

WHITEPAPER

Silver Mining Industry Overview

www.primeindexes.com

Contents

Abstract
Introduction
What is Silver?
History of Silver
Silver Production
Regions of Production
Uses of Silver
Supply and Demand of Silver
Silver Price
Influencing Factors of Silver Price
Investing in Silver
Sustainability
Conclusion
References

Abstract

Silver is a unique metal that has been used through many centuries and for different purposes. It began solely as a medium of exchange, then was obtained for the production of jewelry and silverware, and now is used in a myriad of industrial applications and new technologies. Silver, and silver miners, can thus be considered for investment because it is useful both in periods of market volatility as well as periods of economic growth where industrial demand for the metal increases worldwide.

Silver is often compared to gold for valuation purposes, and for decades, investors have used traditional measures to determine whether one metal is undervalued or overvalued. One such measure of historical interest and importance is the gold-silver ratio. This paper explores potential reasons for dislocations in that ratio, as well as the current record level of the gold-silver ratio.

Introduction

The White Metal

Silver, also known as the white metal, has historically been associated with jewelry, coins, and most importantly, as a store of value. But today, among the many different uses, silver's primary use is industrial. Whether in cell phones or solar panels, new innovations are constantly emerging to take advantage of silver's unique properties.

Industrial use absorbs around 50% of the world silver production, making it a crucial metal.¹ In that sense, silver prices show a much greater sensitivity to industrial growth compared to gold prices, since the annual industrial demand for gold is only 10-15%, the rest being used for jewelry and investments.

During the last decade, the largest silver consumer countries for industrial purposes have been the United States, Canada, China, India, Japan, South Korea, Germany and Russia.² During the same period, India and the United States accounted for the majority of silver's demand for its more traditional uses such as jewelry and silverware.³

In recent years, silver has had a valuable use in LED chips, battery manufacturing, photography, nuclear reactors, photovoltaic energy, RFID chips, touchscreens, semiconductors, water purification systems, among many others. All these different uses allow silver to shine in the industrial arena, while its long history in coinage and jewelry sustains its status as a symbol of wealth and prestige.

What is Silver?

Silver is considered both a precious and a noble metal because, on one hand, it is valuable and relatively hard to find, and on the other hand, it is highly resistant to corrosion and oxidation. Pure silver is rarely found in its native form but blended within ores.⁴ Because it is the best thermal and electrical conductor of all the metals, silver is ideal for electrical equipment and devices such as conductors, switches, contacts, and fuses.⁵ It is also useful in medicine and consumer products because of its antimicrobial and non-toxic qualities; it is sold as jewelry, silverware, and mirrors because of its luster and reflectivity; and it is utilized in film and photography because its photosensitivity makes it react to visible light in such a way that it creates images on its surface.⁶

Because of its capability to be shaped, bent or drawn out, silver can be ground into powder, turned into paste, converted into a salt, alloyed with other metals, flattened into printable sheets, drawn into wires, shaved into flakes, suspended as a colloid, or even employed as a catalyst, making it the best choice for numerous industrial applications.⁷ When heated, Silver can melt at a temperature of 962°C (1,764°F). It has a density of 10.49 grams per cubic centimeter making it the lightest of the precious metals. Silver can be obtained from both parting or affination which are the separation of silver and gold using concentrated nitric or sulfuric acid.⁸

Silver has been used as a store of value for over five thousand years and as medium of exchange in many different cultures before the twenty-first century.⁹ Because it is more abundant than gold, silver is much less expensive as a native metal, but still retains its value as a commodity due to its different uses.¹⁰ Its purity is typically measured on a per-mille basis; a 95%-pure alloy is described as "0.950 fine".¹¹ Many individuals choose to invest in silver through financial instruments, such as futures contracts, exchange-traded funds (ETFs) and mutual funds, or by buying and storing pure silver bullion bars, coins, or medallions. In addition, investors can gain exposure to the price of silver through investments in silver mining stocks or ETFs comprised of silver mining stocks. Some countries produce silver collector's edition coins, which they typically sell to buyers at a price exceeding the value of the silver used to make the coin.¹²

History of Silver

Silver objects were first found around the fourth millennium BC in areas now known as Greece and slightly later in Turkey. It is believed that one of the earliest uses of silver was as a medium of exchange as civilizations evolved from simple bartering.¹³ Silver jewelry and artifacts were later created in places now located in Iraq around the third millennium BC.¹⁴ Because of its low structural strength, silver was not a contributor to the growth of metallurgy for a long time until smelting and cupellation were discovered. The former allowed the extraction of silver from ore or concentrates, and the latter allowed the refinement of silver using high temperatures. Lead ores were smelted to obtain an impure lead-silver alloy, which was then fire-refined through cupellation.¹⁵ The most important ancient mines that used these processes were found in Greece where active production continued until the end of the first century AD.

The Roman Empire recorded one of the biggest amounts of silver extraction from the first centuries producing at its peak almost 200 metric tons of silver per year and greatly supporting its economy and currency with the supply of silver bullion.¹⁶ The level of silver production came to a nearly complete stop when the Western Roman Empire fell in the fifth century AD, and resumed by the time of Charlemagne in the ninth century AD. By then, tens of thousands of tons of silver were already depleted.¹⁷

During the Middle Ages, Central Europe became the center of silver production as the Mediterranean deposits exploited by the ancient civilizations had been extracted. Silver mines were opened in countries such as Hungary and Austria, and in Scandinavian countries such as Norway. Because of the abundance of the naturally exposed mineral, silver could simply be separated by hand from the remaining rock and then smelted. Many of these mines were soon exhausted, but a few of them remained active until the Industrial Revolution, when the world production of silver was around 50 metric tons per year.¹⁸

By the sixteenth century, the silver industry saw a revolutionary change when the Spanish Empire discovered and developed silver mines in Mexico, Bolivia, and Peru. These mines were much richer in silver and resulted in the rise of South and Central America as the largest silver-producing areas in the world. For the recovery of New World silver, different processes were employed such as the Patio process. This trend continued from the 1500s through 1800s, where Mexico, Peru and Bolivia accounted for more than 85% of world production and trade.¹⁹

By the end of the nineteenth century and beginning of the twentieth century, Cyanidation processes supplanted the Patio process and new techniques such as the Moebius and Thum Balbach electrorefining processes started to emerge.²⁰ Continuing into the twentieth century, North America became the primary area of silver production, particularly Canada, Mexico, and Nevada in the United States. Some production from lead and zinc ores also took place in Europe, as well as from deposits in Siberia, Russia and Australia. Poland emerged as an important producer during the 1970s where copper deposits rich in silver were discovered. However, the center of production returned to the Americas the following decade. Today, Peru and Mexico are still among the primary silver producers with a production of approximately 10,000 metric tons per year.²¹

Silver Production

How is Silver Extracted?

Silver is quite different from gold because it is mostly found within ores that require specialized mining techniques to extract. Ores are naturally occurring solid materials from which metals or valuable minerals can be profitably extracted . Silver is usually found in the crust of the earth either in its native form or more commonly as an alloy of other metallic elements. It is not very abundant in native form and thus its purity is measured using a per mille measurement. In many places, silver ore is mined as a byproduct of gold, copper, zinc, or lead.²²

Although some silver ores contain silver as their largest metal value, almost none has silver as its main component. Typical ore might contain 0.085% silver, 0.5% lead, 0.5% copper, and 0.3% antimony. After flotation separation, which is a method employed to separate minerals found within ores, the concentrate would contain 1.7% silver, 10-15% lead, 10-15% copper, and 6% antimony. Of the three major types of mineralization, lead concentrates contain the most silver and zinc concentrates the least.²³

According to the Silver Institute²⁴, only 26% of silver output in 2018 came from mining activities where silver was the primary source of revenue. The remaining 74% came from projects where silver was a by-product of mining other metals. As expected, revenues of firms focused on primary silver production tend to be much more impacted by silver prices than firms that produce it as a by-product.²⁵

Silver	Output	by S	ource	Metal
--------	--------	------	-------	-------

(million ounces)*	2017 Output	% of Total	2018 Output	% of Total	Change Y-O-Y
Primary	240.9	27%	224.0	26%	-7%
Gold	102.2	12%	104.1	13%	2%
Lead/Zinc	329.9	38%	322.8	38%	-2%
Copper	199.5	23%	200.8	23%	1%
Other	4.6	0%	4.0	0%	-13%

Source: GFMS, Refinitiv as cited in The Silver Institute²⁶

* (1 million ounces = 28.35 metric tons)

Mining & Concentrating

Most silver ores are mined by surface or underground methods:

Surface mining is a process where mineral deposits are removed from soil and rock overlying those minerals. There are two main types of surface mining, strip mining and open-pit mining. Strip mining is the process of mining layers of mineral by removing long strips of overlying soil and rock. When the ore body that is to be extracted is near the surface, strip mining is the most practical and efficient technique. Open-pit mining is the process of extracting rock or minerals from the earth through their removal from an open pit or borrow.²⁷

On the other hand, underground mining is used to extract ore from below the surface of the earth with as little waste as possible. The entry from the surface to an underground mine may be through a horizontal or vertical tunnel, known as an adit, shaft or decline. Underground mining is practical when the ore body is too deep to be mined by open pit, when the quality of the ore body is high enough to cover the costs of the project, or when the mine has a lower ground footprint than an open pit.²⁸

Extraction & Refining

The specific extractive metallurgy processes applied to a silver ore concentrate depend on whether the major metal is copper, zinc, or lead.

