacobsen (1999) found asymmetric correlations between collectibles and equity markets. They found that collectibles are negatively correlated when the stock market rises but found no evidence that the returns to collectibles rise when equities enter a bear market.

In summary, for any collectible to be a candidate for possible inclusion into a portfolio of assets, not only do the price stability and expected return of the collectible need to be estimated, but also its correlation with other asset classes must be calculated to determine potential usefulness for purposes of portfolio diversification.

## BOOSTER BOXES OF MAGIC THE GATHERING CARDS

Worldwide, Magic the Gathering (MTG) is a popular trading game between two or more dueling players. Hasbro is the parent company of Wizards of the Coast, which makes MTG cards. Hasbro has annual earnings of approximately $5B, of which approximately $1.6B comes from sales of MTG cards. The popularity of the game comes from the ability to customize each deck of cards. Over 20,000 different cards are available (magic.wizards.com), and each player can custom build one's deck with an infinite number of card combinations. Although marketed as fantasy, the game is based on mathematics and economics; the ability to optimize resources to either control or overwhelm one's opponent(s) is the game's strategy. The complexity and customizability of the game draws players to local, national, and international tournaments. The value of individual MTG cards is derived from the relative power of each card contained in popular decks.

MTG cards, like sports cards, are sold in booster packs which contain an element of randomness regarding contents. Most sets of MTG contain a few highly valuable cards out of several hundred possible cards contained in each set. Likewise, most years in major league sports begin the season with two or three highly anticipated rookies starting their careers, along with a few overlooked "sleepers" that outperform expectations. Thus, across the hobbies within each season or set, there are very few highly valued cards and up to several hundred cards worth only a few cents or a few dollars. Thus, for most sealed products, including packs and boxes, the expected value of the contents is less than the retail price of the merchandise. Similar to opening scratch-off tickets at the gas station, booster packs of collectible card games have an element of chance, and most often the expected value is less than one dollar for each dollar of bet.

When discussing investment in sealed product, with the rare exception where the expected value is greater than one, opening sealed product is not an "investment"; it is a titillating endeavor with an expected net loss. But despite an expected return of less than one, there is something about human nature that is drawn to games of chance. Whether lottery tickets at the gas station, trips to Las Vegas, or opening packs of baseball cards, curiosity, or a desire for excitement in an otherwise mundane life overrides the rational side of the human brain, and thus, sealed packs of cards get opened. A new set of MTG is released approximately every three months, and with each new set of MTG, most packs get opened almost immediately. As packs are opened by millions of participants who enjoy each hobby, the remaining supply of sealed product in each set is substantially reduced. The reduction of supply over time to absolute zero is what creates an opportunity for investment in sealed product of sets containing highly coveted

cards by enthusiasts looking for packs to open. For clarification, we define investment in sealed product as: (1) purchasing sealed boxes, (2) keeping product sealed, and (3) selling the boxes with the shrink wrap intact, to provide a future opportunity for consumers in the hobby to open packs. Participants in the hobby are willing to pay a premium to open a product from older, out-of-print sets, especially for sets with highly-sought-after chase cards.

People's willingness to pay a premium to participate in a game of chance raises an important issue. Why are investors not including this acknowledged premium in a portfolio of assets? Investors include casino stocks in one's portfolio, but instead, why don't they directly capture this premium? The lack of participation may result from the liquidity of the asset. Physical consumable goods are less liquid than equities. Burton and Jacobsen (1999) suggest that collectibles require higher returns to compensate for the lack of liquidity. The tradeoff between a potential premium paid versus lack of liquidity suggests that the investment potential of sealed product in each of these hobbies needs to be more clearly understood.

This study will focus on MTG sealed product for one important reason. The expected value for the contents within each MTG sealed booster box is readily available ex post, where it would need to be calculated by hand for other hobbies. This is a data-availability-based decision to analyze sealed MTG product.

**Demand for Magic the Gathering Sealed Booster Boxes**

To better understand the consumer's demand for sealed booster boxes, we refer to Hughes' (2022) consumer valuation model. Assume $V_i$ is a consumer's valuation for any rare consumable. Valuation can be divided between the intrinsic value of any good, $f(X_i)$, and value based on scarcity, $V_s(Q_i)$:

$$V_i = f(X_i) + V_s(Q_i)$$

Where $Q_i$ is the total quantity of collectible good because, $V_s$ and $Q_i$ are inversely correlated, and $f(X_i)$ is an internal evaluation of desirability of the piece by collectors. Because collectibles are "useless artifacts" establishing an intrinsic value for collectibles is significantly more subjective than establishing the intrinsic value of an equity, which can be an objective calculation based on expected future cash flow or the value of the underlying assets. Therefore $f(X_i)$ may capture both objective components and a subjective evaluation. More specifically:

$$f(X_i) = f(g(X_{i,\,investors}),\ g(X_{i,\,LGS}),\ g(X_{i,\,players}),\ g(X_{i,\,collectors}),\ g(X_{i,\,influencers})) \quad (1)$$

The internal evaluation of desirability $f(X_i)$ occurs across at least five different cohorts, namely investors, local game store owners, MTG players, MTG card collectors, and social media influencers. We will next discuss the intrinsic evaluation for each of these groups.

First, sealed-product investors understand that for each set supply is finite and continuously decreases until the remaining supply goes extinct. They know that opening booster boxes is unidirectional. Like a tube of toothpaste, once opened and the contents are revealed,

packs and boxes cannot return to being unopened. With the understanding of shrinking supply, investors purchase and hold MTG sealed products with the expectation of price appreciation. The past performance of 25 years of price appreciation may alter/skew one's perceptions of risk/reward if investors have experienced continuous positive returns to their sealed acquisitions. Unlike the stock market, the MTG sealed product market has not crashed in 25 years and may cause overconfidence on behalf of investors, which affects one's risk tolerance. While investors are creating a store of value for future collectors, past performance may skew perceived risk.

Local game store owners need an inventory of single cards from recent sets for customers who play MTG and other TCG's. Depending on the size of the store, owners may crack open any quantity from a few boxes to several thousand boxes of each new set. Often, instead of purchasing cards, customers will trade in their MTG cards for other cards or sealed product. Normally stores give credit around 60% of retail prices credit for trade-in cards. Customers trading in their collections creates a constant churn of inventory, with a 40% margin on each transaction, resulting in a multiplier effect on the value of the new-card inventory from opening sealed boxes. Thus, game store owners may be willing to pay a premium for boxes over the value of the contents, especially if cards in a specific set are highly sought after by customers.

35 million people worldwide play MTG (www.businessinsider.com) and specific cards are required for competitive decks. There is intrinsic value to securing the cards needed for a proven deck and entering game play with one of the post powerful decks available for a specific format of gameplay. For those who are passionate about the game, acquiring cards and winning competitive games and tournaments results in recognition, prizes, including prize money, and creates significant enjoyment and utility. Depending on the value of the extrinsic rewards at stake, the intrinsic value of MTG cards may exceed the retail price. Also, the competitive nature of the hobby and a player's passion to win may alter one's perception of the risk/reward trade off when opening booster packs. A person who may be risk adverse for purchasing lottery tickets because of the established odds ratio, may also have a greater appetite for risk while participating in a competitive game through the subjective alteration of the risk/reward ratio.

Also, there may be additional demand for older cards. Being made of paper, MTG playing cards wear out with play. As uniquely different cards are released in new sets, and if together newly released and old cards create powerful combinations for gameplay, demand for specific older cards increases, and booster boxes from the associated set also rise in value. Thus, the intrinsic value of a booster box may exceed the current market price.

