LEGO: THE TOY OF SMART INVESTORS

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Abstract

We study financial returns on alternative collectible investment assets, such as toys, using LEGO sets as an example. Such iconic toys with diminishing over time supply and high collectible values appear to yield high returns on the secondary market. We find that LEGO investments outperform large stocks, bonds, gold, and alternative investments, yielding an average return of at least 11% (8% in real terms) in the sample period 1987–2015. LEGO returns are not exposed to market, value, momentum, and volatility risk factors but have an almost unit exposure to the size factor. A positive multifactor alpha of 4%–5%, a Sharpe ratio of 0.4, a positive return skewness, and low exposure to standard risk factors make the LEGO toy and other similar collectibles an attractive alternative investment with good diversification potential.

JEL classification: D14, G12, G15

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1. INTRODUCTION

Increasing globalization and networks between various asset markets limits the opportunities for diversification. Therefore, investors resort to alternative nonfinancial assets to reduce their risks and increase potential returns. A Barclays (2012) survey showed that the average high net-worth individual holds about 10% wealth as collectible assets, such as artworks, antiques, jewelry, fine wines, rare automobiles, and other luxury items partially to diversify their portfolios and hedge their financial investments. Investment funds that deal with collectible wines, artworks, precious metals, and stones improve the accessibility of such assets to retail investors.[1] Studies have focused on such typical alternative investments, which have been popular for decades.[2]

However, there is a wide array of collectibles, including toys (e.g., LEGO sets, Barbie dolls, superhero figures, car or train models, Beanie Babies, and Silvanian families), which have been neglected in academic literature mainly because of the lack of comprehensive and systematic data. Anecdotal evidence suggests that collectible toys generate high (in some cases, tremendous) returns on the secondary market, because of their limited supply and rarity. Such toys are produced by companies in limited editions. Once they become retired and disappear from the shelves of stores, they can only be bought on the secondary market. Over time, items are increasingly fewer in supply, whereas collectors' desire increases with rarity, and so do the prices.

We study secondary market returns on collectible toys using LEGO sets as an example. LEGO is the most popular toy around the globe, and although it may seem odd to invest in a toy, a huge secondary market for LEGO sets with tens of thousands of transactions per day has developed in the 2000s (Maciorowski and Maciorowski, 2015). LEGO investments are popular because this alternative asset does not belong to the luxury segment and is therefore affordable to any retail investor. LEGO

[1] For example, the IQ Physical Diamond Trust, the Diamond Circle Capital Fund, and the diamond fund by Swiss Asset Advisors are several recent examples (Romano, 2011; Popper, 2012).

[2] For example, works of art (Baumol, 1986; Goetzmann, 1993; Mei and Moses, 2002; Renneboog and Spaenjers, 2011 and 2013; Dimson and Spaenjers, 2014), precious metals and stones (Renneboog and Spaenjers, 2012; Auer and Schuhmacher, 2013; Low et al., 2016), collectible automobiles (Martin, 2016), postage stamps (Dimson and Spaenjers, 2011, 2014), collectible violins (Graddy and Margolis, 2011; Dimson and Spaenjers, 2014), fine wines (Masset and Weisskopf, 2010; Kourtis et al., 2012; Dimson et al., 2015). More details are reported in section 2.

Group (LEGO henceforth), a Danish company, which was established in Billund in 1932 as a small wooden toy producer, is the current largest toy producer in the world.[3] Fortune magazine named LEGO "the toy of the century" in 2000. According to a massive survey of more than 3,000 adults in 2010, LEGO was named "the most popular toy of all times" (Robertson and Breen, 2013). With Coca-Cola and Disney, LEGO occupies a top position in the Young & Rubicam rating of the world's most popular brands. The LEGO factory in Billund produces 2.2 million bricks every hour, and the number of LEGO bricks produced each year is five times as high as the current world population (Robertson and Breen, 2013). Every child in every country knows and plays LEGO.

Apparently, LEGO is not just a kids' toy. Thousands of adults around the world collect LEGO sets. LEGO bricks are used to build large-scale objects and real art masterpieces (e.g., the world famous exhibition "The Art of the Brick" by Nathan Sawaya). Even a full-scale house was built of 3.2 million LEGO bricks by a British television presenter and journalist James May.

LEGO sets and rare minifigures also serve as popular alternative investments. There is a huge secondary market for new and used sets (e.g., eBay), where, globally, tens of thousands of sets are traded daily (Maciorowski and Maciorowski, 2015). The returns on some retired sets reached outrageous numbers (up to 600% p.a.), which received much attention from the financial press. For example, the *Telegraph* reported a 12% average return on LEGO sets since the turn of the millennium compared with 4.1% on FTSE 100 and 9.6% on gold (the *Telegraph*, December 24, 2015). The article also named five most expensive sets with the current values above £1,500 and five most profitable sets with returns above 1,000% over 8–10 years since their release dates.[4]

We study LEGO not only because of its popularity but also because a systematic database of LEGO secondary market prices was available. We study historical returns on a large sample of 2,322

[3] In the online appendix, we present a brief fascinating history of the LEGO group and describe how the LEGO toy transformed over time and became a popular alternative investment in addition to being just a kids' toy.

[4] The five most expensive sets (secondary market value as of December 2015 in parentheses) are Ultimate Collector's Millenium Falcon (£2,712), Café Corner (£2,096), Taj Mahal (£1,848), Death Star II (£1,524), and Imperial StarDestroyer (£1,467). The five most profitable sets (total return in parentheses) are Café Corner (2,230% over 8 years), Market Street (1,064% over 8 years), Holiday Train (1,048% over 9 years), Rescue from the Merpeople (1,018% over 10 years), and The Batboat: Hunt for Killer Croc (1,011% over 9 years).

LEGO sets from all most popular themes to understand the attractiveness of this market to investors. We find that different sets perform unequally with average returns ranging from −50% to 600% p.a. The cross-sectional distribution of set average returns has a mean of 18.5%, standard deviation of 35%, and skewness of +9. Small and huge sets are more profitable than medium-sized sets. Small sets often contain unique parts or minifigures, whereas huge sets are released in limited editions and are popular among adult collectors.[5] Different LEGO themes are not equally attractive either. Typically, seasonal, architectural, and movie-based themes deliver higher returns. The cross-sectional analysis suggests that not all LEGO sets are potentially attractive. Rarity is the main feature, which makes a toy a profitable alternative investment, similar to other collectibles (Koford and Tschoegl, 1998; Cameron and Sonnabend, 2020).

The LEGO price index, constructed from hedonic regression coefficients, has an average return of 11% p.a. (8% in real terms) over 1987–2015.[6] Discounted purchases of LEGO sets on the primary market make the returns even higher.[7] Thus, LEGO investments outperform large stocks, bonds, gold, and other typical "hobby investments," such as wine or stamps. The LEGO returns are not significantly exposed to market, value, momentum, and volatility risk factors. We only identify a unit exposure to the Fama–French size factor, suggesting that LEGO investments perform similarly to small stocks. The positive multifactor alpha of 4%–5%, a Sharpe ratio of 0.4, positive return skewness, and low exposure to standard risk factors make the LEGO toy an attractive alternative investment with a good diversification potential. Moreover, because sales of LEGO were constantly increasing in the 1990s and 2000s despite the global financial crises, we can expect "safe-haven" properties from LEGO investments. Indeed, the LEGO secondary market delivered positive average returns in the crisis years 2002 and 2008, when the CRSP index plunged.

[5] Thanks to a LEGO hobbyist Gaurav Thakur for highlighting this.
[6] LEGO prices continued to rise at the pace of 6.2% p.a. in 2016–2018 (based on a sub-sample of 320 sets).
[7] Because in this study, we calculate returns relative to the official primary market prices, we significantly underestimate returns, actually received by LEGO investors. All LEGO resellers are unanimous in the view that it is important to search for bargains. "The goal is to buy retail and on discount," says Jeff Maciorowski to Wealthsimple ("How to invest in Legos and make a bazillion dollars" by Bill Bradley, Wealthsimple, September 14, 2016).

The main reason for such high returns on the secondary market is diminishing over time supply. Thus, LEGO and other collectible toys can be compared with fine wines.[8] Once a bottle of wine is opened, the supply of this unique wine declines. Once a LEGO box is opened, the supply of this particular set falls. Eventually, old LEGO sets become rarer, collectors hunt for them, and their prices inevitably rise.

The high return on LEGO secondary market is also attributed to the underpricing of collectible sets on the primary market. We explore the evolution of secondary market prices during the first six years after sets are released by the company and we find the following tendency. The secondary market prices are lower than the official prices while the sets are still available in stores, and the prices tend to increase after 2–3 years of the release when the sets disappear from the primary market. The prices continue to rise gradually thereafter. Hence, investment in collectible toys only pays off in the long run, when these toys become really rare.

