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SOME REMARKS ON THE WORLD PRODUCTION OF GOLD IN THE PERIOD OF 1900–2010

Abstract

In the last one hundred years the production of gold has risen one hundred times. Today, China is the main gold producer. Gold is most commonly used in electronic and jewellery industries. In 2001 the average price of an ounce of gold was 271 US dollars. In 2008 it reached 871 US dollars. The production of gold is more and more expensive. In the paper the statistical analysis of the world gold production is presented. The analysis covers the period of 1900–2010. The purpose of the article is to show how important gold production is for the world economy.

Keywords: world gold production, Shapiro-Wilk statistics.

Introduction

Gold is a chemical element with the atomic number 79. It belongs to a subgroup of coinage metals. It is a precious metal, soft and very ductile. Gold is also a good thermal and electrical conductor with an oxidation number +1 and +3. This metal is being mainly used in the form of alloys in jewellery as well as in electrical and electronic industry. It belongs to rare metals. Despite many problems, the world production of gold is continuously developing. The peak production of this metal was observed in 2001 and amounted to 2,600 tonnes. Leading producers of gold

include China, the RSA, the USA, Australia, Peru, Russia, Canada and Indonesia. Present years are being mainly characterised by a decline in gold production in the RSA and an increase in its production in China. The cost of one ounce of gold was on average USD$ 872 in 2008 and USD$ 871 in 2009. These have been the highest prices for over 150 years. The largest world gold producer is China for the third time in a row. It broke its own record of 285 tonnes in 2008 to 300 tonnes in 2009. China's production of gold has increased by 62% since 2001, whereas its world production decreased by 9.6% in the same time period. The RSA lost its first place in gold production in 2007. In relation to 2001, gold production in the RSA dropped from 402 tonnes to 213 tonnes in 2009. This drop can be partly attributed to the problems related to energy production and massive depletion of gold deposits. History shows that gold stores the value of property. This is the most visible during financial crises, hyper-inflation and currency reforms.

Germany after the First World War can be given as an example. Gold was the safest investment by means of which people could protect their property. In 1919, the Germans paid 200 Deutsche marks for one ounce of gold, whereas in 1923 one ounce of gold was priced at 100 milliard Deutsche marks. Similar problems were experienced by the Polish Marka (Polish mark) until Władysław Grabski's reforms.

The opposite situation when gold leads to inflation and economic decline occurs rarely. However, this happened in case of Spain which, being a poor country, became a very rich country in a short time and this all due to the Spanish Conquest of America and unusual inflow of gold. A consequence of this was "overheating of economy" and economic crisis.

The following factors inducing an increase in gold prices include: 1) Growth of inflation stimulated by growing public debt and growing monetary base[1]; 2) Favourite relations of gold prices to other assets, mainly the stock market, much below turning points in history; and 3) Annual deficit in the gold market where demand for gold increases, with a decreasing gold mining. We also rely on historical data related to the cyclic character of conjuncture. The risk factors affecting the gold price include: High variability of gold prices resulting from periodic realisation by speculative hedging funds. Corrections amount to 15–20% from periodic price peaks. This is the next reason why allocation of resources in the instruments based on the rate of

[1] See D. Begg, S. Fischer, R. Dornbusch, *Economics*, McGraw-Hill, International (UK) Limited 1994, p. 253.

gold in the time horizon of several years is being recommended. In case of Polish investors, foreign exchange risk results from basing the price of gold on the exchange rate of American dollar at the stock exchange in the United States of America and London. If gold transactions are not secured with respect to the exchange rate, valuation of the currency itself affects deposit results in case of high variability of PLN exchange rate. Another risk factor may be state intervention, particularly operations of central banks which stabilise the gold prices through strong demand for that ore within Central Bank Gold Agreement.