From copper concentrates: The smelting and converting of ore with high levels of copper concentrates result in a product that contains 97-99% of the silver present in the original concentrate. Upon electrolytic refining of the copper, insoluble impurities, called slimes, gradually accumulate at the bottom of the refining tank. These contain the silver originally present in the concentrate but at a much higher concentration. This is then smelted and later electrolyzed in a solution of silver-copper nitrate. The two different electrorefining techniques employed in this process are the Moebius and Thum Balbach systems. The chief difference between them is that the electrodes are disposed vertically in the Moebius system and horizontally in the Thum Balbach system. The silver obtained by electrolysis usually has a purity of three-nines fine; on occasion it may be four-nines fine, or 99.99% silver.²⁹

From lead concentrates: Lead concentrates are first roasted and then smelted to produce a lead bullion that contains impurities such as antimony, arsenic, tin, and silver. Silver particles are removed by a process called the Parkes process, where zinc is added to the lead bullion. Zinc reacts rapidly when it is in contact with gold and silver, forming very insoluble compounds that float to the top of the bullion. These are skimmed off and their zinc content recovered by vacuum retorting. The remaining lead-gold-silver residue is treated by cupellation, a process in which the residue is heated to a high temperature. The result of that process is noble silver and gold in its elemental form, while the lead oxidizes and is removed. The gold and silver alloy thus produced is refined by the Moebius or Thum Balbach process.³⁰

From zinc concentrates: Zinc concentrates are roasted and then leached with sulfuric acid to dissolve their zinc content, leaving a residue that contains lead, silver, and gold, along with 5-10% of the zinc content of the concentrates. This is processed by slag fuming, a process whereby the residue is melted to form a slag through which powdered coal or coke is blown along with air. The zinc is reduced to the metallic form and is vaporized from the slag, while the lead is converted to the metallic form and dissolves the silver and gold. This lead bullion is periodically collected and sent to lead refining, as described above.³¹

From scrap: Silver can be recycled from spent photographic processing solutions and photographic film. The solutions are processed electrolytically, while the film is burned, and the ashes leached to extract the silver content. High-grade jewelry scrap is usually re-alloyed rather than refined. When metal jewelry is polished and ground, fine dust called sweeps is generated. This is usually smelted to form an impure silver, which is electro-refined. Since silver scrap has a much lower value, recycling techniques applicable to gold are uneconomic for silver. Low-grade silver scrap is instead returned to a smelter for processing.³²

The Metal & Its Alloys

With the passage of time, silver can start showing signs of recrystallization, even at room temperature and after being fully worked-hardened. This condition softens the metal and makes it susceptible to marring and scratching. Due to this natural condition, other metals are usually added to form alloys to maintain its hardness and be less prone to fatigue.

The best-known copper-silver alloy is sterling, which is 92.5% silver and 7.5% copper. Coin silver is an alloy of 90% silver and 10% copper. For jewelry and ornaments, 85-90% silver and the balance copper is frequently used. In dentistry, alloys of 60-70% silver, 18-25% tin, 2-14% copper, and 0.5-2% zinc are combined with varying quantities of mercury to form the filling materials for cavities in teeth.³³

Because silver has the highest electrical conductivity of all metals, it is used in alloyed form for electrical contacts. Telephone relays, circuit breakers, and other electrical switching equipment are made with silver and alloys of silver and copper with at least 40% palladium added to them. Palladium is added to improve the metal's chemical resistance to oxidation and sulfidation as well as its resistance to tarnishing. In order to obtain the luster and corrosion resistance of silver on other metals and alloys, silver electroplating is practiced employing cyanide-based baths.^{34 35}

Silver brazing fillers are the most frequently used precious metal fillers and can be found in solid form, like rings and wire, slugs, washers, powder, and paste. They are suitable for brazing nearly all steels and nonferrous metals except aluminum, magnesium, and titanium. A typical brazing alloy composition is 50% silver, 34% copper, and 16% zinc.³⁶

Regions of Production

Global Silver Mine Production 2005-2019

The estimated global production of silver in 2019 amounted to 27,000 metric tons. This trend shows that silver production has increased considerably since 2005 when the production was 20,800 metric tons. Considering that silver has been extracted for thousands of years, it can be inferred from this positive trend that silver production is still healthy.³⁷



Global Mine Production of Silver from 2005 to 2019 (in metric tons)

World Silver Production in 2018

Source: Statista 2020³⁸



In terms of world distribution in 2018, the Americas occupied the first position with approximately 62% of world production, followed by Asia with 22%, Europe with 12%, Oceania 4% (primarily Australia) and lastly Africa with 2% of world production.

Source: The Silver Institute³⁹

Leading Silver Producing Countries

The three leading silver producing countries worldwide in 2018 were Mexico, Peru, and China. In that year, Mexico produced 196.6 million ounces, Peru produced 144.9 million ounces, and China produced 114.9 million ounces. This trend has been constant during the last 10 years, with Mexico and Peru as the leading countries, followed by China with a slightly lower level of production and Russia, Chile, Bolivia and Poland alternating their positions throughout the years.^{40 41}

Mexico overtook Peru in 2010 to become the largest producer of silver, accounting for 23% of the world's total silver production as of 2018. The top 4 producers - Mexico, Peru, China, and Russia - account for over 58% of the world's silver production as of 2018. This is a clear example of the geographic diversification of silver production, with large mines in the Americas, Europe, and Asia.⁴² This geographic diversity reduces the possibility that a natural disaster in a certain area can negatively affect the world production of silver.



Leading Silver Producing Countries Worldwide in 2018 (in millions of ounces)

Silver Production in the Americas

Latin American countries account for five of the ten leading silver mining countries in the world. This includes Mexico, Peru, Chile, Bolivia, and Argentina. The US and Canada have a smaller share of production in the region compared to the other countries, but their individual production levels have seen an increase in the case of Canada and a decrease in the US since 2005, mostly due to falling ore grades and mine economics.⁴⁴ As the world's largest producer of silver, Mexico understandably is home to five out of the ten largest silver producing mines worldwide.



Mine Production in the Americas (in millions of ounces)

Source: Statista 202043

Source: GFMS, Refinitiv as cited in The Silver Institute⁴⁵

Silver Production in Asia

Mine Production in Asia (in millions of ounces) Asian production shows a positive trend for the last 10 years, with China producing the vast majority of silver compared to other countries with 63% of silver production. India has been showing a great growth during the last 5 years particularly due to the increase in underground operations and better silver grades.



Source: GFMS, Refinitiv as cited in The Silver Institute⁴⁶

Silver Production by Company

Producing Companies

1 Including 100% of Penmont mines, excluding silverstream; 2 Primary silver producer; 3 Reported metallic silver

5 includes minority partners; 6 Includes 100% from Pallancata.

7 Integrated refined metal;

10 Excludes 100% of Fresnillo plc.

9 Metal in concentrate;

Top 20 Silver

production;
4 Estimate;

includes Moris:

8 Mined silver:

Fresnillo plc was the leading global silver mining company in 2018. The Mexico-based company produced 54.2 million ounces of silver in 2017, and 58.1 million ounces of silver in 2018 according to data from the Silver Institute. Their operational headquarters are in Mexico City, while their corporate headquarters are situated in London. The second largest silver mining company in 2018 was the British-Swiss based mining company Glencore plc. The company is also known for being one of the leading diversified mining companies worldwide. In 2018, it produced around 34.9 million ounces of silver according to the Silver Institute.⁴⁷

Rank 2017 2018			Output 2017	: (tons) 2018
1	1	Fresnillo plc. ¹	54.2	58.1
2	2	Glencore plc. ²	37.7	34.9
3	3	KGHM Polska Miedz S.A. Group ^{3,4}	36.5	33.9
6	4	Cia. De Minas Buenaventura S.A.A. ⁵	26.4	26.2
5	5	Polymetal International plc.	26.8	25.3
7	6	Pan American Silver Corp. ²	25.0	24.8
4	7	Goldcorp Inc.	28.6	24.5
9	8	Hochschild Mining plc.	19.1	19.7
11	9	Hindustan Zinc Ltd. 6	16.9	19.6
13	10	Southern Copper Corp. ⁷	15.9	17.3
12	11	Corp. Nacional del Cobre de Chile	16.8	17.1
10	12	Volcan Cia. Minera S.A.A. ⁵	17.3	17.0
17	13	Industrias Peñoles S.A.B. De C.V. ^{8,10}	12.2	14.8
19	14	South 32 Ltd.	12.0	13.3
14	15	Boliden A.B. ⁹	13.3	13.2
18	16	Coeur Mining, Inc. ²	12.1	12.9
15	17	Sumitomo Corp. ⁴	12.8	12.6
22	18	First Majestic	9.7	11.7
8	19	Teck	21.5	11.5
16 20 Hecla Mining Company		12.5	10.4	

Source: GFMS, Refinitiv as cited in The Silver Institute⁴⁸

Uses of Silver

Due to its unique physical and chemical properties as a metal, silver has had many different uses throughout the years. Taking a closer look at today's demand, silver is mostly used in the industrial arena. Within the industrial uses, silver demand comes from sectors such as electronics, energy (solar), brazing alloys and solders, and photography. Outside of the industrial production, the main uses of silver are in jewelry, silverware, coins and investments.⁴⁹

Uses of Silver in Electronics

The main use of silver in industry is in electronics. This is due to the low cost of silver compared to other metals that have similar thermal and electrical conductivity properties . For example, small quantities of silver are used in electrical switches where current passes through when two contacts are joined. This technology is used in automobiles to control electronic features, as well as in consumer appliances.

