

What is the best game console? A free-market-based approach

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1 Introduction

This is a tale of parallels: Two worlds interconnected by a beautiful symmetry: The two worlds being: Video Games, and, symmetrically: the Stock Market.

Since Curry and Howard were first found to be isomorphic, mathematics has regularly deployed connections between seemingly unrelated fields to solve problems. Here, again, we weave such a tangled web. We make use of an elegant bijection between game consoles and publicly-traded securities to use well-known theorems from one domain (the efficient market hypothesis) to solve an open problem in another: What is the best game console?

This question has vexed us for some time, as has the stock market. Even in the earliest days of video game consoles, it was very annoying when your friend had a ColecoVision and you had an Atari 2600, even if the friend had the expansion that allowed it to play Atari games. The friend would beat you in the game of Combat, but you could swear it was because of the console’s inferior, imprecise controllers. At the end of the 1980s the console wars really began to heat up, with zealous gamers forming factions around popular brands like Nintendo and Sega. Each had their own mascots and lifestyle magazines. The number of bits were growing exponentially. Few families could afford multiple video game systems, and those that did found their houses torn asunder by infighting. Which console would be hooked to VHF Channel 3, and which to the slightly superior Channel 4?

The antipathy continues to this day and does not seem to be resolvable by traditional means (spec comparison tables, forum posts, console exclusives). Perhaps the problem is too emotional to be solved by direct analysis. This is where the current approach really shines: By transforming the problem into a different domain (one ruled by the emotionless *homo economicus* [4]) we can address the problem with pure reason.

The stock market is completely rational, by definition [1]. Prices of securities reflect the exact actual value of the underlying physical good (for example, a basket of option contracts intended to synthetically reproduce the inverse of the day-to-day change in forward 3-month USD LIBOR, as determined by Eurodollar futures [2]) at each moment

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in time. This is why they change so often: The value of everything around you is rapidly changing, thousands of times per second. We can use this to understand what console is best (i.e., has the greatest value), by constructing an isomorphism.

2 Methodology

To create an isomorphism, we need to represent each object in one domain (game consoles) with an object in the other (stock market). This is surprisingly easy to accomplish for many consoles. Game consoles have a standard set of abbreviations that are used so that people don't have to write out e.g. "Nintendo Entertainment System" every time. As it turns out, many of these abbreviations are also symbols of publicly-traded securities in the stock market.

There are many dozens of video game consoles [5, 6], not all of which have standardized abbreviations [3]. Therefore, the isomorphism here is technically a *partial best-effort* isomorphism. We find 14 consoles that have a natural counterpart in the stock market. These are given in Table 1, which is the next three pages.

3 Putting my money where my mouth is

Having identified 14 suitable console–security pairs, the next step is to invest money in the market. In March 2019, in preparation for SIGBOVIK 2020, I purchased shares of each of these 14 securities. In order to create a balanced portfolio, I acquired approximately \$100 USD of each; since prices range from less than 3¢ to \$131, this of course meant buying a different quantity of each. The actual amounts are given in Figure 3. Some of these symbols trade on foreign exchanges using other currencies, which is a headache at tax time.

There are many consoles that have no corresponding symbol on any exchange (i.e. they are privately held). This includes popular consoles like Nintendo 64 (N64), Wii (WII), XBox 360 (X360), Neo Geo Pocket Color (NGPC), and so on. There are some whose securities were too exotic for even the ambitious author to acquire. For example, PlayStation Vita (PSV), trades on the Johannesburg Stock Exchange, which is not among the 140 exchanges supported by Interactive Brokers. DreamCast, abbreviated DC, is futures on Class III Milk (milk solids used to make cheese and whey). While this trades readily on the Chicago Mercantile Exchange, you have to be careful about buying Class III Milk futures because you might end up with a bunch of Class III Milk instead of money or video games. Many obscure or fabled consoles (Figure 1) were treated as out-of-scope.



Figure 1: This video game store in Ambergris Caye, Belize, sells games for the fabled PlayStation $2/3$.

