Compositional Analysis of Foreign Currency Reserves in the 1999-2007 Period : The Euro vs. The Dollar as Leading Reserve Currency

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COMPOSITIONAL ANALYSIS OF FOREIGN CURRENCY RESERVES IN THE 1999-2007 PERIOD - THE EURO VS. THE DOLLAR AS LEADING RESERVE CURRENCY

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Abstract

Using a critical analysis of the acquired data, this article mainly aims to present the currency composition of the foreign currency reserves of central banks in selected countries in the 1999-2007 period and, on this basis, to establish whether the euro stands any real chances of dethroning the US dollar as the global currency. Among other things, the empirical results, for the most part overlapping with the theoretical and empirical expectations, confirm the hypothesis that in the near future the euro may be regarded as a global reserve currency on a par with the US dollar or it may even become the leading reserve currency. Finally, the empirical analysis also shows that the proportion of the euro in foreign currency reserves differs by the groups of countries concerned; however, in the period under scrutiny it was mainly increasing.

Key words: *international monetary system, international currency, foreign currency reserves, dollar, euro*

JEL Classification: *F02, F31, G20*

1 Introduction

Given that most raw materials (oil, gold etc.) are these days globally traded with in (US) dollars and that this currency dominates with over more than four-fifths of foreign trade and one-half of global exports, most central banks hold their foreign currency reserves in dollars. Moreover, the United States is at the helm of the world economy in terms of the size of its national economy and it is also the second largest financial center. Nevertheless, the speculation often heard in recent times continues, namely that the new European currency, the euro, could replace the US dollar as the world's main currency.The introduction of the euro was a milestone in the EU's development and a watershed in the monetary history of modern Europe. The new European currency has thus implemented the final stage of the Economic and Monetary Union (hereinafter: the EMU). The introduction of the euro not only contributed to lower foreign exchange risk in EMU countries but also diminished the technical, regulatory and psychological limitations which had until then shaped the markets

along national borders. In addition, it politically and economically strengthens Europe and, being a stable international currency, contributes to the stability of the entire global economy.

Much has been written about the dollar and the euro as international currencies but the topic of the reserve currency and potential structural changes in the foreign currency reserves of central banks all over the world has received less attention. There is a lack of empirical literature examining data on the composition of foreign currency reserves by country. Using secondary data acquired from websites and internal data provided by some central banks, we present the composition of foreign currency reserves of 22 countries (whose data were available) and of groups of developed and emerging/developing countries. The analysis mainly aimed to ascertain that, in the period under scrutiny, the proportion of euros in foreign currency reserves mainly increased; however, some differences were established by groups of countries.

The article is organized as follows. The Introduction is followed by a section offering an overview and analysis of the major world currencies in the foreign currency reserves of central banks. The focus is on the proportion of dollars, euros and other major currencies in the reserves and the main findings about the composition of foreign currency reserves. The third section covers an empirical analysis of the composition of foreign currency reserves in selected countries in the 1999-2007 period. The studied countries are divided into groups using the following four criteria: development level, geographical principle, balance of payments surplus or deficit, and size of country. The section concludes with a presentation of the results of an empirical analysis of the composition of foreign currency reserves of all analyzed countries. The Conclusion recapitulates the main findings of the article, including the findings of the empirical analysis which was conducted on the basis of data acquired for the studied countries.

2 Overview and analysis of the major world currencies in the foreign currency reserves of central banks

2.1 The proportion of dollars in foreign currency reserves

The US dollar is the most important international currency on the global scale in terms of all principal functions of money (medium of exchange, unit of account and store of value) (Wenhao, 2004). Over the entire past decade, over 50% of the foreign currency reserves of central banks[1] were held in US dollars, thereby justifying the dollar's international reserve status. In 1995, 59% of foreign currency reserves were held in US dollars. The share kept rising until the euro was introduced in 1999, when the dollar accounted for slightly less than

[1] The foreign currency reserves of a national economy are divided into international monetary reserves, operational foreign currency reserves and holdings of non-banking business entities abroad. Every central bank holds foreign currency reserves (mainly holdings with banks abroad) as they are indispensable for running the foreign exchange policy. They are classified under international monetary reserves, including monetary gold which is mainly in the form of gold plates and bars, a reserve position at the International Monetary Fund (IMF) which is available only to IMF members, and Special Drawing Rights (SDR) which can only be acquired and used by IMF members (IMF, 2008).

71% of total reserves – the trend reversed at this point and started to fall. In 2007, 64.6% of foreign currency reserves were held in US dollars (Table 1). Notwithstanding the above, the United States is still capable of maintaining a high current account deficit (5.3% of GDP in 2007) (financed by seignorage) with a limited effect on the economy.

In the last quarter of the past century, the proportion of dollars in the global reserve composition plunged and this was related to the shrinking share of the United States in world output. The strongest decline was recorded in the late 1970s, in the period of high inflation and macroeconomic instability in the United States. Between 1987 and 1990, the proportion of dollars in global foreign currency reserves again plummeted due to the changed currency composition of the holdings of industrially developed countries. In 1988, the dollar accounted for 63% of foreign currency reserves, thus exceeding the proportion of the ECU (22%) by nearly three times, whereas other currencies accounted for 15%. The size of the EMU's economy was nearly equivalent to that of the United States and many economists therefore expected the share of the ECU to grow over the years (Gros & Thygesen, 1992).