The rest of the paper is organized as follows. Section 2 explains how LEGO (and similar collectible toys) differ from ordinary kids' toys and why they can be considered as alternative investments. Section 3 reviews literature on typical "hobby investments." Section 4 describes an illustrative model of the secondary market price behavior over time. Sections 5 and 6 describe the data, the data sources, and descriptive statistics. In Section 7, we build LEGO price indices and analyze their characteristics and risk exposure. In Section 8, we explore the dynamics of LEGO returns in the first several years after set release. Section 9 focuses on related transaction costs. Section 10 concludes. The online appendix briefly presents the history of the LEGO Group and describes how LEGO became "the toy of the century."

[8] Other similarities between collectible toys and fine wines are their consumption values and relatively cheap initial prices. Such alternative investments have an embedded option of being consumed in case of financial losses.

2. WHY LEGO?

What makes the LEGO toy a special investment asset with high expected returns besides just being the "toy of the century"? Why shall we expect high returns in the future? Several features make LEGO bricks different from ordinary toys and create an investment potential.

First, the *adult audience*, owing to the brand's long history and compatibility of all sets ever produced by the company. "A lot of the buyers are people who are in their 30s and 40s, and they are looking for something that is nostalgic from when they were a kid," stated Nate Tobik, a LEGO reseller, in an interview with Marketplace.[9] He claimed that part of what drives demand on the secondary market is the sheer enthusiasm and the financial means of adult fans of LEGO. Because LEGO is rather expensive for a toy and not always affordable by parents, we observe a high demand for sets released decades ago by adults regaining their childhood, claimed a LEGO retail shop manager Adrian Burke.[10] Adult collectors often buy sets in a particular theme (such as Pirates or Star Wars), and the compatibility of old and newly released sets is important. The LEGO Group recognizes this, and most big and expensive sets are marketed toward adult collectors. "Adult fans of LEGO are also an important audience for the company," claimed Julia Goldin, the LEGO marketing director, in an interview with CNBC.[11]

Second, the *diminishing over time supply* on the secondary market. LEGO Group has a policy to continuously release new sets and not to repeat older sets in production. As Julia Goldin said to CNBC, "children are always looking for novelty." The company releases new sets to attract children and make high profits. However, if a collector wishes to buy a retired set, it can be bought only on the secondary market. The supply is limited by the number of sealed sets in resellers' hands. Once sets are bought and opened, they leave the secondary market, and the total supply falls. Therefore, eventually, it becomes increasingly difficult to buy older sets; collectors should hunt for them, and their prices increase. LEGO investments are considered very long term. Rare (limited edition) sets tend to pay off sooner; however,

[9] "Bang for your brick: behind LEGO's thriving secondary market," by Justin Ho, Marketplace, March 4, 2019.
[10] "Is LEGO still a good investment in 2019?" by Adrian Burke, Quora, January 26, 2019.
[11] "How marketing built LEGO into the world's favorite toy brand," by Lucy Handley, CNBC, April 27, 2018.

for common sets, one should wait many years before they become rare on the secondary market to realize a positive return. Thus, LEGO investments are similar to other consumable alternative investments such as art or fine wines.

Third, *underpricing of collectible sets on the primary market*. The high collectible value of LEGO sets is not reflected in the primary market prices because of the company's policy of marginal cost pricing, that is, the price of a set depends on the amount of plastic used to produce it. However, as a LEGO hobbyist highlighted in a private conversation, many sets having any of the following features:

> *1) rare parts or minifigures, 2) licensed sets, 3) large sets with >1,000 pieces, 4) sets with low price per piece ratio, 5) sets with short production runs, 6) limited edition sets, 7) small sets and polybags, 8) seasonal sets, 9) sets, which were only sold at promotional events, 10) unique sets*

have high collectible value despite their moderate original prices. A good example is a minifigure of Mr. Gold, which is desired by many collectors and offered on the secondary market for approximately $2,000 nowadays despite its original price of $2.99 in 2013. A price jump on the secondary market is often observed once a set is retired and disappears from the primary market (see section 9 for details). Therefore, the LEGO's long-run return is partially because of the mispricing on the primary market. The bad news is that this mispricing is difficult to recognize before a set is retired.

3. AN OVERVIEW OF TYPICAL ALTERNATIVE INVESTMENTS

Collectible assets (so-called emotional assets or investments of passion) form an important part of portfolios of high net-worth investors around the globe.

For several decades, studies have focused much on returns in art markets, which is the most popular and traditional "emotional asset." Early studies of the art market (e.g., Baumol, 1986; Goetzmann, 1993; Pesando, 1993) have analyzed art performance in the 17th to the 20th centuries and obtained controversial results. Although Goetzmann's art index significantly outperformed both stocks

and bonds during 1900–1986, Pesando (1993) found that modern prints underperformed both stocks and bonds during 1977–1992. However, these studies have used limited samples of paintings or short sample periods. Mei and Moses (2002) studied a large sample of repeat sales of about 5,000 paintings during 1875–1999 and concluded that art outperforms fixed-income securities but underperforms stocks in the United States, earning a real return of about 5% p.a. However, art returns were higher and closer to equity returns in the second half of the 20th century. Art is also found to have lower volatility and correlation with other assets, making it attractive for portfolio diversification.

Renneboog and Spaenjers (2013) used a new dataset of more than one million transactions of paintings and constructed a hedonic art price index for 1957–2007. They estimated a 4% p.a. average real return to art, which is comparable to corporate bond returns. The risk–return profile of art, measured by the Sharpe ratio, is inferior to that of financial assets but superior to that of physical assets, such as gold, commodities, and real estate.

Several studies have identified lagged equity market returns, real income, and income inequality as the main determinants of art returns, highlighting the importance of luxury consumption demand for art (Goetzmann et al., 2011; Renneboog and Spaenjers, 2013; Dimson and Spaenjers, 2014). Art returns have been particularly high in fast-growing emerging economics, such as China, Russia, and the Middle East, where there has been significant growth recently in income inequality and personal wealth of a small fraction of the population (Renneboog and Spaenjers, 2011).

Another group of popular alternative assets includes precious metals and stones. Renneboog and Spaenjers (2012) developed a hedonic price index for gems and found that white and colored diamonds outperformed the stock market, earning a real return of 6.4% and 2.9% p.a., respectively, in 1999–2010. The average returns on other precious stones (sapphires, rubies, and emeralds) were between 3% and 6% p.a. Gem returns covary positively with stock returns underlying the importance of wealth-induced demand. Auer and Schuhmacher (2013) confirmed the superior performance of diamonds compared

with the stock market in 2002–2012. However, they highlighted the low correlation of diamond returns with financial asset returns and diversification potential.

Precious metals such as gold and silver also tend to be attractive (Renneboog and Spaenjers, 2012; Low et al., 2016). Moreover, precious metals, as well as 1 carat flawless colorless diamonds, exhibit "safe-haven" hedging properties during high volatility (Baur and Lycey, 2010; Low et al., 2016).

Collectible automobiles also showed superior returns to traditional equity, bond, and gold investments in 2007–2016 (Martin, 2016). This alternative asset class offers higher risk-adjusted returns and presents potential portfolio diversification benefits.

Dimson and Spaenjers (2011) analyzed the returns to British collectible postage stamps using Stanley Gibbons catalog prices for 1900–2008. They estimated the average long-term real (nominal) return of 2.9% (7%) p.a., which is between bond and equity returns. The stamp return volatility is comparable to that of equities, the market correlation is positive, although the systematic risk measured by beta is rather low. Dimson and Spaenjers (2014) updated the stamp return index to 2012 using Stanley Gibbons' GB 30 Rarities Index and found a slightly lower average annualized real return (2.8% p.a. in GBP).

Graddy and Margolis (2011) studied the returns on collectible musical instruments. They collected prices of old Italian and French violins, about half of which were made by Stradivari, and estimated the average real return of 3.5% p.a. during 1850–2008, which is lower than the stock and bond markets. However, the violin returns were stable over time with a slightly negative correlation with bond and stock returns.

Dimson and Spaenjers (2014) used the data from Graddy and Margolis (2011 and 2013) and estimated the average annualized real (nominal) return on violins of 2.5% (6.5%) in 1900–2012, which is similar to the long-run performance of collectible stamps and art. They concluded that collectibles such as art, stamps, and violins outperform bonds and bills, although underperform equities over a century.

Dimson et al. (2015) studied the long-term investment performance of fine wines. Wine collections of high net-worth individuals, on average, represent about 2% of their wealth (Mitchell, 2012). Studies that have focused on short samples of 15 years or less found rather low net returns on wine investments, although adding wine to an investment portfolio improves its risk–return profile (Masset and Weisskopf, 2010; Kourtis et al., 2012; Lucey and Devine, 2015). Dimson et al. (2015) estimated the average long-term real return on collectible wine investments (net of storage and insurance costs) of 4.1% in 1900–2012, which exceeded bonds, art, and stamps, although underperformed equities and precious metals. Returns on wine and equities are significantly positively correlated due to wealth-induced demand.