Silver paste, which is formed by dissolving pure silver in nitric acid, has many industrial uses because it can convert an insulative surface into a conductive one.⁵⁰ Membrane switches and rear window defrosters in cars are some examples of applications of silver paste. In electronics, circuit paths, semiconductor chips, as well as passive components called multilayer ceramic capacitors (MLCCs), depend on silver paste. One of the fastest growing uses of silver paste is in the creation of photovoltaic cells used to produce solar energy.

Nanosilver, which are extremely small particles of silver, has allowed the development of new technologies such as printed electronics which use nanosilver conductive ink. Radio frequency identification (RFID) tags are a good example of how printed electronics are put into work since these tags can store more information and be read from a greater distance than bar codes for inventory tracking. Other than in electronics, nanosilver is used in cosmetics, food packaging materials tracking, disinfectants and cleaning products.⁵¹

Within consumer electronics, silver is used in the technology of light emitting diode (LED) televisions because it gives a sharper image quality and produces low-level, energy efficient light. In addition, CDs and DVDs also contain thin layers of silver used to reflect the laser that reads or writes to the devices.⁵²

Another electronic application of silver is in batteries that use silver oxide or silver zinc alloys. These are light-weight, high-capacity batteries that can perform efficiently at high temperatures. Silver-oxide is used in button batteries that power cameras and watches, as well as in aerospace and defense applications. Silver-zinc batteries are used as an alternative to lithium batteries for laptop computers and electric cars since they can provide up to 40% more run time than lithium batteries in a more compact space.⁵³ This is achieved through its water-based chemistry that reduces the need for protective casings and packaging that increase bulk.⁵⁴

When paired with superconductors, silver can increase the speed at which electricity is transmitted. At very low temperatures, superconductors carry electricity with little or no electrical resistance, which makes them useful to generate magnetic energy for turning motors or propelling magnetic levitation trains.

Uses of Silver in Energy

Silver paste is used to make solar panels because it can be printed onto photovoltaic cells. When light shines on a cell, this light may be reflected, absorbed, or pass right through it. Since these cells are composed of semiconductor material, they are uniquely capable of converting light into electricity. This is the main reason why photovoltaic cells are one of the fastest growing uses of silver.

Silver's reflectivity gives it another role in solar energy. It reflects solar energy into collectors that concentrate solar radiation from the sun. These devices are primarily used for active solar heating and have many uses at individual and industrial scales. Examples are evacuated-tube collectors for personal water heating, line focus solar collectors used to generate steam for solar thermal power

plants, and point focus solar collectors used for driving Stirling engines in submarines or nuclear plants.55 Nuclear energy also uses silver since it is employed in control rods to capture neutrons and slow the rate of fission in nuclear reactors. By inserting the control rods into the nuclear core, nuclear reactions can be slowed down, while removing them can speed them up. Brazing and soldering are used to create tight joints between two metal pieces **Uses of Silver in** making use of silver's high tensile strength and ductility. According to the American Welding Society (AWS) the main difference between brazing and soldering **Brazing and Soldering** is that brazing produces the joining of materials by heating them to the brazing temperature and by using a filler metal (solder) having a melting point above 450°C (840°F). On the other hand, soldering has the same definition but takes place at temperatures below 450°C (840°F).⁵⁶ Silver scrap can be used in brazing and soldering since these processes do not require very pure silver. Brazing and soldering produce strong joints for products such as heating and air conditioning vents to plumbing. Silver's antibacterial properties and non-toxicity to humans make it a great replacement for leadbased bonds between water pipes. Due to the rise of digital media, the use of silver in photography decreased con-**Uses of Silver in** siderably. Before this advent, photography used to be one of the primary industrial uses of silver. Traditional film photography relies on the light sensitivity of **Photography** silver halide crystals present in film. This means that when the film is exposed to light, the silver halide crystals change to eventually develop into a photograph. The accuracy of this process makes it useful for non-digital consumer photography, film, and X-rays. Engines usually work at very high temperatures for long periods of time and most **Uses of Silver** metals cannot withstand that level of stress. The way to prevent engines from collapsing is by using engine bearings that have been electroplated with silver to in Engines make them stronger and more resistant. This process also allows the reduction of friction between the ball bearing and its housing. These bearings are essential in the construction of jet and helicopter engines since these types of engines require stronger ball bearings compared to other types of machinery. Silver is used as a catalyst to produce chemicals like ethylene oxide and form-**Uses of Silver in** aldehyde by increasing the speed of reactions without getting used up. Ethylene oxide is used to produce molded and flexible plastics, in addition to antifreeze, **Chemical Production** adhesives, detergents, polyester, fumigants and pesticides, and sterilization agents for medical equipment.⁵⁷ Formaldehyde is used to make solid plastics and resins and also used as a protective coating, disinfectant and embalming agent. It can also be used as a preservative in some foods and products such as antiseptics, medicines, and cosmetics.58 The two other major sectors of silver demand are jewelry and silverware. Usual-**Uses of Silver in** ly, silver products such as bracelets, earrings, and necklaces are a great choice for jewelry consumers because of its reflectivity and luster. Silver can also be **Jewelry & Silverware** alloyed with other metals to create products with different softness and brightness such as silver sterling where 92.5% silver and 7.5% copper are used.

> Because it is less expensive than gold, silver is a popular choice for fine silverware. Silver-plated base metals offer a less costly alternative to silver. However, silver dishes and plates may accompany silverware, and these have often been considered symbols of wealth and prestige.

Uses of Silver in Coins & Investments

Historically, silver was used in coins and in the designing and minting of local currency because, together with gold, melts at very high temperatures and its luster makes it attractive. For centuries, people used silver as a medium of exchange in the form of silver coins and to store their wealth. As recently as the twentieth century, many countries used silver and/or gold reserves as the base to set their currencies. These monetary systems took the names of gold and silver standard and allowed units of national currency to be converted into units of gold or silver at a fixed exchange rate.⁵⁹

The most important out of the two, the gold standard, lasted in the US until August 1971. That is when President Richard M. Nixon declared a temporary suspension of the dollar's convertibility into gold, concerned by the amount of gold supply relative to the number of dollars in circulation. By 1973, the Bretton Woods System, which allowed gold to be converted at a fixed rate of \$35 US dollars per ounce and also allowed other currencies to be pegged to the US dollar, officially collapsed. The US government then repriced gold to \$42.22 US dollars per ounce and decoupled the value of the dollar from gold altogether in 1976. The price of gold quickly shot up to \$124.84 US dollars per ounce in the free market.⁶⁰

As a consequence, countries were then free to choose any exchange arrangement for their currency, except pegging its value to the price of gold, which cemented the use of fiat currency as we know it in modern times.⁶¹ In addition, once the gold standard was dropped, countries began printing more of their own currency resulting in inflation. In the US, the breakup of the gold standard, together with other economic decisions such as freezing wages, tax cuts, and a world energy crisis generated high levels of inflation reaching double digits in 1974 and early 1980s, even when the level of interest rates where dramatically increased.⁶² However, and for the most part, abandoning the gold standard created more economic growth.⁶³ Today, there is no country in the world that uses the gold or silver standard as the base to value their currency.

Regarding the uses of silver as an investment, silver is still considered a valuable commodity and investors can get exposure to it through different asset classes. The four biggest categories in terms of dollars invested are derivatives (futures and options), physical investments (bullion bars, coins or medallions), ETPs (exchange traded products) and silver mining stocks and funds.⁶⁴

Silver has had a significant role in medicine because of its non-toxicity and anti-bacterial properties. Before the development of antibiotics, silver was used to heal wounds and kill bacteria by interfering with their respiration. This process is possible because silver ions act as a catalyst by absorbing oxygen and preventing bacteria from growing. In addition, silver has been used in eye drops and in dental hygiene to cure and prevent infection.

In hospitals, silver is used in surgical equipment, wound dressings, and ointments to protect wounds from getting infected. Silver sulfadiazine is widely used by doctors for burn patients because it kills bacteria and allows the skin to regrow. Treatments with silver ions allow regeneration of damaged tissue and healing of bone infections.