Console	Code	Symbol	Exchange	Trades as
Nintendo Game Boy	GB	GB	TSXV (Toronto)	Ginger Beef Corp.
<p>When I was a game boy of about ten years old, my parents forbade me from having a Game Boy, even if purchased with a sock full of dimes that I had personally found around the house and thus made my own property, because "if Nintendo is an addiction, this is like a flask." These same parents also referred to Nintendo games as "tapes." This little pocket monster from 1989 was the birthplace of the Pokémon video game series.</p> <p>Fun Fact: The second most popular IEEE standard, IEEE-1394 (a.k.a. "FireWire"), has its connector designed after the Game Boy's link cable.</p>				<p>Ginger Beef Corp., through its subsidiaries, engages in the operation of franchised take out/delivery service restaurants and the production of frozen and ready-to-serve deli Chinese food products for distribution to retail outlets. The company was founded on April 26, 2000 and is headquartered in Calgary, Canada.</p>
Nintendo DS	NDS	NDSN ¹	NASDAQ (New York)	Nordson Corp.
<p>Nintendo's "Dual Screen" handheld, released November 2004. The title <i>Nintendogs</i> was conceived due to a typo of this console's name.</p>				<p>Nordson Corp. engages in the engineering, manufacture and market of products and systems used for adhesives, coatings, sealants, biomaterials and other materials. It operates through three segments: Adhesive Dispensing, Advanced Technology, and Industrial Coating Systems. The company was founded in 1954 and is headquartered in Westlake, OH.</p>
Sega Genesis	GEN	GEN	NYSE (New York)	Genesis Healthcare Inc.
<p>Genesis does what Nintendon't! This 16-bit console from 1989 competed directly against the Super Nintendo. In South Korea, it was known as the Super Gam*Boy. Who knows what the * stands for?</p>				<p>Genesis Healthcare, Inc. is a holding company, which engages in the provision of inpatient services through skilled nursing and assisted and senior living communities. It also offers rehabilitation and respiratory therapy services. It operates through the following segments: Inpatient Services, Rehabilitation Therapy Services, and Other Services. The company was founded in 1985 and is headquartered in Kennett Square, PA.</p>
Sega Game Gear	GG	GG	NYSE (New York)	Goldcorp Inc.
<p>This color hand-held platform came out in 1991, competing against the 4-shades-of-beige Game Boy. With 3–5 hours of play time on six AA batteries, what's not to love?</p>				<p>Goldcorp is one of the world's fastest growing senior gold producers, with operations and development projects located in safe jurisdictions throughout the Americas. The Company is committed to responsible mining practices and is well positioned to deliver sustained, industry-leading growth and performance. The company is headquartered in Vancouver, British Columbia.</p>

¹The standard abbreviation is NDS, but an additional N can be added to emphasize that this is Nintendo's Nintendo DS, not another company's Nintendo DS.

Console	Code	Symbol	Exchange	Trades as
PlayStation (original)	PSX	PSX	NYSE (New York)	Phillips 66
PlayStation began as a CD-ROM expansion for the SNES! But then Nintendo was like j/k we are going to make one with Philips instead! But then Nintendo was like j/k also about that, and made the Nintendo 64. Philips went on to release the abysmally bad console called CD-i, making full spiteful use of their contractual rights to Nintendo characters with abysmally bad titles like <i>Hotel Mario</i> . Sony went on to make the PlayStation, mostly for revenge.				Phillips 66 engages in the processing, transportation, storage, and marketing of fuels and other related products. The company operates through the following segments: Midstream, Chemicals, Refining and Marketing & Specialties. Phillips 66 was founded on April 30, 2012 and is headquartered in Houston, TX.
Sony Playstation 3	PS3	PS3	FWB (Frankfurt)	Agilysys Inc.
The X in "PSX" stands for the × symbol in the PlayStation's official occult incantation: △ ○ × □. The 3 in "PS3" stands for the other three symbols. This console followed the PlayStation 2 and was released in 2006. It's sort of like the PlayStation 2 but moreso.				Agilysys, Inc. operates as a technology company. It offers innovative software for point-of-sale, payment gateway, reservation and table management, guest offers management, property management, inventory and procurement, analytics, document management, and mobile and wireless solutions and services to the hospitality industry. The firm also serves the gaming for both corporate and tribal; hotels resort and cruise; foodservice management; and restaurants, universities, stadia, and healthcare sectors. The company was founded in 1963 and is headquartered in Alpharetta, GA.
Sony Playstation 4	PS4	PS4	FWB (Frankfurt)	Phoenix Solar Aktiengesellschaft
Well, what do you know: They keep making PlayStations. In fact, the PlayStation 5 was announced in 2019, but is still privately traded; it is expected to IPO in late 2020.				Phoenix Solar AG operates as holding company, which engages in the development, manufacture, sale, and operation of photovoltaic plants and systems. It operates through the following segments: USA, Middle East, Asia/Pacific, Europe, and Holding Company. The company was founded on November 18, 1999 and is headquartered in Sulzemoos, Germany.
PlayStation Portable	PSP	PSP	NYSEARCA (New York)	Invesco Global Listed Private Equity ETF
Unique for using optical discs for storing its games, this 2005 portable disc-man was fairly successful. It is technically more powerful than the contemporaneous Nintendo DS, but ultimately sold 80 million fewer units than it.				The Invesco Global Listed Private Equity ETF (Fund) is based on the Red Rocks Global Listed Private Equity Index (Index). The Fund will normally invest at least 90% of its total assets in securities, which may include American depository receipts and global depository receipts, that comprise the Index.
Nintendo Entertainment System	NES	NES	NYSEARCA (New York)	Nuverra Environmental Solutions Inc.
This grey 8-bit family computer from 1985 was the breakthrough console for Nintendo, before we even knew that we would have to keep getting consoles every few years. Several Nintendo franchises were born here: Zelda, Metroid, Kirby, Punch-Out!!, and Wii Fitness.				Nuverra Environmental Solutions, Inc. engages in the provision of water logistics and oilfield services. It focuses on the development and ongoing production of oil and natural gas from shale formations in the United States. It operates through the following segments: Northeast Division, Southern Division, Rocky Mountain Division, and Corporate or other. The company was founded on May 29, 2007 and is headquartered in Scottsdale, AZ.

