__Financial and Banking Services Market__

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DRIVERS OF GOLD FRACTION IN GLOBAL EXCHANGE RESERVES

Abstract

Over the last 20 years, central banks have exhibited both declining demand for gold and tendency to substantially expand gold holdings. At the same time, the aggregate share of gold in global exchange reserves remains considerably volatile. Growing political and military instability in the world is a strong argument in favour of central banks' renewed interest in gold holdings. This is confirmed by the actions that some states take. However, on the aggregate level, the positive relationship between geopolitical risks and rising share of gold in exchange reserves is not evident. The same is true for the diversification towards gold from the viewpoint of large exchange reserves hoarding. The uncertainty factor and the benefit of holding / opportunity costs factor play a key role in determining the aggregate share of gold in global exchange reserves. Moreover, gold prices, provided their trend is predictable, better explain the growing share of gold in the exchange reserves than interest rates on the US market. This is due to the growing complexity of the global monetary conditions, which are sensitive to historical context and expectations when it comes to the choice of reserve assets.

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138

V i k t o r K o z i u k
Drivers of gold fraction
in global exchange reserves

Key Words:

gold; exchange reserves; central banks; geopolitical risks; diversification of reserves; global monetary conditions.

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2 figures, 2 tables, 22 references.

Introduction

Foreign exchange reserves continue to be the focus of many studies. Moscow's war against Ukraine has only highlighted the question of the role that external central bank assets play in ensuring geopolitical stability. No less important is the role gold plays in the management of foreign exchange reserves in cases where certain countries take into account the risks of geopolitical confrontations. Special interest in gold is naturally caused by its features as a reserve asset:

1. the precious metal is not someone's liability, meaning it is not subject to sovereign solvency risk;

2. gold does not depend on the behaviour of the issuer of reserve assets, and therefore cannot be subject to restrictions;

3. gold embodies value substantially (intrinsic value).

It is this specific feature of this reserve asset that often encourages the view of gold as a safe asset, which allows you to hedge the so-called tail risks, or, in other words, the risks of unexpected and hard-to-predict events. Of course, global financial shocks and geopolitical conflicts fall under this definition. There is an additional geopolitical argument in favour of gold: the geopolitical ambitions of countries encourage them to go beyond the traditional bounds of reserve assets dominated by bonds denominated in hard currencies. The geopolitical status of

the country can be considered a motive in the management of exchange re-
serves.

However, the role of geopolitical factors in the management of exchange
reserves is often debated with strong counter-arguments. It is based on the eco-
nomic criteria of optimal management of reserves, which, in turn, are the practi-
cal result of the adoption of portfolio approach to the management of external as-
sets by the central banks. In particular, gold prices are volatile, physical storage
of the precious metal in significant volumes is an expensive indulgence, opportu-
nity costs of holding it are significant, and fiscal revaluation losses can be sub-
stantial. Accordingly, despite a certain set of advantages to holding gold, there
are also drawbacks. This means that the impact of geopolitical factors on the ag-
gregate changes in the share of gold in reserves of central banks may not corre-
spond to the specific portfolio decisions of individual countries, going beyond the
dominance of portfolio arguments regarding the optimal share of gold in re-
serves. In light of this, an empirical analysis of competing hypotheses (geopoliti-
cal factors, uncertainty, opportunity costs of holding or diversification motives for
larger reserves) is also relevant regarding the extent to which a reorientation in
favour of gold is justified if a country is limited in its ability to convert it into cur-
rency. This article shows that geopolitical factors are clearly overstated, and in-
stead economic motives may be variable, and the diversification of larger re-
serves does not necessarily apply to gold.

Literature Review

There are several distinct directions in the economic literature that present
significantly different starting hypotheses regarding the role of gold in the man-
agement of exchange reserves. Among them is the approach close to interna-
tional political economy, which emphasises that the choice of reserve assets is
determined by geopolitical or historical factors, and not exclusively economic
ones. Another approach states that gold plays a special role in reserve manage-
ment due to the specific behaviour of its prices, and so portfolio optimization en-
tails special treatment for the metal. Yet another approach emphasizes the con-
flict between diversifying reserves in favour of gold and maintaining liquidity of
reserves for reasons of external vulnerability. The growing need to diversify re-
serves as they continue to accumulate, however, may not contradict the motiva-
tion to maintain more liquid reserves in case of an external shock. As a result,
gold cannot preclude the choice in favour of a more complex balance of foreign
assets.