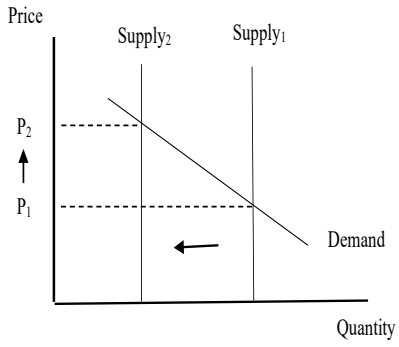
For collectors, older sets of MTG cards are difficult and expensive to complete a full set. For example, a complete set of beta cards costs $321,000 and alpha costs $458,000 as of October 2022. With older sets, the same card could be worth thousands of dollars or only a few dollars based on condition. Sealed boxes offer collectors and players a source of "pack fresh" cards. Similar to the distinct smell of the interior of a brand-new car or freshly laid new carpet, fresh MTG cards being pulled from opening booster packs also have a distinct smell and finish. There is utility for collectors when one completes a "master set" of all cards and variants found within a specific set. The "chase" for obtaining scarce cards in pack fresh condition creates excitement which may alter one's risk/reward preferences.

Finally, not only is MTG a hobby, but it is also entertainment. Social media influencers understand the popularity and loyal following of TCG's. YouTube content creators are paid according to video view counts. Thus, there is a continuous incentive to increase the number of subscribers on a Social Influencer's YouTube, Instagram, and TikTok channels. Opening booster packs of MTG cards online creates a sense of excitement and helps grow YouTube channels. Often content creators will open expensive MTG packs of cards to "flex" the importance of one's channel, in order to impress their audiences and attract new viewers. But there is a secondary benefit to growing one's YouTube channel besides online notoriety and direct payments from YouTube. A large, established social media influencer can attract corporate sponsors, who are willing to pay the channel for advertisements placed on the platform. This additional source of revenue from sponsors can be lucrative, alters financial returns from opening booster packs on the channel, and provides a premium for online content creators above the value of the contents inside the MTG booster box. Thus, over time, as the supply of booster boxes for each set goes to zero, competition between cohorts creates a price premium for the opportunity to open sealed MTG product.

**Expected Value of Sealed Magic the Gathering Product**

Wizards of the Coast produces one new Magic the Gathering set every three months, and annually one set for a format called "commander" and one premium-priced set containing expensive cards from the past in need of a reprint. Wizards has a "print to demand" strategy and places each new set in retail stores for one to two years. When the supply of a new set runs low at distributors, Wizards orders a reprint of the set, to restock the merchandise. Popular sets are reprinted to make the product available in stores for up to two years. By contrast, poor selling sets may not be reprinted, and supply may be available for less than a year. But once the printing period has ended and no more supply becomes available, the existing supply of sealed product begins to appreciate in price (See Figure 1). Wizards began printing MTG cards in the summer of 1993, and for twenty-nine years introduced four to five sets per year. Thus, with over 100 sets now available, the pricing of sealed product from each set creates a useable data set for analysis.

**Figure 1**
**Price Increases as Supply Decreases**



As Figure 1 suggests, after the printing period has ended, the quantity of sealed boxes of a particular expansion is a measurable finite number. Assuming a downward sloping demand curve, as the finite supply of sealed product continues to be reduced over time, the price appreciates as people are willing to pay more for the remaining supply. Sealed product will continue being opened after distribution ends for the aforementioned reasons. As supply is continuously reduced over time due to sealed boxes being opened, price will continue to appreciate.

Regarding the Expected Value of the contents of sealed MTG booster boxes, standard booster boxes of Magic the Gathering cards contain 36 sealed packs. Each sealed pack contains 1 rare or mythical card, 3 uncommon cards, 10 common cards and 1 basic land card. The expected value of any booster box can be calculated as follows:

$$E(V) = 36*\frac{1}{M} \sum_{i=1}^{M} Rare_i + 108*\frac{1}{N} \sum_{i=1}^{N} Uncommon_i + 360*\frac{1}{P} \sum_{i=1}^{P} Common_i + 36*\frac{1}{L} \sum_{i=1}^{L} Land_i \quad (2)$$

where M, N, P, and L stand for the number of rare or mythical (R/M) cards, uncommon (U) cards, common © cards and land (L) cards within the particular set associated with the booster box. The card prices for every R/M, U, C, and L card come from current card market prices, and are available on websites including TCGplayer.com. Based on the market price for each individual card, the average price across R/M, U, C, and L cards are calculated for each set contained in the booster box, across 109 unique sets of MTG cards. The average price for R/M, U, C, and L cards is then multiplied by the number of each card contained in the booster box to obtain the expected value of box contents. The actual cards in each sealed pack and box are random, so the expected value is based on the average price of the R/M, U, C, and L cards contained in each set.

And the variance of the value of any booster box can be calculated by:

$$\sigma^2_{E(V)} = (36)^2\sigma^2_{\overline{Rare}} + (108)^2\sigma^2_{\overline{Uncommon}} + (360)^2\sigma^2_{\overline{Common}} + (36)^2\sigma^2_{\overline{Land}} \quad (3)$$

where $\overline{Rare}$, $\overline{Uncommon}$, $\overline{Common}$, and $\overline{Land}$ are expected values.

Over time sealed products create a store of value. It provides a future opportunity for customers who are willing to pay a premium to enjoy a game of chance. Three pertinent empirical questions remain: (a) How can the price of a booster box be predicted? (b) How much returns can sealed boxes produce annually on average? (c) Can sealed booster boxes be useful for purposes of portfolio diversification?

## DATA AND METHODOLOGY

The purpose of modeling is to better understand the nature of sealed product as a potentially investible product. There are five useful variables. The first three variables are the current prices of sealed booster boxes, the total face value of all the cards in the set of cards, and the price of the most expensive card in the set. The website MTG Goldfish has developed powerful and useful algorithms for computing prices of all MTG cards, sets, and sealed product, aggregated daily. For each card, every day the algorithm collects all available listings on eBay, TCGplayer.com, ToadandTroll.com, and Channel Fireball.com, and averages the price across all listings, to create an average daily price. Then they sell the data on a subscription basis. Daily prices for MTG booster boxes started to appear on June 3rd, 2015. The daily price from June 3rd, 2015, to December 31st, 2020, for MTG booster boxes, complete sets, and the most expensive card in each set was purchased from MTGgoldfish.com.

Next, the date that each MTG set was released, to determine the age in years, was obtained from the website mtg.fandom.com/wiki/Set. Likewise, the original prices for booster boxes were collected at the time of release. Original prices for new sealed product, charged by Wizards of the Coast, when the set was released, were obtained from discussions from Alpha Investments (LLC) and Alpha Beta Unlimited Games abugames.com.

For the last two potential explanatory variables, in July 1995 Wizards of the Coast released a set called “Chronicles”. Chronicles reprinted valuable cards from previous sets and became perhaps the most controversial set in the history of the game. The release of the Chronicles set caused a firestorm within the MTG community because it debased the value of many highly sought-after cards. To calm the market Wizards of the Coast made a “reserve list” of cards that will never be reprinted to maintain their prestige and value. A dummy variable was created called “reserve list” to indicate whether each set contained cards in it from the reserve list. The set “Urza’s Destiny” released in 1999 was the last set to contain cards found on the reserve list.