One more type of collectible assets studied in the literature is Baedeker guidebooks issued between 1828 and 1945 (Erdös and Ormos, 2012). These guidebooks are traded on eBay, where approximately 100 online auctions run in parallel, 24 hours a day. The authors collected and analyzed eBay auction prices for 2005–2009, which ranged from $1 to $14,000. Given that the studied period is short and includes the crisis years, the average return to the guidebooks was negative with a slightly lower volatility than the stock market returns. The guidebook returns exhibited a correlation of 45.57% with the stock market. The estimated Jensen alphas were significantly negative in multifactor models, suggesting underperformance compared with equities.

Overall, studies of various "investments of passion" have suggested that although they tend to yield lower returns than the traditional stock market (and incur higher transaction costs), they provide valuable opportunities for diversification and can sometimes serve as a "safe haven" during crises. The high demand for such assets among high net-worth individuals suggests that subjective utility derived from owning such assets far outweighed the lower financial returns.

4. A PRICING MODEL

How are the prices of collectible toys expected to change over time? We use the model of Dimson et al. (2015) to illustrate this point. The model was proposed to explain the prices of collectible wines, which can easily be adjusted to collectible toys because both goods are similar in terms of properties: both have consumption values and long-run investment potential due to decreasing over time supply.

Suppose the representative investor's wealth grows at a constant rate *z*: $W_t = W_0 * (1 + z)^t$. The consumption value of a *j*-year-old LEGO set (i.e., opening and building a set) at time *t* is

$C_{i,j,t} = c_{i,j} * W_t$, where *i* is the index of desirability (rarity, collectability) of a particular set. The cross section of LEGO sets is different in terms of their desirability, so that c_i belongs to a continuum $[c_L, c_H]$. Ordinary sets (generally targeted at small children as mere toys) have low desirability c_L, which diminishes over time, because children like novelty. Collectible sets, which possess any of the features listed in section 2 and targeted at adult fans of LEGO have high desirability C_H that grow with set's age and rarity.

Keeping an unopened LEGO box *i* generates an ownership dividend $d_{i,j}$ (with $d_{H,0} > d_{L,0}$), which grows with age *j*, reflecting greater rarity of old sets. To keep the model simple, we assume that the ownership dividend increases with age at a constant rate *g*. The equivalent monetary value of the ownership dividend depends of collectors' wealth: $D_{i,j,t} \equiv d_{i,j} * W_t$ (similar to the model of Goetzman and Spiegel, 1995). Then, this monetary ownership dividend grows at the rate $k \equiv (1 + g) * (1 + z) - 1$, which is assumed to be lower than the discount rate *r*.

The price of a *j*-year-old LEGO set *i* at time *t* is the maximum of the value of immediate consumption and the present value of all future ownership dividends:

$$P_{i,j,t} = max\left(C_{i,j,t}, \frac{D_{i,j+1,t+1}}{r-k}\right) \quad (1)$$

Figure 1 illustrates a resulting price dynamics starting at $t = j = 0$ for three ad-hoc examples of LEGO sets: an ordinary set with diminishing over time consumption value (panel A), a collectible set

with increasing consumption value (panel B), and a collectible movie-related set with a future jump in consumption value due to a release of a new series, for example, Star Wars (panel C). In panel A, the price decreases initially due to a falling consumption value (and sufficient supply on the market) until the present value of ownership dividends exceeds the consumption value. After this point, the price grows at a constant rate *k* due to ever-increasing rarity and higher collectors' wealth. In panel B, the price grows immediately after a set release because collectible sets tend to be quickly sold out on the primary market (or may even be unavailable on the primary market, e.g., limited edition of promotional sets). In panel C, we observe a jump in the price in the future, which is associated with a release of a related movie series. Since the set is retired and in limited supply on the secondary market, the demand for movie-related old sets generates a great opportunity for resellers to earn high returns selling during the peak. If the related movie series were not released, the price dynamics would be the same as in panel B. Hence, movie-related licensed sets have an embedded option to be realized at high prices in case the new movie is released.

5. DATA

We collect price data for LEGO sets from the website Brickpicker.com and the book *The Ultimate Guide to Collectible LEGO Sets* (subsequently referred to as "price guide") written by the founders of Brickpicker.com Ed and Jeff Maciorowski. Brickpicker.com was launched in 2011. With more than 38,000 registered members in 2014, it has become a premier LEGO community on the internet. This site is the main source of information on current secondary market prices for new and used LEGO sets for collectors and investors. Brickpicker.com buys LEGO price data from Terapeak Market Research, which, in turn, collects the original sales data from eBay. Brickpicker.com then aggregates data from thousands of completed eBay LEGO auctions, filtering out bad listings and removing outliers. Each set price represents an average of the 30 most recent *completed* transactions (not offer prices) on eBay, and the data are updated on a monthly basis.

In addition to the secondary market price, the book and website also provide the initial US primary market price set by the LEGO Group at the time of set release. All prices are in US dollars in nominal terms.

Brickpicker.com provides set prices for two categories: new and used. However, we only use the data for new sets[12] to compare them with the primary market prices and to calculate the returns.

There have been more than 10,000 LEGO sets created over the past 50 years (figure A2 in the online appendix). The LEGO price guide used in this study provides information on a sample of 2,322 sets released in 1981–2014. This sample includes all major sets that were still available on the secondary market in 2015 at the time when the book was published.[13] Most of the sets in the sample were released after 2000, and there are only 149 pre-2000, or vintage, sets covered in the book. Therefore, our price index constructed using these data are not sufficiently diversified before 2000 and should be taken with caution.[14] In the 21st century, however, the index has become highly diversified and provides reliable information on the price trends in the LEGO secondary market.

Our sample covers all the most popular LEGO themes, such as City, Star Wars, Harry Potter, Ninjago, Pirates, Bionicle, Architecture, and Technic. In total, there are 44 themes covered in the sample. Unfortunately, neither the price guide nor Brickpicker.com provides a complete time series of prices for each set. The price guide only provides the initial primary market price in the year when the set was released and final secondary market price in 2015 when the book was published. Because prices are not dated exactly and have yearly frequency, we assume that they represent end-of-year prices. We use these prices to calculate historical returns and build our yearly LEGO price indices.

Our data set also contains monthly prices for a sub-sample of 320 LEGO sets collected manually from brickpicker.com during 2016–2018. We picked several *a priori* interesting for collectors themes

[12] A new set is a complete set with contents sealed in factory plastic bags, whereas the box conditions may vary from excellent and sealed to damaged.

[13] There is, perhaps, a survivorship bias in these data, but the direction of the bias is unclear. On the one hand, some sets that proved to be unattractive for investors may have quickly left the secondary market. On the other hand, some very attractive sets may have also been sold out quickly and left the secondary market simply because they were consumed (built).

[14] Since an active secondary market for LEGO sets developed only in the 2000s, this lack of information is not crucial for our research.

(Advanced models, Architecture, Discovery, Harry Potter, Hobbit, Star Wars, and The Lord of Rings) and collected the secondary market prices for *all sets* in these themes to minimize selection bias. These sets were released in 2000–2018, and new sets that appeared in 2016–2018 were added to the sample. These price data spans from December 2015 to December 2018. We use these data to trace the secondary market price dynamics from when new sets are available on the primary market to several years later.

6. DESCRIPTIVE STATISTICS

Table 1 reports the average yearly nominal returns on LEGO sets released in different years. The returns are calculated using the initial primary market prices in the years of release and the final secondary market prices in 2015. Therefore, they represent the average returns during the circulation of the sets up to 2015. For each year of release, the average return is the equal-weighted average for all sets introduced in the respective years. The table also reports cross-sectional standard deviations of average returns on sets released in each year.

Newer sets show a remarkable tendency to yield higher yearly average returns than older sets. However, this can be a consequence of the growing popularity of investments in LEGO over time and a more developed secondary market, rather than the age of a set itself. It is likely that older (vintage) sets yield higher returns than newer sets in any given year, but because we only observe the average returns over longer horizons, we obtain lower estimates. In addition, newer sets exhibit higher cross-sectional dispersion of returns. For example, returns on sets released in 2013 vary from −26.73% to 227.71% p.a. with an average of 16.05% and a standard deviation of 28.49%.

The returns on individual sets vary from −53.61% to 613.28% p.a. with the average return of 18.5% p.a. (see the bottom panel of Table 1). The cross-sectional distribution of returns has a standard deviation of 35.09% and a positive skewness of 9.10. The five top performers are “Darth Revan” (Star Wars), “Elves’ Workshop” (Seasonal), “Seal’s Little Rock” (Friends), “TC-4” (Star Wars), and “Ice Skating” (Seasonal) – all were released in 2014 and earned 425%–613% during 2014–2015. The

following top performer is “Iron Man & Captain America” (Super Heroes), which was released in 2012, and earned 405% per year over 3 years. Overall, 34 sets in our sample earned yearly average returns above 100%, 162 sets above 50%, 58% (1,344) above 10%, and 90% (2,080) earned positive average returns. Only 221 (less than 10%) were losers, which lost no more than 50% of their initial retail price.