Conventionally, the geopolitical approach abounds with firm convictions
that gold is a special central bank asset. The article of Aizenman and Inoue
(2012) emphasizes that an imperial past as a motive to maintain geopolitical

140

V i k t o r   K o z i u k
Drivers of gold fraction
in global exchange reserves

grandeur translates into higher volumes of demand for gold. In other words, imperial narcissism manifests itself in flaunting the ability to make sub-optimal decisions regarding the accumulation of gold due to perceptions of geopolitical freedom of manoeuvre (Koziuk, 2022). The selection of reserve assets for reasons of geopolitical orientation and bilateral relations is also presented in the article by Eichengreen et al. (2019). Direct warnings about the prevailing role of geopolitical motives are presented in the work of Bahrami Moghadam and Baghernia (2020). The historical role of the demand for gold as part of the reserves also depends on the economic power of the countries, in particular due to the significant volumes of exports (Aizenman & Inoue, 2012; Barros, 2020; Oktay et al., 2016). A survey of gold reserve managers also showed that geopolitical motives are important to a third of central banks (Carver & Pringle, 2020).

Nevertheless, there is a problem of correctly interpreting the geopolitical approach. On the one hand, geopolitical motives may be related to the very nature of gold as an asset, as not being a liability, it makes those who own it independent from the issuer of the reserve assets (Bahrami Moghadam & Baghernia, 2020). On the other hand, geopolitical risks are often seen as drivers of behavior on the financial markets, in particular for gold prices; therefore, the demand for gold reflects its ability to perform the role of a safe asset. Numerous articles show that the price of gold and the demand for it on the part of central banks correspond to the motives of improving the stability of the reserves value by investing in safe assets (Baur & McDermott, 2010; Roboredo, 2013; O'Connor et al., 2015; Baur & Lucey, 2010; Beckmann et al., 2015).

The «safe haven» approach seems quite universal, as it allows for the translation of a geopolitical shock into the language of portfolio analysis, and at the same time demonstrates that the demand for gold stabilizes the portfolio in the case of an inverse correlation with other financial instruments (Baur & McDermott, 2010; Roboredo, 2013; O'Connor et al., 2015; Baur & Lucey, 2010; Beckmann et al., 2015; Emmrich & McGroarty, 2013). This has the potential to increase demand for gold and opens up opportunities for central banks to improve the structure of their reserves in the same way that institutional investors do (Emmrich & McGroarty, 2013). In other words, if gold prices are inversely correlated with the yield of bonds (hedging the risk of a decrease in the yield of financial assets), stocks (hedging the risk of collapses in financial markets), the dollar rate and inflation in the United States (hedging inflation risks), then the inclusion of the precious metal in the portfolio improves its stability. However, there is no convincing evidence as to what exactly constitutes the optimal share of gold in central bank reserves (Zulaica, 2020). The portfolio-based approach and the value-at-risk approach give different results (Baur & McDermott, 2010; Roboredo, 2013; Zulaica, 2020). Surveys show that most managers believe the optimal share of gold should not exceed 25% (Carver & Pringle, 2020), while a higher share of gold may meet the narrow specific objectives of a portfolio approach (Zulaica, 2020). At the same time, sensitivity to the selected periods for analysis

shows the extent to which gold is a safe asset. For example, an article by Mokni et al (2022) suggests that the Covid crisis is a good indication that gold has not behaved like a safe asset.

The latter does not mean that, for example, non-economic motives for holding a larger amount of gold cannot be justified based on the characteristics of the portfolio approach. The risk of fiscal losses may also play a role. Significant fiscal losses from holding a suboptimal share of gold in reserves can be acceptable for either a central bank with a lower level of independence, or a central bank directly subordinated to the dominant ideology. That is, if there is a relationship between the amount of reserve holdings and political regimes, as well as between political regimes and the status of central banks (Koziuk, 2021a), then the political regime that potentially generates riskier geopolitical behaviour may require larger amounts of gold reserves (Koziuk, 2022). However, this is no guarantee that, on a collective level, all central banks behave in this way, merely means that economic motives probably dominate in the management of exchange reserves.