Likewise, to test for possibility of COVID pandemic affecting the price of sealed product, a dummy variable, starting March 1, 2020, was also included. There are two possible ways the recent pandemic may impact booster boxes. First is through a change in spending of discretionary income. During the pandemic people did not go to restaurants to eat nor take normal vacations. Thus, they may have changed their spending patterns on discretionary income. Second, the Federal government issued two rounds of direct stimulus checks to every American during the pandemic.

Finally, to calculate the correlations with another asset class, the daily price of the S&P 500 from June 3rd, 2015, to December 31st 2020 was also included in the dataset. To determine the correlation of sealed product, the daily stock price of the S&P 500 was taken from Bloomberg.com.

Our panel dataset consisted of 109 unique sets of cards and 2031 temporal observations (from June 3rd, 2015, to December 31st 2020) for a total of 197,638 unique observations. We used fall 2019 as the cutoff for the last booster box to be included, in order to give that booster

box one full year (2020) of observations. Sets released 3rd quarter 2015 to 4th quarter 2019 did not contain the full number of observations. Formally our model based on panel data becomes:

$$lnBox_{it} = \beta_0 + \beta_1 lnSet_{it} + \beta_2 lnTop_{it} + \beta_3 lnOrigP_i + \beta_4 Reserve_i + \beta_5 Age_{it} + \beta_6 Age_{it}^2 + \beta_7 Age_{it}^3 + \beta_8 Covid_t + U_{it} \quad (4)$$

where: i = 1, ..,109 unique sets of cards; t = 1, …, 2031 temporal observations;

*lnBox* is the logarithm of the current price of a sealed booster box,

*lnSet* is the logarithm of the total value of the cards in the set,

*lnTop* is the logarithm of the value of the most expensive card in the set,

*lnOrigP* is the logarithm of the original price of the booster box,

*Reserve* is a dummy variable indicating if the particular set contains cards that will never be reprinted,

*Age* is the age of the set since it was released; $Age^2$ and $Age^3$ are squared and cubed Age variables that aim to capture the non-linear impact of age,

*Covid* is a dummy variable starting March 1, 2020, used to capture the effects of the pandemic,

and $U_{it} = u_i + v_{it}$ are the residuals containing both a time-invariant component and a time-variant component.

We used the logarithm price, instead of the raw price, because the latter exhibits a significantly higher degree of non-normality (positive skewness and excess kurtosis) than the former (see the summary statistics table below). We also run the regressions using raw prices and the results are similar to their logarithm counterpart (see the appendix).

## EMPIRICAL RESULTS

In this section, we report the summary statistics and the regression results from Equation (4). We also evaluate the benefits of including MTG investment to a traditional portfolio of stocks and bonds.

### Summary Statistics

The available data for each booster box were from June 3rd, 2015, to December 31st, 2020, and across 109 unique sets were aggregated. The descriptive statistics for our sample are presented in Table 1.

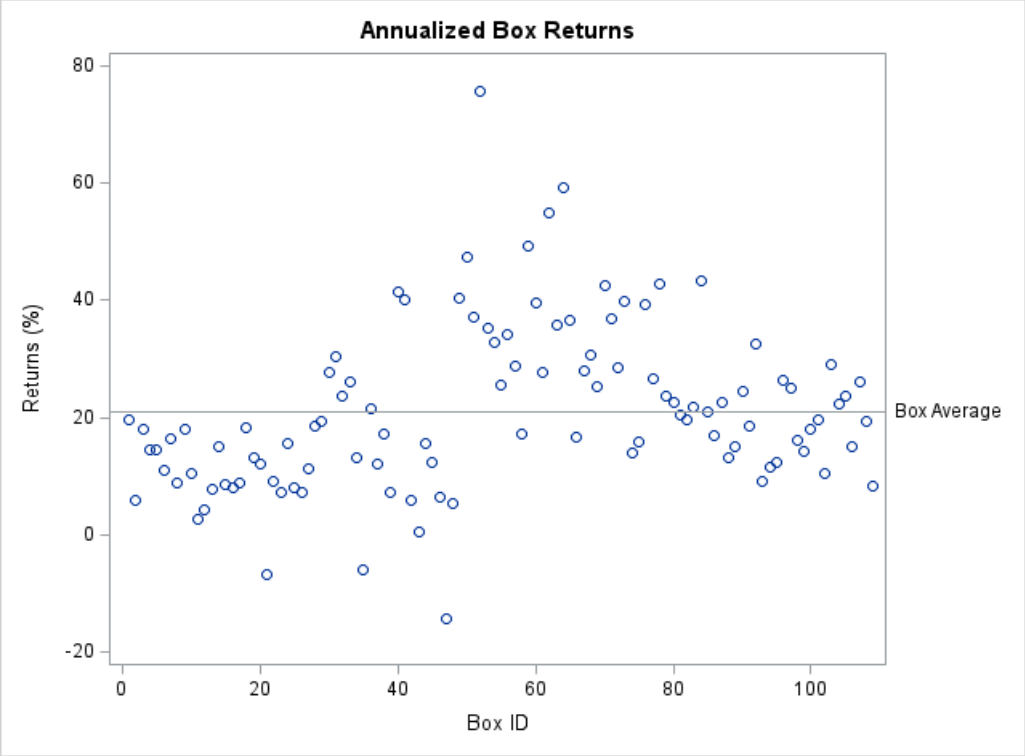
**Table 1**
**Descriptive Statistics**

| Variable | Mean | Std. Dev | Minimum | Maximum | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| Booster Box | 1033.25 | 3607.56 | 59.51 | 65110.00 | 8.58 | 94.27 |
| Ln Box Price | 5.86 | 1.13 | 4.09 | 11.08 | 1.24 | 2.56 |
| Set Value | 487.21 | 1399.20 | 32.86 | 155639.00 | 17.57 | 954.89 |
| Top Card Value | 73.09 | 302.35 | 0.40 | 9800.00 | 13.33 | 278.30 |
| Original Price | 78.55 | 24.16 | 60.00 | 240.00 | 3.74 | 14.75 |
| Age (years) | 11.43 | 7.33 | 0.00 | 26.75 | 0.15 | -1.17 |
| Reserve list | 0.19 | 0.39 | 0.00 | 1.00 | 1.56 | 0.42 |

Table 1 shows that Booster Box, Set, Top Card and Original Price, show high degrees of right skewness and excess kurtosis. In the rest of the paper, we choose to model log prices, instead of raw prices because the logarithm transformation significantly reduces the non-normality of these three variables. Q-Q plots for Box, Set, and Top prices and their logarithmic values are provided in Appendix 2. All three prices exhibit right skewness and excess kurtosis, whereas their logarithmic counterparts show much lesser degree of non-normality. We also apply logarithm transformation to Original Price to maintain consistency of measures across price variables.

During the sample period from June 3, 2015, to December 31, 2020, sealed booster boxes generated annualized return of 21.10% on average (compared to S&P500 index's 13.56%), with a standard deviation of 14.40% across boxes. On average, sealed booster boxes seem to present an attractive investment opportunity relative to stock investment. Figure 2 shows the annualized daily average returns for each of the 109 booster boxes during the sample period. There is considerable variation over time and across individual box returns, ranging from -14.37% to 75.54%. The wide range of returns is a source of diversification across boxes within this alternative asset class, which will be elaborated in the following section.

**Figure 2: Annual Returns to Booster Boxes**




## Regression Results

Our panel data set contained daily observations from June 3rd, 2015, to December 31st, 2020 for 109 unique booster boxes. But for sets released fall 2015 to fall 2019 the number of observations fell with each successive set released. The MTG set "Core 2020" was released during the fall of 2019, and only 549 daily observations are available. This data limitation unfortunately created an unbalance panel. Because the dataset is an unbalanced panel, we employ two models for empirical analysis: the hedonic pooled OLS, the fixed effects and the random effects models.

