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International Reserves Management Report

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Executive summary

Over the years, the Central Bank of Brazil (BCB) has sought to expand the transparency of the international reserves management process. This publication is the 10th volume of the International Reserves Management Report and describes in detail the evolution of the Brazil's international reserves, as well as the changes made to its management throughout the year 2017.

The international reserves management is based on a sound governance framework, which comprises the hierarchy defined among the decision levels, as well as an IT system with daily performance control and evaluation, and investments monitoring. For this end, a framework based on three pillars was conceived: i) benchmark portfolio; ii) operational limits; and iii) performance evaluation. In addition, the market risk, credit risk, liquidity risk and operational risk are also monitored on a daily basis.

The Board of Governors is responsible for establishing the strategic goals and the risk-return profile of the international reserves. In accordance with the guidelines defined by the Board, the strategic allocation seeks an anti-cyclical behavior and protection against currency fluctuations.

On December 30th, 2017, the international reserves amounted to US$381.97 billion, according to the concept of international liquidity. The average yearly Value at Risk (VaR) of the investments, a market risk metric which takes into account both the interest rate and foreign exchange rate components, was 2.0% in 2017, slightly lower than in the previous year. The average term of investment of the portfolio was at 1.69 year, showing a small fluctuation when compared to 2016. In regars to credit risk, 89% of the exposure of the portfolio is rated Aaa, whereas 8% is rated Aa. In 2017, the liquidity risk of the reserves, which takes into account the bid-ask spread of the bonds in the portfolio, remained at low levels, comparable to those of 2016: 0.03%, 0.12% and 0.10% for sovereign, supranational and agency bonds respectively.

The year 2017 was marked by broad acceleration in the global economy, especially in the developed countries. In fact, 2017 was the year of the consolidation of the economic recovery in the Euro Zone, while the expansion in the US remained solid and Japan showed the longest period of growth since 1999.

The growth environment with interest rates at historically low levels, combined with excess liquidity generated by the unconventional accommodative monetary policy and the subdued inflation expectations led the stock market indices to

reach record levels, with unprecedentedly low volatility. In addition to that, the expectation of corporate tax cuts and financial deregulation in the US, coupled with higher profits than expected from companies listed in exchanges also gave support to the rise in stocks.

In 2017, the international reserves showed a positive return of 2.27%. Throughout the year, yields went up as the recovery of the central economies showed resiliency. Nonetheless, this movement in yields was countervailed by the returns due to carry, and the interest rate result finished the year at 0.74%. The relative devaluation of the US dollar against in counterparts contributed with 1.53% to the positive result of the reserves.

The International Reserves Management Report is divided into four chapters. The first one presents the foundations on which the international reserves management is based. Chapter 2 describes the investment policy of the reserves. The third chapter discusses the several risks involved in these investments. The last chapter describes the aggregate results of the reserves, allowing us to verify the adequacy of the strategies vis-à-vis the long-term objectives defined by the BCB. The Report also contains an Annex with data from which the graphs are derived, as well as a glossary with the main terms used throughout the document.

1 International reserves management

This chapter presents the foundations upon which the management of the international reserves is based.

1.1 Introduction

The growth in global economic activity went up slightly in 2017 when compared to 2016 to 3.7%, the highest value since 2011. As shown in Table 1.1, both central and emerging economies showed acceleration in 2017.

Table 1.1 – Real GDP Growth (%)

Period	2016	2017[1/]
World	3.2%	3.7%
Developed Countries	1.7%	2.3%
USA	1.5%	2.3%
Euro Zone	1.8%	2.4%
Japan	0.9%	1.8%
Emerging Countries[2/]	4.4%	4.7%
China	6.7%	6.8%
India	7.1%	6.7%
Russia	-0.2%	1.8%
South Africa	0.3%	0.9%
Brazil	-3.5%	1.1%

Source: International Monetary Fund

1/ IMF projections for 2017.

2/ This group includes developing economies.

The year 2017 was marked by broad acceleration in the global economy, especially in the developed countries. In fact, 2017 was the year of the consolidation of the economic recovery in the Euro Zone, while the expansion in the US remained solid and Japan showed the longest period of growth since 1999.

The US economy showed resiliency to the interest rate increases by the Federal Reserve (Fed), having kept the pace of its recovery, with positive results, such as growth in the gross domestic product (GDP) and a decrease in the unemployment rate. These results, together with the fiscal reform approved in the fourth quarter that aimed at providing further stimulus to the economy (already close to full employment), favor expectations for the continuity of the interest rate hikes by the Fed, as well as the future Fed balance sheet unwinding.

The Euro Zone showed broader and more robust growth in 2017, along with a drop in the unemployment rate among all its members, including its periphery. Nonetheless, despite the pick-up in growth, inflation rates remain subdued, especially its core. This explains the cautious stance of the European Central Bank (ECB) when it comes to normalization of its monetary policy.

Japan, as an exporting country, benefitted from the increase in global demand and the relatively depreciated yen and recorded larger growth in 2017. In addition to that, the chronic deflation that has afflicted the Japanese economy for decades was reversed in 2017, although the inflation rate has not yet reached the 2% target established by the Bank of Japan.

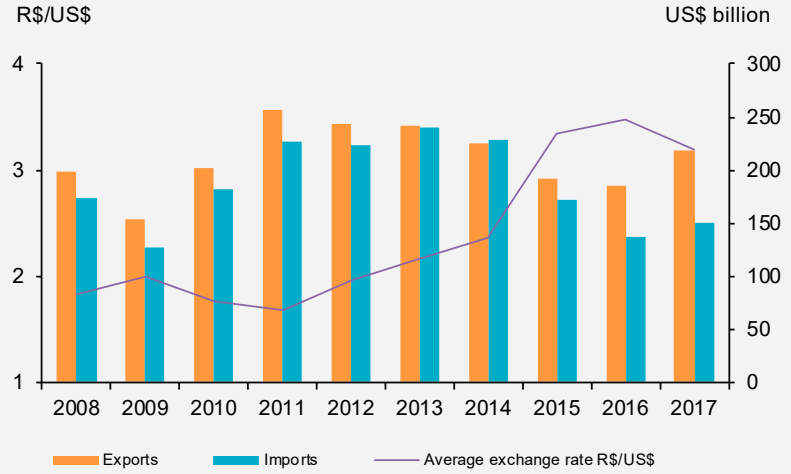
The monetary authorities of the USA, Canada and the UK have responded to the current economic conditions with gradual monetary tightening. Their fixed income markets have signaled that there may be limited room for interest rate hikes, once their yield curves have flattened significantly. In the Euro Zone, despite the announcement of the tapering of the ECB asset purchase programme, there is no expectation of interest rate hikes in the short term.