A long period of growth in the volume of exchange reserves affected the established beliefs that larger volumes should be more diversified (Beck & Weber, 2010). However, the question of whether diversification should be aimed at increasing the share of gold remains open. On the one hand, gold is mostly passively managed (Aizenman & Inoue, 2012; Aizenman & Marion, 2003). On the other hand, central banks use specific approaches of gold valuation to reduce the impact of revaluation on financial results (Aizenman & Inoue, 2012). Given the volatility of gold prices, it can be assumed that diversification towards gold is not imperative. We can only assume that there is a probability of a certain autonomous increase in the demand for gold to the extent of the increase in reserves (Aizenman & Marion, 2003). But this is not quite an imperative to increase the share of gold in the structure of reserves. Indeed, geopolitical motives can be clearly traced on the example of some countries such as Russia or Turkey (Koziuk, 2022). For India, internal motives for increasing the share of gold are also possible (Ghosh, 2016). The demand for gold is also considered from the standpoint of the optimal share of liquid reserves (Barros, 2020; Gopalakrishnan & Mohapatra, 2017). At the same time, a shift towards holding larger shares of gold than the world average was found for commodity economies (Koziuk, 2021c).

In terms of choosing liquidity versus profitability, the results of empirical tests are also ambiguous. It could be assumed that if the country is more vulnerable to external shocks, it will choose in favour of a smaller share of gold. However, Gopalakrishnan and Mohapatra (2017) show that the demand for gold is strongly driven by the global risk factor expressed by the VIX index, and the external vulnerability of countries encourages higher demand for gold. On the other hand, the paper by Teresa Barros (2020) shows that management of gold is not homogeneous. Central banks from developed countries do not respond to

142

V i k t o r   K o z i u k
Drivers of gold fraction
in global exchange reserves

macro-financial factors. For them, the scale of the economy, the volume of exports and the historical experience of holding gold reserves are more important. Central banks of countries with emerging markets behave differently and take into account opportunity costs. In other words, they take into account the trends in inflation, changes in exchange rates, interest rates, as well as the likelihood of sanctions (Barros, 2020).

At the same time, the analysis of gold reserves is often carried out either in terms of tons (Aizenman & Inoue, 2012; Barros, 2020; Oktay et al., 2016) or specific groups of countries (Aizenman & Inoue, 2012; Oktay et al., 2016). Also, geopolitical motives may be important for some countries (Koziuk, 2022; Barros, 2020), but not for others. This makes it difficult to understand how aggregate demand for gold is behaving and whether there is a shift in favour of larger gold holdings in central bank reserves overall.

In order to avoid a discussion about how to correctly determine the geopolitical orientation of an individual country and its propensity for certain decisions, this article analyses the aggregate behaviour of the gold share in central bank reserves for 2000-2020. At the same time, the paper tests the assumption that such a share can be determined by geopolitical factors, macro-financial factors (including the prices of gold itself, which determine the opportunity costs), or factors motived by reserve diversification. That said, geopolitical motives do not appear relevant with the exception of some countries (Koziuk, 2022) and such factors do not accurately explain the behaviour of gold prices (Koziuk, 2021b). Therefore, the starting hypothesis is that economic motives play a more decisive role in the choice regarding the share of gold in external assets of central banks.

Empirical Analysis:
Is Geopolitics Overrated?

Over the past 20 years, the exchange reserves have been on the rise (Fig. 1.). After 2014, the rate of accumulation of external assets by central banks slowed down somewhat. Regardless, the long-term growth trend of global exchange reserves is upward. However, during this period, the behaviour of reserves in gold was not nearly as unidirectional.

Thus, the accumulation of gold reserves had a clear downward trend for almost ten years, and only since 2009 has the trend reversed (Fig. 2.). By the end of 2021, the gold holdings of central banks exceeded the corresponding indicators from the end of 2000, and over the past 10 years, such reserves have grown significantly (Fig. 2.).
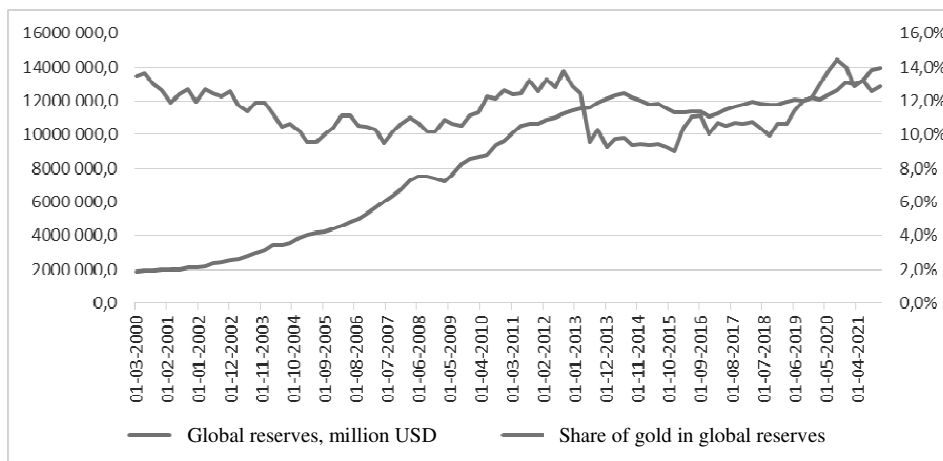
Figure 1