Table 1: International accumulation of foreign reserve currencies in the 1995-2007 period (in %)

Currency	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US dollar	59.0	62.1	65.2	69.3	70.9	70.5	70.7	66.5	65.8	65.9	66.4	65.7	64.6
Euro	-	-	-	-	17.9	18.8	19.8	24.2	25.3	24.9	24.3	25.2	25.8
German mark	15.8	14.7	14.5	13.8	13.8	-	-	-	-	-	-	-	-
Pound sterling	2.1	2.7	2.6	2.7	2.9	2.8	2.7	2.9	2.6	3.3	3.6	4.2	4.2
Japanese yen	6.8	6.7	5.8	6.2	6.4	6.3	5.2	4.5	4.1	3.9	3.7	3.2	2.8
French franc	2.4	1.8	1.4	1.6	1.6	-	-	-	-	-	-	-	-
Swiss franc	0.3	0.2	0.4	0.3	0.2	0.3	0.3	0.4	0.2	0.2	0.1	0.2	0.2
Other currencies	13.6	11.7	10.2	6.1	1.6	1.4	1.2	1.4	1.9	1.8	1.9	1.5	2.0

Source: Currency Composition of Official Foreign Exchange Reserves (COFER), IMF, 2008; The accumulation of foreign reserves, ECB, 2006.

The dollar hit bottom in 1990 when it accounted for only 45% of reserves and deposits. In the 1990s, it regained its position due to the rapidly growing reserves of developing countries and their inclination to favor the dollar (Galati & Wooldridge, 2006). As the Japanese yen gained ground and the EMS grew stronger, thereby increasing the demand for the French franc and the German mark, the abovementioned alternatives became more appealing. As of 1992, when the EMS experienced some difficulties and the Japanese economy had stagnated, the proportion of dollars in the global foreign currency reserves was on the rise (Wyplosz, 2001). Until 2001, dollar reserve holdings grew and reached their highest point since the 1970s. At the end of March 2006, the proportion of the dollar declined, accounting for 66% of reserves and 59% of deposits – a value similar to that witnessed a decade ago (Galati & Wooldridge, 2006).

Different international institutions encourage the central banks of emerging national economies to disperse their assets into other currencies. The development of international financial markets has intensified pressure on the dollar, with the euro becoming a serious alternative for foreign assets. In addition, following a short initial period transaction costs in the euro markets dropped drastically. Many currencies of other industrial countries improved their liquidity, thus offering a window of opportunity for alternative assets for further diversification. The central banks were forced to reduce the proportion of the dollar in their foreign currency reserves due to the growing current account deficit and the large external debt of the United States. A major change in assets would have impacted significantly on the exchange rate and the dollar's position as the leading international currency, which could have held grave consequences for the international monetary system (Papaioannou et al., 2006).

In recent times, an opinion has been gaining ground which mirrors the pessimistic scenario for the US currency because in the years to come the dollar is expected to gradually lose its role as the leading global reserve currency (see e.g. Bergsten (1997), Mundell (1998), Wyplosz (2001), Chinn & Frankel (2005)).This is postulated to be a consequence of changes in oil trading as oil-exporting countries will start charging for oil in euros and the latter will accordingly supplant dollars. Namely, in November 2000 Iraq started selling oil in euros because the bulk of its oil trade is conducted with the EU, India and China, not the United States. However, this measure was unsuccessful and ended in the war of the United States against Iraq and the closing of the Iraqi oil exchange where oil was being traded with in euros. Several countries have followed the Iraqi example, including Iran, Libya, Venezuela, Russia, Indonesia and Malaysia (Sharma et al., 2004).

Similarly, the beginning of the end of the dollar's role as the leading international monetary currency could also involve the decision announced by China in July 2003 to switch some of its reserves out of dollars and into euros (Sharma et al., 2004). In the past, China tied its currency to the dollar while at present it fixes it against a basket of currencies. This example was followed by some Asian central banks which have diversified some of their reserves into euros.

On the other hand, another opinion is that an increase in the diversity of the currency composition is relatively unlikely. However, if diversification does take place it will be moderate and slow. This is underpinned by the fact that most central banks with massive reserve holdings, particularly those in East Asia, co-operate with their governments in formulating export-oriented strategies with a particular emphasis on the US market, which is why it is in their interest to keep the exchange rate unchanged against the dollar (Papaioannou et al., 2006).

The concentration of foreign reserve holdings in dollars continues to play a major role, especially in Asia. As mentioned earlier, this is connected with the exchange rate regimes in many Asian countries whose currencies are often quoted against the dollar, and with the

structure of their foreign trade where ties with the United States and the dollar area predominate. Moreover, this is also connected with a desire to improve through diversification the balance between the risk and return at the level of not only the central bank but also the state. The advantage of diversification at the national level can occur when a central bank invests some of its savings, which it otherwise holds in the domestic currency due to its inclination to favor domestic financial markets, in dollar assets (The accumulation of foreign reserves, 2006).

2.2 The proportion of euros in foreign currency reserves

The new, attractive alternative – the euro – is paving the way for major changes in the currency composition of global reserves, whereby the striking of a balance in international financial markets depends on tectonic shifts in the euro/dollar exchange rate. The gradually increasing use of the euro in global foreign reserves has been supported by the smooth functioning of the euro area and the euro's appreciation against other international currencies in recent years (The accumulation of foreign reserves, 2006).

After World War II and the rebuilding of the German economy, the German mark acquired the status of the second largest global reserve currency. When the euro was introduced in 1999, it supplanted the German mark and became the second-best reserve currency. Since then, its proportion in the official reserve holdings was only rising as banks, in a desire to expand their businesses, diversified their reserves and trading in the euro area markets. From 1999 to 2007 the euro's share in foreign currency reserves was growing steadily – from nearly 18% to just below 26% (see Table 1).

According to Galati and Wooldridge (2006), the fluctuating dollar's share in reserves is chiefly a reflection of the euro's fluctuating share. The euro legacy currencies peaked in 1990 at 39% of reserves and 32% of deposits. On the eve of the EMU, the share of euro legacy currencies declined to 20% and rebounded during the first few years after the monetary union. Between 1999 and 2003 the proportion of reserves allocated to euro-denominated instruments rose by nearly 7 percent points, reaching 25%. In the same period, the proportion of developing countries' reserves allocated to euros rose from 19% to 27%, while the dollar's share fell commensurately. The reallocation to euros was more pronounced among countries with close trade or financial ties to the euro area and less significant in Asia and the Americas (Lim, 2006). After 2003, the euro's share of reserves has leveled off at a level equal to the one it had in the mid-1990s.