Table 2 reports the average returns by LEGO themes with a large variation. LEGO Ideas and Seasonal sets yield the highest returns on the secondary market. Sets that follow popular movies (e.g., Super Heroes) are also attractive. The least attractive themes appear to have been discontinued before 2010. Perhaps, the company stopped production because of the low popularity on the primary market.

Table 3 reports the average returns by set size. To assign sets to four size groups, the sets are sorted by the number of pieces in decreasing order and first sets with 25% of total pieces are assigned to group 1, the following sets with 25% of total pieces to group 2, and so on. Therefore, each group has an approximately equal number of pieces in total, although with a different number of sets. Whereas group 1 (Big) contains 96 sets with 1,928 pieces in each set, on average, group 4 (Small) contains 1,628 sets with only 113 pieces in each set, on average.

Table 3 shows that small sets yield higher returns, on average, than bigger sets, similar to the stock market size premium. However, there is no strict monotonicity here because huge sets with set size above 1,200 pieces yield higher returns than medium sets (340–1,200 pieces). The average return to huge sets above 3,000 pieces is 18.53% p.a., which is similar to the average return in the LEGO market. Therefore, we conclude that huge and small sets are the most attractive for investment. The reason is simple—the uniqueness. Small sets often contain rare parts or minifigures, whereas huge sets are initially targeted at collectors and are produced in small quantities.

7. LEGO PRICE INDICES

7.1 Methodology

Given the limitation of the data that for each LEGO set, we can only observe its return between the year of release and the final year in 2015 (i.e., for several years in a row), we construct the LEGO chain

index as follows. We start with all LEGO sets released in 2014 and calculate their cross-sectional average return for 2015.[15] We then take all sets released in 2013 and, knowing their 2-year average return up to 2015 and the LEGO market return for 2015, calculated in the previous step, we extrapolate the return for 2014 using the compound interest formula as follows:

$$(1 + R_t)^{2015-t} = \prod_{i=1}^{2015-t}(1 + r_{t+i}) \quad (2)$$

where t is the year of release, R_t is the cross-sectional average annualized return from t to 2015 of all sets released in year t calculated using the formula $(1 + R_t)^{2015-t} = P_{2015}/P_t$, r_{t+1} is the return that we extrapolate, and r_{t+2}, and so on, are the returns extrapolated in the previous step(s).

Similarly, we proceed to sets released in 2012 and repeat the exercise. Under the assumption that portfolios of LEGO sets released each year are sufficiently diversified and that their average returns represent the true LEGO market returns, we build the chain index for the LEGO market for 1987–2015.

As an alternative to this simple chain index, we also build a hedonic index that considers the varying hedonic characteristics of LEGO sets over time. We estimate the following cross-sectional hedonic regression:

$$ln\frac{P_{iT}}{P_{it}} = \alpha + \sum_{m=1}^{M}\beta_m X_{im} + \sum_{t=1}^{T}\gamma_t\tau_t + \eta_{it} \quad (3)$$

where P_{iT} is the final secondary market price of set i in 2015, P_{it} is the initial retail price of set i at time t (and, hence, the dependent variable is the gross return on set i during its circulation period), X_{im} are hedonic characteristics consisting of 43 dummy variables representing themes (theme "Miscellaneous" serves as the benchmark) and 3 dummy variables representing set size groups (size group 1–the biggest sets–serves as the benchmark), τ_t are 29 dummy variables representing release years from 1986 to 2014, and η_{it} is an error term.

[15] We assume that sets are released at the end of the year and that the 2015 prices are also year-end prices because thereis no information regarding months in this data set. This may lead to a time bias in the resulting price index, that is, the index may lag behind the actual unobserved index by approximately half a year, on average.

Equation (3) resembles repeat sales methodology with buy and sell prices on the left-hand side. However, it includes hedonic characteristics as explanatory variables because it is reasonable to assume that they may affect LEGO returns on the secondary market since the initial primary market prices P_{it} do not contain collectible value.

The estimates of $\alpha+\gamma_t$ represent the average cumulative returns from period t to 2015 after controlling for the individual set characteristics. Under the assumption that all omitted set characteristics are orthogonal to those included, these coefficients account for constant-quality price trends over the sample period. We use the estimates of α and γ_t to construct the hedonic price index using the compound interest formula, similarly as we construct the simple chain index.

The hedonic chain index is different from the simple chain index because it is free from biases that may arise due to varying set characteristics over time. Moreover, the hedonic approach allows testing the significance of individual set characteristics, such as theme and size, in determining returns in the LEGO market.

7.2 Results

Table 4 reports our estimates of the chain and hedonic LEGO indices and Figure 2 illustrates their dynamics compared with bonds and stocks.

The chain and hedonic indices are highly correlated (the correlation coefficient of 0.95) and have similar return distributions. Therefore, the varying LEGO set characteristics over time do not impose significant biases on the return estimates of the simple chain index. The average return in the LEGO market is 10%–11% p.a. with a standard deviation of 25%–28% and a positive skewness of about 0.7. The positive skewness reflects a low crash risk in the LEGO market, unlike the stock market. LEGO investments slightly underperform the CRSP index, which includes all NYSE, AMEX, and NASDAQ stocks (CRSP's average return was 12% during the sample period), but outperform big stocks proxied by the S&P500, long-term government bonds, and Treasury bills (CRSP data).

LEGO returns correlate slightly negatively with bonds (the correlation coefficients are −0.13 and −0.16) and slightly positively with stocks (the correlation coefficients are less than 0.24). The correlation with the CRSP index is higher than that with the S&P500, and therefore, the performance of LEGO investments is closer to the performance of small stocks. Interestingly, the LEGO market appears immune to US stock market crashes and provides some opportunities for diversification. However, the greatest plunges in the LEGO returns have occurred during financial crises in other countries: the 1992 Exchange Rate Mechanism crisis in Europe, the 1998 Asian and Russian financial crisis, and the 2007 global financial crisis. As the stock returns in the United States in all these years were positive, we obtain low market correlation estimates and low market risk.

The hedonic regression allows us to explore if and how individual set characteristics affect returns (a cross-sectional analysis). Column 1 of Table 5 reports the estimates of theme and size dummy coefficients in regression (3). Apparently, there is a significant heterogeneity in returns of different themes and size groups. The most attractive for investment themes are those with positive and statistically significant dummies: Advanced models, Batman, Dino, Discovery, Harry Potter, Hero Factory, Ideas, Indiana Jones, Monster fighters, Superheroes, and Seasonal sets. Noticeably, many of these themes follow popular movies. The least attractive themes are Atlantis, Factory, Prince of Persia, Racers, Space, and Toy Story. These findings are consistent with the descriptive statistics in Table 2.[16]

Regarding set size, we find that medium-sized sets (groups 2 and 3) yield significantly lower returns than the biggest (the benchmark group 1) and the smallest (group 4) sets, and the smallest sets yield the highest returns. This confirms the evidence in table 3.

In columns 2–4 of Table 5, we report the estimates of alternative specifications with the number of pieces, the number of pieces^2 and the number of minifigures instead of the size group dummies. We confirm that bigger sets yield lower returns, on average, and that the relationship between set size and

[16] Rarity of particular sets or themes is also an important factor for returns because there is a premium for rarity (Koford and Tschoegl, 1998; Cameron and Sonnabend, 2020). Unfortunately, we do not have data on the quantities of sets released worldwide, so we leave this issue for future research.

returns is U-shaped. The greater number of minifigures, which is usually associated with greater set size, has an additional negative effect on returns.

Whereas the returns in the LEGO market are comparable with those in the stock market, they are not significantly exposed to market risks. Table 6 reports betas of LEGO chain and hedonic index returns with respect to the market, SMB (small-minus-big stocks), HML (high-minus-low book-to-market stocks), momentum (winner-minus-loser stocks), and VIX risk factors. The only significant exposure is consistently observed relative to the SMB factor. The SMB beta estimates are all close to 1. Therefore, the returns in the LEGO market seem to be closely related to small stock returns. The hedonic index also has a significant HML beta of −0.5. Betas to other risk factors are low and statistically insignificant.[17]

The LEGO alpha is positive (about 4%–5%) but statistically insignificant. Thus, we can conclude that the LEGO market does not outperform the stock market. However, the insignificant exposure to risk factors suggests that LEGO sets provide good opportunities for portfolio diversification and they are also more attractive than other alternative investments such as art, wine, stamps, and automobiles, which significantly underperform on the stock market.