These same properties are useful in water purification systems. Nowadays, silver coating is used in carbon-based water filters to prevent bacteria from building up, while silver ions are used to carry oxygen that oxidizes and kills microbes. Silver-copper ions can replace corrosive chlorine to sanitize pools and tanks.

The antimicrobial properties of silver that make it useful to medicine and water purification are also applied in food and hygiene. Nanosilver coatings are applied to food packages, refrigerators, and many consumer products such as washing machines, clothing, and personal hygiene products.

Uses of Silver in Medicine, Water, Food and Hygiene

Other Uses of Silver

Silver is used in the production of mirrors, glasses and medal awards. Because of its reflectivity when polished, silver mirrors have been made by coating a transparent glass surface with a thin layer of silver, though modern mirrors also use other metals like aluminum. Many windows of modern buildings are coated with a transparent layer of silver to reflect sunlight and help control the temperature inside. In aerospace, silver-coated tiles protect spacecraft from the sun.

Due to its status as a precious metal, silver is used to award second place. The most famous silver award is the second-place Olympic Silver Medal. Since silver also symbolizes honor, valor, and accomplishment, many military organizations, clubs, and associations use silver or silver-colored awards to honor individuals.⁶⁵

Supply and Demand of Silver

World Silver Demand Outlook

According to the Silver Institute, the use of silver for industrial purposes has been the most important during the last decade compared to its other uses.⁶⁶ The total demand for silver has been fluctuating at around the level of 1 billion ounces per year since 2009, with a demand of more than 50% coming from the industrial applications sector, even though that sector's demand growth has been relatively flat since the financial crisis. As mentioned before, the other two main categories of silver demand have been jewelry and silverware and coins and bars.



World Silver Demand (in millions of ounces)

Regarding the other two categories, the demand of silver for jewelry is quite concentrated, with Indian and US jewelry consumption making up just over half the global total. This makes it similar to gold, where India and China account for 57% of the total gold demand. However, the latter two countries' gold jewelry consumption amounts to a noteworthy 30% of total gold demand, whereas that share for US and Indian silver jewelry is only around 10% of total silver demand.



Source: Metal Focus as cited in The Silver Institute⁶⁸



Source: GFMS, Refinitiv as cited in The Silver Institute⁶⁷

According to the Silver Institute, the industrial applications accounted for 56% of world demand in 2018; Jewelry and silverware accounted for 20%, and coins and bars for 16%.



Within the industrial applications, the electrical and electronics sectors have been the main users of silver accounting for almost 43% of the demand in 2018. The total amount of silver used for electrical and electronic purposes has been slightly decreasing since 2010, implying a possible correlation with silver prices. In other words, if less silver is used for electronic equipment, then the forces of supply and demand can cause the silver spot price to decrease. A remarkable observation from the graph below is the use of silver for solar energy. As mentioned previously, solar panels take advantage of silver's reflectivity and conduciveness. The amount of silver used in solar technology has been increasing greatly during the last decade and is expected to continue to rise.⁷⁰ However, solar energy's demand for silver might influence silver prices in the long term, making solar panels production and subsequent sales costs much higher. A report released in 2019 from the University of Kent in the United Kingdom argued that the solar industry will require new alternative technologies to ensure solar panel production will stay cost-effective.⁷¹ In the meantime, solar energy is still a growing area within the silver industry showing a demand of a little of more than 80 million ounces in 2018.72



Industrial Silver Fabrication (by category)

Note: Photovoltaic in "Other" category prior to 2011

Source: GFMS, Refinitiv as cited in The Silver Institute⁷³

A final point on the demand side is that silver is far less vulnerable to specific sector or geographic demand shocks than other metals. First, its industrial demand is spread across many different categories and sectors making it soundly diversified. Second, countries that depend on a critical single segment, for example India's jewelry demand, can be of secondary importance for other sectors such as physical investment in that country. This means breaking news or catastrophes are less likely to have an unprecedented impact on silver demand or its price.⁷⁴

World Silver Supply Outlook

Taking a look at the supply side, we previously mentioned that most of the world silver supply comes from 4 main countries which are Mexico, Peru, China, and Russia. Together, they account for over 58% of the world's silver supply as of 2018. Most of this production comes from silver mines which account for almost 85% of total silver supply in the market, followed by scrap supply.⁷⁵ Scrap silver is the combination of waste silver, metallic material and any product that contains silver that is capable of being recycled from previous consumption or product manufacturing.⁷⁶ It is clear from this table that the increase in supply from mine production is negatively correlated with the price of silver, implying that when too much mine silver is extracted, the price tends to fall.



World Silver Supply

News that can impact silver supply also has a limited role. At a country level, mine production is not overly concentrated compared to other metals, with Mexico and Peru accounting for around 40% of the global total. In contrast, 80% of platinum and palladium production comes from South Africa and Russia, and the spot prices usually react strongly to events in those two countries. The same is true of concentration at the mine level - silver's top 10 miners accounted for 23% of total mine output in 2018 versus 69% and 76% respectively for platinum and palladium. In addition, less than 30% of silver comes from primary mines so total output is better insulated from specific events in other silver mining fields.



Precious Metals' Country-Level Mining Exposure (2018)*

* Share of global mine output attributable to the top 2 and top 5 countries.

Source: Metal Focus as cited in The Silver Institute⁷⁸

Source: GFMS, Refinitiv as cited in The Silver Institute⁷⁷

Silver scrap and recycling have an even lesser impact for silver supply when the price of silver fluctuates between \$10 and \$20 US dollars since its production stays relatively stable. However, investors can experience increasing volumes when the price of silver gets close to historic highs, especially if this occurs during a recession, triggering waves of opportunistic selling of silverware by consumers and of unsold jewelry by the supply chain.⁷⁹

World Silver Supply and Demand Numbers

The following is the world's silver supply and demand data for ten years from 2009 to 2018. What is interesting about these numbers is the consistent silver supply-demand net deficit.

Precious Metals' Country-Level Mining Exposure (2018)*

*Photovoltaic demand included in "Other Industrial" prior to 2011

(million ounces)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Supply										
Mine Production	717.3	753.0	758.3	791.7	823.3	867.8	893.7	893.4	876.9	855.7
Net Government Sales	15.6	44.2	12.0	7.4	7.9	-	-	-	-	-
Scrap	200.6	227.2	261.2	253.8	191.2	167.4	150.2	151.8	153.8	151.3
Net Hedging Supply	-17.4	50.4	12.2	-47.1	-34.8	16.8	7.8	-19.4	1.9	-2.8
Total Supply	916.1	1,074.8	1,043.8	1,005.8	987.6	1,052.0	1,051.8	1,025.8	1,032.6	1,004.3
Demand										
Jewelry	176.9	190.0	191.5	186.7	219.7	227.3	223.3	202.7	204.5	212.5
Coins & Bars	79.6	174.1	211.7	161.2	240.7	233.6	293.6	208.7	150.4	181.2
Silverware	53.2	51.9	47.5	43.8	59.3	61.2	63.2	52.4	57.6	61.1
Industrial Fabrication	528.2	633.8	653.0	600.1	604.6	596.3	582.6	566.4	585.8	578.6
of which Electrical & Electronics	227.4	301.2	290.8	266.7	266.0	263.9	246.0	233.9	243.1	248.5
of which Brazing Alloys & Solders	53.8	61.2	63.2	61.1	63.7	66.7	61.5	55.3	57.5	58.0
of which Photography	76.4	67.5	61.2	54.2	50.5	48.5	46.1	44.7	40.9	39.3
of which Photovoltaic*	-	-	67.4	64.4	54.8	53.9	64.5	74.9	88.9	80.5
of which Ethylene Oxide	4.8	8.7	6.2	4.7	7.7	5.0	10.2	10.2	6.9	5.4
of which Other Industrial*	165.8	195.2	164.2	148.9	162.0	158.5	154.4	147.3	148.4	146.9
Physical Demand	837.8	1,049.8	1,103.7	991.8	1,124.3	1,118.4	1,162.8	1,030.2	998.4	1,033.5
Physical Surplus/Deficit	78.3	25.0	-59.9	13.9	-136.6	-66.4	-111.0	-4.4	34.2	-29.2
ETP Inventory Build	156.9	129.5	-24.0	55.3	2.5	1.4	-17.8	49.8	2.4	-20.3
Exchange Inventory Build	-15.3	-7.4	12.2	62.2	8.8	-5.3	12.6	79.8	51.5	71.2
Net Balance	-63.3	-97.0	-48.0	-103.5	-147.9	-62.5	-105.8	-133.9	-19.7	-80.1
Silver Price, \$/oz.	14.67	20.19	35.12	31.15	23.79	19.08	15.68	17.14	17.05	15.71

Source: GFMS, Refinitiv as cited in The Silver Institute⁸⁰

Silver Price

What is Silver Spot Price and How is it **Determined?**

Silver spot price, or the spot price of any metal, is the price at which the metal can be exchanged and delivered upon now. The price is constantly changing and is carefully watched by banks, financial institutions, dealers and retail investors.