In the future, a more intensive reserve diversification is to be expected since reserves are now commonly perceived to be greater than needed for intervention purposes. Therefore, the management of reserves could focus even more on the maximization of returns for a given level of risk and place less importance on the preservation of liquidity and capital. Moreover, the liquidity and breadth of the euro financial markets are fast approaching those of dollar markets (Galari and Wooldridge, 2006) which will, according to Wooldridge (2006), contribute to the euro being a stronger alternative to the US dollar in official reserves.

2.3 The proportion of other currencies in foreign currency reserves

In the 18th and 19th centuries, the leading global reserve currency was the pound sterling. However, due to protracted deficits in the balance of payments and public finances funded by cheap loans, unsustainable monetary and fiscal policies and the decline of the United Kingdom as the world's leading military and economic force, the pound sterling lost its status. However, Wooldridge (2006) estimates that the most significant change in recent years was the replacement of the yen by the pound sterling as the third largest reserve currency. In the past decade the share of the pound sterling in total foreign currency reserves rose from 2.1% (in 1995) to 4.2% (in 2007) (Table 1).

The share of currencies other than the big three decreased in the period under scrutiny. The share of the yen more than halved (from 6.8% to 2.8%), while the share of other currencies declined from 13.6% in 1995 to 2% in 2007 (Table 1). For a long time, the Japanese yen was the third largest reserve currency but it has experienced a fall in recent times and ended up fourth, behind the pound sterling. The Swiss franc is often said to fit in the company of reserve currencies due to its stability; however, it too has fallen out of favor in recent years, similarly to the yen. Swiss francs account for only about 0.3% of total foreign currency reserves and, in the past five years, its proportion was even below the abovementioned figure (Galati & Wooldridge, 2006).

2.4 Main findings on the composition of foreign currency reserves

According to Wyplosz (2001), the currency composition of global reserves has not received as much attention as other aspects of the international monetary system. The choice of the reserve holdings of developing countries is influenced by the exchange rate and financial and trade ties to the countries of the reserve currencies. The foreign currency reserve composition is determined by the following factors (The accumulation of foreign reserves, 2006):

a) the currency composition of reserves usually reflects a country's exchange rate regime and, if the exchange rate regime is not a pure float, it is closely linked to the choice of an anchor currency or basket;
b) one issue specific to Asia is the existence of dollar zones in the region with many Asian currencies being more or less strictly linked to the dollar;
c) official reserves, in particular in developing countries with fragile access to international capital markets, are considered to be a cushion for paying for imports and ensuring the servicing of external debt in foreign currencies; therefore, the reserve currency composition is often linked to the composition of trade and financial flows;
d) recently, risk management considerations and optimal asset allocation approaches have gained in importance; and
e) central banks consider the 'market neutrality principle' as prescribed by the IMF to the extent that it is compatible with their other objectives.

Papaioannou (2006) presents some other findings on the composition of reserves:

a) monetary authorities hold a large proportion of their reserves in the currencies of their main trading partners;

b) the currency composition of external debt is an important factor of the allocation of the reserve holdings of central banks;
c) a central bank which ties its domestic currency to a specific currency strives to hold the bulk of its reserves in that currency; and
d) central banks follow portfolio-diversification strategies.

Many central banks support the view that by diversifying reserves into different currencies the value of the reserves is protected against high-risk events and international inflation, which is why they diversify their reserve holdings into different currencies. Depending on the relative size and importance of individual currencies, central banks can define reasonable restrictions on different currencies making up their reserves. A study by Ramaswamy (1999) presumes that a representative central bank would only want to invest in four leading global currencies: the dollar, the euro, the yen and the pound sterling. For these currencies, a central bank can stipulate the acceptable share of a given currency that can make up the reserve holdings and base its stipulations on the depth and liquidity of an individual currency in the global foreign exchange market.

Over the past few years the growth rate and allocation of the world's international reserves have changed substantially. In a number of countries, especially emerging market economies, the public sector has been accumulating sizeable crossborder financial assets, mainly in the form of official foreign currency reserves. World reserves rose from USD 1.2 trillion in January 1995 to USD 4 trillion in September 2005, growing particularly rapidly since 2002. Between 2000 and 2005 international reserves grew to 91% in SDR and 110% in dollars[2] (The accumulation of foreign reserves, 2006). Noyer (2007) assesses that at the beginning of 2007 global foreign currency reserves totaled USD 5 trillion.

This change in official foreign holdings has been especially pronounced in Japan and the Asian emerging market economies. The share of Asian countries rose from USD 600 billion to over USD 2 trillion as a consequence of the accumulation of reserves at a rate of USD 200-300 billion per year since 2003 (Noyer, 2007). Wijnholds and Sondergaard (2007) continue that, with the exception of Japan, most industrial countries, particularly those in the euro area, have either added smaller holdings to their reserves or even reduced them. In this period, other European countries have doubled their reserves, which is mainly a reflection of Russia's rapid and recently built up foreign holdings. Noyer (2007) adds that, besides Russia, sizeable foreign asset accumulation has also been taking place in oil-exporting countries such as Algeria and Norway. Stocks of reserves of oil exporters rocketed in 2005 and 2006 by over USD 200 billion per year. This is mainly related to the fluctuations seen in oil prices (particularly strong since 2004), whereas Russia has also benefited from the surge in its oil exports (The accumulation of foreign reserves, 2006).

[2] The difference mirrors the dollar's depreciation in comparison with SDR (a basket consisting of the dollar, the euro, the yen and the pound sterling).

3 Empirical analysis of the foreign currency reserve composition of central banks in selected countries

The purpose of the empirical analysis was to present changes in the foreign currency reserve composition of central banks in selected countries, consisting mainly of US dollars and euros. Movements in the share of the two world currencies in foreign currency reserves are presented below for the 1999-2007 period.