Console	Code	Symbol	Exchange	Trades as
<p>Super Nintendo Entertainment System</p> <p>At the time this console was released in 1990, it was believed that all progress followed a trajectory consisting of <i>X</i>, Super <i>X</i>, Mega <i>X</i>, Hyper <i>X</i>, Giga <i>X</i>, Ultimate <i>X</i>, and then <i>X</i> Infinite. This was eventually disproved by its successor, the Nintendo 64.</p>	SNES	SNES	NASDAQ (New York)	Senestech Inc.
<p>Nintendo GameCube</p> <p>Technically a rectangular prism, the GameCube is a tiny-disc-based system that followed the Nintendo 64. It was released in 2001.</p>	GCN	GCN	TSXV (Toronto)	Goldcliff Resource Corporation
<p>Nintendo Switch</p> <p>Following the relatively unsuccessful and confusingly-named Wii U, Nintendo somehow made itself quite relevant again with this hybrid home/portable console (this is perhaps to what the “Switch” refers). Released in 2017, its competition includes powerful boxes such as the XBox One and PS4.</p>	NS	NS	NYSE (New York)	NuStar Energy L.P.
<p>WonderSwan Color</p> <p>The WonderSwan Color is a hand-held gaming console released by Bandai in 2000. It followed the WonderSwan (makes sense) and preceded the SwanCrystal (??). The console was modestly successful in Japan with about 100 games, but ultimately lost in popularity to Nintendo’s Game Boy Advance.</p>	WSC	WSC	NASDAQ (New York)	Willscot Corporation
<p>XBox One</p> <p>Microsoft is expert at creative counting. We have Windows: 1, 2, 3, 3.1, 3.11 For Workgroups, 95, CE, 98, 98b, NT, ME, 2000, XP, Server 2003, Vista, 7, 8, 8.1, 10. For XBox: XBox, 360, One, One S, One X, Series X (which will be called simply “XBox”). Only the XBox One is publicly traded.</p>	XONE ²	XONE	NASDAQ (New York)	ExOne Co.

Table 1: Isomorphism between video game consoles (left columns) and stock market (right columns).

²There is not consensus on this abbreviation; Wikipedia uses XBO for example.

EUR.USD IDEALPRO ●	1.14070	+1180	6.00K	69.5
European Monetary...	1.14065– 1.14070	1.05%		
GB VENTURE	C0.120		500	0
GINGER BEEF COR...	0.085– 0.190			
GCN VENTURE	0.140	-0.005	1.00K	-15.0
GOLDCLIFF RESOU...	0.140	-3.45%		
GEN NYSE	H1.44	-0.15	75	-10.9
GENESIS HEALTHC...		-9.18%		

Figure 2: Market excitement on the day the experiment ends! The contract at the top (Euro–US Dollar exchange rate) is well-behaved, with a bid–ask spread of half a basis point. Ginger Beef Corp GB’s spread is nuts: It is the difference between a total valuation of \$1.13M and \$2.54M Canadian. Genesis Healthcare has unlocked an achievement: Trading was halted with the last sale at \$1.44 (H1.44) due to its price dropping so much.