The main short-term risks envisaged by the end of 2017 were: i) faster pace of monetary policy normalization than currently priced in the market, leading to risk aversion and economic slowdown ii) unexpected increase in the inflation rate, leading to faster tightening; iii) slowdown of the Chinese economy in this moment of transition, which could have a negative impact on stocks, currencies and commodities.

1.2 Economic indicators

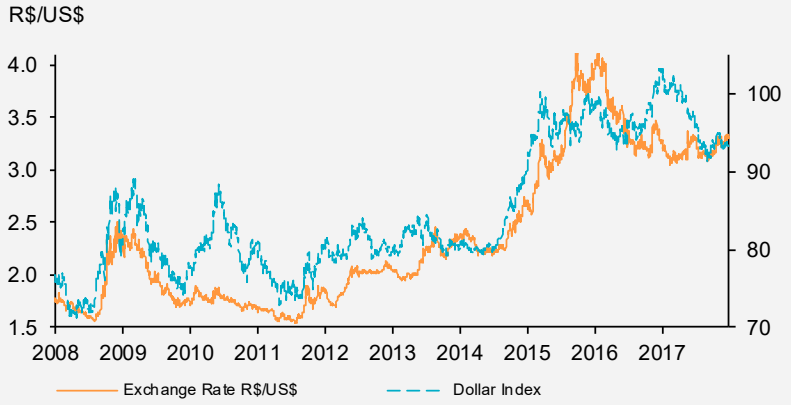
Graph 1.1 shows the behavior of Brazilian imports and exports, as well as the Brazilian Real/US dollar exchange rate, for the period from 2008 to 2017. Exports grew by 17.55%, while imports grew by 9.59% in 2017, when compared to 2016, and as a result, the Brazilian trade balance recorded the largest surplus of its history. The nominal exchange rate was 1.49% higher at the end of 2017 than one year before, and fell 8.35% when yearly averages are compared against each other. It should be noted that the depreciation of the Brazilian Real has a strong positive correlation with the increase of the US dollar index, which is composed of a basket of developed country currencies, as shown in Graph 1.2. The exchange rate also has a high (in this case, negative) correlation with the CRB commodities index, as shown in Graph 1.3.

Graph 1.1 – Trade balance and exchange rate (R$/US$)



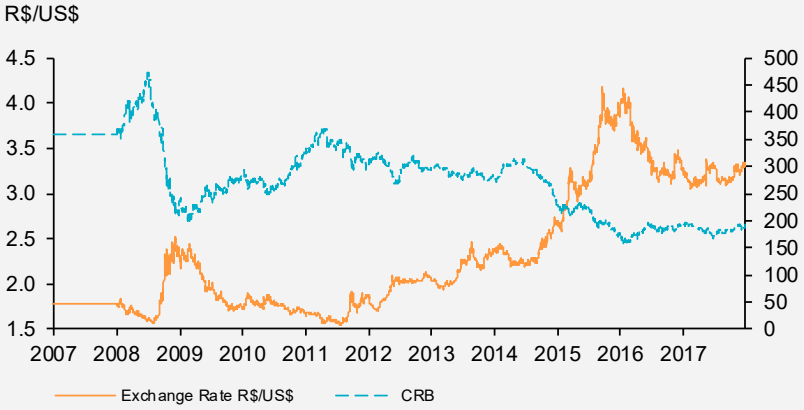
Source: Central Bank of Brazil

Graph 1.2 – Exchange Rate (R$/US$) and Dollar Index



Source: Reuters

Graph 1.3 – Exchange Rate (R$/US$) and CRB



Source: Bloomberg

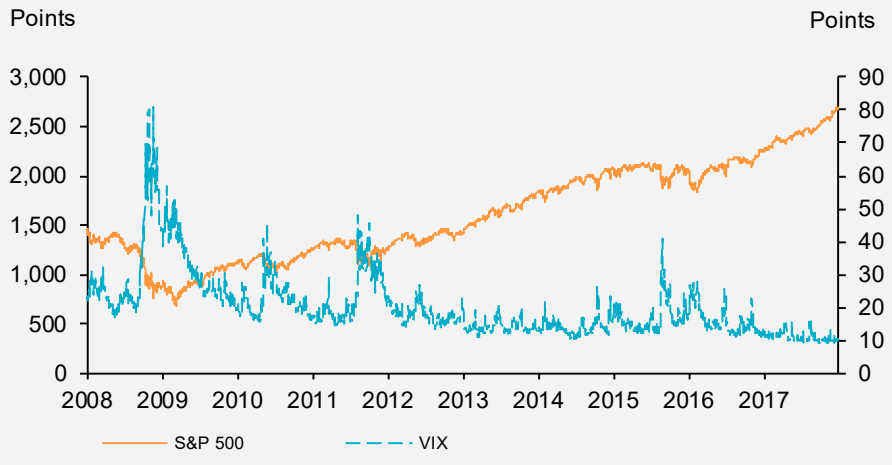
The GDP in Brazil recovered in 2017, with a projected growth of 1.1%, after two years of recession. As shown in Graph 1.4, the net public debt continued its rise to a level of 51.6% of the GDP, while the international reserves fell slightly to 18.2% of the GDP, due to fluctuations in the exchange rate.

Graph 1.4 – Net public sector debt and international reserves (% GDP)

Source: Central Bank of Brazil

The US stock market, represented in Graph 1.5 by the S&P 500 Index, ended 2017 with a gain of 19.45%. The ongoing economic recovery in the US, the profitability of the companies (higher than expected by the market), the effect of the fiscal stimulus from the corporate tax cuts passed in December and the low level of interest rates are the main factors associated with this strong increase in stocks, which in 2017 was marked by its very low volatility.

Graph 1.5 – S&P 500 and VIX

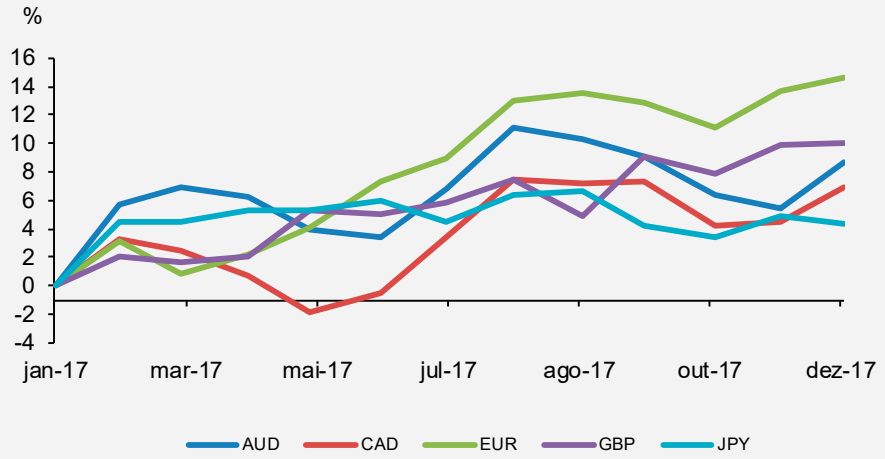


Source: Bloomberg

Throughout 2017, the US dollar fell against its major counterparts, including those in the reserves. This movement can be explained by the fact that the divergence in monetary policy between the US tightening and the stimuli in the remaining developed economies might be reverted in the near future, given the broadening

of the global economic recovery. Graph 1.6 shows the fluctuations of the US dollar against the other currencies that compose the reserves in 2017.