Global exchange reserves in gold and in US dollars
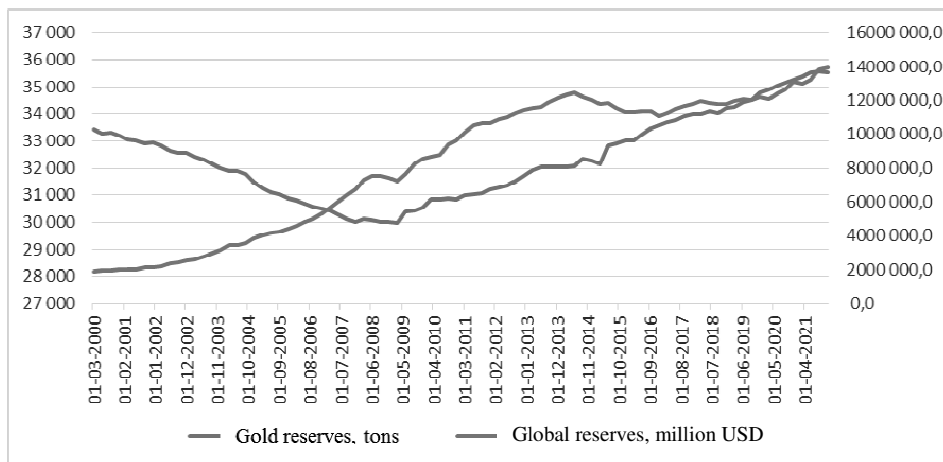
Source: created by the author using the data of World Gold Council.

Figure 2

Global exchange reserves and the share of gold

Source: created by the author using the data of World Gold Council.

144

V i k t o r   K o z i u k
Drivers of gold fraction
in global exchange reserves

Such a sharp break in the trend is difficult to explain solely by the hypothesis that diversification of large reserves prompts an increase in gold holdings. As shown in fig. 2, the share of gold in the central bank's external assets is quite volatile. At the same time, the value of such a share at the end of 2021 returned to the level of 2000, having experienced several breaks in the trend. Comparison of the data from figures 1 and 2 proves that the trends in gold holdings in tons and as a share of reserves do not coincide. It is obvious that the choices regarding gold by a single central bank can be significantly different from such choices by the vast majority of monetary authorities. That is, it can be assumed that the choice in favour of the precious metal is under the influence of more complex factors.

Naturally, the assumption about the geopolitical conditioning of the incentives to increase gold holdings is a traditional argument, given that the number of conflicts in the world has increased significantly since 2014. At the same time, we should not reject alternative hypotheses, if only because the last decade has seen extremely special global macro-financial conditions. They are characterized by both a sharp increase in the level of uncertainty and a significant easing of monetary restrictions in developed countries in response to deflationary risks, slowing growth and Covid-19 stress. Meanwhile, since 2020, the growth of exchange reserves has resumed. In other words, potentially most of the factors that can explain the growing interest of central banks in favour of gold have occurred in recent times. At the same time, increasing demand for gold does not always equate to diversification in favour of gold. For example, provided an increase in reserve holdings and an asset allocation policy that involves a certain share of gold, the demand for gold will increase automatically. Whereas the superiority of gold over other reserve assets must be based on some additional arguments that would have a relatively medium-term effect. Otherwise, a change in market conditions may increase the opportunity costs of holding the chosen asset.

Factors that influence the share of gold in reserves can be roughly divided into:

• geopolitical;

• uncertainty (because uncertainty affects the difficulty of assessing the investment features of certain assets, increasing the «price of error» in terms of holding larger reserves);

• opportunity costs of holding gold (given the fact that they can determine the advantage of this reserve asset over others and gold has specific attractive characteristics);

• diversification (interest in which potentially increases as more reserves are accumulated).

A multivariate regression model was used to empirically assess the behaviour of the aggregate demand for gold from central banks. The time period covers the years 2000-2020. Data – on a quarterly basis.