Since silver is a commodity, its price is determined on futures exchanges and trades virtually 24 hours per day across different exchanges such as New York, Chicago, London, Zurich and Hong Kong. Out of all these exchanges, the most important one is the US COMEX (Commodity Exchange), which is a division of the Chicago Mercantile Exchange (CME) that trades futures in different metals.⁸¹ The spot price of silver is calculated using the near term futures contract price, which is usually the front month contract or the contract that is closest to expiration. This contract usually has the most volume.



US\$ Silver Price

	1988	1998	2008	2018
Annual Average	6.53	5.54	14.99	15.71
Maximum	7.82	7.81	20.91	17.52
Minimum	6.05	4.69	8.88	13.97
Range:Average	27%	56%	80%	23%

Source: LBMA, GFMS, Refinitiv as cited in The Silver Institute⁸³

Silver Price in Other Currencies in 2018

	Euro/kg	Rupee/kg	Yen/10g	Yuan/kg
Annual Average	427.39	38,505	557.3	3,600
Maximum	477.12	41,380	624.2	3,836
Minimum	388.54	35,700	506.3	3,370
Range:Average	20.7%	14.8%	21.2%	12.9%

Source: LBMA, GFMS, Refinitiv as cited in The Silver Institute⁸³

Spot prices can sometimes diverge from prices at which physical precious metals are sold. This is because during periods of market volatility, it may be hard to obtain physical metal close to the spot price. Premiums on retail bullion, coins and bars may surge as a consequence of a demand increase. During periods of market ease, physical metals still carry small premiums due to minting costs and the dealer's profit. In addition, any wholesale premium that the dealer must pay to acquire the inventory might also be added to the final price.⁸⁴⁸⁵

Silver Spot Price Movements Over Last 10 Years

Silver prices have seen a lot of volatility over the last 10 years due to varying reasons. From 2009 to 2011, the spot price rose sharply because of an increase in investment demand for the metal in the wake of the global financial crisis. Prices even reached \$50 US dollars per ounce in April 2011, though the annual average was \$35 US dollars for the year.⁸⁶

However, beginning in 2012, silver prices started to decline in response to the government's steps to avoid a major debt crisis. A strong economic recovery in the US and a weaker quantitative easing program led to a continuous drop in silver prices. Additionally, due to a lack of inflationary pressure, other financial asset prices started to increase relative to the spot price of silver, harming investors who kept physical silver as a store of value.⁸⁷

From 2015 until now, the spot price of silver has ranged from a little bit less than \$15 to \$20 US dollars per ounce. However, prices dropped during the month of March 2020 to levels close to \$10 US dollars per ounce mainly due to institutional investors selling silver to cover margin calls and increase the amount of liquidity in their companies.⁸⁸ Even though silver has historically shown a positive correlation to the world industrial growth rate, it was during these last years that the correlation became weaker. We will explore the reasons why later in this section.



10 Year Silver Price in USD/oz

Source: Silver Price⁸⁹

Influencing Factors of Silver Price

Gold-Silver Ratio

The price dynamics of silver and gold are different from other commodities. The reason is they both possess quasi-monetary characteristics so macroeconomic factors and investors' reactions to these factors influence their prices.

Among the many reasons that cause price fluctuations, we are going to pay closer attention to three main areas: the gold-silver ratio and silver's correlation to other commodities; the macroeconomic factors that are relevant for silver specifically; and silver's fundamentals.

The gold-silver ratio is one of the best indicators for silver prices according to many sources.⁹⁰ This ratio tells us how many ounces of silver it takes to buy an ounce of gold. The benefits of the gold-silver ratio arise when there are fluctuations from historical patterns. In other words, when the ratio widens or narrows to levels that are considered extreme, trading opportunities are created. If the gold-silver ratio widens to 100, then a consumer who owns one ounce of gold could sell it and buy 100 ounces of silver. When the ratio widens, silver becomes more favorable because, relative to the ratio, silver is somewhat inexpensive. Trading based on the gold-silver ratio is considered by many to be a good strategy to follow when trying to accumulate either gold or silver.⁹¹

Looking at the chart below we can clearly see that the ratio has been at its highest level ever getting to almost 115 in March 2020. In addition, the ratio tends to spike before and during recessionary periods, as highlighted by the grey areas, especially since the 1970s.



Why has the gold-silver ratio spiked to historic levels? In reality, many factors might have caused the ratio to spike. The first two obvious reasons are the prices of gold and silver individually, which continued to be correlated, but the magnitudes of their moves resulted in gold significantly outperforming silver. While the price of gold has increased substantially more than the price of silver during the metals bull market starting in June 2019, the drop in the price of gold during the last weeks of March 2020 was less than the drop in the price of silver. This can be associated with the fact that gold is considered a much stronger asset to hold during periods of market volatility. However, a drop in metal prices during market volatility is also uncommon, and one reason why the prices of both gold and silver saw a drop during the last weeks of March 2020 could be liquidity driven due to the Covid-19 crisis. This situation created a sudden stop in the world economy impacting many industries. The market declines forced many leveraged investors to sell any liquid asset that they had indiscriminately. During market panics, liquid assets tend to fall together. While some investors might have been buying gold or silver to protect their assets during the market panic, others were forced to sell to free up capital during the crisis caused by the virus.93

Gold-Silver Ratio Trends

Furthermore, the Federal Reserve, and central banks overseas, agreed to print as much money as needed to keep economies alive. Most central banks lowered their interest rates to boost the economy. In the US, the government has agreed to significant fiscal spending programs, increasing the national debt.⁹⁴ Because of these reasons, investors believe that inflationary pressures will start to affect the economy, and many retail and institutional investors are considering buying gold as a hedge to increasing prices.⁹⁵ This can also impact the gold-silver ratio because it can potentially make the price of gold increase more than the price of silver.⁹⁶

Even though as of April 2020 the ratio is at historic highs, since 1998 there has been a technical pattern where every time the ratio reached 80 or above, it dropped down to around 45. Logically, the opposite happened when the ratio dropped to 45, bouncing back to levels around 80. However, since late 2018, the gold-silver ratio moved above 80 and it has been above that number since.



Gold-Silver Ratio Historical Pattern

Therefore, based on historical patterns, and assuming the price of gold stays the same, then we should expect the price of silver to rise. However, and in addition to the reasons mentioned before, there are certain items regarding this ratio and the relationship between gold and silver that should not be overlooked.

The gold-silver ratio has historically been negatively correlated with the global industrial cycle. In other words, when industrial growth deteriorated the gold-silver ratio spiked mostly because the price of gold increased more than the price of silver or it declined less than silver declined. In addition when industrial growth was strong, silver prices increased more than gold prices, since industrial silver fabrication accounts for more than 50% compared to gold's industrial production that only accounts for 10-15%.⁹⁸ However, this relationship between the gold-silver ratio and industrial growth appears to have broken and even reversed post the global financial crisis: silver outperformed gold in 2016 when growth accelerated.



Historical Relationship Between IP and Gold to Silver Ratio Appears to have Broken Post GFC

Source: Bloomberg, GFMS, Goldman Sachs Global Investment Research as cited in Goldman Sachs⁹⁹

Source: Trading View as cited in Gold Price⁹⁷

According to Goldman Sachs¹⁰⁰, the two main reasons why this has happened are that during the last 7 to 9 years there has been a below-trend growth in industrial demand for silver, and there has also been a continued increase in silver mine supply as shown in the following graph.



Source: Bloomberg, GFMS, Goldman Sachs Global Investment Research as cited in Goldman Sachs¹⁰¹

A lack of industrial demand led to a strong build-up of exchange inventories, which reached levels last seen in the early 1990s. Their argument is that the gap between industrial demand and mine supply could take years for industrial demand recovery to tighten up the market.¹⁰² ¹⁰³





However, this does not necessarily mean that silver prices will stay low until industrial demand increases above historic levels since some people, like Edmund C. Moy, who was the director of US mint from 2006 until 2011, recently argued that an increase in industrial demand during this economic uncertainty can bring confidence to the metal's demand and potentially lead to a price increase.¹⁰⁵

Regarding the relationship between silver and gold, there are certain factors that can make the price of silver move independently from the price of gold. First, silver prices can be influenced by other industrial metals like copper. Second, the physical silver market is less liquid than the physical gold market and the chances of getting squeezed are higher. Third, silver prices are typically more volatile than gold prices. As a result, and even though silver is also considered a medium of exchange and a store of value, it is gold that is viewed more as a proxy for money and it is therefore more influenced by macroeconomic news.¹⁰⁶

Touching on the first point, silver price moves are linked to those of other commodities, in particular gold. The price correlation between the two metals has

Silver Industrial Demand Lagged Growth of Mine Supply Since GFC (in Moz)

Physical Surplus and Large

Increases in Silver Inventories

held relatively steady at a high level of around 0.8 since the mid-2000s. That figure does not tell which metal leads, but comparing the value of all forms of investment in gold in 2018 - which was over \$45 billion according to Metal Focus - to the total value of silver for 2018 - which was \$3 billion - it is evident that gold is the dominant partner.¹⁰⁷



In contrast, the link with base metal prices shows a positive but weak correlation and, for example in 2017, the correlation stayed below 0.2 for much of that year. In addition, changes in the oil industry can create the impression that metal prices are linked to oil prices. Volatile oil prices can cause many markets to enter into shocks like the one seen in 2015 or the one seen in March 2020. In both cases, the prices decreased by almost half from the prior year, making investments in safe haven assets like gold very profitable. In such situations, silver prices can get pulled along by gold, creating the impression that silver is negatively correlated with oil. However, for the most part since the 2000s, silver and oil prices have shown a positive correlation as shown in the graph below.