Graph 1.6 – Currencies – *Variation against the US Dollar*



Fonte: Bloomberg

1.3 Governance

In accordance with the Law 4595, from December 31st 1964, the BCB has the exclusive responsibility to be depositary of the gold, foreign currency and special drawing rights (SDR) reserves. In the BCB, it is the responsibility of the Board of Governors to establish the strategic objectives and the profile of risk and return of the country's international reserves.

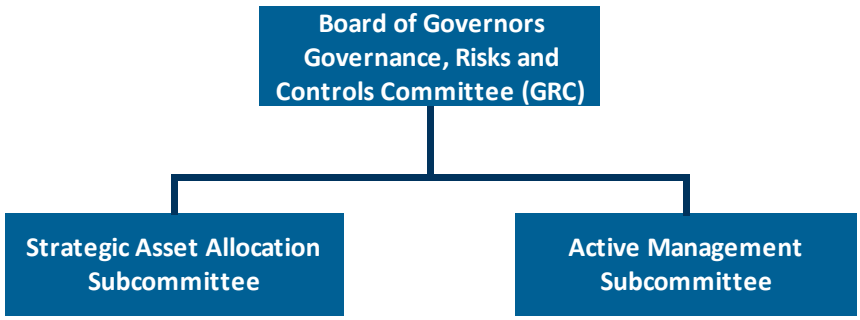
The reserves governance structure is supported by an integrated risk management policy of the BCB. The investments are made in accordance with guidelines established by the BCB Board of Governors, within the Governance, Risk and Control Committee (GRC). The GRC defines the risk-return profile by means of an appropriate benchmark portfolio, the operational limits for the authorized deviations from this benchmark and the performance evaluation criteria. The organizational structure reinforces the control and information flow mechanisms, enabling the institution to have an investment process focused on adequate risk management. The GRC was created in May 2017 aiming at the improvement corporate governance, risk management and internal controls at the BCB, leading to a better decision-making process.

Risk management at the BCB takes into account several distinct risk dimensions, such as financial, strategic, reputational, legal and operational. This integrated approach, known as Enterprise Risk Management (ERM), contributes significantly to the continuous improvement of the BCB's tasks, optimizing allocation of institutional, human and financial ressources. Besides that, it makes things clear with respect to the institution's risk profile and helps to adequate it according to the BCB's strategic goals.

With the adoption of a novel integrated and structured risk management model, the BCB is aligned with the best international practices, consolidating its excellence in this area.

As far as the structure of governance is concerned, reserve management at the BCB is organized according to Figure 1.1

Figure 1.1 – Governance structure of the international reserves



At the highest level is the BCB Board of Governors, within the GRC, which is responsible for: i) defining the long-term strategies by means of a benchmark portfolio; ii) evaluating the results of the international reserves; and iii) defining the operational limits to which the teams that implement the investment policy are subject.

Reserves management can be divided in two levels. The first level is the long-term strategic management, which is overall responsible for the investments that contribute the most to the returns of international reserves. The Strategic Allocation Subcommittee, which is composed of the Deputy Governor of International Affairs and Corporate Risks (Direx) as its president, as well as the Deputy Governor for Monetary Policy (Dipom) and the Deputy Governor for Economic Policy (Dipec), is responsible for proposing to the GRC the benchmark portfolio, the operational limits and the performance measurement criteria.

At the second level is the short-term management. The Active Management Subcommittee, composed of the Dipom as president, as well as the Direx and the Dipec, meets quarterly to establish deviation strategies from the benchmark portfolio, within the limits set by the GRC. This type of management has the objective of improving the returns in the short-term by taking advantage of circumstantial market opportunities.

The investment parameters and criteria are monitored by an internally developed system. The controls run on a daily basis, and any breach in the operational limits is automatically reported to all members of the Board of Governors.

With regards to the operational aspects, the process of investing the international reserves is comprised of the investment, compliance and settlement tasks. Compliance and settlement are critical procedures since they affect security, liquidity and profitability given that the reserves are traded in an environment of multiple currencies, regions and time zones.

Finally, the international reserves management process is subject to five different types of control: i) internal control by the International Reserves Department (Depin), through its Internal Control Division (Dicoi); ii) internal control by the BCB's Audit; iii) control by the Office of the General Comptroller (CGU), an agency that is external to the BCB, but part of the Federal Executive branch; iv) external control by the Brazilian Court of Audit; and v) external control by an independent auditor.

2 Investment policy

The investment policy reflects the risk preference of the Central Bank of Brazil.

The Board of Governors defines the investment policy, within the GRC based on the long-term strategic goals of the international reserves, such as: to provide confidence to the market that the country is capable to honor its international commitments and support the execution of its exchange rate and monetary policy. As strategic consequences of these goals, the BCB seeks a strategic allocation that has a countercyclical behavior and reduces the country's exposure to exchange rate fluctuations. With these principles in mind, the strategic allocation is determined with the help of risk-return optimization techniques, once the criteria of safety, liquidity and profitability are taken into account, prioritized in this order.

The Board defines a benchmark portfolio as reference for the allocation of the reserves according to a long-term strategic profile that reflects the institutional preferences of the BCB when it comes to risk and return. Short-term fluctuations in variables that affect the asset prices, such as interest and exchange rates, are not considered in the long-term decisions.

Intentional deviations from the benchmark portfolio as a function of oscillations in market conditions can be made and are monitored on a daily basis by internal control systems. In other words, the international reserves are actively managed, being allowed to marginally deviate from the benchmark portfolio within operational limits previously defined by the Board of Directors.

The BCB invests in two funds managed by the Bank for International Settlements (BIS), known as BIS Investment Pool (Bisip) funds. The first fund is composed of US Treasury Inflation-Protected Securities (TIPS), whereas the other invests in Yuan-denominated Chinese sovereign bonds. The total volume allocated to these Bisip funds was US$362.6 million. In January of 2017, the International Reserver External Management Program (PGER) was ended, and its resources, which added up to US$ 5.68 billion on its last day, were transferred back to internal management.