4 A watched dollar never bills

The next step of the process is to wait it out. If you wish to follow along, place an opaque sheet of paper over the time-series in Figure 4 and move it at the desired pace, revealing information about the performance of each investment. Major video-game events are labeled on this figure, so you can also do a spit-take in real time as decade-tenured Nintendo CEO Reggie Fils-Aimé steps down and is replaced by a man whose name is really... Doug Bowser?

5 Putting my mouth where my money is

Finally, after a year of investing, it is time to divest and reap the monetary harvests. Selling stocks is the simple inverse of buying them.

One surprise is that on March 9th, the first trading day after one year of holding, the stock markets were very active (I think that this was excitement due to an announcement of a new type of beer from the Corona beverage company?). Two issues arose (Figure 2):

- The bid–ask spread became quite wide. There are really two prices for a security: The “bid” (the highest amount that someone is currently willing to pay to buy it) and the “ask” (the lowest amount that someone is willing to sell it for). Gamers can perhaps think of this like the “new” vs. “used” price for a console. When the market is functioning correctly, these prices are typically within a few cents of one another. The issue was even worse for symbols that have low volume (number of trades/day).

For example, GB had a bid of 0.085 CAD and an asking price of 0.190—more than twice the price! Since I tried to get a favorable price when selling the portfolio, this delayed some divestment for several days.

- Due to much market excitement, trading was halted for many securities! This happens automatically on some exchanges when the price changes more than some amount (say, 15%) in one day, in order to prevent “flash crashes” (this is where an SSD drive fails and loses important banking data). Halted trading of course also delays divestment.

The final balance is displayed in Figure 3; these are the prices actually paid or proceeds actually received.

Symbol	Date (2019)	Bought (Num @ Price)	Cost Basis	Date (2020)	Sold (Num @ Price)	P&L (USD)
XONE	3/8	10 @ 9.302	93.02 USD	3/9	10 @ 5.1927	(\$41.09)
WSC	3/8	10 @ 9.97	99.70 USD	3/9	10 @ 13.17	\$32.00
SNES	3/8	100 @ 1.0973	109.73 USD	3/9	5 @ 2.05	(\$99.48)
PSX	3/8	1 @ 94.1073	94.10 USD	3/9	1 @ 65.601	(\$28.50)
PSP	3/8	9 @ 11.1273	100.15 USD	3/9	9 @ 10.395	(\$6.60)
NS	3/8	4 @ 26.88	107.52 USD	3/9	4 @ 16.29	(\$42.36)
NDSN	3/8	1 @ 131.2673	131.27 USD	3/9	1 @ 134.64	\$3.37
GG	3/8	10 @ 10.62	106.20 USD	3/9	3 @ 49.16	\$41.28
GEN	3/8	75 @ 1.36	102.00 USD	3/9	75 @ 1.415	\$4.13
NES	3/8	11 @ 9.4973	104.47 USD	3/9	11 @ 2.53	(\$76.64)
GCN	3/8	1000 @ 0.08	80.00 CAD	3/9	1000 @ 0.12	\$29.29
GB	3/8	500 @ 0.185	92.50 CAD	3/12	500 @ 0.085	(\$37.25)
PS3	3/12	5 @ 18.29	91.45 EUR	3/9	5 @ 22.2	\$24.23
PS4	3/12	3000 @ 0.0267	80.10 EUR	3/10	3000 @ 0.013	(\$45.46)
Total:	5	NaN	1366.34 USD	91/20	NaN	(\$243.08)

Figure 3: Actual transaction data from the experiment. Each security has a date on which some quantity (around \$100 USD) was bought (“Cost Basis”) and a date on which the entirety was sold for some consequent profit or loss (P&L). Note that the number bought is not always equal to the number sold. In the case of SNES, there was a 20:1 reverse split (reverse splits happen to keep the price from getting embarrassingly low: It would be 10.2¢ in this case). GG was acquired, so the sale was actually of a different symbol (NEM). The P&L column and totals have been converted to USD using historic forex rates. Prices omit transaction fees, which are significant especially for non-US exchanges.