8. DYNAMICS OF SECONDARY MARKET PRICES AFTER RELEASE OF SET

This section is based on the monthly data set for a sub-sample of 320 LEGO sets in 7 themes. Although we picked *a priori* attractive for collectors themes, they proved to deliver moderate returns (Table 2). Hence, this sample of themes is nearly random. The average return of this sample on the secondary market was 6.2% pa in 2016–2018.[18] We use these monthly data to trace the dynamics of secondary market prices after set releases. Table 7 reports average returns in the year of release and 6 subsequent years. Each column represents the average returns for a mixed group of sets released in different years

[17] The results are not sensitive to the number of lags in the Newey–West adjustment.
[18] This extension is also an out-of-sample test of the average LEGO returns after the LEGO Price Guide was published.

(e.g., in column 1 we have sets released in 2015–2018 and we measure their returns in their years of release, respectively). The return dynamics has an interesting general pattern.

First, we observe a few cases when the first secondary market prices in the year of release (or even before the official release) are significantly higher than the primary market prices. This is evidence of speculator activity: speculators managed to obtain sets before they appear on the primary market and benefited from extracting consumer surplus of impatient collectors who are ready to pay this premium.

When sets are officially released and available on the primary market, their secondary market prices fall. On average, the secondary market prices for sealed sets are 10% lower than the primary market prices at the end of their release years (column 1 of Table 7). Hence, short-term investments in LEGO sets are generally not profitable (except for specific cases of unique or limited edition sets).

In the second year after the release ($t + 1$), secondary market prices increase, probably because some sets are retired and sold out on the primary market. However, prices, on average, are still below the primary market prices at the end of the second year. The average cumulative return relative to the primary market price is −4% (column 2).[19] The low secondary market prices can be explained by the fact that some sets are still available in stores (likely at discounted prices) even if they have already been retired.

Next, the secondary market prices sharply increase in 2–3 years after the release (columns 3 and 4). At the end of this period, on average, the secondary market price is already 1.56 times as high the primary market price and the yearly return during the third and fourth years after the release is 13%–14%. This jump in the secondary market prices is probably because retired sets become unavailable on the primary market. Collectors should buy them on the secondary market with limited supply and pay the premium. This jump is also an indirect evidence of the primary market underpricing. Therefore, three years after the release can be considered as the minimum investment horizon for a LEGO reseller.

[19] This figure is calculated for a different sub-sample of 85 sets released in 2014–2017.

In the subsequent three years, the secondary market prices continue to grow, although at a slower pace (the average secondary market return is 6%–8% p.a.), and the average return converges to the long-run level.[20]

This general pattern of price dynamics is consistent with our theoretical model predictions for ordinary LEGO sets. Considering that our sample is random, most sets are ordinary (i.e., do not possess the characteristics of collectible sets listed in section 2). However, if we consider particular collectible sets, gradually increasing secondary market prices right after the release is observed. An illustrative example is set #10262-1 "James Bond Aston Martin DB5" with 1,290 pieces ("Advanced models" theme), which was released in 2018 at the initial retail price of $149.99 and had the secondary market price in December 2018 of $174.83 (16.6% return in the first year).

9. A NOTE ON TRANSACTION COSTS

The returns estimated earlier do not consider the transaction costs. However, similar to alternative investments, trading LEGO sets are associated with relatively high transaction costs.

eBay is the most popular trading platform for LEGO sets, whose prices are used in this study. eBay charges listing and final value fees when products are listed and sold, respectively. Whereas in many cases, the listing fee is absent because sellers receive a certain number of free listings per month depending on their type of account, the final value fee is charged each time a sale is made and accounts for 9.15% of the sale price for the "Toys and Hobbies" category. After accounting for such transaction costs, the average return on individual LEGO sets falls from 18.5% to 14.7% p.a.

Moreover, a seller should pay a fixed cost associated with the eBay subscription ($20–25 per month, as of January 2018). On top of that, one should consider semi-fixed storage costs, which can vary significantly depending on the scale of the business. For example, keeping hundreds of boxes for

[20] Note that row 2 of table 7 reports returns relative to primary market prices, whereas row 3 reports returns relative to the secondary market prices in the previous period. Returns relative to the primary market prices are higher for sets released several years ago because they include the jump due to the primary market underpricing, which is observed in 2–3 years after set release.

several years requires a storage space. The storage costs are not as high as one would expect for alternative investments such as art, wine, or automobiles, but they are higher compared to owning financial assets.

10. CONCLUSION

This study presents a novel analysis of financial returns on collectible toys using the example of LEGO secondary market. LEGO is not just a toy but also a reasonable alternative investment with average returns comparable to stock returns, low market and crash risks, and a positive alpha. Indeed, a huge global secondary market for new and used LEGO sets has developed over the past 30 years.

We manually gathered unique data on the primary and secondary market prices for a sample of 2,322 LEGO sets belonging to all popular LEGO themes. We constructed chain and hedonic LEGO price indices for 1987–2015, analyzing their returns and exposure to major risk factors. We estimated the average return in the LEGO market of 10%–11% p.a. during the study period, which is higher than the returns on most typical alternative investments. Moreover, discounted purchases of LEGO sets on the primary market make LEGO investments even more profitable. However, different LEGO sets are not equally attractive. Small and huge sets, as well as sets based on popular movies or architectural buildings, yield higher returns. Rarity is the main feature that makes toys profitable on the secondary market.

LEGO returns are not exposed to the market, momentum, HML, and volatility (VIX) factors but have an almost unit exposure to the SMB factor. Therefore, the toy market can be considered an alternative to the market for small stocks in terms of risk. However, the average return on the SMB factor is only approximately 1% p.a. during the study period, whereas the average return on LEGO investments is much higher. Hence, investments in toys offer an attractive risk and return relationship.

All these findings are novel in the academic finance literature because collectible toys, in general, and LEGO, in particular, have not been studied before. However, these results should be considered

with caution, because the toy secondary market, similar to markets for alternative investments, is not as liquid as the stock market and requires relatively high transaction and storage costs. Moreover, investment in toys is only profitable in the long run. For example, the minimum investment horizon for a LEGO reseller is 3 years. LEGO investments also require specific knowledge and interest in this product, which not all investors possess. Therefore, this alternative investment would be most attractive primarily for LEGO fans. However, there are millions of LEGO fans around the world!

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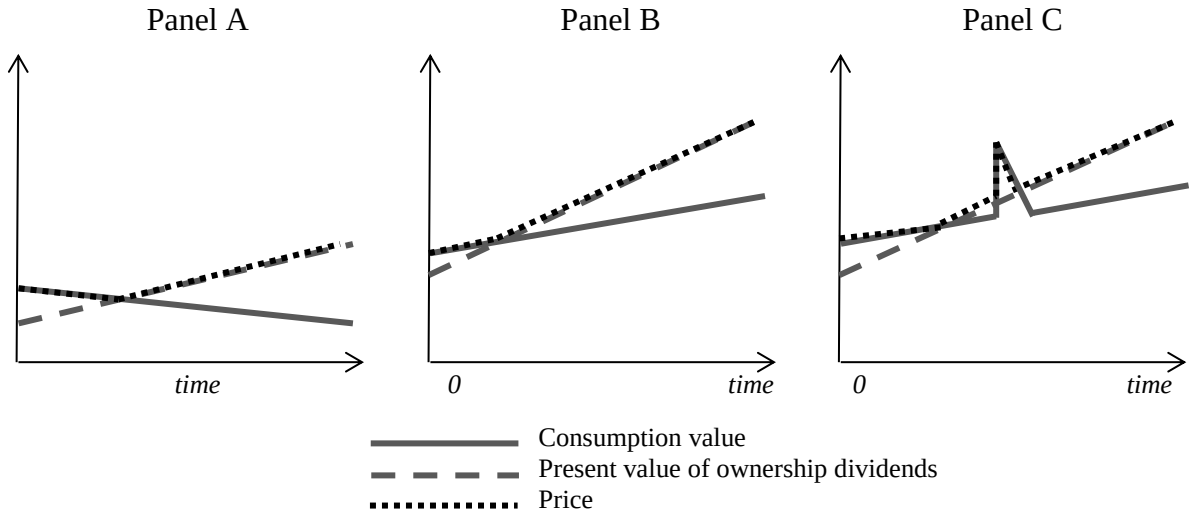
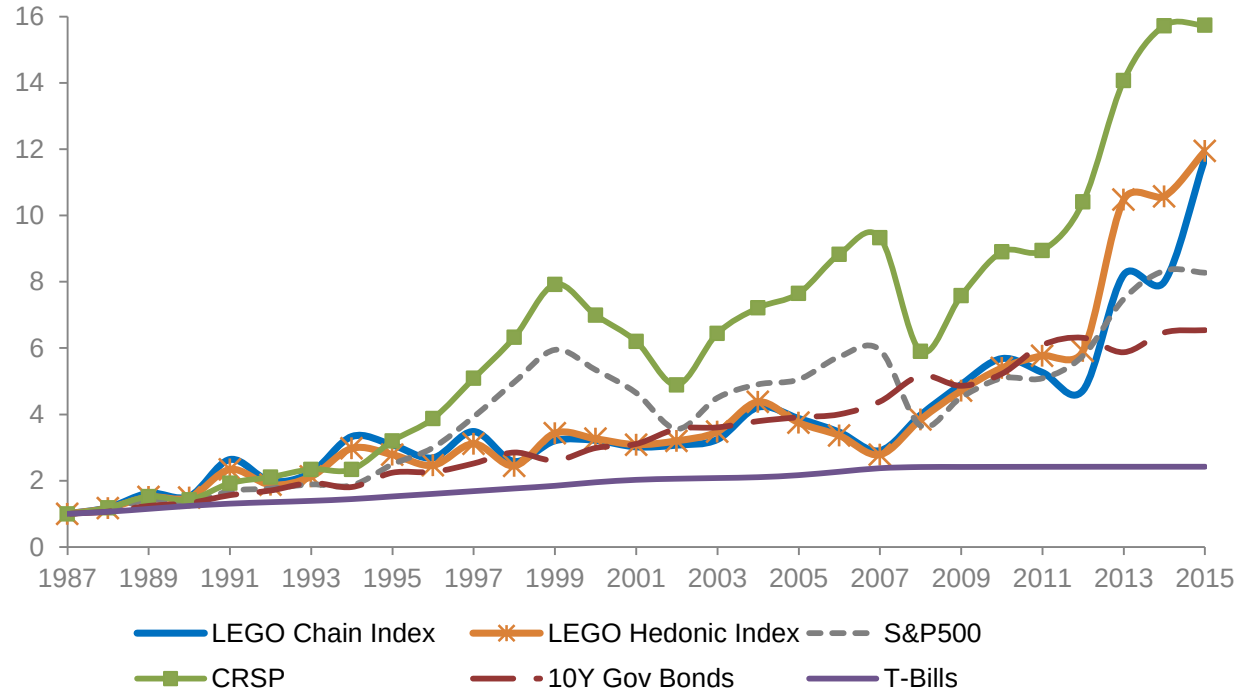
Figure 1. An illustrative model of LEGO price dynamics