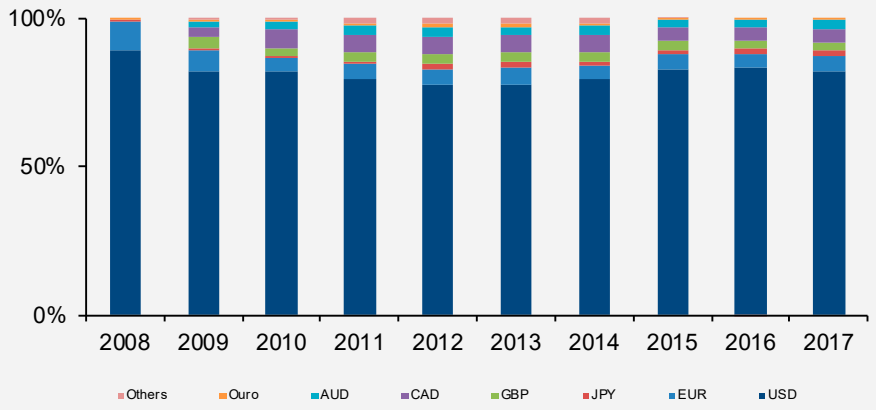
In the following sections, we describe fundamental aspects of the investment policy of the international reserves. In general, this policy can be segmented in terms of currency allocation, distribution by asset class and average term of investment.

2.1 Currency allocation

As previously mentioned, one of the goals of the international reserves management is the reduction of the country's exposure to exchange rate risk. Thus, the BCB seeks to build a diversified portfolio that ensures, as a priority, the hedging of the exchange rate risk of the gross external debt. In December 2017, the currency allocation of the reserves was the following: 82.3% in US dollars, 5.0% in euros, 4.5% in Canadian dollar, 2.9% in Australian dollar, 2.8% in sterling pound, 1.8% in Japanese yen and 0.8% in gold. This currency allocation provides a full hedge of the gross external debt. Graph 2.1 shows the evolution of the currency allocation at the end of each year.

We can see in Graph 2.1 that, for the whole period, the US was the currency with the largest share. In 2009, the BCB initiated a policy of currency diversification in the international reserves. In 2015, there was a small adjustment regarding the currency distribution, aiming at the strengthening of the most significant positions that make up the currency coverage. The distribution has been kept relatively constant since then.

Graph 2.1 – Foreign Currency Allocation[1/]



Source: Central Bank of Brazil
1/ Reserves in cash concept (end of period data)

2.2 Distribution by asset class

The international reserves are invested primarily in fixed income assets, especially in sovereign bonds, agency bonds from several countries, bonds issued by supranational organizations and fixed-term bank deposits. Agencies are entities sponsored by a national government, created with the objective of promoting the development of certain sectors of the economy, raising funds mainly through the issuance of bonds in the international markets. The central governments issue bonds in order to finance their fiscal deficits. Supranationals are multilateral organizations, such as the World Bank and the Bank for International Settlements (BIS), which issue bonds and, in some cases, act as financial intermediaries.

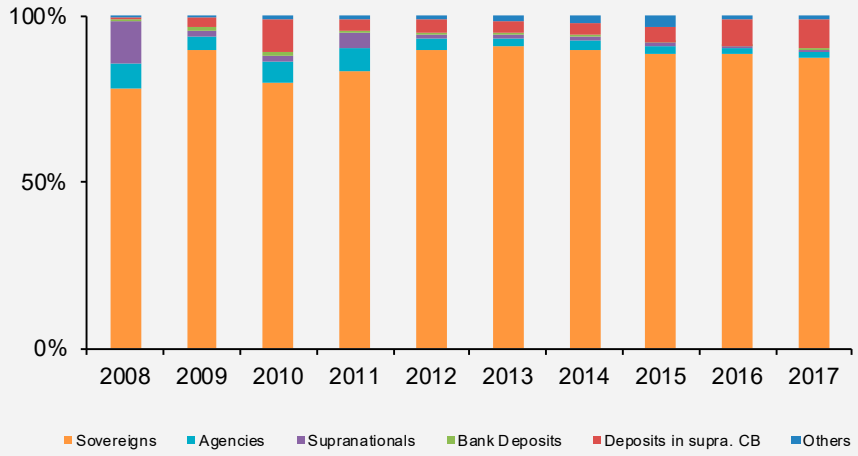
In December 2017, the reserves were allocated as follows: 87.6% in sovereign bonds; 8.5% in deposits in central banks and supranational organizations; 1.6% in

agency bonds; 0.7% in supranational bonds; 0.7% in deposits in commercial banks; and 0.9% in other asset classes, such as gold.

Graph 2.2 shows the asset class distribution, in percentage terms, in the period from December 2008 to December 2017 (end of period data). Graph 2.3 shows the same evolution in terms of US dollars.

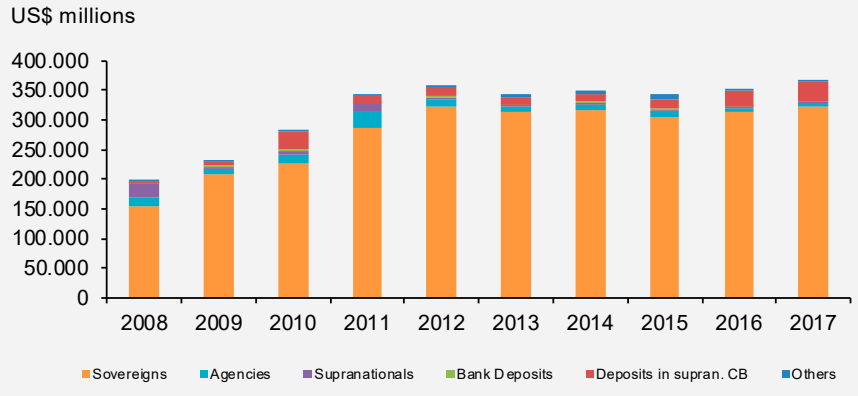
In 2017, there was a slight decrease in the allocation of sovereign bonds, and a small increase in deposits in commercial banks as well as in central banks and supranationals, due to operational reasons concerning cash management. These deposits include repurchase agreements with the Federal Reserve.

Graph 2.2 – Asset class allocation[1/]



Source: Central Bank of Brazil
1/ Reserves in cash concept (end of period data)

Graph 2.3 – Asset Allocation[1/]

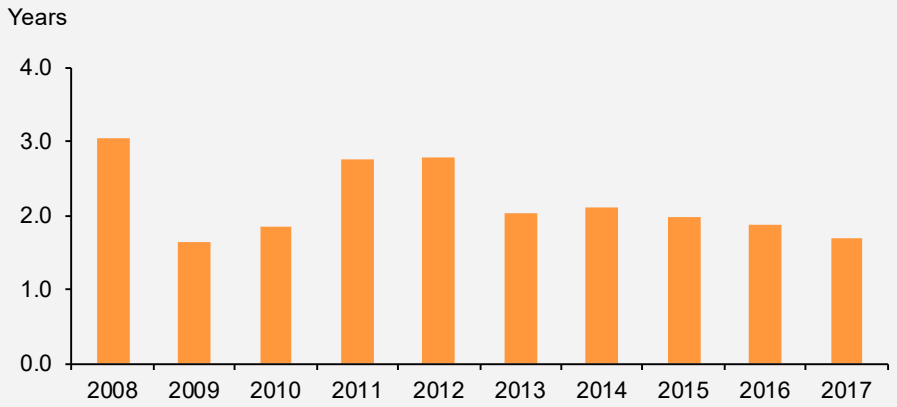


Source: Central Bank of Brazil.
1/ Reserves in cash concept (end of period data).