Using a critical analysis of the gathered data, this article strives to present the currency composition by groups of countries and, on this basis, to establish whether the euro stands any real chances of dethroning the US dollar as the global currency and, if it does, when this might be expected to happen. The empirical part is underpinned by secondary data acquired from websites and internal data of some central banks and delves into the composition of their foreign currency reserves. The selected countries are divided into groups according to the following four criteria: development level, geographical principle, balance of payments surplus or deficit, and size of country. The empirical analysis mainly aimed to prove that, in the period under scrutiny, the proportion of euros in the foreign currency reserves of selected groups of countries mainly increased and that it differs by groups of countries.

The sample includes 22 countries representing 11.4% of all countries in the world in 2007. The empirical analysis was conducted using data on the following countries: Australia, Barbados, Belgium, Costa Rica, the Czech Republic, Chile, Estonia, Guatemala, Hong Kong, Croatia, Jamaica, Canada, Kirghizia, Latvia, Lithuania, Namibia, Peru, Slovakia, Swaziland, Switzerland, Uruguay and the United Kingdom. Other countries refused to disclose the required data since they regard that information as being strictly confidential. The data refer to the 1999-2007 period and apply to December of each year.[3]

The empirical analysis is performed using the SPSS 16.0 statistical software package; a test of groups and a paired t-test were carried out. The first procedure consisted of an independent samples t-test to verify whether the share of euros in the foreign currency reserves differs by groups of countries (which were divided according to the abovementioned criteria). The sample was divided into two groups and the arithmetic means of the two units (of the population) were compared. The paired t-test consisted of a paired-samples t-test which was performed to compare the arithmetic means of two variables for so-called dependent samples. The paired values of the variables were used to calculate the differences and to test the hypothesis that the average difference differs from zero. We wanted to establish whether the average share of euros differs from the beginning to the end of the analyzed period so the first

[3] The exceptions are some countries which failed to gather data for individual years. These include: Australia and Namibia (data for 1999 are unavailable) as well as Peru, Estonia and Kirghizia (data for 1999 and 2000 are unavailable).

and last years of the analyzed period were selected.[4] The next step was to compare the average share of euros (based on annual data) in the 1999-2001[5] and 2002-2007 periods.[6]

3.1 Foreign currency reserve composition by a country's development level

The countries were first divided into developed and developing/emerging groups, according to the IMF classification. The group of developed countries included Australia, Belgium, Hong Kong, Canada, Switzerland and the United Kingdom. The developing countries included Barbados, Costa Rica, the Czech Republic, Chile, Estonia, Guatemala, Croatia, Jamaica, Kirghizia, Latvia, Lithuania, Namibia, Peru, Slovakia, Swaziland and Uruguay.

In the period under consideration, the developed countries recorded a decrease in the dollar's share from 70.5% to 63.4% and, consequently, an increase in the euro's share from 17.8% to 27.3%. The share of other currencies reached its peak of 13.8% in 2001 and its low point of 9.3% in 2007. In the group of developing and emerging countries the currencies' shares fluctuated; however, the shares of the two major world currencies were at about the same level at the beginning and the end of the analyzed period. The dollar's average share in this group accounted for 63.7%, the euro's average share was 32.1%, while that of other currencies represented 4.2% of the total.

The data acquired for the developed and developing/emerging countries were compared to data compiled by the IMF (COFER – Currency Composition of Official Foreign Exchange Reserves). Between 1999 and 2007 the euro's share in developed countries fluctuated; however, at the beginning and end of this period it achieved roughly the same level. In developing countries, the euro's share rose by 9.6 percentage points whereas that of the dollar dropped by 10.7 percentage points. Both the IMF official data and the data acquired from the sample of 22 countries confirm the growth in the euro's share in both groups of countries in the studied period.

The above results of the sample of 22 countries were tested against zero and alternative hypotheses, which were defined as follows: $H_0 : \mu_{developed} = \mu_{developing}$; $H_1 : \mu_{developed} \neq \mu_{developing}$. A test of the hypothesis about the difference in the arithmetic means of two independent samples (test of groups) was performed to establish whether the developed and developing countries differ in terms of the euro's average share in the analyzed period. According to the alternative hypothesis, it was expected that the developed and developing countries would differ in terms of the proportion of euro-denominated reserves. The empirical analysis revealed statistically significant differences in terms of the average share of euros by development level (see Table

[4] For those countries whose 1999 data were unavailable, the data used in the analysis are those from the next year for which data were available.

[5] For those countries whose 1999 data were unavailable, the 2000-2001 average was taken into account. For those countries whose 1999 and 2000 data were unavailable, only 2001 was taken into account.

[6] The division between the two periods was set between the end of 2001 and the beginning of 2002, which corresponds to the transition from Phase 1 to Phase 2 of the introduction of the new European currency at which stage it was put into circulation. During this period, the trend in the nominal foreign exchange rate reversed and the euro started appreciating against the dollar in nominal terms.

2). In developed countries, the average euro's share is larger than that in developing and emerging countries.

Table 2: Independent sample t-test for developed and developing/emerging countries in the studied period

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
% of EUR	Equal variances assumed	0.395	0.538	4.970	16.000	0.000	9.3482	1.8807	5.3612	13.3352
	Equal variances not assumed			4.970	15.751	0.000	9.3482	1.8807	5.3560	13.3403

Source: National Central Banks; own calculations from SPSS.

Further on, we performed a paired t-test to verify whether the arithmetic mean of the euro's share differs by the group of countries in the 1999-2007 period. The zero hypothesis assumed that the arithmetic mean of the euro's share was the same in 1999 and 2007 ($H_0 : \mu_p = 0$). The alternative hypothesis assumed that the arithmetic mean of the euro's share was higher in 2007 than in 1999 ($H_1 : \mu_p > 0$). Based on the sample data the zero hypothesis was rejected and the alternative hypothesis accepted, namely that the arithmetic mean of the euro's share in developed countries in 2007 is higher than that in 1999 (Table 3). A different situation was observed in developing/emerging countries as their sample data revealed no statistically significant differences between the euro's share in 1999 and 2007. It hence follows that the share of euros in developing/emerging countries in 2007 did not differ statistically significantly from that in 1999 (Table 4) (similar results were found by Masson (2008)).