A poolability test was conducted to test whether the pooled hedonic regression is valid. The P-value is less than 0.0001, indicating the inadequacy of the pooled regression in addressing the variability in the error terms. Next, the stationarity of the data was tested using the augmented Dickey Fuller test. The P-values were low enough to reject the null hypothesis of a unit root. We conducted the Breusch-Pagan test for random effects and rejected the null hypothesis of "no random effects" with a P-value less than 0.0001, indicating a presence of random effects. Finally, we conducted the Hausman test (Chi-square statistic 0.11 with a p-value of 1) is in favor of random effects vs. fixed effects. Despite the Hausman test favoring random effects, both models produce similar estimates. The regression results for the hedonic regression

with the heteroskedastic consistent variance correction, the fixed effects and the random effects models are presented in Table 2.

**Table 2**
**Dependent Variable: Ln Sealed MTG Box Price**

| Variable | Hedonic Regression (Pooled OLS) | Fixed Effects (Panel) | Random Effects (Panel) |
|---|---|---|---|
| Intercept | 0.90 | 2.46 | 2.44 |
| | (54.87)** | (147.92)** | (58.17)** |
| Ln Set | 0.73 | 0.40 | 0.41 |
| | (321.27)** | (119.61)** | (81.05)** |
| Ln Top Card | 0.05 | 0.03 | 0.03 |
| | (33.11)** | (19.97)** | (13.71)** |
| Ln Original Price | -0.12 | - | - |
| | (27.22)** | | |
| Reserve List | 0.23 | - | - |
| | (37.03)** | | |
| Age | 0.16 | 0.09 | 0.09 |
| | (133.80)** | (89.43)** | (98.82)** |
| Age2 | -0.004 | -0.003 | -0.003 |
| | (39.77)** | (30.27)** | (29.90)** |
| Age3 | 6.00E-05 | 1.00E-04 | 1.00E-04 |
| | (15.96)** | (62.82)** | (56.10)** |
| Covid Pandemic | 0.06 | 0.06 | 0.06 |
| | (22.52)** | (39.44)** | (38.82)** |
| F-stat | 1,336,612.00 | 63,520.00 | 43,210.00 |
| $R^2$ | 0.85 | 0.76 | 0.76 |

N = 197,638; T-stat in (): **, * Significant at the 1%, 10% level

The first column contains the results from the hedonic regression. The results are in line with expectations. The set and value of the most expensive card in the sealed box have a positive impact on box prices. As the retail price of booster boxes has risen over the past twenty-five years, the more recently released, higher retail-priced boxes have a lower current value on the secondary (resale) market than older boxes, thus causing a negative coefficient. The positive and significant coefficient on the Age variable suggests that there is a measurable positive return to booster boxes. The two additional polynomial age variables, $Age^2$ and $Age^3$ are included to capture the non-linear decline of booster box supply. The overall effect of positive, negative and positive coefficients for Age, $Age^2$ and $Age^3$ is that the positive convex relationship with the age of the box, i.e. the older the box the higher potential of appreciation in value, especially when the age is greater than 10. This finding is consistent with Hughs' (2022) notion of rarity. And during the Covid pandemic (starting March 1, 2020) created an additional positive effect return on booster boxes, which implies that the pandemic drove investors to seek alternative investments.

Together, these variables suggest that further investigation into the historical returns of sealed product is warranted.

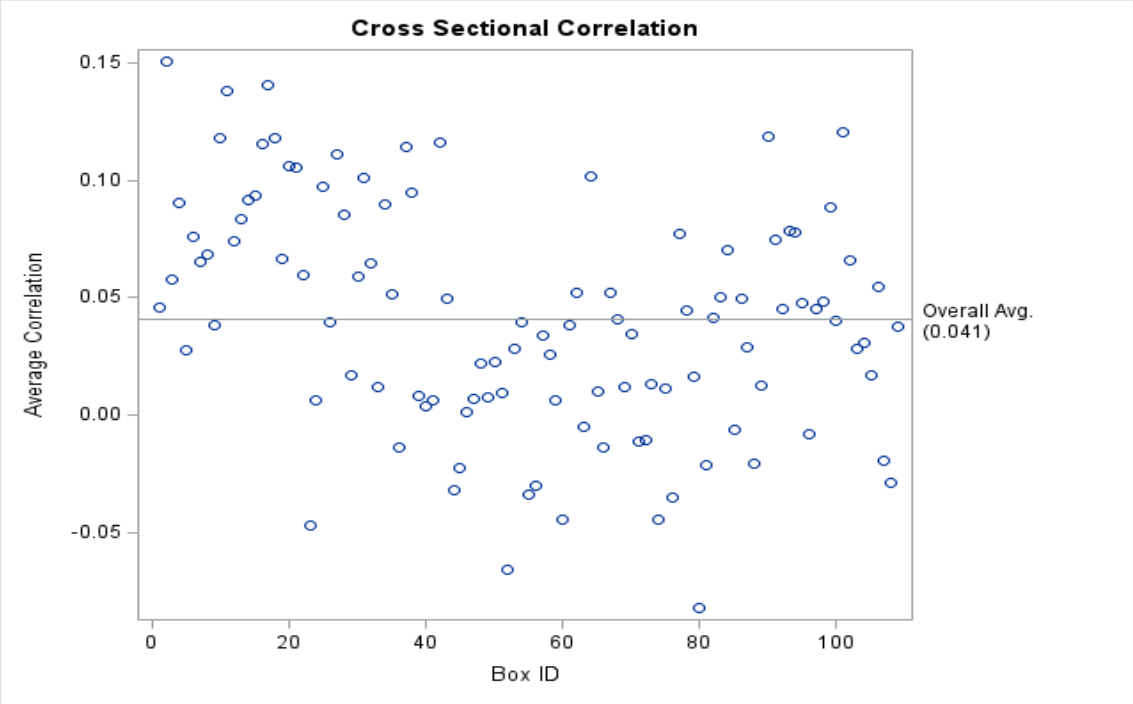
Next, to control for the possibility of omitted variables biasing our estimates, we ran both fixed-effects and random-effects panel-data models. We did not include "original box price" and "reserve list" in the fixed effects model due to no variation in both variables. We also excluded them for the random effects model for direct comparison with the random effects model. Both panel data models provide consistent and comparable estimation results with the pooled OLS model. Regression coefficients for the former are of larger magnitude than those for the latter.

**Diversification Benefits of Sealed booster boxes**

To assess the potential diversification effect of Booster Box investment, we computed the correlation among daily Booster Box returns, and the correlation between Booster Box returns and S&P 500 index returns. It will become clear in the following discussion that the average correlations in both cases are low. Given its high return and low correlations, we further investigate whether Booster Box returns can be explained by the three classical Fama-French risk factors.

Figure 3 presents return correlations across booster boxes. The top panel shows the average correlation between each box and the rest of 108 boxes. The overall average correlation between boxes is low 0.041. For any given box, the average correlation ranges from -0.08 to 0.15. The bottom panel provides a detailed view of correlations for all boxes, with Box IDs going up from left to right and from bottom to top. The 5886 pairs of correlations, unlike the average correlation, have a much larger range from -0.75 to 0.95. Therefore, the most diversification would be achieved by investing in as many boxes as possible to avoid high correlations for some boxes. For instance, the bottom left area of the correlation matrix shows relatively higher correlations. This is likely because Wizards of the Coast switched from printing a fixed number of MTG boxes for each set to a "print to demand" printing strategy, and as a result between 2015 and 2017 people lost confidence in collecting sealed boxes due to higher numbers of boxes printed, and thus, boxes published during that period tended to behave similarly.