2.3 Average term of investment

The choice of the average maturity of the investment of the international reserves reflects the risk preferences of the Board of Governoras. It is aligned with the criteria of safety, liquidity and profitability, in this order. Graph 2.4 shows the evolution of the average term of investment for the period between December 2008 and December 2017 (end of period data).

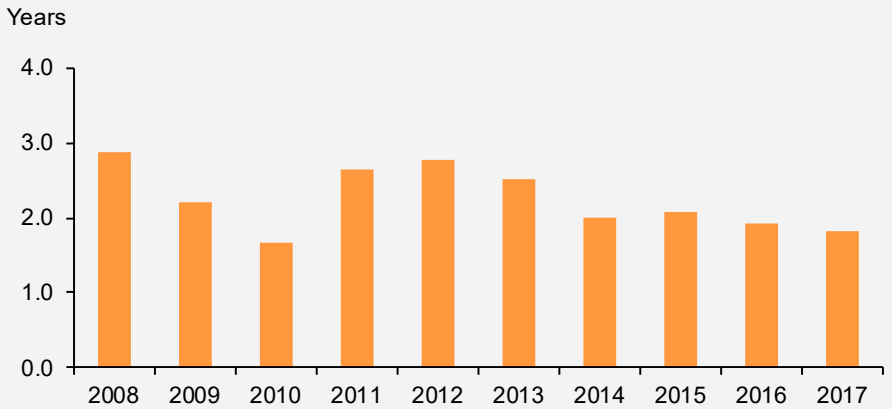
Graph 2.4 – Average term of investment – End of Period[1/]



Source: Central Bank of Brazil
1/ Reserves in cash concept (end of period data)

In 2013, the benchmark index for the main portfolio was reduced from 1-5 years to 1-3 years, with the objective of reducing the sensitivity of the portfolio to interest rate movements (particularly to US interest rates). This index was kept in place from 2014 to 2017. With this measure, the average term of investment went from 2.79 years at the end of 2012 to a level close to 2 years in the following years. In fact, at the end of 2017, the average term of investment was 1.69 years. We can also observe this decrease when yearly mean of the average term of investment is considered (graph 2.5). In 2017, the yearly mean was 1.81 years.

Graph 2.5 – Average term of investment[1/]



Source: Central Bank of Brazil
1/ Reserves in cash concept (annual average).

3 Risk management

Market, credit, liquidity and operational risk are monitored in the international reserves investment process.

The risk analysis related to the investment process is a key aspect to understand the financial performance and to make the benchmark portfolio adequate to the investment objectives.

As mentioned before, the different risks taken in international reserves investments are controlled daily by an IT system developed internally by the Central Bank of Brazil (BCB). This system includes the market, credit and liquidity risks calculations, operational losses registration, and several other operational limit controls.

The market risk of a portfolio is the risk of financial loss due to market price variations of portfolio's assets.

Liquidity risk refers to the risk of not being able to sell an asset or closing a position when desired, without incurring in significant costs.

Credit risk is the risk of an institution not being able to meet payments due to the securities issuance, deposits or any other contractual obligation or financial commitments made to investors.

Operational risk may be defined as risk of direct or indirect loss resulting from inadequate or failed internal processes, people and systems or from external events.

3.1 Market risk

There are several sources of market risk related to the international reserves management. The main sources are the risk of change in exchange rates and interest rates. It is important to highlight that the reference currency (numéraire) used by BCB for the international reserves management is the US dollar. In order to measure the reserves market risk, the BCB uses the Value at Risk – VaR, as can be seen on next section. Additionally, stress tests are used for measuring the reserve's sensitivity to risk factors, as can be seen on section 3.1.2.

3.1.1 Value at Risk

The main market risk measure used by the BCB for the international reserves is the Value at Risk (VaR). The VaR is a statistical measure related to how volatile the prices of the assets held in a portfolio are, based on the recent history of the risk factors. For a given probability p, the VaR is an estimate of the p quantile of the

return distribution of a portfolio for a given time horizon. This means that a loss greater than the VaR should be expected to happen only p fraction of the time.

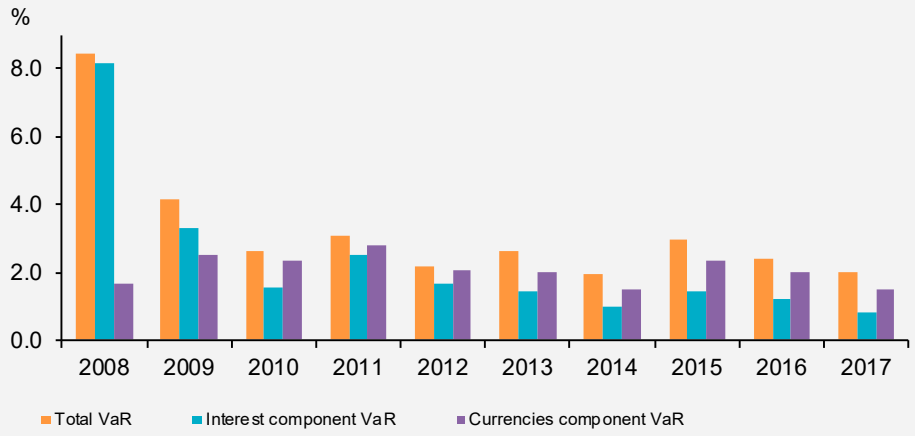
The VaR is calculated on a daily basis for the reserves, with probability 5% for the time horizon of one day. That is, if the return distribution remains the same, a daily loss greater than the VaR should only happen 5% of the days. Besides the total VaR, the BCB also calculates its interest rate and exchange rate components, which are computed by taking into account these two types of risk factors separately.

Graph 3.1 shows the mean annualized VaR of the international reserves in percentage terms. The graph also shows the interest rate and foreign exchange components. The total VaR was 2.0% a year on average in 2017, a value somewhat lower than in the previous year.

In 2017, the interest rate component of the VaR fell to 0.8% from 1.2% registered in 2016. The exchange rate component also fell from 2.0% to 1.5% a year. These drops are due primarily to the low levels of volatility of the risk factors seen in 2017.

In May of 2012, the international reserves started to carry exposure to risk factors related to stocks and commodities. However, since the volume invested in these asset classes was small, their contribution to overall market risk was very low throughout the year. In fact, the average of the equity/commodity component of the annualized VaR was lower than 0.09% during 2017.