Table 3: Paired t-test for the euro's share in 1999 and 2007 in developed countries

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
% of EUR in 1999 – % of EUR in 2007	–9.83833	10.82319	4.41855	–21.197	1.520	–2.227	5	0.076

Source: National Central Banks; own calculations from SPSS.

A paired t-test was also performed to compare the average share of euros in the 1999-2001 and 2002-2007 periods in developed countries. Based on the sample data the zero hypothesis was again rejected and the alternative hypothesis accepted, namely that the arithmetic mean of the euro's share in developed countries in the 2002-2007 period is higher than that in the 1999-2001 period.

Table 4: Paired t-test for the euro's share in 1999 and 2007 in developing/emerging countries

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
% of EUR in 1999 – % of EUR in 2007	–7.24375	17.03198	4.25799	–16.319	1.832	–1.701	15	0.110

Source: National Central Banks; own calculations from SPSS.

A test of the hypothesis about the difference in the average euro's share in the 1999-2001 and 2002-2007 periods was also performed for all the groups of countries presented below as well as for all 22 studied countries together. In those cases where the differences between 1999 and 2007 were statistically significant in terms of the arithmetic means of the euro's shares, the calculation also revealed differences in arithmetic means between the periods of 1999-2001 and 2002-2007, and vice versa.

3.2 Foreign currency reserve composition according to the geographical principle

The analysis of the share of euros and dollars in foreign currency reserves according to the geographical principle aimed to demonstrate that preferences may vary by region. Therefore, the selected countries were divided into three geographical areas: 1. Europe; 2. Africa, the Americas and Asia; 3. Australia and Canada. The first group included the following European countries: Belgium, the Czech Republic, Estonia, Croatia, Latvia, Lithuania, Slovakia, Switzerland and the United Kingdom. The second group consisted of the following African, American and Asian countries: Barbados, Costa Rica, Chile, Guatemala, Hong Kong, Jamaica, Kirghizia, Namibia, Peru, Swaziland and Uruguay. The third group included Australia and Canada.

Compared to the second and third groups of countries, Europe's reserves allocated to the euro are larger than those in US dollars. In the period under scrutiny, Europe underwent a diversification from dollars into euros. The dollar's share dropped from 50.3% to 40% and the euro's share rose from 41.6% to 49%. The bulk of foreign currency reserves in the second group of countries (Africa, the Americas and Asia) are held in dollars (over 80%). The dollar's share increased only negligibly in the studied period, whereas the euro's share rose by slightly less than 10%, thus revealing that both world currencies grew on account of other currencies. In the third group of countries (Australia and Canada) the euro holdings rose from 25.4% to 45.5% on account of dollar holdings which went down from 52.7% to 44.7% and holdings in other currencies which dropped by 55.7%.

A test of the hypothesis about the difference in the arithmetic means of two independent samples was performed to verify the alternative hypothesis, namely that there are statistically significant differences in the euro's share in the analyzed period between Europe on one hand and Africa, the Americas, Asia, Australia and Canada on the other. The zero and alternative hypotheses were set up as follows: $H_0 : \mu_{Europe} = \mu_{other}$; $H_1 : \mu_{Europe} \neq \mu_{other}$. The empirical analysis

revealed statistically significant differences in terms of the average share of euros according to the geographical principle. The average euro's share is larger in Europe (as was expected) than in Africa, the Americas, Asia, Australia and Canada (see Table 5).

Table 5: Independent sample t-test for Europe and for Africa, the Americas, Asia, Australia and Canada in the studied period

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
% of EUR	Equal variances assumed	0.985	0.336	23.731	16.000	0.000	31.0438	1.3081	28.2707	33.8170
	Equal variances not assumed			23.731	14.526	0.000	31.0438	1.3081	28.2477	33.8400

Source: National Central Banks; own calculations from SPSS.

In the continuation, a paired t-test was performed where the zero and alternative hypotheses were set up as follows: $H_0 : \mu_p = 0$; $H_1 : \mu_p > 0$. The sample data showed that, in Europe, the euro's share in 1999 did not differ from that in 2007 (Table 6). By contrast, in the second group of countries (Africa, the Americas and Asia) the arithmetic mean of the euro's share was higher in 2007 than in 1999 (Table 7).

Table 6: Paired t-test for the euro's share in 1999 and 2007 in Europe

	Paired Differences					t	Df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
% of EUR in 1999 – % of EUR in 2007	–3.84889	20.71374	6.90458	–19.771	12.073	–0.557	8	0.592

Source: National Central Banks; own calculations from SPSS.

Table 7: Paired t-test for the euro's share in 1999 and 2007 in Africa, the Americas and Asia

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
% of EUR in 1999 – % of EUR in 2007	–9.10636	9.70078	2.92490	–15.623	–2.589	–3.113	10	0.011

Source: National Central Banks; own calculations from SPSS.

3.3 Foreign currency reserve composition by balance of payments surplus or deficit

The first group consisted of countries with a balance of payments surplus (a surplus in the current account of the balance of payments), namely Belgium, Chile, Hong Kong, Canada, Namibia, Peru and Switzerland. The second group included countries with a balance of payments deficit (a deficit in the current account of the balance of payments): Australia, Barbados, Costa Rica, the Czech Republic, Estonia, Guatemala, Croatia, Jamaica, Kirghizia, Latvia, Lithuania, Slovakia, Swaziland, Uruguay and the United Kingdom.