The figure plots price patterns for three examples of LEGO sets: an ordinary set with diminishing consumption value (panel A), a collectible set with increasing consumption value (panel B), and a collectible movie-related set with a jump in consumption value due to a new movie series release (panel C). The patterns are implied by the model in section 4.

Figure 2. Returns on LEGO indices



The figure plots the LEGO chain and hedonic indices as well as indices of stocks and government bonds in the USA.

Table 1. Average returns by year of release

Year of release	Number of sets	Average return (% pa)	Cross-sectional SD of returns (%)
2014	297	46.51	81.71
2013	261	16.05	28.49
2012	278	24.04	31.18
2011	215	18.12	16.76
2010	171	13.44	10.92
2009	160	13.96	8.58
2008	133	14.72	8.45
2007	104	14.75	8.97
2006	101	12.53	7.97
2005	94	10.04	6.31
2004	74	8.66	4.98
2003	73	9.99	5.22
2002	75	9.77	4.32
2001	84	8.91	4.85
2000	53	7.37	4.98
1999	20	7.18	4.05
1998	14	8.86	2.65
1997	10	6.49	2.57
1996	13	7.64	2.21
1995	10	6.60	1.90
1994	9	5.73	2.23
1993	14	6.65	3.35
1992	12	7.72	1.81
1991	4	6.10	2.00
1990	6	8.28	1.50
1989	12	7.44	2.25
1988	7	8.55	1.79
1987	3	9.11	1.00
1986	4	5.55	5.37
1984	8	7.60	1.78
1981	3	6.51	2.49
Total	**2,322**		
Min		**−53.61**	
Average		**18.50**	
Max		**613.28**	
SD		**35.09**	
Skewness		**9.10**	

The table reports average returns for LEGO sets released in a given year. For each LEGO set, we first calculate its geometric average return p.a. for the period of its circulation (i.e. between the year of release and the final year in the sample 2015). We then take the average and the standard deviation of these returns across all sets released in a given year. The bottom panel reports the descriptive statistics of the distribution of individual sets' average returns for the total sample of 2,322 LEGO sets.

Table 2. Average returns by LEGO theme

Theme	Number of sets	Average return (% pa)	Cross-sectional SD (%)	Period
Ideas	8	64.11	83.20	2010–2014
Seasonal	61	58.07	95.00	2006–2014
Super Heroes	46	51.14	78.91	2011–2014
Minecraft	9	45.50	36.19	2013–2014
Friends	82	38.17	65.71	2012–2014
Monster Fighters	13	36.01	33.16	2012–2012
Dino	7	34.76	12.38	2012–2012
Hero Factory	83	29.76	21.60	2010–2014
Batman	33	27.62	21.92	2006–2014
Legends of Chima	75	24.82	30.59	2013–2014
Miscellaneous	28	24.72	27.71	2010–2014
Pirates of Caribbean	14	20.54	16.83	2011–2011
Indiana Jones	16	19.83	7.18	2008–2009
Creator	123	19.74	27.64	2001–2014
Ninjago	91	19.49	20.20	2011–2014
Disney Princesses	7	17.99	20.97	2014–2014
Power Miners	16	17.84	6.98	2009–2010
Star Wars	341	17.29	46.68	1999–2014
Advanced Models	34	16.99	12.71	2000–2014
City	238	16.63	23.95	2005–2014
Harry Potter	52	16.33	8.10	2001–2011
Lone Ranger	8	16.23	27.57	2013–2013
The LEGO movie	23	16.08	25.77	2014–2014
Architecture	25	15.89	48.26	2008–2014
Spongebob Squarepants	14	15.43	6.37	2006–2012
Agents	19	15.22	9.93	2008–2014

Cars	22	14.64	12.39	2011–2012
Discovery	6	14.41	6.72	2003–2003
Lord of the Rings	32	12.71	23.08	2012–2014
Technic	124	12.05	11.87	1994–2014
Trains	28	11.67	6.76	2001–2013
Bionicle	243	10.90	6.10	2001–2010
Spider-man	8	10.31	8.65	2003–2004
Castle	189	9.19	8.52	1981–2014
Pirates	62	8.74	4.63	1989–2013
Model team	1	8.51	n/a	1996–1996
Racers	11	8.50	12.87	2002–2010
Toy story	15	6.52	9.90	2010–2010
Atlantis	21	6.08	7.66	2010–2011
Space	62	6.04	11.67	2001–2013
Teenage Mutant Ninja Turtle	18	4.64	17.40	2013–2014
Factory	7	2.69	8.23	2005–2008
Prince of Persia	6	0.90	7.74	2010–2010
The Simpsons	1	−3.52	n/a	2014–2014

The table reports average returns for 44 LEGO themes sorted in descending order. For each LEGO set, we first calculate its geometric average return p.a. for the period of its circulation (i.e. between the year of release and the final year in the sample 2015). We then take the average and the standard deviation of these returns across all sets that belong to a given theme. The last column reports the period when sets in a given theme were released.

Table 3. Average returns by set size

Group	Average set size (# of pieces)	Range of set sizes	Number of sets	Average return (% pa)	Cross-sectional SD (%)
1 - Big	1,928	1,204–5,922	96	12.07	12.15
2	862	660–1,197	215	6.88	13.26
3	466	340–659	383	10.08	18.66
4 - Small	113	1–339	1628	22.44	39.93

The table reports average returns and cross-sectional standard deviations of LEGO set groups formed by size. All sets are sorted by the number of pieces and allocated to four size groups so that each group has approximately equal *total* number of pieces. Columns 2–4 report the group size characteristics.

Table 4. LEGO index returns

	Chain index returns	Hedonic index returns	CRSP returns
1987	−0.33	−0.31	0.02
1988	0.19	0.17	0.18
1989	0.37	0.29	0.29
1990	−0.06	−0.01	−0.06
1991	0.73	0.57	0.35
1992	−0.25	−0.20	0.10
1993	0.13	0.13	0.11
1994	0.48	0.40	−0.00
1995	−0.08	−0.06	0.37
1996	−0.13	−0.12	0.21
1997	0.29	0.26	0.31
1998	−0.26	−0.21	0.24
1999	0.24	0.40	0.25
2000	0.00	−0.05	−0.12
2001	−0.06	−0.05	−0.11
2002	0.02	0.04	−0.21
2003	0.06	0.09	0.32
2004	0.30	0.26	0.12
2005	−0.08	−0.14	0.06
2006	−0.11	−0.10	0.15
2007	−0.16	−0.17	0.06
2008	0.37	0.38	−0.37
2009	0.23	0.23	0.28
2010	0.16	0.15	0.17
2011	−0.07	0.07	0.00
2012	−0.10	0.03	0.16

2013	0.74	0.77	0.35
2014	−0.03	0.01	0.12
2015	0.47	0.13	0.00
Average return	**0.11**	**0.10**	**0.12**
Standard deviation	**0.28**	**0.25**	**0.18**
Skewness	**0.69**	**0.75**	**−0.73**
Corr. with S&P500	**0.13**	**0.16**	**0.99**
Corr. with CRSP	**0.20**	**0.24**	**1.00**
Corr. with bonds	**−0.13**	**−0.16**	**−0.15**
Corr. of LEGO indices	**0.95**		

The table reports LEGO simple chain and hedonic index returns as well as the historical returns on CRSP equity index for comparison. The bottom panel reports the descriptive statistics of these indices and correlations with other indices.