**Figure 3: Daily Correlations between Box Returns**



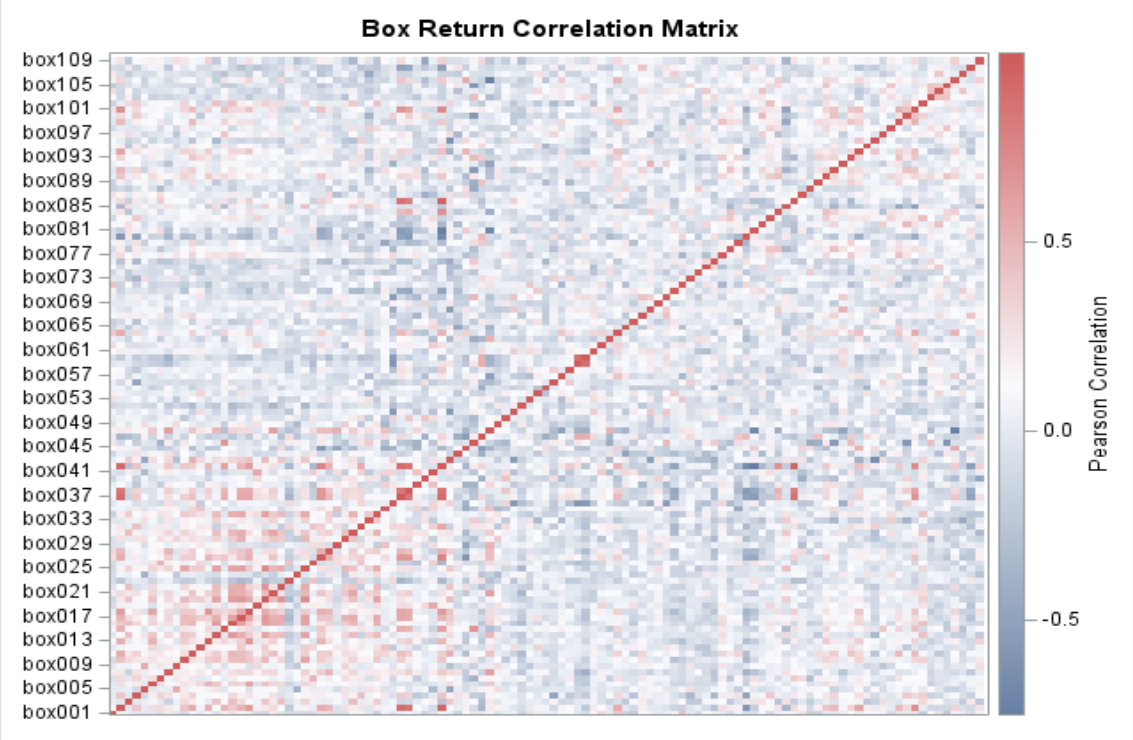



Figure 4 presents return correlations between booster box and the SPX index. The horizontal axis represents the 109 boxes. The return correlations are generally low with a range between -0.27 and 0.27. The overall average correlation between booster box and the SPX index is nearly zero (-0.006). We can conclude that both individual correlations and the average correlation of booster box with the stock market with the SPX index are low. The low correlations may provide a potential benefit to a traditional stock portfolio.

Figure 5 presents the time series returns to Magic booster boxes and the S&P 500 using monthly returns. The horizontal axis is labeled as a combination of two-digit year and two-digit month. The monthly return series for sealed boxes on the vertical axis is based on the average of all 109 box returns. We notice a slight upward trend in the booster box monthly returns, consistent with the early finding of positive "age" variable. Because of the diversification effect due to averaging booster box returns with low correlations, we find that the monthly returns to sealed product (with 2.9% standard deviation) are more stable than the S&P 500 (with 4.6% standard deviation). The monthly return correlation between two boxes and the SPX is low, consistent with the findings based on daily returns.

**Figure 4: Daily Correlations between Box Returns and SPX Returns**

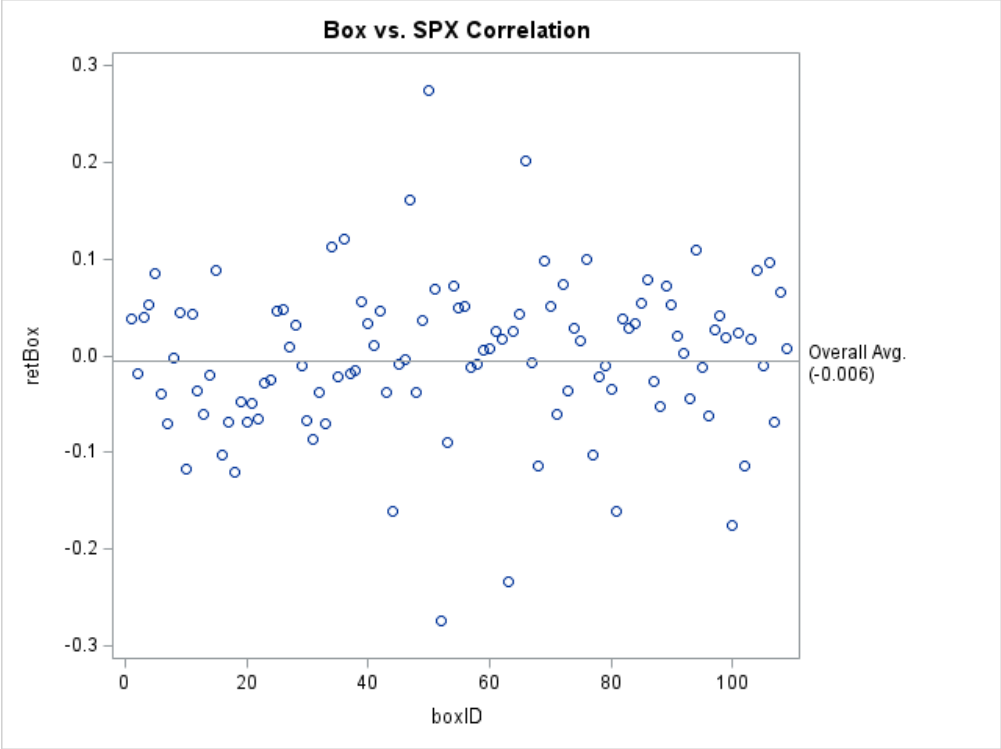
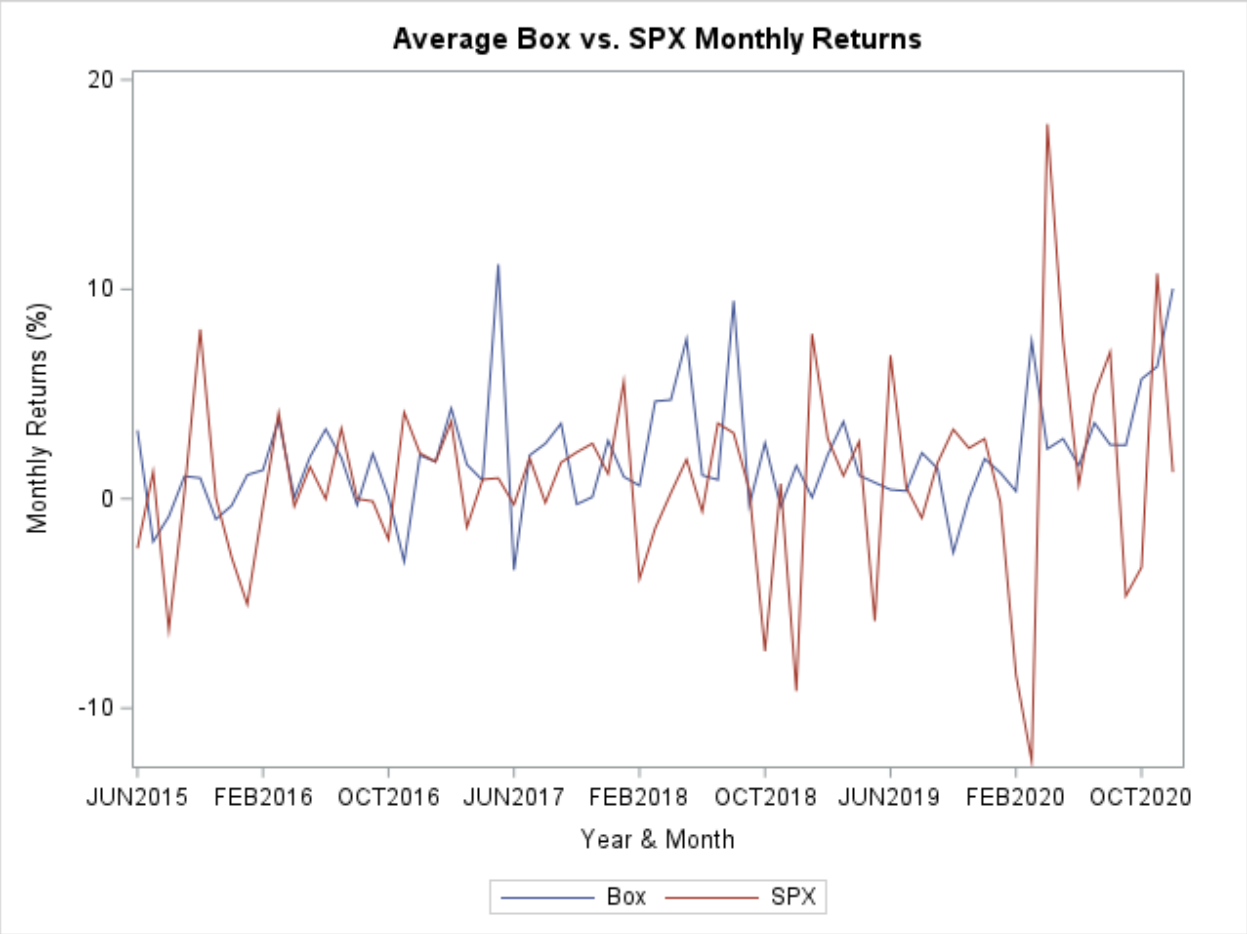