6 Results

Most of these investments lost money, as did the overall portfolio. Both the SNES and NES performed very badly, which was a disappointment to me, since these are my two favorites. But this is exactly why this approach is needed: It removes the emotional

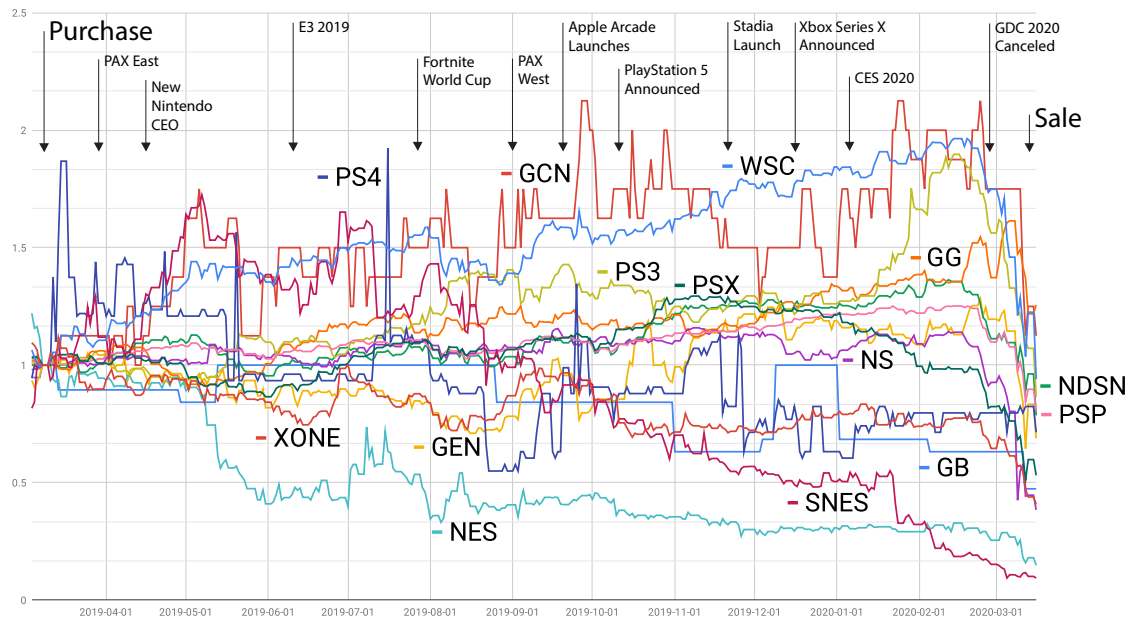


Figure 4: Relative daily closing price for the fourteen publicly-traded video game stocks in the experiment. The closing price is adjusted in arrears for dividend payments and splits. Each price is 1.0 on the date of acquisition (9 March 2019) and other closing prices are given relative to this value. For example, GCN was briefly worth more than twice its starting price at the end of September.

component. Both of these fell relentlessly throughout the year and lost more than 90% of their value. The best overall were the Game Gear (GG) and WonderSwan Color (WSC) with PlayStation 3 and GameCube also performing well.

It is interesting how little the game consoles react to major video game news (Figure 4). The announcement of the PlayStation 5 in October didn't seem to cause any movement; this is especially odd for the PlayStation 4 whose value is normally quite volatile. One hypothesis is that this information was already "priced in." October was when the name "PlayStation 5" was officially unveiled; the successor to the PlayStation 4 had been rumored for some time, but its name was a complete mystery. Arguably, only the cancellation of GDC had any real effect on prices.³

³Also the event marked "Sale", which is when the experiment ended. It seems like a joke that this would affect the market, but this is literally true for extremely low-volume stocks where my transaction may have been a significant portion of the day's activity. You can tell a low-volume stock from long flat horizontal lines.

7 Is this the most expensive SIGBOVIK paper?

Probably not.

8 Are video games a good investment?

The efficient market hypothesis tells us that every contract is priced according to the true value of the underlying good. In this sense, every transaction is value-neutral, and money can only be made or lost by predicting the future value of goods. With no information about the thing being bought, as is the case for a basket of random stocks, the investment should technically not gain or lose money (in expectation).

Of course, we do know another theorem about the stock market, from economics: The market always goes up in the long-run! The US Government considers a year to be “long term” for the sake of capital gains tax, so we should expect that randomly selected stocks increase in value over this long term.

So why, in fact, did this investment lose 17.8% of its value? This is because the stocks are not randomly selected; they represent video game consoles. Because video games are high-tech items which rapidly become out of date, they actually tend to *depreciate* with time. Only a few beloved classic consoles gained in value, for nostalgia reasons.

So this finally allows us to answer the question: What is the best game console? And the answer, established with an elegant isomorphism:

All video game consoles are bad.

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