Graph 3.1 – International reserves VaR[1/]



Source: Central Bank of Brazil.
1/ Yearly average for each year of the annualized daily VaR.

3.1.2 Stress tests

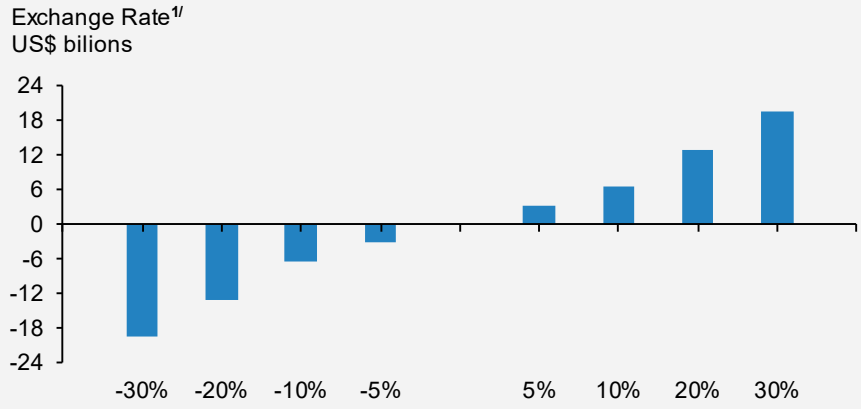
The stress test is another tool used for measuring the market risk of the international reserves holdings. It seeks to quantify the negative impact of shocks and events that are unfavorable to the BCB's positions. Thus, the stress/ crisis scenarios are designed to evaluate the potential financial losses caused by an adverse shock to each of the risk factors to which the reserves are exposed.

The tests are performed considering the BCB's positions at the end of 2017, and the risk factors used in these tests are the exchange rates of the US dollar against

the remaining currencies in the reserves, as well as the yield curves. Graph 3.2 shows the impact of the fluctuation of all the other currencies against the US dollar on the result of the reserves, varying in amplitude from 0% to 30%. Any appreciation of the US dollar against the remaining currencies on the reserves should have a negative impact on the returns.

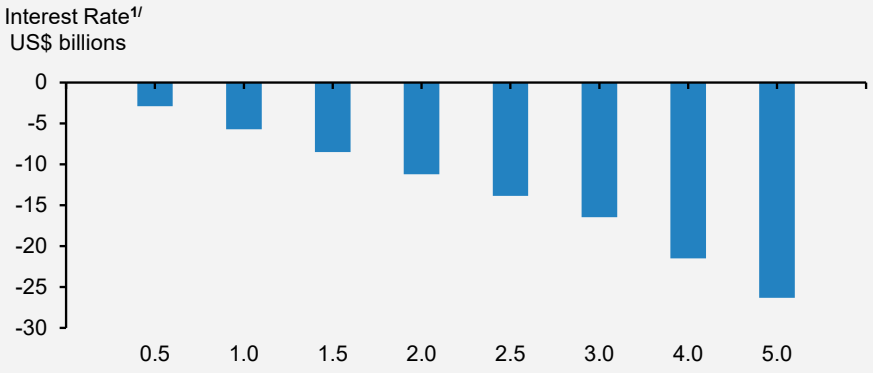
Graph 3.3 shows the results of parallel shifts of 0.5 to 5.0 percentage points to the yield curves of the markets where the reserves are invested. The larger the shift in the international interest rates, the larger the negative effect on the market value of the reserves.

Graph 3.2 – Forex stress test



Source: Central Bank of Brazil.
1/ Impact of the exchange rate variations against the US dollar on the value of the reserves, as of 12.30.2017.

Graph 3.3 – Interest rate stress test



Source: Central Bank of Brazil.
1/ Impact of parallel shifts of the yield curves on the value of the international reserves, as of 12.30.2017.

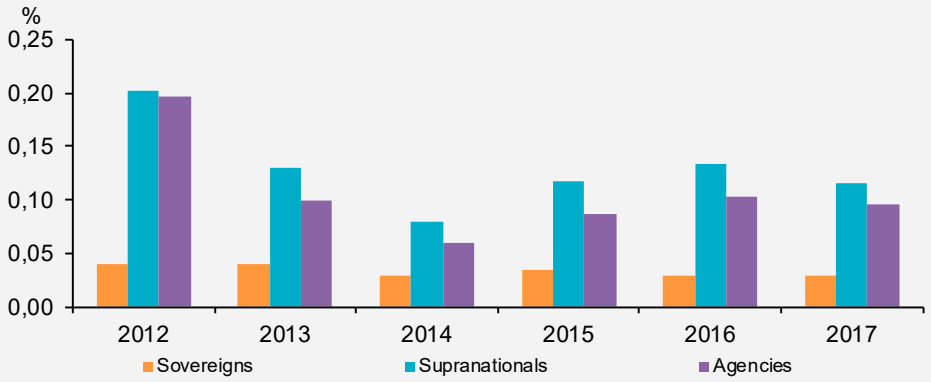
3.2 Liquidity risk

One of the pillars of the investment policy of the international reserves is liquidity. Therefore, restrictions in terms of asset classes are taken into account in the allocation process in order to mitigate liquidity risk. Liquidity risk corresponds to the risk of not being able to sell an asset or to close a position without incurring significant costs.

In order to guarantee an adequate level of liquidity for the international reserves, the BCB has guidelines that limit holdings' size and investment maturity. For sovereign, supranational and agency securities, there is a maximum purchasing limit per issuance as well as a maximum share of the outstanding amount for each asset. These operational limits have the goal of: i) making sure that the eventual sale of these assets by the BCB will not alter their prices significantly; and ii) limit the impact of a given issuance in the portfolio return.

In addition to the controls already mentioned, the BCB also monitors the portfolio's liquidity risk using some liquidity cost scores. These scores take into consideration the bid-ask spreads of all the portfolio holdings, and they are calculated for each type of bond issuer (sovereigns, supranationals and agencies).

Graph 3.4 – Liquidity Risk[1/]



Source: Central Bank of Brazil.
1/ Values refer to the respective portfolios.

As we can see in Graph 3.4, the liquidity risk computed as the difference between bid and ask prices of the bonds marginally decreased in 2017 in relation to 2016. We can also note that the liquidity risk of assets issued by sovereigns is consistently lower than that of assets issued by agencies and supranational organizations. The liquidity risk measured for sovereign issuers went from 0.0294% in 2016 to 0.0286% in 2017, while it was 0.134% for supranational issuers in 2016 and reached 0.115% in 2017, and for agencies it was 0.104% in 2016 and fell to 0.095% in 2017. Thus, the liquidity risk of each class of bonds in the reserves only fluctuated slightly over the year.