**Figure 5: Monthly Returns to Magic Boxes and the S&P 500 Over Time**




To find possible risk factors that explain booster box returns, we form an equal-weighted portfolio of all booster boxes and regress its daily excess returns on the daily Fama-French factors. The Fama-French 3-factor model is given as follows:

$$R_{BB} - R_f = \alpha + \beta(R_m - R_f) + b_s SMB + b_s HML + \varepsilon$$

where $R_{BB}$, $R_f$, $R_m$, SMB, HML is the booster box portfolio (or individual box) return, the risk-free rate, the return of the market portfolio, the small factor, and the value factor, respectively.

The regression results are shown in Table 4. The market beta is 0.01, not statistically significant from zero. Neither the size factor nor the value factor explains the booster box's returns during the period of 2015-2020. This finding confirms the uniqueness of the booster box

investment, as opposed to traditional risk factors. The low beta is driven by the low correlation between the box returns and the market factor, despite the higher volatility of box returns. As we documented earlier, the average correlation between box returns and SPX returns is nearly zero (Figure 4), which can potentially make sealed booster boxes a good diversifier to a stock portfolio. We also performed the same regression of booster box's weekly returns on Fama-French factors. The same findings hold true—none of the factors is significant at the 10% level.

**Table 4: Fama-French Regression of Booster Box Returns**

| Variable | Estimate | Std Err | t Value | P-Value |
|---|---|---|---|---|
| **Const.** | 0.052 | 0.019 | 2.66 | 0.01 |
| **Rm-Rf** | 0.010 | 0.013 | 0.75 | 0.45 |
| **SMB** | 0.021 | 0.045 | 0.47 | 0.64 |
| **HML** | -0.038 | 0.030 | -1.30 | 0.19 |

Based on historical returns of boxes being higher than returns to the S&P 500, and a nearly zero correlation between the two asset classes, we decided to map out the efficient frontier for a portfolio containing three asset classes, stocks, bonds, and sealed product. Table 5 shows the underlying monthly returns and correlations used to construct the efficient frontier. These input statistics are based on the monthly sample observations from June 2015 to December 2020. (The slight difference in the average return in the section of summary statistics and the expected return in Table 5 is due to the difference in sampling frequency. The summary statistics reported earlier are based on daily returns while Table 5 is based on monthly returns).

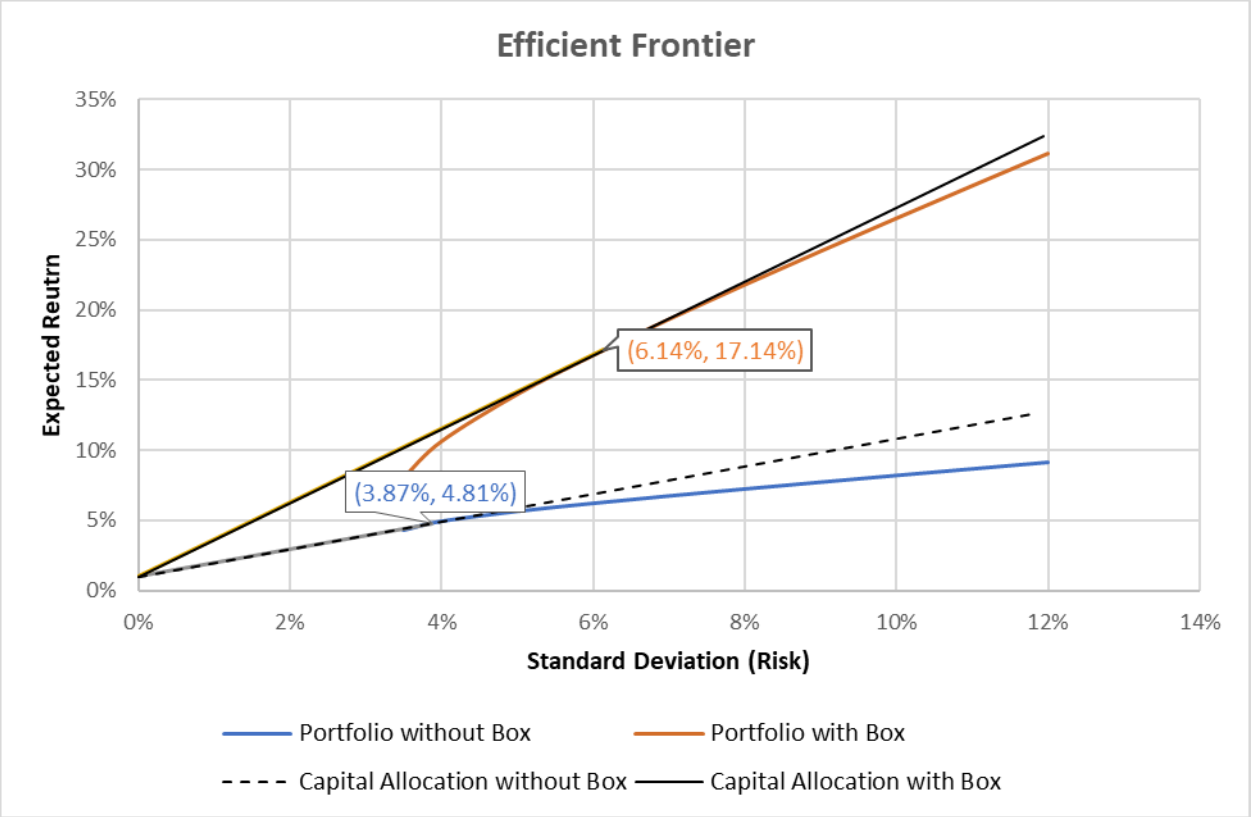
**Table 5: Returns and Correlations used to construct the Efficient Frontier**