Until 1971, American dollar was exchangeable for gold in clearances between central banks. The gold price was established rigidly in international clearances at USD 35 per ounce. In the free-market trade, the cost of gold was USD 40 per ounce which was induced, among others, by the growing debt of the USA, which exceeded three times its gold reserves. Taking advantage of price differences, France carried out an arbitration and exchanged its total currency reserves for gold at an exchange rate of USD 35.

1. Analysis of world gold production in 1900–2010

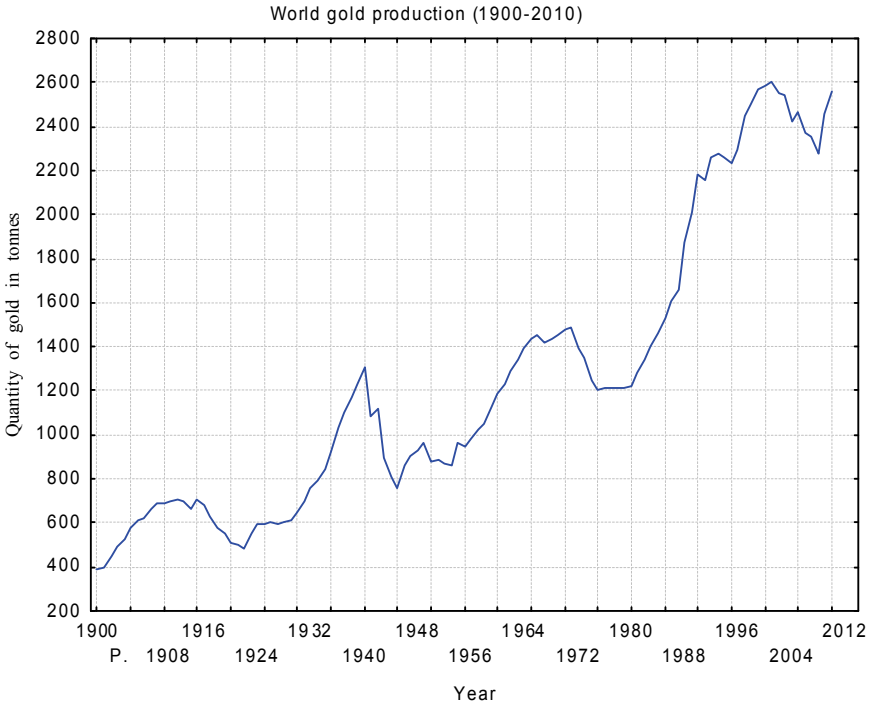
As it can be seen from Figure 1, gold production peaks occur in 1916, 1940, 1971 and 2001. From 1900 to 1935, gold production did not exceed 1,000 tonnes each year. From 1936 to 1940, gold production grew constantly from 1,030 tonnes to 1,310 tonnes. In 1943–1956, like in 1900–1935, gold production decreased below 1,000 tonnes. Starting with 1957 to 1971, gold production grew constantly, with some minor exceptions, reaching 1,490 tonnes in 1971. A barrier of 2,000 tonnes was exceeded in 1989 and this trend has been sustained until now.

Table1. Descriptive statistics

Average	Median	Modal value	Number of modal value	Minimum	Maximum	Variance	Standard deviation	Kurtosis
1,247.23	1,120	1,210	4	386	2,600	424,776	651.75	–0.5478

Source: own studies on the basis of www.dani.2989.com (16.05.2012).

Figure 1. World gold production



Source: own studies – on the basis of www.dani.2989.com (16.05.2012).