Gold-Silver Correlation (Basis

300-day logarithmic return)



Macroeconomic Variables

Similar to the correlation that silver prices show with gold and industrial metals, there are a number of macroeconomic variables that can have an important impact on silver prices.

GDP Trend: News about changes in GDP growth and industrial production can have different implications depending on how impactful they are. The link with silver prices can be broken down as certain macroeconomic variables can lead investors to react to news of weak GDP growth and, as a product, increase the demand for gold as a haven asset and drag silver with it as well. However, poor news on the global economy could at other times be taken as harmful for the industrial metals and therefore silver too. The case of GDP-silver price dynamics is therefore complicated, as a drop in growth rate fuels safe-haven investment demand for silver, whereas a pick-up in growth drives higher industrial demand for the metal.

USD Value: The value of the US dollar is important simply because silver is priced in dollars. News that is specifically supportive of, or harmful to, the US dollar can therefore move exchange rates and the US\$ silver price in such a way that the silver price in other currencies barely moves. As shown in the graph below, when the value of US\$ depreciates, silver prices tend to move higher. On the other hand, when it appreciates, the silver price tends to decrease.



Spot Price vs. US\$/Euro

Interest Rates and Inflation: Interest rates, which are tied in with both exchange rates and GDP data, can impact precious metals directly as rate changes can raise or lower the opportunity cost of holding what is essentially zero-yielding assets. Inflation is also important as this can dictate if real interest rates are either positive or negative. There is also a direct link between silver and high inflation since the latter tends to trigger strong demand for safe haven assets. Similarly, deflation can also benefit the precious metals as investors fear that deflation can only mean poor economic prospects and so imminent stock market weakness.

Asset Prices: Equities, government and corporate bonds, real estate and cash can all act as competitors for silver and gold. As such, changes in the valuations of these assets, without considering macroeconomic variables, can have a separate impact on investor's decision to purchase precious metals. New legislation on real estate loans or capital gains tax treatment, for example, could impact all the above financial markets to the potential benefit or detriment of precious metals.

Debt: Whether corporate, government or household, debt levels can have an important impact on precious metals' prices. This can act as an independent factor whether investors believe that its scale and/or direction can be a threat to financial stability. For example, the ongoing rise in US Federal debt has created concern for some investors, boosting demand for safe haven assets. Similarly, China's pile of non-financial corporate debt is creating interest in safe havens, all to the benefit of precious metals.

Source: Refinitiv Eikon as cited in The Silver Institute¹¹¹

Current account: Current account balances rarely have a direct impact on precious metals, although one good example exists: when India's trade balance has swung to heavy deficits which led to its government raising import duties on gold and silver. Since India is heavily dependent on silver imports, the tax increase created a negative demand shock which was reflected in the price of silver.

Industrial Demand: As mentioned before, industrial demand has historically been a clear influencing factor of silver prices. However, after the financial crisis there has been weak evidence of silver's prices becoming more closely related to its industrial demand.



Silver's Fundamentals

Annual Percentage Changes in Industrial Demand & Silver Price

All that said, investors are still not immune to silver-specific stories on its industrial demand. This is particularly the case where data is more readily available and the link to silver is well known. A good example is silver used in photovoltaic applications for solar energy production, where investors can pick up price changes very quickly.

However, according to the Silver Institute¹¹³, new uses of silver including flexible electronics and wearables such as bandages or clothing can become a game changer in the following years because of the low unit cost of silver in each item and the potentially large number of products that could be fabricated.

Jewelry and Silverware Demand: News on Indian silver imports can have a great impact on investors' sentiment because these imports go to serve the country's sizable silverware and physical investment segments. Indian demand in those two sectors plus jewelry accounts for almost a fifth of total global demand. Not only is this more relevant, but all three can be price sensitive.

Coins and Bars Demand: In the short-term, the fundamental that looks to have the greatest impact on decisions by institutional investors is the strength of coin and bar purchases in the US. First, statistics on US silver Eagle sales are updated every week, typically gaining widespread attention. Second, these figures are assumed to act as a guide to overall investor sentiment. And third, a slump in coin investment can contribute to a rise in COMEX inventories, as we have seen over the last three years.¹¹⁴



US Silver Eagle Sales versus Comex Inventories (Mozzarellas)

Source: Metal Focus as cited in The Silver Institute¹¹²

Investing in Silver

There are numerous ways for investors to gain exposure to the price of silver. These include: investments in derivatives and option contracts through commodity exchanges such as COMEX; investments in physical products such as silver coins and bars; investments in ETPs such as exchange traded funds backed by physical metal, or through ETFs or mutual funds that include mining stocks; and also buying silver mining equities individually, getting direct exposure to specific companies.

Commodity Futures

Paper trading of silver is conducted through the futures market. Future contracts provide investors with exposure to silver without needing to physically hold the metal, potentially improving liquidity and reducing the cost of ownership. Unlike the physical market, futures markets can also allow investors to use leverage.¹¹⁶

The two types of investors that usually participate in the futures market are commercial/institutional users of the metal and speculators. The former group uses the futures market to take positions that will reduce the risk of financial loss due to a change in price. The later, hopes to profit from changes in the price of the contract. Speculators typically close out their positions before the contract is due and never take actual delivery of the commodity itself.¹¹⁷

One downside of investing in the futures market is contango. This is a situation where the futures price of a commodity is higher than the spot price. Contango usually occurs when an asset price is expected to rise over time resulting in an upward sloping forward curve. This can erode gains over time, even if the spot price of silver rises.¹¹⁸

Most futures contracts also have options associated with them. Buying options on futures contracts allow investors to have the right, but not the obligation, to follow through on the transaction. Therefore, if the price of the contract doesn't move in the direction that investors anticipated, they can limit their losses to the cost of the option.¹¹⁹

Physical Investments

Silver bullion are sold by dealers in various sizes and formats and are usually available in coin and bar forms. The advantage of physical ownership is that its value closely tracks the price movements of the broader silver market.¹²⁰ On the other hand, one disadvantages of buying physical silver is that its price moves strongly according to supply and demand dynamics, and a shortage or oversupply of bullion can have the resultant effect on prices. In addition to that, dealers charge premiums to buy silver and discounts to sell bullion, which can negatively impact investor's returns.¹²¹

ETPs on Silver Prices

Exchange-traded funds (ETFs) and Exchange-traded notes (ETNs) that give exposure to the price of silver can either own silver futures or silver directly (physical ownership), which offer investors an alternative to owning silver bullion directly. Each share of a silver ETP corresponds to a certain notional amount of silver. Like any mutual fund or ETP, silver ETPs have expenses that get charged through to shareholders, but they tend to be fairly low.

In addition, ETP shares usually track the prices of its underlying investments pretty efficiently, but sometimes can trade at a premium or discount to the actual value of silver. This can lead to some discrepancies depending on when the shares are traded.¹²² However, the main advantage of silver ETP shares is that it allows investors to participate in the general movements of the silver market. In addition, ETPs provide greater liquidity than holding the metal itself, can be instantly traded, and are more accessible for retail investors than the futures markets.¹²³

ETPs on Silver Miners

ETFs and ETNs can also offer investors exposure to silver miner stocks. For example, there are ETPs that track indexes that measure the performance of stocks of companies primarily engaged in the mining, exploration, and production of silver in developed as well as emerging markets. ETPs on silver miners have the same trading and liquidity characteristics as ETPs on silver prices, with the difference that they offer investors the ability to benefit from the inherent leverage associated with a company in the business of mining silver. Owning silver mining ETPs vs owning an individual silver mining stock has the advantage of stock diversification thus decreasing company-specific risks, such as a company's inability to develop and operate mines as projected, or disruptions at a mine due to labor problems or regulatory hurdles.

The performance of silver miners ETPs and mutual funds depend more on the operational and financial standing, as well as growth prospects, of individual mining companies that are part of the ETP. This performance will also vary depending on the market capitalization or size, business model or geography that the ETPs or mutual funds focus on.¹²⁴

Silver Miners Stocks

Silver mining stocks offer investors the benefits of having exposure to silver producers as well as developers. These stocks tend to be leveraged to the price of silver due to the high fixed costs of extracting the metal. In other words, when silver prices go up, silver mining stocks tend to experience an even greater boost to their business. Their embedded leverage to the price of silver is why in a rising market they can often outperform the silver price and hence offer higher returns. These stocks can sometimes also offer dividend streams.¹²⁵

Mining stocks are considerably more liquid than physical silver as they can be bought and sold during market trading hours. Furthermore, given the complex nature of most orebodies, many primary silver miners also earn revenue from other metals, helping to diversify income streams.