Those countries with a balance of payments surplus hold a larger proportion of dollar-denominated reserves than countries with a deficit. In the period under consideration, the euro's share in countries with a balance of payments surplus grew from 13.9% to 19% while the dollar's share declined from 78.4% to 74.1%. The dollar's and euro's shares in countries with a balance of payments deficit are relatively equal; however, the dollar remains the predominant reserve currency. The exceptions are 2002 and 2007 when the euro overtook the dollar. In the analyzed period, the share of other currencies dropped from 19.7% to 9.5%.

A test of the hypothesis about the difference in the arithmetic means of two independent samples was performed to verify the alternative hypothesis, namely that there are statistically significant differences in the euro's share in the studied period between those countries with a balance of payment surplus and those with a deficit ($H_0 : \mu_{surplus} = \mu_{deficit}$; $H_1 : \mu_{surplus} \neq \mu_{deficit}$). The sample data show that the zero hypothesis can be rejected and the following conclusion may be drawn, namely that statistically significant differences exist in terms of the euro's average share between countries with a surplus and those with a deficit in their balance of payments (see Table 8). The average share of euros in the reserves of countries with a balance of payments deficit is larger than that of countries with a surplus.

Table 8: Independent sample t-test for countries with a balance of payments surplus and those with a deficit in the studied period

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
% of EUR	Equal variances assumed	7.54	0.014	–13.851	16.000	0.000	–24.2724	1.7523	–27.9872	–20.5576
	Equal variances not assumed			–13.851	11.846	0.000	–24.2724	1.7523	–28.0959	–20.4488

Source: National Central Banks; own calculations from SPSS.

The next step was a paired t-test ($H_0 : \mu_p = 0$; $H_1 : \mu_p > 0$). Based on the sample data the zero hypothesis was rejected and the alternative hypothesis accepted, namely that the arithmetic mean of the euro's share in countries with a balance of payments surplus in 2007 is higher than that in 1999 (Table 9). The empirical results for countries with a balance of payments

deficit revealed a different picture, namely that their share of euros in 2007 did not differ from that in 1999 (Table 10).

Table 9: Paired t-test for the share of euros in 1999 and 2007 in countries with a balance of payments surplus

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
% of EUR in 1999 – % of EUR in 2007	–11.90000	10.75969	4.06678	–21.851	–1.949	–2.926	6	0.026

Source: National Central Banks; own calculations from SPSS.

Table 10: Paired t-test for the share of euros in 1999 and 2007 in countries with a balance of payments deficit

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
% of EUR in 1999 – % of EUR in 2007	–6.10867	17.13748	4.42488	–15.599	3.382	–1.381	14	0.189

Source: National Central Banks; own calculations from SPSS.

3.4 Foreign currency reserve composition by size of country

According to a study by Bernal (1998) a small economy is one that is a price-taker in the world market which means that it cannot influence world prices for goods, services and assets. The next criterion is the size of the population, with an upper limit of 5 or 10 million. Therefore, we set the dividing line between a small and a large country on the criterion of a population of 5 million and a GDP of USD 100 million. The group of small countries included Barbados, Costa Rica, Estonia, Guatemala, Croatia, Jamaica, Kirghizia, Latvia, Lithuania, Namibia, Swaziland and Uruguay. The group of large countries included Australia, Belgium, the Czech Republic, Chile, Hong Kong, Canada, Peru, Slovakia, Switzerland and the United Kingdom.

Compared to large countries, small countries hold a substantially bigger share of dollars in their foreign currency reserves than euros. The euro's share in small countries rose from 14.8% to 18.9% in the 1999-2007 period. On the other hand, large countries diversified their foreign currency reserves more equally between dollars and euros, yet the proportion of dollars still exceeds that of euros. In the period under scrutiny, the euro's share surged from 28.2% to 42.6%. In this area, the reserves were mainly diversified from other currencies, the proportion of which dropped by 49%.

Table 11: Independent sample t-test for small and large countries in the studied period

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
% of EUR	Equal variances assumed	2.747	0.117	–10.402	16.000	0.000	–17.0908	1.6429	–20.5738	–13.6079
	Equal variances not assumed			–10.402	13.168	0.000	–17.0908	1.6429	–20.6357	–13.5460

Source: National Central Banks; own calculations from SPSS.

First, a test of groups was performed for large and small countries so as to establish whether in the analyzed period there were any differences between the small and large countries in terms of the average euro share ($H_0 : \mu_{large} = \mu_{small}$; $H_1 : \mu_{large} \neq \mu_{small}$). The empirical analysis revealed statistically significant differences in terms of the average euro share by size of country (see Table 11). On average, the proportion of euros in large countries exceeds the respective proportion in small countries.

We later performed a paired t-test to verify whether the arithmetic mean of the euro share differs by group of countries in 1999 and 2007 ($H_0 : \mu_p = 0$; $H_1 : \mu_p > 0$). The results showed that, in small countries, the arithmetic mean of the share of euros in 2007 was higher than that in 1999 (Table 12). A different situation was observed with large countries as their sample data showed no statistically significant differences between their euro shares in 1999 and 2007. It hence follows that in large countries the 2007 share of euros did not differ statistically significantly from that in 1999 (Table 13).

Table 12: Paired t-test for the share of euros in 1999 and 2007 in small countries

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
% of EUR in 1999 – % of EUR in 2007	–10.68583	13.28106	3.83391	–19.124	–2.247	–2.787	11	0.018

Source: National Central Banks; own calculations from SPSS.