| Investments | Expected Return | Std Dev. | Correlation | SPX | BND | BOX |
|---|---|---|---|---|---|---|
| **SPX** | 10.93% | 15.92% | **SPX** | 1 | 0.19 | 0.01 |
| **BND** | 3.99% | 3.45% | **BND** | 0.19 | 1 | 0.10 |
| **Box** | 26.23% | 10.08% | **BOX** | 0.01 | 0.10 | 1 |

Figure 6 presents the efficient frontier, optimal risky portfolio, and capital allocation line using monthly time series (annualized) returns of SPX, BND (Vanguard Bond ETF), and Box prices. From the efficient frontier, across the range of risk, the inclusion of sealed boxes into the portfolio increases the expected return to the combination of assets. Assuming the existence of risk-free asset, proxied by 3-month T-Bill, we find the optimal risk portfolios including and excluding boxes have a risk-return combination of (6.14%, 17.14%) and (3.87%, 4.81%), respectively. Furthermore, the Sharpe ratio, the slope of capital allocation line, including and

excluding boxes are 2.63 and 0.98, respectively. Based on the increase in expected returns and better risk-return tradeoff from the inclusion of sealed boxes into the portfolio of assets, we see evidence that sealed product from a collectible card game is a useful asset for purposes of portfolio diversification.

**Figure 6: Efficient Frontier for a Portfolio of Stocks, Bonds, and Sealed Boxes**




Finally, as a robustness check, we also consider the potential dynamic correlation between booster box and the SPX and other investments such as Bitcoin, along the line of Uddin et al. (2020). We ran both constant-conditional-correlation (CCC) and dynamic- conditional-correlation (DCC) multivariate GARCH for an overall portfolio of equal weighted boxes and for 5 representative boxes (with the longest samples). Both the log likelihood ratio test and the AIC(c) criterion indicate that DCC model might be a better model fit at the portfolio level and for the individual boxes. The regression results based on the portfolio show a small positive unconditional correlation coefficient (4.39%) between box returns and SPX at the 10% significance level. Similar results are confirmed by running a MGARCH model on select 5 individual booster boxes along with SPX and Bitcoin. Therefore, it confirms that sealed booster boxes could provide an effective diversification benefit to the traditional equity/bond portfolio.

## CONCLUSIONS

In this study, we set out to answer the three questions for sealed booster boxes: (a) How can the price of a booster box be predicted? (b) How much returns can sealed boxes produce annually on average? (c) Can sealed booster boxes be useful for purposes of portfolio diversification?

Our hedonic regressions show that the price of a sealed booster box can be explained with high R-square by the set value, the price of the top card, the original retail price of the box, age, and whether the box contains cards on the reserve list. Except for the original retail price, all factors positively influence the price of a sealed booster box. Because older boxes had low original prices and command high current prices, the negative correlation of the original retail price and the current box price is justified. We also find that the COVID pandemic lifted the prices of sealed booster boxes.

Our empirical results show that on average sealed booster boxes of MTG cards produced an average annual return around 21%. Although individual booster box prices are volatile, a portfolio of sealed booster boxes can achieve relatively low volatility due to the diversification effects across different boxes. This result is encouraging because empirical studies of art markets have produced similar results. For example, McQuillian and Lucey (2009) analyzed London auction sales from 1998 to 2007 and concluded that returns on Islamic art outperformed both the London stock and bond markets over the same time period. Using a longer time horizon, Renneboog and Spaenjers (2013) used a hedonic regression to analysis art auctions between 1957 and 2007 and found that art has appreciated in value by a moderate 3.97% per year, in real U.S. dollars over five decades.

Next, we find that sealed MTG booster boxes have a low correlation with the stock market. The market beta of booster box returns is nearly zero in the Fama-French 3-factor model. The low return correlation between booster boxes and the SPX makes them an excellent diversifier to a traditional stock/bond portfolio, pushing the efficient frontier favorably in terms of the return and risk tradeoff. These results are consistent with previous findings for both art and wine markets. Masset and Henderson (2010) found wine returns have low correlations with other assets and are useful in reducing systemic risk of an equity portfolio. Likewise, Öztürkkal and Togan-Eğrican (2020) demonstrated that Turkish art is only slightly correlated with other investments, including stocks.

For the risk averse investor seeking to diversify one's portfolio, sealed product of collectibles may hold a place in the modern portfolio. Once out of print, due to ever-shrinking supply, sealed MTG boxes continuously increase in value. From our empirical results, the consistent estimation across the hedonic model and the panel data models tells an important story. First, sealed booster boxes had on average a 21% return during the period 2015 until 2020. Second, in terms of constructing an efficient portfolio, the inclusion of broadly diversified sealed products significantly improves the expected returns and reduces the risk to a traditional portfolio of stocks and bonds. Thus, in conclusion, sealed booster boxes may be worth considering as an asset for portfolio diversification. Admittedly, the 5-year sample period might

still be limited, and the past performance of sealed booster boxes may not persist in the future. The popularity of MTG game may decline and drive down the demand for sealed booster boxes. Finally, despite high historic returns, being illiquid as opposed to equities and bonds may prevent investors who are concerned about liquidity from adding collectibles to one's portfolio. In a recession, all asset classes tend to fall, including equities, real estate, collectibles, and Bitcoin. Understanding the pricing behavior of collectible card games across different business cycles might make interesting future research.