The share of gold in global exchange reserves was chosen as the dependent variable. This approach differs from those where the demand for gold is mainly presented as the behaviour of reserves in tons (Aizenman & Inoue, 2012; Barros, 2020; Oktay et al., 2016), as it allows for a better assessment of diversification motives under the influence of the amount of holdings. Indicators that had already been used in the analysis of gold prices were chosen as independent variables (Koziuk, 2021b).

GPR – The Geopolitical Risk Index (GPR Benchmark Index). This index measures the level of geopolitical tension based on the analysis of papers in leading international publications (the methodology is presented in more detail in *Measuring Geopolitical Risk* (Caldara & Iacoviello, 2019). If this factor is significant, a direct relationship is assumed.

GEPU – The Global Economic Policy Uncertainty Index. This indicator measures the level of uncertainty regarding economic policy based on the analysis of papers in leading publications (the methodology is presented in more detail in *Measuring Economic Policy Uncertainty* (Baker et al., 2016). It is calculated based on an index of economic policy uncertainty for 20 countries and then weighted based on the GDP indicator. If the economic uncertainty factor is proved effective, as shown in the article by Gopoalakrishnan & Mohapatra (2017), a direct relationship is assumed (however, in this article, the VIX index was chosen as the explanatory variable).

GPrice – gold price (data of World Gold Council). Gold prices can be considered an important factor affecting the efficiency of the portfolio management of central bank reserves. Prices also affect the opportunity costs. If gold prices motivate central banks to increase its share in reserves, then a direct relationship is expected.

FED, 1Y and *10Y* – the interest rate on US federal funds, the yield on one-year and ten-year US Treasury bonds, respectively (US Fed data). These interest rates potentially reflect the impact of global monetary conditions on central banks' choice of reserve assets, and they also indirectly determine the opportunity costs of holding gold. The direction of the relationship, however, is open to interpretation. Low rates, increasing demand for gold, may indicate a decrease in the opportunity costs. High rates, reducing demand for gold, may indicate a shift toward more liquid reserves during times of stress in markets or increased demand for assets whose prices are less volatile. However, the Fed rate and bond term rates can also be interpreted differently in light of inflation expectations and the corresponding motive of hedging inflation risks,

Rbln and *Rgdp* – global exchange reserves (without gold) in billion dollars US and global exchange reserves as % of global GDP respectively (data of World Gold Council). Both indicators test whether holding more reserves really pushes central banks to diversify more. If so, a positive relationship is expected.

146

V i k t o r   K o z i u k
Drivers of gold fraction
in global exchange reserves

Taking into account the change of gold reserves' downward trend to an upward trend, the model is additionally tested for 2000-2009 and 2009-2020. The specifications of the regression equation with and without gold prices are applied across three periods. This is done in order to determine how stable the factors influencing the motives for the share of metal in reserves are under the direct influence on the profitability of holding reserves in gold. Also, variable amounts of reserves are applied separately.

The obtained results of empirical testing are presented in the tables 1 and 2.

Table 1

Results of regression analysis for 2000-2020

	(1)	(2)	(3)	(4)
GPR	0,00005 (1,6936) 0,1142	0,000013 (1,2662) 0,209317	-0,00009 (-1,33587) 0,2029	-0,00005 (-2,69229) 0,0087
GEPU	-0,00004 (-1,1396) 0,2750	0,000075 (4,2704) 0,00006	0,00016 (2,4743) 0,0268	0,000154 (4,9375) 0,00000
GPrice	0,00008 (8,5978) 0,0000	0,00007 (13,9136) 0,0000		
FED	0,01397 (2,8029) 0,01495	0,00034 (0,1764) 0,86044	0,01836 (1,4863) 0,15938	0,003436 (0,96696) 0,336592
1Y	-0,01722 (-3,2734) 0,00605	-0,0004 (-0,1836) 0,85483	-0,02306 (-1,7732) 0,09795	-0,005711 (-1,4138) 0,16146
10Y	0,00646 (2,9017) 0,01237	0,00265 (1,6325) 0,1067	0,00342 (0,62495) 0,54205	0,00087 (0,2881) 0,77407
Rbln		-0,000008 (-15,3655) 0,00000		-0,000003 (-3,9118) 0,000196
Rgdp	-0,01009 (-10,3687) 0,00000		-0,00324 (-2,32698) 0,03549	
Intercept	0,143996	0,094924	0,1391	0,11905
R^2	0,9328	0,8239	0,5509	0,3753
F statistics	$F_{(7,13)}$=25,794	$F_{(7,76)}$=50,798	$F_{(6,14)}$=2,8625	$F_{(6,77)}$=7,7117

Source: calculated using the *STATISTICA* software.