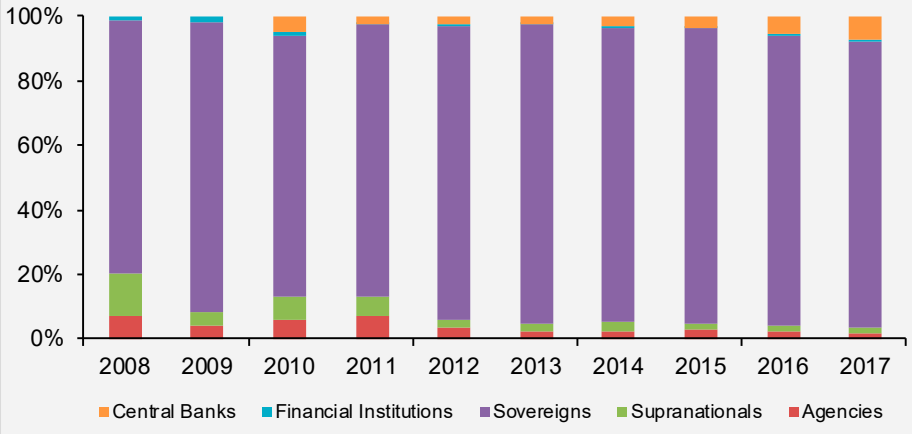
3.3 Credit risk

The aim of this section is to present the annual evolution of the exposure of the international reserves to credit risk since 2008, as well as the control mechanisms for such exposure. In addition, we present some concepts concerning credit risk and the asset distribution according to three criteria: type of issuer or counterparty, geographic region, and creditworthiness.

Credit risk is defined as the uncertainty related to the occurrence of a credit event (downgrade or default of a counterparty), which results in a loss in value of holdings linked to this counterparty. A credit event occurs when a counterparty does not fulfill its assumed obligations of payment. The BCB's counterparties considered to pose a credit risk are the ones on which the BCB has claims, such as: agencies, central banks, central governments, financial institutions and supranational organisms. The category of financial institutions includes both commercial and investment banks. The graphs in this section show that most of the reserves is allocated in sovereign bonds, and, within this group, in US treasuries.

The evolution of the distribution by type of issuer and counterparty is shown in Graph 3.5. In this graph, we observe that along the depicted period the increase in the share of the reserves allocated to sovereign bonds occurred as the share invested in financial institutions, agencies and supranationals fell. In 2017, the distribution was similar to that in 2016, with a small increase in central bank deposits to the detriment of sovereign bonds.

Graph 3.5 – Distribution by counterparty type[1/]



Source: Central Bank of Brazil
1/ Average yearly values

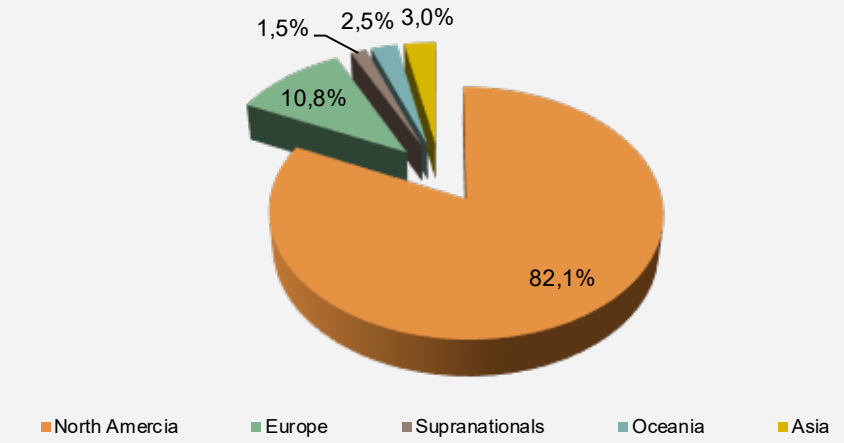
The portfolio's credit risk level is due to the composition of the portfolio and the counterparties' credit quality. The individual credit risks of agencies and supranational organisms authorized by BCB are low due to the limits established, which enable only investments in instruments of fixed income with high level creditworthiness, according to a credit rating agency and an internal analysis.

As for the credit risk control of financial institutions, two types of limits were established: one per transaction and other for the portfolio as a whole. Each

transaction is subject to operational limits that define the minimum credit quality, the maximum exposure per issuer or counterparty and the maximum term of each exposure. Market indicators and accounting information are also considered in the credit analysis of the counterparties and issuers of the bonds in the reserves' portfolio. The aggregate limits for the portfolio aim at restricting the total credit exposure. Pursuing this goal, the BCB employs a statistical model of credit risk developed internally.

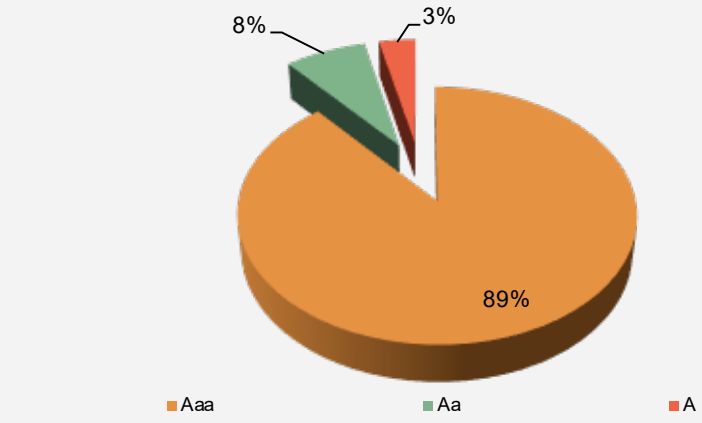
Graphs 3.6 and 3.7 refer to average exposure data for 2017. The distribution of assets with credit risk by geographic region is shown in Graph 3.6. Most of the allocation (82.1%) is in North-American issuers and counterparties. As previously mentioned, this is due to the large share of the reserves that is invested in United States sovereign bonds, as a consequence of the prevalence of the US dollar in the reserves. Graph 3.7 shows the distribution by credit risk rating, and we can see that 89% of the exposure has a Aaa rating, whereas 8% has a Aa rating and 3% a A rating.[1]