In recent years, weak silver prices have encouraged the industry to reduce costs. As a result, when silver prices rise, this can lead to improved margins, which in turn should lead to higher share prices. Therefore, as silver prices go up, this should deliver further inflows into silver mining equities.¹²⁶



Source: Bloomberg as cited in The Silver Institute¹²⁷

As mentioned before, the leverage inherent to silver mining stocks means that increases in silver prices will have a greater increase to their revenues and earnings and cash generation for the benefit of the company and its shareholders. ¹²⁸To put this into an example, suppose the cost of mining silver is \$10/oz when the price of silver is \$12/oz. The company would be earnings \$2 for every ounce of silver mined. However, if silver prices go up to \$14/oz, or a 16.67% increase from the original price, then their profits would rise to \$4 per ounce, or an increase of 100%.

Performance of Silver Mining Equities

	Base Case Scenario	Price Increase Scenario	% Increase
Miner's Cost	\$10/oz	\$10/oz	-
Silver Price	\$12/oz	\$14/oz	16.67%
Profit	\$2/oz	\$4/oz	100%

To show how this can actually work relative to stock prices, the following chart is a comparison between the price of silver and the mining company First Majestic Silver Corp (Ticker: AG) from the beginning of 2010 until now. As you can see, whenever the price of silver went up, the percentage increase in the stock price was much greater than that of the price of silver. Even more, in years like 2016 the difference was outstanding, with returns of 53% for silver price vs 503% for AG, both from its lowest levels registered before they rallied.



Source: Trading View as cited in Gold Price¹²⁹

In addition to the relationship with the price of silver, the gold-silver ratio can also be a good technical indicator for stock appreciation. As mentioned before, the gold-silver ratio has moved between two clear levels since 1998, and every time the ratio got to those two levels, it reverted to its mean. Whenever the ratio reached its resistance level, it was a clear indicator for investors to buy silver miner stocks. This can be interprested as silver prices being undervalued compared to the price of gold. The red circles in the chart below can clearly picture that.





Comparison of Silver Price with First Majestic Silver Corp (Ticker: AG)

Comparison of Gold-Silver Ratio

with Silver Miner Stocks

PRIME INDEXES | www.primeindexes.com | Silver Mining Industry | 29

However, as every techincal indicator, the gold-silver ratio is not a perfect guideline because certain macroeconomic and fundamental variables can make it behave abnormaly from a historical point of view. This is what happened recently where the ratio reached its highest level ever, mainly due to different issues and significantly exacerbated by the Covid-19 crisis. One of the reasons for this breakdown was that gold prices increased more than silver prices, as investors tried to hedge from market volatily. However, many investors also sold metals to raise cash to cover margin calls and avoid liquidity drawbacks, making the prices of both gold and silver drop during some trading sessions.

Investors should also be aware of the silver deposits that each mine has since that is ultimately what will decide the amount of revenue silver miners will be able to produce. Nowadays, most of the world's silver is extracted alongside base metals or gold.

Given that only 26% of annual world silver production is derived from primary silver producers according to Metal Focus¹³¹, there is a relatively small number of silver focused companies worldwide. Even for these companies, while silver might represent the most significant revenue generator, the portion that comes from other metals can be remarkable, with the ratio of silver to by-product production often changing over time, as the mine matures. Because the revenue generated from other metals can be so mercurial, using silver-based production cost metrics to analyze different mines can be disadvantageous. That is why it is preferable that investors use cash operating margins to assess the financial health of silver mines.¹³²

Regarding silver miners market capitalization, investors can find companies in the senior and junior categories. Junior producers, those with a lower market capitalization, are usually newer entrants to the silver market, but can often offer increased growth opportunities. These are the firms that are in the stage of identifying or developing new mines. Even though they may not sell silver or even have any profits they can still be very attractive for investors.¹³³ These companies usually rely on capital markets or private investors to finance their projects and exploration activities. Besides the fact that silver miners are inherently leveraged to the price of silver, junior silver mining stocks can offer a bigger return than larger silver miners when markets are rallying because of the additional leverage associated with being an early stage mining operation. These companies, many with a geographic focus in Mexico, include Endeavour Silver, Fortuna Silver Mines, Great Panther Silver, Silvercorp, Mag Silver Corp, among others.¹³⁴

In terms of the ability to assess the performance of silver mining companies, there is no straightforward way of doing it. The most commonly used financial metric by market analysts is the EV/EBITDA ratio, with lower numbers presenting better value. Another point to consider when analyzing silver miners is the average mine life, which is usually shorter than that of a gold mine, and differs depending on the types of metals they can extract from those mines.¹³⁵

Finally, there are also some silver stocks that pay dividends like Fresnillo and Wheaton Precious Metals. Generally, investors are less interested in the dividend yield of precious metal stocks and more focused in the gearing of earnings to metal price movements.¹³⁶

Sustainability

There is a clear trend nowadays to push investors and companies to be socially and environmentally conscious to avoid the unpleasant result of experiencing global warming. Within the mining sector, this is also the case. According to a World Bank report, "The Growing Role of Minerals and Metals for a Low-Carbon Future", it is expected that new types of greener technologies will create a substantial demand for metals such as silver to move towards a low-carbon future.

The report comments that these technologies will create opportunities for companies that promote environmentally friendly production and countries with longterm strategies for sustainable extraction. The future demand for specific metals will not only depend on the degree to which countries commit to a low-carbon future, but also on the technologies that they end up developing. Wind, solar, and low-carbon technologies that can emerge will play a key role in defining the commodity marketplace over the next 50 years.¹³⁷

Lastly, but not less important, there are also significant challenges that still have to be resolved by countries with regards to the social, environmental and carbon footprint of increased mineral extraction. If not properly managed, the growing demand for minerals and metals to supply these greener technologies could end up harming the efforts and policies of supplying countries to meet national objectives and commitments regarding climate change and related sustainable development goals. That is why both countries and companies will need to be extremely careful and ensure that ecosystems do not get affected.¹³⁸

Conclusions

The silver industry has had an important role in the history of human development, from the early ages when silver was used as a medium of exchange by ancient societies, to when it became a luxury product and used as jewelry, until the present where it is most predominantly used as a technological and innovative industrial material. Silver has also the advantage of being found in every corner of the world and being extracted and recycled by different companies with different business purposes. Most importantly, the uses of silver are increasing with the development of new technologies.

From an investment standpoint, silver can offer investors a wide range of options, since it can be used as a store of value, can be physically bought, can be traded through stocks and ETPs, can be used as a hedging strategy, and also utilized in new technologies such as solar power. Silver and silver stocks offer good portfolio diversification and are in high demand in both periods of market turmoil as well as in years of strong economic and industrial growth.

References

1 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

2 https://www.docsity.com/es/el-oro-y-la-plata-y-sus-usos-en-la-industria/5292633/

3 https://www.silverinstitute.org/global-silver-demand-4-2018-fueled-soaring-investment-demand-along-rising-jewelry-silverware-offtake/

4 https://www.mgsrefining.com/blog/2014/07/02/cupellation-and-the-birth-of-precious-metal-refining/

5 https://www.theexpresswire.com/pressrelease/Silver-Market-Global-Industry-Size-Share-Key-Companies-Trends-Growth-and-Regional-Forecasts-Researchby-2022_10543746

- 6 https://nameplatesdiv.com/what-exactly-are-photosensitive-plates/
- 7 https://geology.com/articles/uses-of-silver/
- 8 https://www.911metallurgist.com/blog/parting-separate-gold-silver-melting
- 9 https://preciousmetalsstocks.info/silver-facts/silver/
- 10 http://www.sellgoldhq.com/why-is-silver-cheaper-than-gold/
- 11 https://www.jewelrynotes.com/sterling-silver-vs-pure-silver-what-is-the-difference/
- 12 https://geology.com/articles/uses-of-silver/
- 13 https://www.britannica.com/technology/silver-processing
- 14 https://www.chemicool.com/elements/silver.html

15 Readon, Arthur C. (2011). Metallurgy for the Non-Metallurgist. ASM International. pp. 73–84.

16 de Callataÿ, François (2005). "The Greco-Roman Economy in the Super Long-Run: Lead, Copper, and Shipwrecks". Journal of Roman Archaeology. 18: 361–72 [365ff].

17 Patterson, C.C. (1972). "Silver Stocks and Losses in Ancient and Medieval Times". The Economic History Review. 25 (2): 205235 (216, table 2, 228, table 6).

18 Andreas Brumby et al. "Silver, Silver Compounds, and Silver Alloys" in Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH, Weinheim, 2008.