Table 2

Results of regression analysis for 2000-2009 and 2009-2020

	2000-2009				2009-2020			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
GPR	0,00009 (0,7448) 0,59247	-0,000008 (-1,0601) 0,29817	0,00003 (0,4873) 0,67424	-0,000011 (-0,6597) 0,51464	0,000008 (0,29) 0,78349	0,00001 (1,6839) 0,0998	-0,00034 (-1,5902) 0,1629	-0,00008 (-1,7014) 0,09626
GEPU	-0,00005 (-0,1822) 0,8853	0,00007 (2,7938) 0,00929	0,00012 (1,3974) 0,29714	0,000112 (2,23038) 0,033623	0,000023 (1,4013) 0,22004	0,00003 (5,1976) 0,0000	0,00026 (2,01459) 0,0906	0,000124 (2,71803) 0,009502
GPrice	0,00012 (0,62426) 0,6447	0,000199 (10,6232) 0,0000			0,00008 (23,9737) 0,00000	0,00007 (46,3137) 0,0000		
FED	0,01702 (2,0412) 0,29001	0,000578 (0,4648) 0,64567	0,015599 (2,33299) 0,144485	0,003964 (1,49586) 0,145496	-0,02895 (-5,1572) 0,00359	-0,00515 (-2,9349) 0,00545	-0,04435 (-0,8089) 0,44942	0,014595 (1,1878) 0,24158
1Y	-0,01811 (-1,8312) 0,31821	-0,000298 (-0,1796) 0,85875	-0,01764 (-2,1454) 0,16508	-0,005935 (-1,7103) 0,0979	0,02201 (3,8468) 0,01204	0,00598 (3,6064) 0,00084	0,04294 (0,77241) 0,46919	-0,018086 (-1,5913) 0,11904
10Y	0,00317 (0,3561) 0,78222	0,002401 (1,4683) 0,15318	0,00622 (1,0018) 0,42195	0,008393 (2,48159) 0,01912	0,00716 (8,5604) 0,00036	0,00025 (0,4236) 0,6741	0,000736 (0,09449) 0,92779	-0,001665 (-0,3944) 0,6953
Rbln		-0,00003 (-11,9508) 0,00000		-0,000003 (-3,6288) 0,001085		-0,000007 (-26,2695) 0,00000		-0,000002 (-1,153) 0,2554
Rgdp	-0,01557 (-0,7478) 0,5913		-0,00262 (-1,7135) 0,2288		-0,009295 (-13,929) 0,00003		0,00278 (0,6451) 0,54274	
Inter-cept	0,1758	0,105702	0,10502	0,08567	0,11198	0,08701	0,0496	0,1307
R^2	0,9576	0,9419	0,9411	0,7075	0,9969	0,9902	0,6348	0,4749
F sta-tistics	$F_{(7,1)}=$ 3,2267	$F_{(7,28)}=$ 64,787	$F_{(6,2)}=$ 5,3243	$F_{(6,29)}=$ 11,690	$F_{(7,5)}=$ 226,06	$F_{(7,41)}=$ 588,86	$F_{(6,6)}=$ 1,7382	$F_{(6,42)}=$ 6,3311

Source: calculated using the *STATISTICA* software.

The results of the empirical test can be summarized in terms of selected factors.

Geopolitical factors. In the basic equation (for 2000-2020, Table 1), specifications with gold prices (1-2) show a direct relationship between the dependent variable and the variable characterizing geopolitical risks, but its statistical significance is low. For specifications without gold prices (3-4), the direction of the relationship changes to the opposite and for specification (4) it becomes statistically

148

Viktor Koziuk
Drivers of gold fraction
in global exchange reserves

significant. That is, geopolitical risks are not convincing drivers of the aggregate behaviour of the share of gold in central bank reserves. Across periods, the results are even more ambiguous, but they only strengthen this interpretation. During the first period (2000-2009, Table 2), the direction of the relationship changes in accordance with the variable characterizing the reserves holdings rather than the inclusion of the gold price variable. During the second period (2009-2020, Table 2), the direction of the relationship is similar to that of the basic equation (Table 1). In all specifications (Table 2), statistical significance is low regardless of the direction of the relationship. The only conclusion that follows from this is that geopolitical factors are not stable and convincing drivers of a shift in favour of a greater share of gold in central bank reserves. Such results are correlated with the conclusions in articles by Koziuk (2022; 2021b) about the clear overestimation of instability in the world as a criterion for decisions central banks make regarding the management of exchange reserves.