Table 13: Paired t-test for the share of euros in 1999 and 2007 in large countries

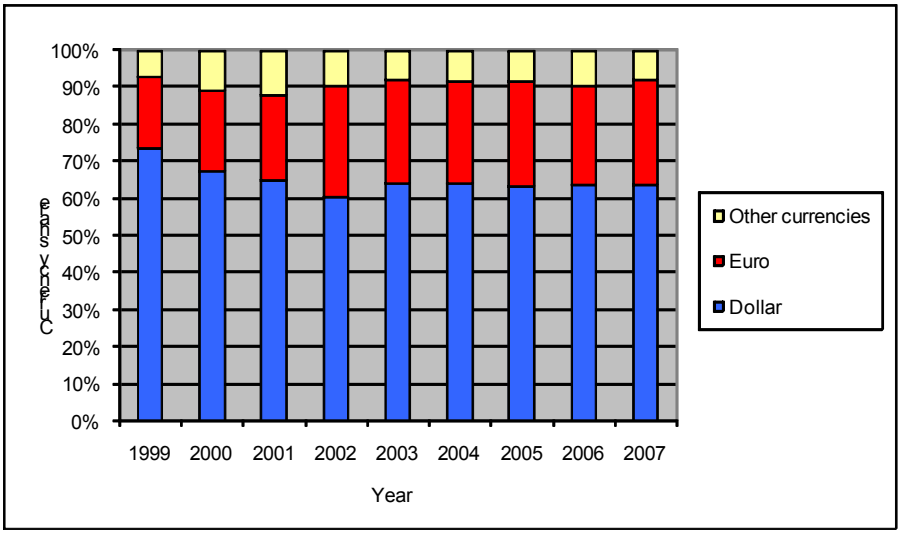
	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
% of EUR in 1999 – % of EUR in 2007	–4.67000	17.72867	5.60630	–17.352	8.012	–0.833	9	0.426

Source: National Central Banks; own calculations from SPSS.

3.5 Foreign currency reserve composition in all studied countries

It was observed that between 1999 and 2007 a diversification of foreign currency reserves took place in all 22 studied countries. The dollar's share dropped from 73.5% to 63.6% and the euro's share rose accordingly from 19.2% to 28.6%. The proportion of other currencies remained at about the same level (Figure 1).

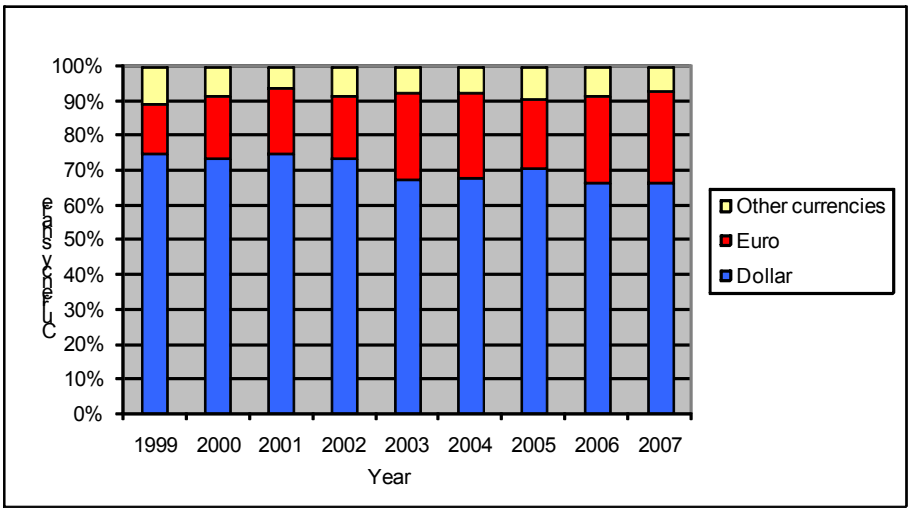
Figure 1: Foreign currency reserve composition in all studied countries in the 1999-2007 period (in %)



Source: National Central Banks; own calculations from SPSS.

The foreign currency reserve composition in the 22 studied countries was compared with the IMF data. Figure 2 shows the drop in the dollar's share from 74.4% to 65.9% and the rise in the euro's share from 14.3% to 26.6%. A comparison of the IMF data with the data acquired from the sampled countries reveals similar movements in the shares of both world currencies. In both cases the euro's share grew (according to the IMF data by 12.3 percentage points and in the selected countries by 9.4 percentage points), whereas the dollar's share shrank (according to the IMF data by 8.5 percentage points and in the selected countries by 9.9 percentage points).

Figure 2: Foreign currency reserve composition in all countries in the 1999-2007 period according to IMF data (in %)



Source: Currency Composition of Official Foreign Reserves (COFER), IMF, 2008.

At the end, a paired t-test was also performed for all analyzed countries together. The zero hypothesis assumed that the arithmetic mean of the euro's share in all studied countries was the same in 1999 and 2007 ($H_0 : \mu_p = 0$). The alternative hypothesis assumed that the arithmetic mean of the share of euros in 2007 was higher than that in 1999 ($H_1 : \mu_p > 0$). Based on the sample data the zero hypothesis was rejected and the alternative hypothesis accepted at P = 0.012, namely that the arithmetic mean of the euro's share in 2007 is higher than the respective 1999 figure (see Table 14).

Table 14: Paired t-test for the share of euros in 1999 and 2007 in all studied countries

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
% of EUR in 1999 – % of EUR in 2007	–7.95136	15.37841	3.27869	–14.770	–1.133	–2.425	21	0.024

Source: National Central Banks; own calculations from SPSS.

3.6 Main findings of the empirical analysis

Gourinchas and Ray (2005) report that two-thirds of global international reserves were denominated in dollars, which has also been proven by our empirical analysis using a sample of 22 countries. The available data confirm that, in the period under scrutiny, the dollar's share ranged between 60% and 73%. A diversification of foreign currency reserves was also observed, namely the dollar's share dropped by 9.9 percentage points whereas the euro's share rose by 9.4 percentage points. Table 15 shows that in more than half of the groups of countries the proportion of euros was larger in 2007 than in 1999, whereas in the remaining countries the changes were not statistically significant. In none of the groups of countries did the share of euros decrease. Given the upward trend in the proportion of euros in reserves

since 1999, it can be expected that the foreign currency reserve diversification process will probably continue and this supports the hypothesis about the gradual increase in the euro's role in international trade and finances.