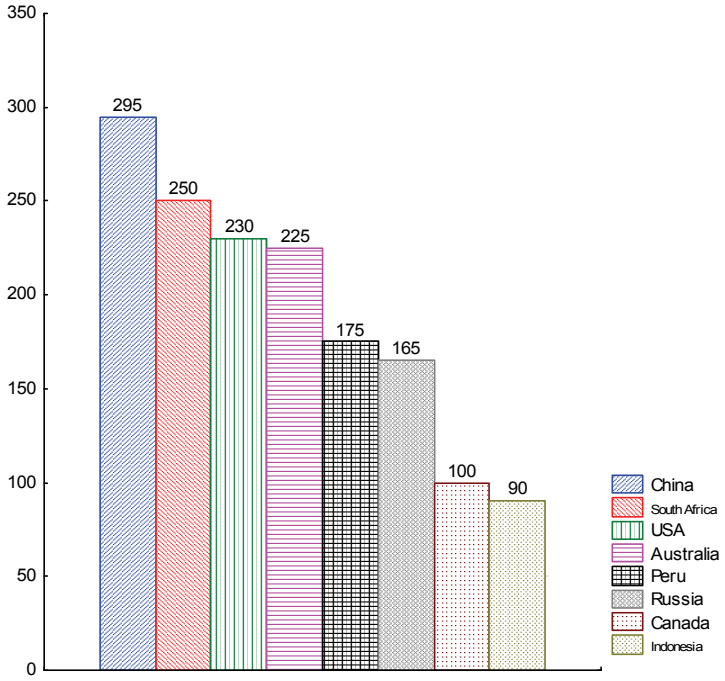
As shown in Table 1, the average value of gold production amounted to 1,247.23 tonnes in 1900–2010, with the median value of 1,120 tonnes and the modal value of 1,210 tonnes.

The least gold production was observed in 1900, that is 386 tonnes, whereas the highest one in 2001, that is 2,600 tonnes. The variance, which is 424,776 numerically, speaks of a quite large dispersion in relation to the average value. Negative kurtosis is evidence of the fact that gold production distribution graph is less concentrated due to the axis being drawn through the average point of 1,247.23.[2]

[2] See H. Kowgier, *Elementy rachunku prawdopodobieństwa i statystyki na przykładach z ekonomii*, WNT, Warszawa 2011, p. 190.

The leading gold producers in 2008 are presented in Figure 2. The Figure also illustrates the fact who is a gold production magnate in our times. Four countries definitely outrun the other ones, i.e. China (295 tonnes), the RSA (250 tonnes), the USA (230 tonnes) and Australia (225 tonnes).

Figure 2. Leading producers of gold in 2008

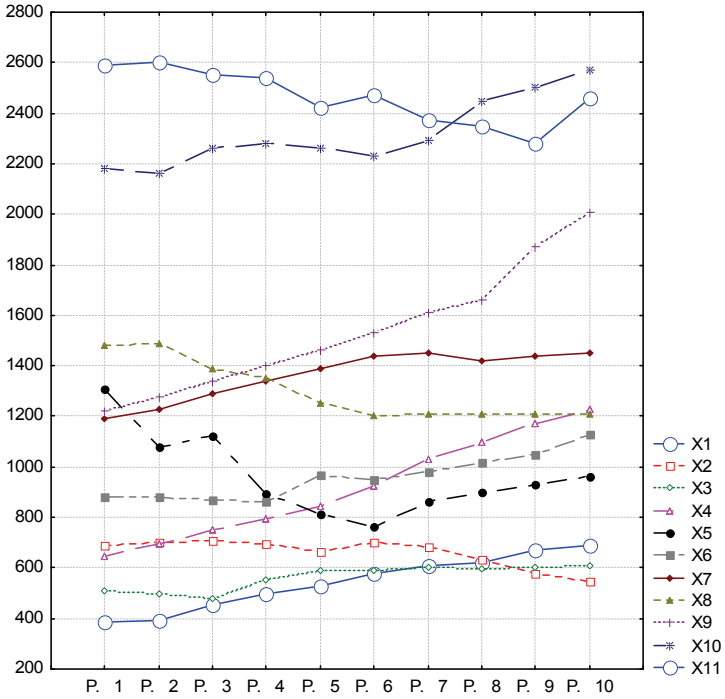


Source: own studies.

Figure 3 shows how gold production, with its decreases and increases, looked like in the respective time periods.