Table 5. Hedonic regression coefficients for theme and size dummies

	(1)	(2)	(3)	(4)
Advanced Models	0.3434***	0.5729***	0.5451***	0.4591***
Agents	−0.0480	−0.1395	−0.0469	0.0163
Architecture	−0.0817	−0.1337	−0.0526	−0.1338
Atlantis	−0.3709***	−0.4067***	−0.3644***	−0.3300**
Batman	0.4484***	0.4101***	0.4741***	0.5098***
Bionicle	−0.0981	−0.1045	−0.0926	−0.0884
Cars	−0.0692	−0.1042	−0.0575	−0.1078
Castle	−0.1130	−0.1385	−0.0972	0.0087
City	0.0090	−0.0386	0.0110	0.0624
Creator	−0.0059	−0.0457	0.0117	−0.0393
Dino	0.4316**	0.3944*	0.4596**	0.4790**
Discovery	0.6124***	0.5117**	0.6241***	0.5718***
Disney Princesses	−0.0936	−0.1044	−0.0656	−0.0696
Factory	−0.6098***	−0.6234***	−0.4765**	−0.5447***
Friends	0.1585	0.1307	0.1548	0.1585
Harry Potter	0.4008***	0.3783***	0.4366***	0.5439***
Hero Factory	0.2018**	0.1996*	0.1982*	0.1749*
Ideas	0.4905***	0.3718*	0.4488**	0.4334**
India Jones	0.3452**	0.2699*	0.3557**	0.4714***
Legends of Chima	0.0210	−0.0162	0.0133	0.0347
Lone Ranger	0.1025	0.0305	0.0855	0.1754
Lord of the Rings	−0.0746	−0.1219	−0.0533	0.0433
Minecraft	0.3219*	0.1757	0.2730	0.2040
Model Team	0.1056	0.3530	0.5332	0.3574
Monster Fighters	0.4023**	0.3731**	0.4292***	0.4783***
Ninjago	0.0343	−0.0011	0.0288	0.0692
Pirates	−0.0482	−0.0813	−0.0316	0.0938
Pirates of Caribbean	0.1845	0.1200	0.1727	0.2569*

Power miners	0.1891	0.1645	0.2153	0.2725*
Prince of Persia	−0.6044***	−0.6383***	−0.5821***	−0.4850**
Racers	−0.3956**	−0.3419*	−0.2308	−0.3152*
Seasonal	0.3750***	0.3706***	0.3833***	0.3864***
Space	−0.3169***	−0.3749***	−0.3140***	−0.2575**
Spider-man	0.1293	0.1115	0.1683	0.3179
Spongebob Squarepants	0.0772	0.0334	0.1008	0.1543
Star Wars	0.0454	0.0211	0.0727	0.1289
Super Heroes	0.4408***	0.4034***	0.4252***	0.5052***
Technic	−0.1055	−0.1259	−0.0301	−0.1163
Teenage Mutant Ninja Turtles	−0.0738	−0.1691	−0.1033	−0.0268
The LEGO movie	0.0349	−0.0681	0.0072	0.0568
The Simpsons	−0.2677	0.1183	0.0972	0.0830
Toy Story	−0.3516**	−0.3887**	−0.3472**	−0.2756*
Trains	0.1911	0.1634	0.2316*	0.2602**
Size group 2	−0.2438***			
Size group 3	−0.2214***			
Size group 4	0.0536			
Number of pieces		−0.0002***	−0.0005***	−0.0003***
Number of pieces^2			1.33e−07***	9.98e−08***
Number of minifigures				−0.0397***
Constant	2.3694***	2.4124***	2.4357***	2.4980***
R-squared	0.4695	0.4472	0.4698	0.4828
Observations	2,303	2,303	2,303	2,302
29 Time dummies	yes	yes	yes	yes

The table reports estimates of hedonic regression theme and size dummy coefficients (column 1) and estimates of alternative specifications with number of pieces and minifigures instead of the size dummies (columns 2–4). The stars denote the statistical significance: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table 6. Exposure of LEGO returns to risk factors

	Chain index			Hedonic index		
alpha	0.0424	0.0426	0.0487	0.0358	0.0394	0.0471
	[0.8213]	[0.6879]	[0.7335]	[0.7479]	[0.7330]	[0.8841]
Rm	0.3581	0.2441	0.2149	0.3835	0.2577	0.2212
	[1.0069]	[0.6886]	[0.5234]	[1.0977]	[0.7364]	[0.5723]
SMB		1.1000	1.0749		1.0967	1.0654
		[2.6623]	[2.1889]		[3.2954]	[2.6490]
HML		−0.4667	−0.4859		−0.4894	−0.5133
		[−1.2741]	[−1.2320]		[−2.0049]	[−1.8234]
MOM		0.1934	0.1808		0.1671	0.1513
		[0.9216]	[0.8338]		[1.0401]	[0.9524]
VIX			−0.0321			−0.0400
			[−0.1327]			[−0.1808]
R^2	0.0510	0.2555	0.2560	0.0724	0.3280	0.3289

The table reports time-series regression estimates of annual LEGO returns on traded risk factor returns (betas) and alphas. The corresponding *t*-statistics are reported in brackets. The *t*-statistics are calculated using Newey–West standard errors with 1 lag. Sample period: 1987–2015.

Table 7. Dynamics of secondary market prices after set release

	T = t (year of release)	T = t + 1	T = t + 2	T = t + 3	T = t + 4	T = t + 5	T = t + 6
Cumulative return (P_T/P_0-1)	**−0.10**	**−0.04**	**0.11**	**0.56**	**0.89**	**1.21**	**1.42**
(Annualized cum. return)	(−0.10)	(−0.02)	(0.04)	(0.12)	(0.14)	(0.14)	(0.13)
Yearly return ($P_T/P_{T-1}-1$)		0.03	0.13	0.14	0.08	0.06	0.06
Release years	2015–2018	2014–2017	2013–2016	2012–2015	2011–2014	2010–2013	2009–2012
Number of sets	89	85	92	65	75	79	76

The table reports average secondary market returns in the first 6 years after sets are released. The cumulative return is calculated by dividing the secondary market price at the end of the respective period (P_T) by the initial primary market price (P_0). The average annualized returns are in the parentheses. Returns in a given year are calculated by dividing the secondary market price in December of the given year (P_T) by the secondary market price in December of the previous year (P_{T-1}). Samples of sets in columns differ by years of release. Sample period for prices: December 2015–December 2018.

ONLINE APPENDIX

A BRIEF HISTORY OF LEGO

This appendix presents the fascinating history of LEGO Group as a toy producer and the development of the secondary market for LEGO sets over time.

LEGO ("Leg Godt"—"Play Well") was founded in 1932 in a small Danish town Billund by Ole Kirk Christiansen. Initially, it was a small family business, which produced simple wooden toys. The company lost its factory in a fire in 1942 and rebuilt the factory in 1944. In 1946, the company acquired a new machine to produce plastic toys. After several years of experiments and failures, the LEGO brick was finally born and patented in 1958.

The next step was to move from single toys to the LEGO system, where all parts are compatible and there are endless opportunities for adding new objects to an initial set. This break- through innovation led to increasing revenues and popularity of LEGO toys. In the 1960s, the company expanded its sales to Western Europe and the United States. The year 1961 was marked by another important innovation—the invention of the LEGO wheel. Nowadays, with the production of about 36 million tires per year, LEGO is the largest tire manufacturer in the world.

The growing popularity of LEGO led to the creation of the first thematic park in Billund in 1968—LEGOLAND. Currently, there are three LEGOLANDS in Europe and one in the United States.

In the early 1970s, the sales growth slowed and the company entered a period of uncertainty. In 1979, the grandson of the founder, Kjeld Kirk Kristiansen, became the company's president, taking over from his father, Godtfred Kirk Christiansen. He started the company's reorganization. A third important step in the history of LEGO was a creation of minifigures. As of June 2013, LEGO had produced 4.4 billion minifigures, some of which are so rare that cost a fortune on the secondary market. Kjeld Kirk also worked on the creation of new LEGO themes. The "Castle" and "Space" themes, together with minifigures, generated high growth in the company's revenues in the 1980s (figure A1). In 1992, the

company's global market share of construction toys reached 80%. By the mid-1990s, the LEGO Group owed 45 companies on 6 continents.