- 19 https://www.925-1000.com/silverhistory.html
- 20 https://www.britannica.com/technology/silver-processing

21 https://www.investopedia.com/articles/markets-economy/083116/10-countries-produce-most-silver.asp

- 22 http://raregoldnuggets.com/?p=3978
- 23 https://www.britannica.com/technology/silver-processing
- 24 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf
- 25 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf
- 26 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf
- 27 https://www.sciencedirect.com/topics/engineering/open-pit-mining

28 https://www.angloamerican.com/futuresmart/our-industry/mining-explained/digging-deeper-mining-methods-explained

- 29 https://www.britannica.com/technology/silver-processing
- 30 https://www.britannica.com/technology/silver-processing
- 31 https://www.britannica.com/technology/silver-processing
- 32 https://www.britannica.com/technology/silver-processing
- 33 https://www.risejewellery.com/how-is-sterling-silver-jewelry-made/
- 34 https://www.onecklace.com/tips/why-does-silver-tarnish/
- 35 https://www.britannica.com/technology/silver-processing/The-metal-and-its-alloys

- 36 https://www.fusion-inc.com/brazing/silver-brazing/
- 37 https://www.statista.com/statistics/253293/global-gold-production-since-2005/
- 38 https://www.statista.com/statistics/253293/global-gold-production-since-2005/
- 39 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf
- 40 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf
- 41 https://www.statista.com/statistics/253339/leading-silver-producing-countries/

42 https://www.forbes.com/sites/greatspeculations/2019/10/25/silver-prices-10-yearprice-analysis-and-production-demand-gdp-dynamics/#66fe5b2b406b

43 https://www.statista.com/statistics/253339/leading-silver-producing-countries/

44 https://etfdailynews.com/news/u-s-silver-production-at-the-lowest-level-in-morethan-70-years/

- 45 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf
- 46 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf
- 47 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf
- 48 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf
- 49 https://geology.com/articles/uses-of-silver/
- 50 https://www.techinstro.com/silver-conductive-paste/
- 51 https://www.sciencedaily.com/releases/2011/01/110131133005.htm
- 52 https://www.thoughtco.com/what-are-cds-made-of-607882
- 53 https://www.eetimes.com/opinion-recharge-your-engineering-batteries/
- 54 https://www.zpowerbattery.com/silver-zinc-vs-li-ion-microbatteries/
- 55 https://energyeducation.ca/encyclopedia/Solar_collector

56 https://www.lucasmilhaupt.com/EN/Resource-Library/Metal-Joining-Brazing-vs-Silver-Soldering.htm

- 57 https://toxtown.nlm.nih.gov/chemicals-and-contaminants/ethylene-oxide
- 58 https://www.cancer.org/cancer/cancer-causes/formaldehyde.html
- 59 https://www.investopedia.com/terms/s/silver-standard.asp
- 60 https://www.thebalance.com/what-is-the-history-of-the-gold-standard-3306136
- 61 https://www.investopedia.com/terms/b/brettonwoodsagreement.asp
- 62 https://www.marketplace.org/2018/09/05/5-things-70s-inflation/
- 63 https://www.investopedia.com/ask/answers/09/gold-standard.asp
- 64 https://www.thestreet.com/markets/commodities/investing-in-silver-14767113
- 65 https://geology.com/articles/uses-of-silver/
- 66 https://www.silverinstitute.org/silver-supply-demand/
- 67 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf

68 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

69 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf

70 https://www.jmbullion.com/investing-guide/types-physical-metals/silver-solar-demand/

71 University of Kent. "Solar panel demand causing spike in worldwide silver prices." ScienceDaily. ScienceDaily, 17 April 2019. www.sciencedaily.com/releas-es/2019/04/190417102750.htm

- 72 https://www.silverinstitute.org/silver-supply-demand/
- 73 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf

74 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf page 9-11

75 https://www.forbes.com/sites/greatspeculations/2019/10/25/silver-prices-10-yearprice-analysis-and-production-demand-gdp-dynamics/#66fe5b2b406b

- 76 https://www.asm-recycling.co.uk/blog/what-is-scrap-metal/
- 77 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf

78 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

79 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf page 7-9

- 80 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf
- 81 https://capital.com/comex-definition
- 82 https://silverprice.org/spot-silver.html
- 83 https://www.silverinstitute.org/wp-content/uploads/2019/04/WSS2019V2.pdf
- 84 https://www.moneymetals.com/precious-metals-charts/silver-price
- 85 https://www.jmbullion.com/charts/silver-prices/

86 https://dashboards.trefis.com/no-login-required/uPpTICAg/Silver-Prices-10-Year-Price-Performance-And-Production-Demand-GDP-Analysis?fromforbesandarticle=trefis191023

87 https://www.forbes.com/sites/greatspeculations/2019/10/25/silver-prices-10-year-price-analysis-and-production-demand-gdp-dynamics/#e2bdf06406b2

88 https://www.marketwatch.com/story/physical-demand-for-silver-spikes-as-pricedrops-to-an-11-year-low-2020-03-19

89 https://silverprice.org/spot-silver.html

90 https://www.lombardiletter.com/silver-prices-surge-47-percent-2020-hereswhy/32578/?utm_source=OnSite&utm_medium=HomePage&utm_content=%7bhome%7d

91 https://goldprice.com/gold-silver-ratio/

92 https://www.macrotrends.net/1441/gold-to-silver-ratio

93 https://www.nasdaq.com/articles/the-longest-record-broken%3A-gold-silver-ratiohits-highest-in-over-5000-years-2020-03-17

94 https://www.cnn.com/2020/04/03/economy/coronavirus-debt-deficits/index.html

95 https://www.cnbc.com/2020/03/24/goldman-says-buy-gold-now-time-to-buy-thecurrency-of-last-resort.html

96 https://www.cnbc.com/2020/04/01/investors-should-have-up-to-10percent-in-thishedge-against-the-unexpected-says-the-godfather-of-gold.html

97 https://goldprice.org/gold-silver-ratio.html

98 https://www.statista.com/statistics/299609/gold-demand-by-industry-sector-share/

99 Goldman Sach's Investment Research division. "Metals Express: Gold to silver price ratio to stay high for a while". 26 April, 2018.

100 Goldman Sach's Investment Research division. "Metals Express: Gold to silver price ratio to stay high for a while". 26 April, 2018.

101 Goldman Sach's Investment Research division. "Metals Express: Gold to silver price ratio to stay high for a while". 26 April, 2018.

102 Goldman Sach's Investment Research division. "Metals Express: Gold to silver price ratio to stay high for a while". 26 April, 2018.

103 https://www.outsiderclub.com/report/the-coming-silver-shock/1346

104 Goldman Sach's Investment Research division. "Metals Express: Gold to silver price ratio to stay high for a while". 26 April, 2018.

105 https://www.marketwatch.com/story/physical-demand-for-silver-spikes-as-pricedrops-to-an-11-year-low-2020-03-19

106 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

107 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInterimReport2019.pdf 108 https://finance.yahoo.com/quote/SI%3DF/history?period1=951696000&period2=1586044800&interval=1d&filter=history&frequency=1d

109 https://finance.yahoo.com/quote/GC%3DF/history?period1=951696000&period2=1586044800&interval=1d&filter=history&frequency=1d

110 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

111 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

112 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

113 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

114 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

115 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

116 https://www.globalxetfs.com/silver-explained/

117 https://www.investopedia.com/investing/commodities-trading-overview/

118 https://www.investopedia.com/terms/c/contango.asp

119 https://www.investopedia.com/investing/commodities-trading-overview/

120 https://www.fool.com/investing/2017/05/22/how-to-invest-in-silver-the-right-way. aspx

121 https://www.globalxetfs.com/silver-explained/

122 https://www.fool.com/investing/2017/05/22/how-to-invest-in-silver-the-right-way. aspx

123 https://www.investopedia.com/terms/s/silver-etf.asp

124 https://www.fool.com/investing/silver-etf-how-to-find-best-investment-2019.aspx

125 https://www.fool.com/investing/2017/05/22/how-to-invest-in-silver-the-right-way. aspx

126 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

127 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

128 https://seekingalpha.com/article/4327199-impact-silver-rising-silver-prices-and-potential-gold-finds-should-revalue-stock

129 https://goldprice.org/gold-silver-ratio.html

130 https://goldprice.org/gold-silver-ratio.html

131 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

132 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

133 https://www.sunshineprofits.com/gold-silver/how-do-i-buy-gold/gold-and-silvermining-stocks/

134 https://www.juniorminers.com/companies.html

135 https://seekingalpha.com/article/4009168-benchmarking-primary-silver-miners

136 https://www.silverinstitute.org/wp-content/uploads/2017/05/SilverInvestment2019. pdf

137 https://www.worldbank.org/en/topic/energy/publication/minerals-and-metals-toplay-significant-role-in-a-low-carbon-future

138 https://www.worldbank.org/en/topic/energy/publication/minerals-and-metals-toplay-significant-role-in-a-low-carbon-future



www.primeindexes.com