The empirical analysis also confirms the existence of statistically significant differences between the groups of countries, which were divided on the basis of the four criteria, in terms of their foreign currency reserve composition (see Table 15). In the rest of the article the key findings of the empirical analysis are presented by group of countries. A comparison of the shares of currencies in developed and developing/emerging countries showed that the euro's share in the foreign currency reserves of developing and emerging countries is slightly higher, on account of other currencies. In developed countries, an upward trend was observed in the euro's share in the analyzed period. The above was also corroborated by Wijnholds and Sondergaard (2007) who reported that a diversification in favor of the euro was primarily observed in industrially developed countries. The dollar's share has remained high, yet it dropped in 2002 by a percentage that is commensurate with the growth in the euro's share.

Table 15: Comparison of the euro's share of foreign currency reserves in 1999 and 2007 by group of countries (based on statistical analysis)

Group of countries	**Comparison in euro shares in 1999 and 2007**
Developed countries	⇑
Emerging and developing countries	O
Europe	O
Africa, the Americas, Asia	⇑
Countries with a balance of payments surplus	⇑
Countries with a balance of payments deficit	O
Small countries	⇑
Large countries	O
All countries in survey	⇑

Source: National Central Banks; own calculations from SPSS.

As regards the geographical distribution of countries, the foreign currency reserve composition differs substantially by group. The bulk of the foreign currency reserves of Africa, the Americas and Asia are in dollars; they recorded no major fluctuations in the period under scrutiny. In its report, the ECB (2006) established that a high concentration of dollar-denominated reserves was still observed, particularly in Asia. Central banks with a sizeable reserve accumulation, particularly those in East Asia, have maintained an unchanged exchange rate against the dollar which means that in these countries a diversification from dollars into euros is either inexistent or very moderate. The euro's share rose slightly on account of third currencies. In the group featuring Australia and Canada, both leading global currencies are more equally distributed, although dollar-denominated reserves still dominate over those in euros (except in 2007 when the euro's share overtook that of dollars for the first time). By contrast with the abovementioned geographical areas, the analyzed group of European countries prefers euros to dollars. The share of the European currency grew over the studied period on account of dollars. According to Lim (2006), the reallocation to euros was

more pronounced among countries with close trade or financial ties to the euro area (including the group of European countries which are mostly outside the euro area) and less significant in Asia and the Americas.

Countries with a balance of payments surplus hold more dollars in their reserves than euros, whereas in countries with a balance of payments deficit the shares of the two world currencies are more equally distributed. In countries with a balance of payments surplus, the dollar's share dropped by 4.3 percentage points in the studied period, while that of euros rose by 5.1 percentage points. In countries with a balance of payments deficit, the shares of the two world currencies increased – the dollar by 2.5 percentage points and the euro by 7.8 percentage points.

Differences were also established between large and small countries in terms of their foreign currency reserve composition. In small countries, dollar-denominated reserves in the analyzed period accounted for 72.6% of the total and prevailed over euro-denominated reserves, accounting for 19% on average. On the other hand, the shares of the two major currencies in large countries are more equally distributed, with the dollar taking the lead of foreign reserve currencies. Since 1999, the dollar's share has fallen by 7.2 percentage points, while that of the euro has grown by 14.4 percentage points.

4 Conclusion

The United States is the world's biggest economic and military superpower and the dollar has enjoyed the status of the global international and reserve currency since World War II; according to the latest data, it accounts for the bulk of the international official foreign currency reserves of central banks. Despite the drop in its share from 1999, when it stood at 71%, to 2007, when it equaled slightly less than 65%, it is still the dominant currency. Second to the dollar is the euro which is the runner-up among the central banks' reserve currencies. Throughout this period, its share grew persistently and in the nine years since it was introduced it has gone up from 18% to slightly below 26%. The gradually increasing use of the euro is due to the smooth functioning of the euro area and the dollar's depreciation against other currencies in recent years. This was also supported by the power the German mark held prior to the new European currency being introduced.

The abovementioned shares of the two global currencies were also confirmed by our empirical analysis using a sample of 22 countries and covering the 1999-2007 period. Should this trend continue, the euro does stand a good chance of dethroning the US dollar as the global currency. The results of the empirical analysis confirm the hypothesis that the new European currency can become a reserve currency on a par with the US dollar or even the leading global currency. Moreover, the empirical analysis showed that, in the period under consideration, the euro's share rose in developed countries, in Africa, the Americas and Asia, in countries with a balance of payments surplus and in small countries, whereas in developing

countries, in Europe, in countries with a balance of payments deficit and in large countries, the statistical analysis revealed no statistically significant differences between 1999 and 2007.

In the short run, the euro is not yet threatening the US dollar but, in the future, it could become a serious rival for the status of the leading global reserve currency. Many factors are important here: the crucial one is the possibility of the United Kingdom joining the euro area which would substantially affect the euro's enforcement as the leading reserve currency. Namely, London is the most important financial center in both Europe and the world. This process could also be fuelled by the great financial and economic crisis (2008/2009) which has strongly impacted on the United Kingdom's financial and real sectors and caused a plunge in the pound sterling against the euro. The British central bank has been forced to drastically cut interest rates and it appears that equalization of the value of the two currencies is just a matter of time. On top of this, should the general currency tendencies from the recent past continue (dollar depreciation and/or euro appreciation) and should other European countries (Iceland, Sweden, Denmark etc.) remain encouraged to join the euro area, the euro will gain supremacy relatively soon, according to some forecasts already by 2020. On the other hand, despite facts such as the relatively higher degree of expansion of the central bank of the United States, the Federal Reserve (compared to the European Central Bank), the large budget deficit of the United States, relatively poor economic forecasts of the world's strongest economy etc., most investors are prioritizing money for other investments. Consequently, dollar demand is rising and so is the value of the dollar (playing the role of a 'safe haven'). Nevertheless, in a period characterized by a stock market upturn the US currency is expected to depreciate and the role of the euro as a global reserve currency will become stronger. This financial and economic crisis has clearly subjected the euro to the greatest acid test of its ten-year existence yet it also poses a unique challenge to the euro to strengthen its international role in the future.

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