As it can be seen in the Figure 3, the rise of the variables X10 and X11 is the highest.

Figure 3. World gold production in chosen periods



X1 – world gold production 1900–1909, X2 – world gold production 1910–1919, X3 – world gold production 1920–929, X4 – world gold production 1930–1939, X5 – world gold production 1940–1949, X6 – world gold production 1950–1959, X7 – world gold production 1960–1969, X8 – world gold production 1970–1979, X9 – world gold production 1980–1989, X10 – world gold production 1990–1999, X11 – world gold production 2000–2009.

Source: own studies on the basis of www.dani.2989.com.

Table2. Correlations

Variable	Correlations Determined coefficients of correlation are significant at p < 0,05000 N = 10 (Data paucity was eleminated on case – to case basis)										
	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
X1	1.00	**–0.77**	**0.90**	**0.98**	**–0.64**	**0.90**	**0.94**	**–0.93**	**0.96**	**0.87**	**–0.85**
X2	**–0.77**	1.00	–0.61	**–0.84**	0.14	**–0.91**	–0.54	0.54	**–0.90**	**–0.94**	0.59
X3	**0.90**	–0.61	1.00	**0.84**	**–0.77**	**0.80**	**0.92**	**–0.93**	**0.80**	**0.66**	**–0.82**
X4	**0.98**	**–0.84**	**0.84**	1.00	–0.52	**0.94**	**0.88**	**–0.86**	**0.98**	**0.92**	**–0.82**
X5	**–0.64**	0.14	**–0.77**	–0.52	1.00	–0.39	**–0.84**	**0.81**	–0.46	–0.28	0.60
X6	**0.90**	**–0.91**	**0.80**	**0.94**	–0.39	1.00	**0.76**	**–0.76**	**0.96**	**0.89**	**–0.72**

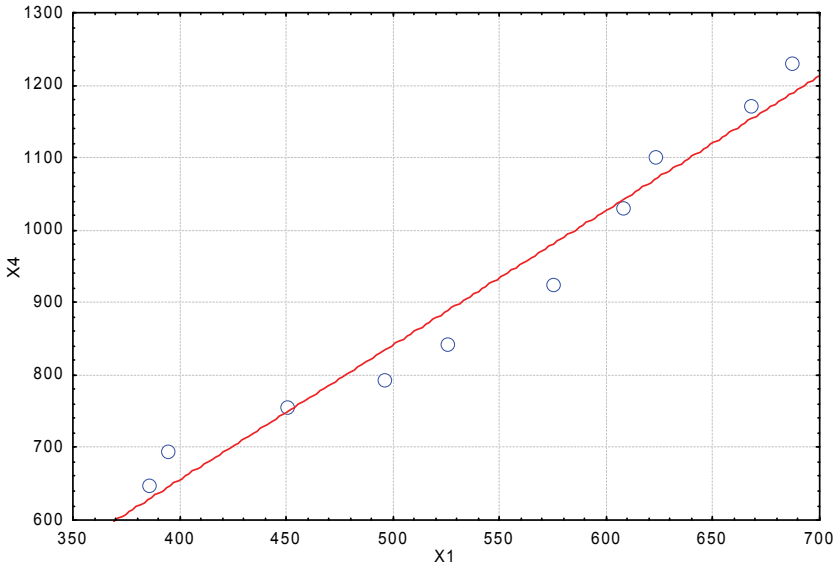
	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
X7	**0.94**	–0.54	**0.92**	**0.88**	**–0.84**	**0.76**	1.00	**–0.99**	**0.83**	**0.68**	**–0.83**
X8	**–0.93**	0.54	**–0.93**	**–0.86**	**0.81**	**–0.76**	**–0.99**	1.00	**–0.80**	**–0.67**	**0.85**
X9	**0.96**	**–0.90**	**0.80**	**0.98**	–0.46	**0.96**	**0.83**	**–0.80**	1.00	**0.94**	**–0.74**
X10	**0.87**	**–0.94**	**0.66**	**0.92**	–0.28	**0.89**	**0.68**	**–0.67**	**0.94**	1.00	**–0.68**
X11	**–0.85**	0.59	**–0.82**	**–0.82**	0.60	**–0.72**	**–0.83**	**0.85**	**–0.74**	**–0.68**	1.00

Source: own studies.