Uncertainty factors. In general, uncertainty regarding economic policy theoretically corresponds correctly with the behaviour of the share of gold in central bank reserves (table 1). Only in specification (1) is the direction of the relationship reversed, but in this case the coefficient has no statistical significance. In the remaining cases (specifications 2-4), the direction of the relationship and its statistical significance correspond to the assumptions and do not depend on the specification of the regression equations. Almost the same is true in terms of periods. Only in the first period (Table 2) in specification (1), the sign of the coefficient is negative, but not statistically significant. Whereas in the remaining cases of the first period and in all equations of the second period, the direction of the relationship is direct and mostly statistically significant. Statistical significance is more affected by the reserve size variable than, for example, by gold prices. That is, uncertainty about economic policy can be considered a factor that affects the decisions of central banks regarding the management of reserves. Better statistical properties for this variable in the second period generally support this view, considering that it was in the second period that the level of uncertainty regarding economic policy increased significantly. This is consistent with the results in Gopalakrishnan and Mohapatra's paper (2017), where the VIX index was taken as a measure of uncertainty. A positive answer to the question about the effect of uncertainty on the propensity to larger holdings of gold in reserves, however, does not remove the question of the channels through which uncertainty affects the decisions of monetary authorities. Most likely, the uncertainty corresponds to the effect of factors that characterize the balance of losses and gains from diversification in favour of gold. Otherwise, it would be difficult to explain why uncertainty about economic policy encourages more gold holdings when such a balance is negative for central banks. Gopalakrishnan and Mohapatra's paper (2017), in turn, emphasizes that the exchange rate regime, openness to capital flows, and vulnerability play a role in how central banks respond to uncertainty. Theoretically, the need for greater liquidity in reserves under uncertain conditions should push away from the gold. On the other hand, this works exclusively in

conditions where reserves holdings are not significant. It follows that even if central banks are concerned with reserve liquidity in response to uncertainty, in general the level of reserve holdings and the balance of losses and gains from holding a larger share of gold will also determine how sensitive monetary authorities are to the need for more liquid reserves in response to increasing uncertainty.

Factors of opportunity costs of holding gold. The effect of these factors is seen in the behaviour of 4 variables, which have different economic meanings. Based on the data in Tables 1-2, it can be said that gold prices alone are a strong enough factor to influence the opportunity costs of holding more gold in reserves. Clearly, this is applicable in the conditions of a relatively stable upward trend in gold prices. The latter are in a credible inverse relationship with rates in the United States (Koziuk, 2021b). Therefore, if global monetary conditions are assessed as soft in the medium term, gold prices may indeed shift the balance of losses and gains from holding gold in its favour. In fact, the data in Tables 1-2 supports this. Notably, the coefficient with a positive sign does not reach statistical significance only in specification (1) for the period of 2000-2009. In all other cases, the statistical significance of this variable is quite high. Additionally, the inclusion of gold prices in the equation significantly increases the statistical significance of other variables and the regression itself.

With regard to monetary variables, the situation is less clear-cut. The Fed rate for the entire period is in a direct and insufficiently statistically significant relationship (with the exception of specification (1) in Table 1) with the dependent variable. This is counterintuitive given the clear inverse relationship between the Fed rate and gold prices (Koziuk, 2021a), and the essential role of gold as a criterion for reserve management decisions. The breakdown into periods somewhat clarifies the conclusion. The relationship is direct in the first period, but it is inverse in the second segment (with the exception of specification (4) in Table 2). That is, when the amount of gold in reserves decrease, the higher rate of the Fed motivates banks increase gold holdings. Conversely, when gold holdings begin to grow, the low Fed rate encourages more increasing reserves. And this influence is more statistically significant. In other words, such differences can be explained by the opposite expectations during the two periods with regards to the impact of the Fed on monetary conditions and, accordingly, the balance of benefits and opportunity costs of holding gold.