However, this huge organization faced new challenges—video and computer games increasingly attracted children's attention. The company responded through a partnership with Lucasfilm and the creation of a new licensed theme “Star Wars.” This was a very important milestone in the LEGO's history. The “Star Wars” LEGO sets increased sales revenues significantly and they remain the most popular targets of LEGO fans, collectors, and investors.

The late 1990s were also marked by a change in the company's management. The company needed reorganization and for the first time hired an external COO Poul Plougmann. He took several steps toward the current position of LEGO in the global market. The company entered new markets; launched the production of thematic LEGO movies, video games, and web-applications; developed educational and robotic sets, the Steven Spielberg MovieMaker set for children to make their own movies; launched new themes following popular movies and cartoons (e.g., Harry Potter, Superheroes, The Lord of the Rings); produced LEGO dolls for girls; created thematic clothes for children; built three new LEGOLANDS (two in Europe and one in the United States); and a huge network of LEGO brand stores.

The company grew rapidly along many dimensions and reported accounting profits; however, a thorough management accounting analysis uncovered economic losses. Several projects turned out to be unprofitable. The company invested excessively into numerous new projects and it was overdiversified. The number of bricks of different shapes produced each year increased from 6000 in 1997 to 14200 in 2004 (the absolute maximum). This was extremely inefficient and almost led to bankruptcy in 2003–2004.

Poul Plougmann left the company, and with Kjeld Kirk Kristiansen at the top, they followed a new strategy of concentration on its main products—LEGO sets. The company sold its four LEGOLANDS to Merlin Entertainments Group. The company also reduced the number of unique bricks by more than half. This emerged as a successful strategy. For instance, the company's profits increased four times in

2007–2011 despite the global financial crisis and slowdown in consumption (Robertson and Breen, 2013). New LEGO themes, such as Mindstorms, Architecture and Ninjago, LEGO games and LEGO movies, all contributed to the tremendous growth in the company's revenues and popularity in the 2000s (figure A1).

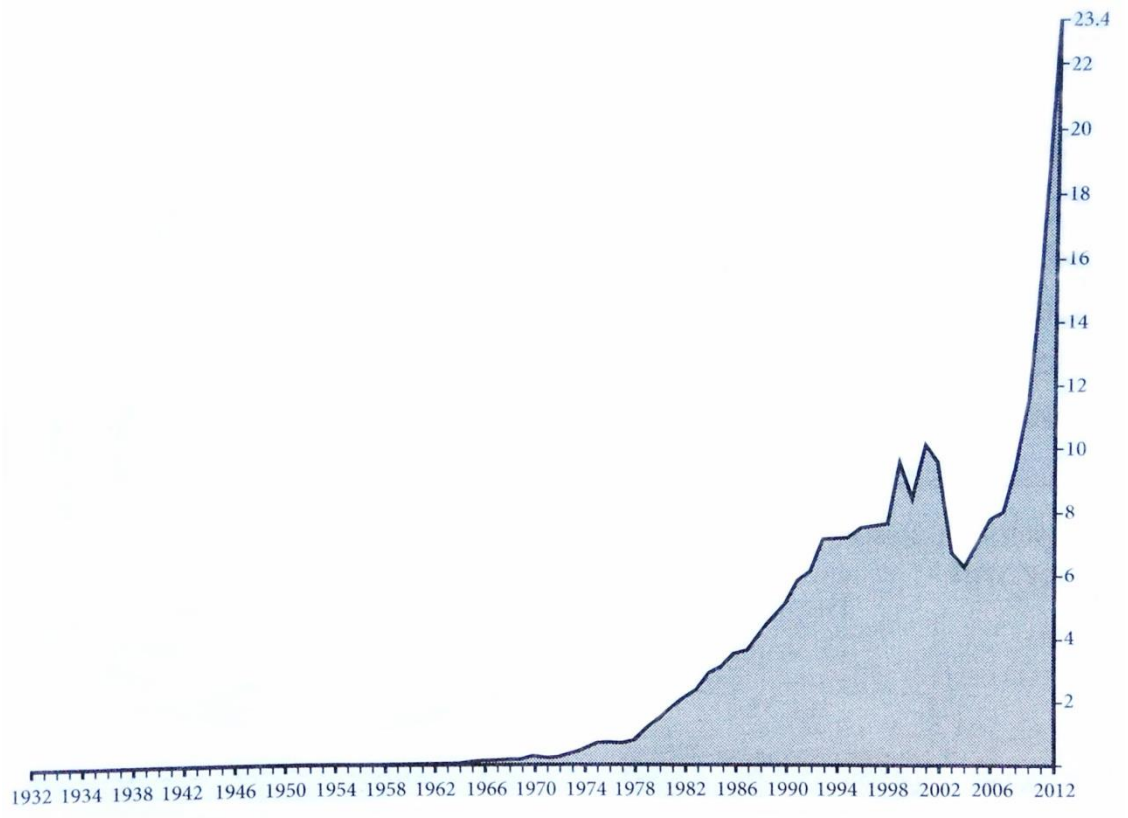
Currently, LEGO is the number one toy producer in the world. LEGO products are sold in 130 countries. On average, the company sells seven sets every second, whereas 36,000 LEGO elements are molded every minute in the factory in Billund (Telegraph, 2011). The number of sets produced varies per time of year and per year. In the United States, the company launches on average 130 new sets per year. The production of LEGO has increased in the past decade and the company produced over 6,000 new sets in 2007–2016 worldwide (figure A2). Sets usually are retired after being in production for 1–2 years.

Whereas the company sells new sets on the primary market through its own stores and other retailers, retired sets (new and used) are actively traded on the secondary market, where the price is determined by supply and demand factors similarly as in the stock market.[21] Once a set is retired, its secondary market price tends to increase significantly. With the advent of the internet and auction sites such as eBay, a huge market for retired LEGO sets developed in the 2000s. eBay is the largest marketplace for LEGO sets on the planet, where there are tens of thousands of transactions that deal with LEGO sets and pieces on any given day. Besides eBay, there are several specialized platforms for LEGO resellers (e.g., Brick Link and Brickpicker.com).

The main LEGO investors are LEGO fans and collectors, but with the development of the LEGO secondary market and spreading rumors of huge returns to LEGO investments in financial press (e.g., *Telegraph*, 2011), this alternative "investment of passion" has gained popularity among nonfan retail investors.

[21] The primary market LEGO set price is usually based on the weight of a set, which depends on the amount of acrylonitrile butadiene styrene (ABS) plastic used to produce it.

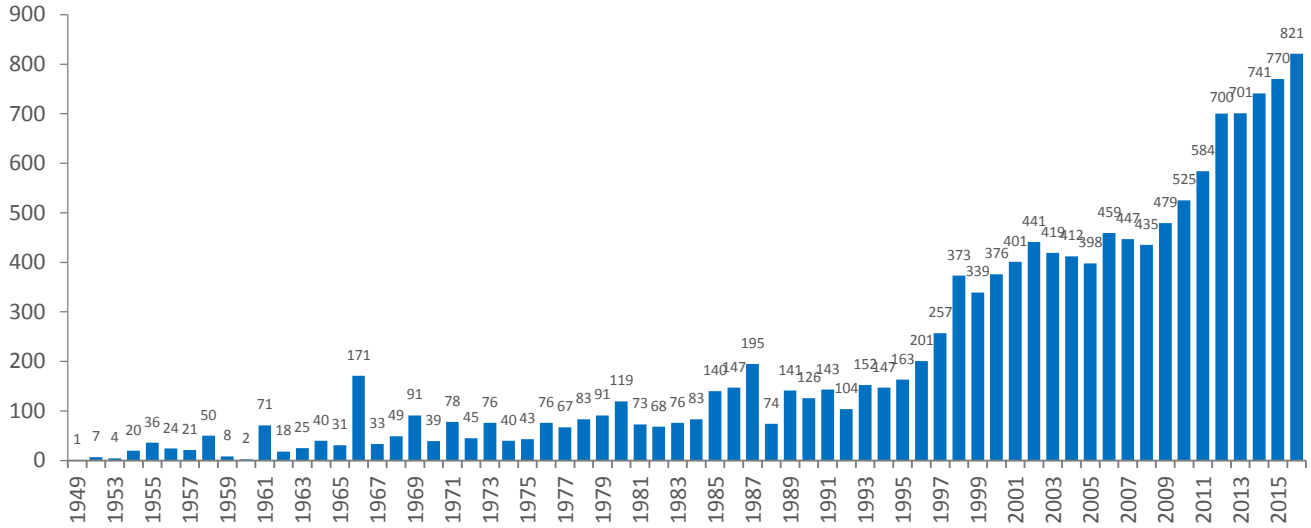
Figure A1. Sales of LEGO



The figure shows the dynamics of sales of the LEGO Group in 1932–2012 in billion Danish krone.

Source: *Robertson and Breen (2013)*

Figure A2. Number of LEGO sets produced each year



The figure shows the dynamics of LEGO production (number of new sets released) in 1949–2015.

Source: brickset.com