As it can be seen from Table 2 there is a large or a very large correlation (positive and negative) between the volume of gold production in individual periods[3] (see bold font). They are most often statistically significant.

Growing demand for gold may have large influence on the existence of positive correlations. Similarly, the growth of gold production costs is likely to have significant influence on the existence of negative correlations.

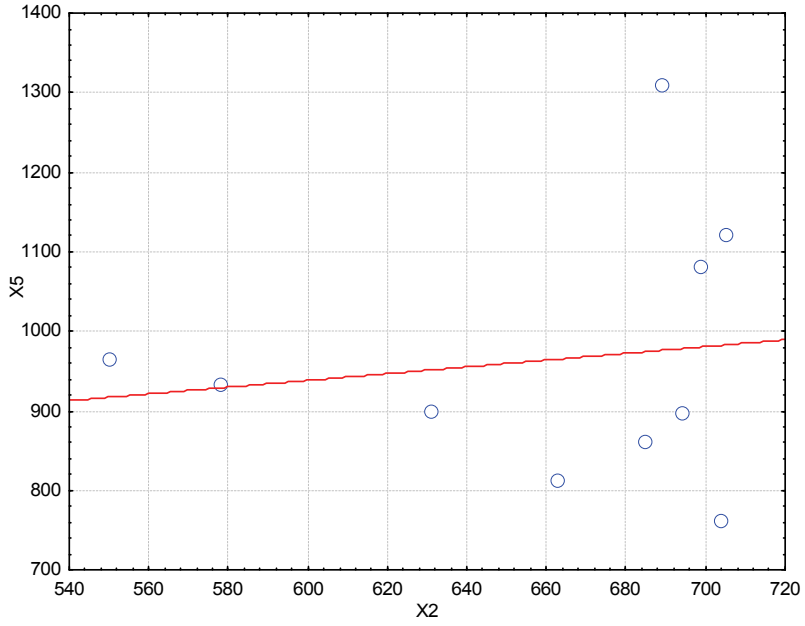
Figure 4. Graph of dispersion – shows significant correlation between X1 and X4



Source: own studies.

[3] See A. Stanisz, *Przystępny kurs statystyki w oparciu o program STATISTICA PL*, StatSoft Polska Sp.z o.o., Kraków 1998, p. 210.

Figure 5. Graph of dispersion – shows insignificant correlation between X2 and X5



Source: own studies.

Let's consider of the Shapiro-Wilk statistics:

$$W = \frac{[\sum_{i=1}^{\left[\frac{n}{2}\right]} a_{n-i+1}(Y_{n-i+1} - Y_i)]^2}{\sum_{i=1}^{n}(Y_i - \overline{Y})^2} \quad (1)$$

where:

a_{n-I+1} – the Shapiro-Wilk coefficients (from statistical tables),

$\left[\frac{n}{2}\right]$ – integral part of number $n/2$,

Y_i – order statistics at number i.

In case of the variable X1 we receive:

$n = 10$ – size of test, and $\left[\frac{10}{2}\right] = 5$.

Table 3. Auxiliary calculation of the Shapiro-Wilk statistics for variable X1

i	Y_i	$Y_{n-i+1} - Y_i$	α_{n-i+1}	$\alpha_{n-i+1}(Y_{n-i+1} - Y_i)$	$(Y_i - \bar{Y}_i)$
1	386	301	0.5739	172.7439	24,180.25
2	395	273	0.3291	89.8443	21,462.25
3	451	172	0.2141	36.8252	8,190.25
4	496	112	0.1224	13.7088	2,070.25
5	526	49	0.0399	1.9551	240.25
6	575				1,122.25
7	608				4,422.25
8	623				6,642.25
9	668				16,002.25
10	687				21,170.25
Total sum	5,415	–	–	315.0773	105,502.50

Source: own studies.