This outcome is further explained by data on the yield of US bonds as the main reserve asset. The share of gold in central bank reserves is inversely related to the yield of annual US government bonds during 2000-2020, although the statistical significance of this relationship is not high. In general, this does not contradict common sense: a fall in bond yields prompts the search for alternative reserve assets. However, the outcome changes when considering separate periods. In the first period, the relationship is inverse, albeit statistically insignificant, and in the second it is generally positive and significant (with the exception of specification (4) in the second period) (see Table 2). If we assume the opposite

150

V i k t o r   K o z i u k
Drivers of gold fraction
in global exchange reserves

periodic outcomes to those of the Fed rate, the considerations of greater opportunity costs of holding gold should prevail given falling short-term bond yields in the first period, while the considerations should be different for the second period. The divergence between Fed rates and yields was seen as evidence of rising inflationary risks, which were better hedged through gold. The direct relationship between the dependent variable and the yield of long-term bonds confirms the hypothesis that the hedging of inflation risks through gold does not contradict the increase in the yield of longer-term securities. On the contrary, an increase in such yields is evidence of an increase in negative expectations about the future, which correlates with considerations for hedging the risks of uncertainty by increasing the share of gold in reserves. At the same time, across all three periods, the relationship is direct (with the exception of specification (4) in the second period (Table 2)), but not always statistically significant, although it is stronger than in the case of the Fed rate and annual yield bonds. That is, monetary conditions have a sufficiently predictable effect on the propensity to larger holdings of gold in reserves, but their complex structure and interaction with other factors makes this effect quite dependent on the context. In other words, the benefits and opportunity costs of holding gold are complexly structured and sensitive to interactions with other incentives for reserve management.

Diversification factors. The data in Tables 1-2 provide an unexpected answer to the question of whether diversification of larger reserves is carried out in favour of gold. During 2000-2020, the increase of reserves was more likely to prompt a decrease in the share of gold, even if this is counterintuitive. The relationship in all specifications is inverse and statistically significant. In terms of periods, the situation is not much different, except for specification (3) in the case of 2009-2020 (Table 2), where the relationship becomes direct but not quite significant. In a number of other cases, the relationship also loses significance when the sign is preserved. Notably, the amount of exchange reserves in billions of US dollars better describes the relationships in the model than the ratio of exchange reserves to GDP. This can be explained by the fact that central banks, in the process of managing external assets, are guided by the volume of potential transactions, and not by the relative value of the indicator, even if the latter better illustrates its «equipped-ness» with reserves. In general, gold is unlikely to be considered the primary asset in favour of which it is necessary to diversify larger volumes of reserves. Examples of countries with significant foreign assets such as China, Saudi Arabia or Brazil confirm this (Koziuk, 2022b).

The empirical testing results of the behaviour of the aggregate gold share in global exchange reserves paint a fairly complex picture. The factors of geopolitics and diversification turned out to be clearly overestimated despite the strong theoretical arguments in their favour. The factors of uncertainty are quite compelling. However, they must interact with the factors determining the benefits / opportunity costs of holding gold. And this is where there is an interpretive problem. If gold prices alone had a strong influence on the increase in the share of gold in

reserves (like uncertainty about economic policy), then there would have been clearer correlation with factors of global monetary conditions. However, the complex structure of the latter requires consideration of their context; therefore, they affect other decision-making criteria in the process of managing exchange reserves. In general, economic motives for changes in the share of gold in the external assets of central banks dominate over geopolitics.

Conclusions

Over the past 20 years, the demand for gold from central banks has increased significantly. However, the aggregate share of gold in global exchange reserves is volatile, compared to trends in the gold holdings in tons. There are competing hypotheses explaining the demand for gold from central banks. International political economy emphasizes the importance of factors of instability in the world. In contrast, other approaches point out that gold is a way of hedging inflation and uncertainty risks, is a «safe harbour», but gold holdings are sensitive to opportunity costs and subject to portfolio optimization. The share of gold in reserves, in contrast to the volume of gold, is a better indicator of whether economic and non-economic factors simultaneously influence the decisions of central banks regarding the management of external assets, since it allows for diversification decisions based on more complex criteria.

The empirical test showed that geopolitical factors are clearly overestimated. Even if significant for individual countries, they do not affect the aggregate changes in the share of gold in global exchange reserves. The same applies to the increase in reserve holdings. The increase of the reserves in the world does not lead to a systematic increase in the share of gold in them. Gold is not an ideal reserve asset, even if the choice in its favour by individual central banks is dictated by specific motives. Rather, the motivations for hedging the risks of economic policy uncertainty and economic factors (benefits / opportunity costs of holding gold) are more important. However, the propensity to increase the share of gold in reserves under the influence of uncertainty should correspond to how current and expected global monetary conditions affect the balance of costs and benefits of holding a larger share of gold. The complex structure of monetary conditions affects weak and not always theoretically consistent connections between interest rates on the US market and the changes in the aggregate share of gold in central bank external assets.

152

V i k t o r   K o z i u k
Drivers of gold fraction
in global exchange reserves

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