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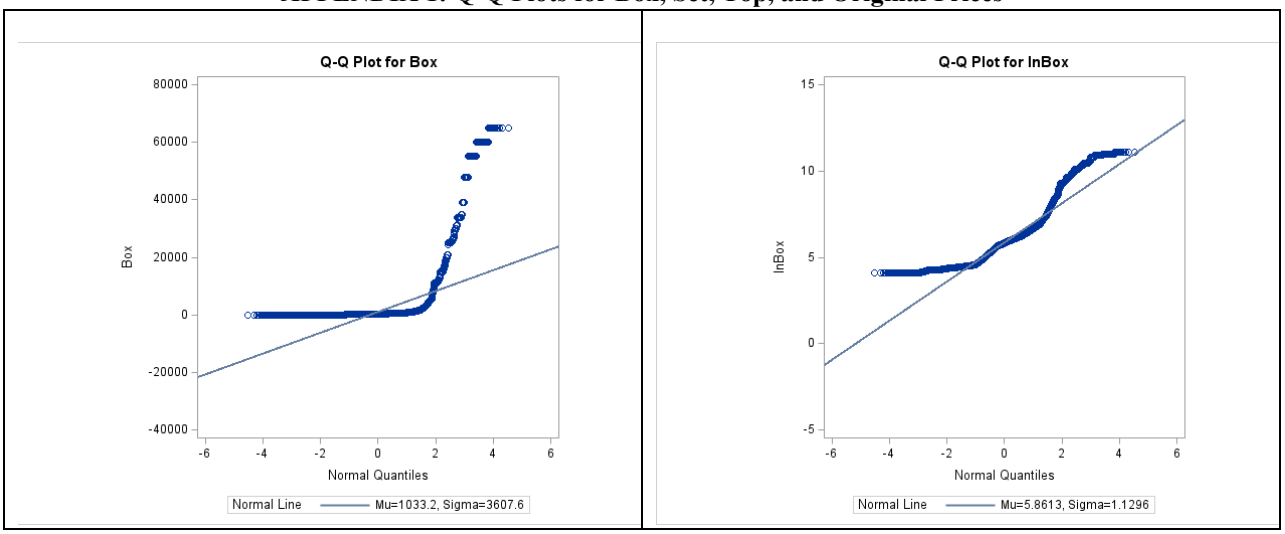
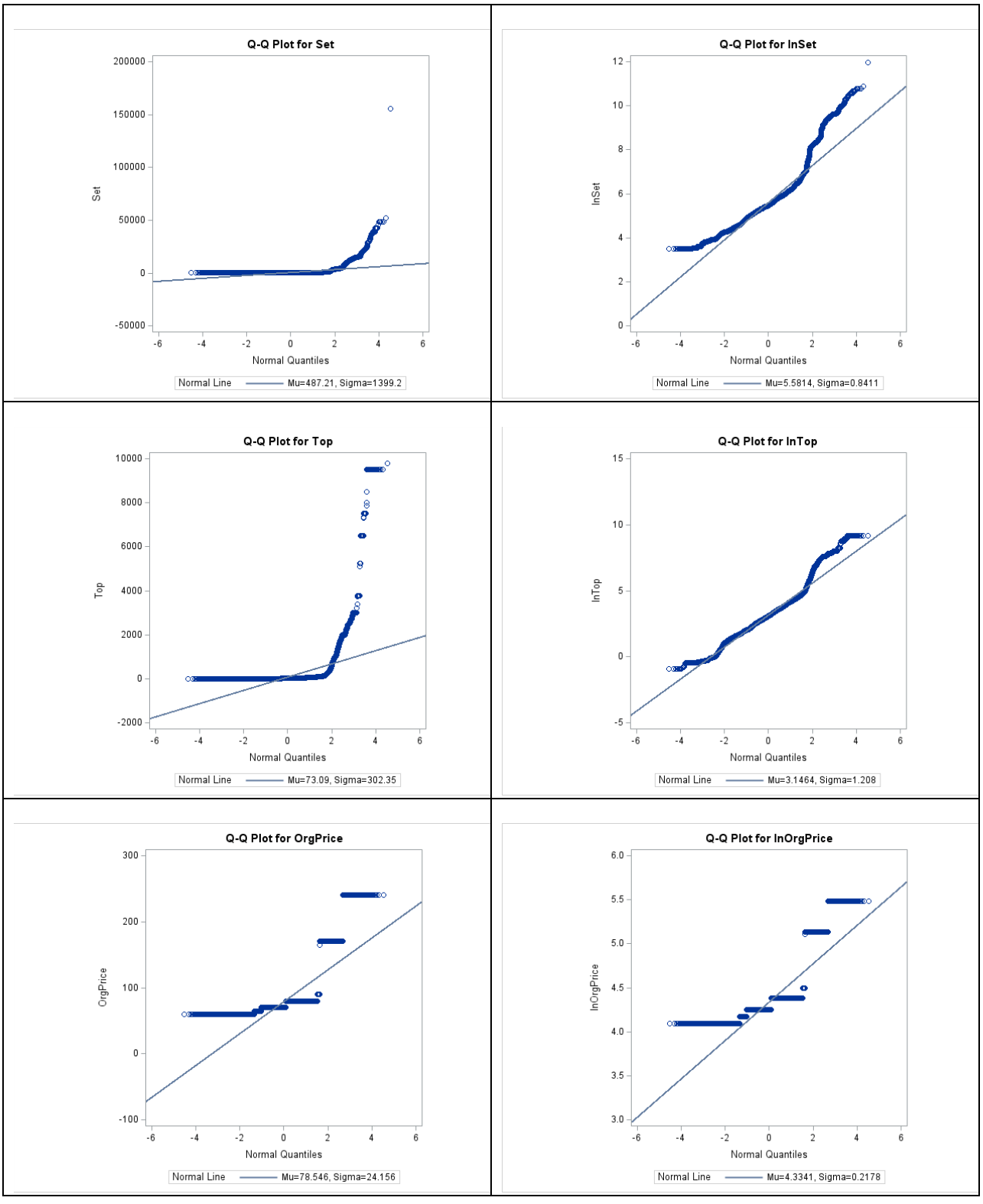
## APPENDICES

**APPENDIX 1: Q-Q Plots for Box, Set, Top, and Original Prices**




Q-Q Plot for Set
Set
Normal Quantiles
Normal Line
Mu=487.21, Sigma=1399.2
Q-Q Plot for lnSet
lnSet
Normal Quantiles
Normal Line
Mu=5.5814, Sigma=0.8411
Q-Q Plot for Top
Top
Normal Quantiles
Normal Line
Mu=73.09, Sigma=302.35
Q-Q Plot for lnTop
lnTop
Normal Quantiles
Normal Line
Mu=3.1464, Sigma=1.208
Q-Q Plot for OrgPrice
OrgPrice
Normal Quantiles
Normal Line
Mu=78.546, Sigma=24.156
Q-Q Plot for lnOrgPrice
lnOrgPrice
Normal Quantiles
Normal Line
Mu=4.3341, Sigma=0.2178

**APPENDIX 2: Regression results of Equation (4) using raw prices of booster boxes**

| Dependent Variable: Raw Prices | | | |
|---|---|---|---|
| **Variable** | **Hedonic Regression** (Pooled OLS) | **Fixed Effects** (Panel) | **Random Effects** (Panel) |
| Intercept | -107.755 | 89.60 | 31.86 |
| | (40.17)** | (2.85)** | (0.23) |
| Set | 0.76 | 0.43 | 0.43 |
| | (7.28)** | (96.12)** | (3.27)** |
| Top Card | 5.5 | 3.71 | 3.71 |
| | (15.46)** | (175.79)** | (9.30)** |
| Original Price | -4.9 | - | - |
| | (8.98)** | | |
| Reserve List | 738.96 | - | - |
| | (12.56)** | | |
| Age | 187.58 | 280.09 | 280.75 |
| | (17.26)** | (40.71)** | (29.23)** |
| Age2 | -20.66 | -46.88 | -46.84 |
| | (15.21)** | (76.32)** | (31.29)** |
| Age3 | 0.66 | 1.73 | 1.73 |
| | (14.42)** | (108.39)** | (33.11)** |
| Covid Pandemic | 299.35 | 155.53 | 153.89 |
| | (16.49)** | (14.91)** | (12.14)** |
| F-stat | 44,656.80 | 29,060.00 | 2,388.20 |
| R ^ square | 0.64 | 0.58 | 0.58 |

N = 197,638; T-stat in (): **, * Significant at the 1%, 10% level