Y_i – values of the variable X1,

$$\bar{Y} = \frac{5415}{10} = 541.5.$$

From (1) and Table 3, we receive:

$$W = \frac{(315.0773)^2}{105{,}502.5} = 0.94096 \tag{2}$$

Because $W \notin <0, W_\alpha> = <0; 0.8420>$, the hypothesis that X1 is normally distributed could not be rejected at the $\alpha = 0{,}05$ level of significance.

Calculations for variable X4 are presented in Table 4.

Table 4. Auxiliary calculation of the Shapiro-Wilk statistics for variable X4

i	Y_i	$Y_{n-i+1} - Y_i$	α_{n-i+1}	$\alpha_{n-i+1}(Y_{n-i+1} - Y_i)$	$(Y_i - \bar{Y}_i)$
1	2	3	4	5	6
1	648	582	0.5739	334.0098	73,170.25
2	695	475	0.3291	156.3225	49,952.25
3	754	346	0.2141	74.0786	27,060.25
4	793	237	0.1224	29.0088	15,750.25
5	841	83	0.0399	3.3117	6,006.25
6	924				30.25

1	2	3	4	5	6
7	1030				12,432.25
8	1100				32,942.25
9	1170				63,252.25
10	1230				97,032.25
Total sum	9185	–	–	596.7314	37,7628.50

Source: own studies.

From (1) and the Table 4, we receive:

$$W = \frac{(596.7314)^2}{377{,}628.5} = 0.94295 \tag{3}$$

Because 0,94295 $\notin$ <0, W_α > = <0; 0.8420>, the hypothesis that X4 is normally distributed could not be rejected at the α = 0,05 level of significance.

For X2 we receive: W = 0.79836 $\in$ <0; 0.8420>, for X3: W = 0.80537 $\in$ <0; 0.8420>, for X8: W = 0.78793 $\in$ <0; 0.8420>. Hypothesis, that these variables are normally distributed should be rejected at the α = 0,05 level of significance. Similarly, we can use the Shapiro-Wilk test to the remaining variables.

Gold production can be also examined using so called Elliott wave principle to attempt to forecast what the future trend referring to that production will be. Elliott wrote: "Nature's Laws embraces the most important of all elements, timing. Nature's Laws is not a system, or method of playing the market, but it is a phenomenon, which appears to mark the progress of all human activities. Its application to forecasting is revolutionary."[4]

Conclusions

The interest in gold production has been growing in the world for a long time. The reason for that is its importance in various industries including jewellery. Since 1989 the world gold production has not dropped below 2,000 tonnes annually. The leading gold producers are such highly developed countries as China, South Africa,

[4] See R. Fischer, *Fibonacci Applications and Strategies for Traders*, John Wiley & Sons 1993, p. 10.

the USA and Australia. There is a large or a very large correlation between the volume of gold production in time individual periods.

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UWAGI NA TEMAT ŚWIATOWEJ PRODUKCJI ZŁOTA W LATACH 1900–2010

Streszczenie

W minionych stu latach produkcja złota wzrosła 4 razy. W obecnym czasie najwięcej złota produkują Chiny. Najczęściej złota używa się w przemyśle elektronicznym i jubilerstwie. Uncja złota w 2001 roku kosztowała średnio 271 dolarów. W 2008 roku za uncję złota należało już zapłacić 871 dolarów. Produkcja złota coraz więcej kosztuje. W pracy przedstawiono analizę statystyczną produkcji złota na świecie. Analiza dotyczy lat 1900–2010. Celem artykułu było pokazanie jak ważne miejsce w świecie zajmuje produkcja złota.

Słowa kluczowe: światowa produkcja złota, test Shapiro-Wilka.