Graph 3.6 – Distribution by region



Source: Central Bank of Brazil

Graph 3.7 – Allocation by credit rating

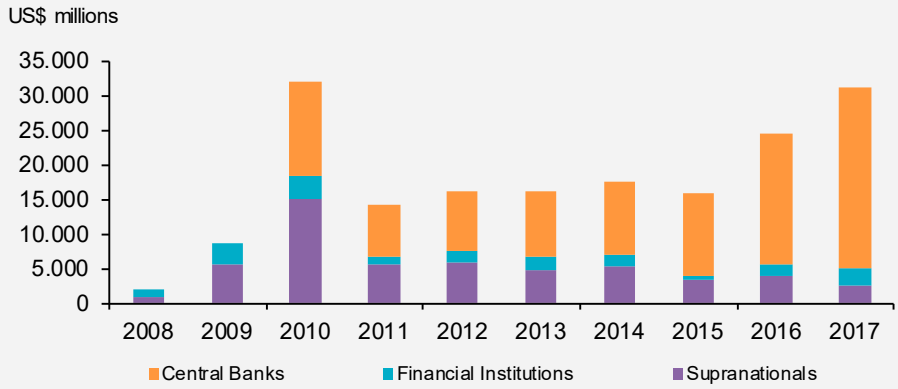


Source: Central Bank of Brazil

1 The international reserves also have a share of 0.05% allocated to assets rated lower than A.

Graph 3.8 shows the evolution of the total volume of the exposure to credit risk arising from money market instruments.[2] It should be noted that this exposure is due to time deposit operations, repurchase agreements and/or derivatives such as swaps and forwards with commercial banks, central banks and supranational organizations, and does not include bonds. In 2011, the worsening in the perception of the credit risk of issuers and counterparties, as well as the increase of the uncertainties in the international markets, caused the exposure to supranationals and financial institutions to decrease considerably. Since then, these exposures have remained relatively unchanged. In mid-2016, repurchase agreements with the Fed were included in the calculations of the exposure to central banks, which caused it to increase markedly that year and in 2017. In 2017, the exposure to financial institutions increased marginally.

Graph 3.8 – Total credit risk exposure to money market operations[1/2/]



Source: Central Bank of Brazil
1/ Values in US$ millions (yearly averages).
2/ Deposits, repurchase agreements, forex.

3.4 Operational risk

Operational risk can be defined as the possibility of direct or indirect loss resulting from failure, deficiency or inadequacy of internal processes, systems or external events. In the past, this type of risk was controlled only with the use of qualitative management practices. Current practices, on the other hand, seek to measure operational risks by means of quantitative models as robust complements of internal controls. The Integrated Risk Management Policy of BCB is driven by guidelines and recommendations contained in main reference in risk management and business continuity such as, COSO, ISO 31000, AS/NZS 4360: 2004, NBR 15999-2, among others, and in Basel recommendations.

The tools of operational risk management (set out in this Policy) and used at BCB during the stages of survey, analysis, prioritization, treatment, monitoring and review of risk are: Risk and Control Self-Assessment (RCSA), the Key Risk Indicators (KRIs) and the Event History Log (RHE).

2 Money Market instruments are short-term investments such as fixed-term deposits and repos.

In the RCSAs, the risks associated to each process and their likely causes are identified through the perception of the business managers. They are classified according to the nature of the potential incidents with negative impacts. The initial approach to the risk self-assessment is performed through interviews where the most relevant risks associated to each business process are identified and classified according to an event-based taxonomy. The results of this identification and evaluation process of the operational risks allows a broad view of the processes, actions and projects as well as their interactions. This allows the design of risk mitigation measures by the organization.

With this procedure, the BCB has identified the risks in the processes related to the management of the international reserves and defined the corresponding risk mitigation measures.

The RHE consists in a database of operational risk incidents, which can be classified into two categories: events and quasi-events. This tool ensures that the incidents are being monitored and makes it possible to analyze the trends in order to improve the controls. Taking into account the risk events that materialize is a powerful tool in the reassessment of processes, avoidance of new losses and correction of misleading risk perceptions.

With the implementation of an integrated non-financial risk at the BCB, Key Risk Indicators (KRIs) were developed for evaluation and monitoring of risk. The KRIs, computed in an automated fashion from data generated in the day-to-day execution of tasks, aim to be predictive tools. Since the KRIs are highly correlated with the risks, they help in measuring the level of exposure and in managing the risks themselves. When associated with pre-defined thresholds, they can trigger an alarm, and thus allow a timely implementation of control measures for the risk in question as well as its consequences. This risk management system also makes it possible to follow risk events and quasi-risk events, ensuring that incidents are monitored and risk trends are analyzed for the improvement of control systems.

When it comes to operational aspects, international reserves management involves trading, compliance and operations settlement processes. Compliance and settlement are considered critical as they may affect security, settlement and profitability in a framework with different currencies, countries and time zones.

For compliance and settlement processes, transaction volume and asset diversification are uniquely important as they represent additional work flows, and thus more exposure to operational risk. In 2017, turnover reached US$ 12.4 trillion, with 16,602 transactions, an estimated 89,897 SWIFT messages and 776,549 accounting records. Differently from the values registered in the contracts, which consider the trade value, the compliance and settlement processes consider all flows related to the transactions due to the operational risks.

When it comes to the number of risk incidents relative to the international reserves management, a fall of 18% was recorded between 2016 and 2017, due to the automation of internal processes at the BCB and to improvements in the informational systems for external counterparties. Furthermore, the total number of incidents represented less than 2% of all the transactions.

4 Returns

The performance evaluation allows for the verification of the strategy suitability vis-à-vis the defined strategic objectives.

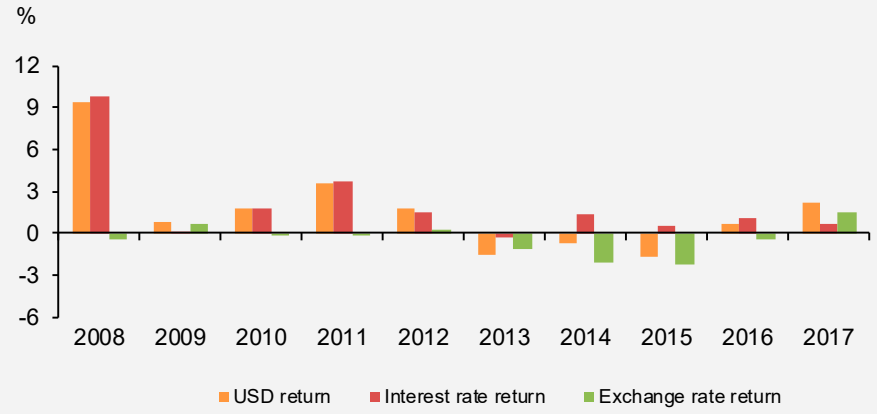
The analysis of returns arisen from international reserves investments must be done considering the different mechanisms used for the calculation. The Central Bank of Brazil (BCB) considers the accounting result for producing its balance sheet and the data from the managerial system developed internally to support the investment decisions and the internal controls.

The accounting result, however, is not the most appropriate metric from the point of view of investments decision making, as the returns are not calculated relatively to the amount invested, which changes due to purchases and sales of foreign currency. Besides, since the reserves are invested in the international markets, measuring the result in Brazilian Real incorporates the US dollar-Brazilian Real exchange rate fluctuations into the investment performance, which makes it hard to analyze the returns of each market. In order to solve these problems, the BCB calculates the returns on the reserves using a managerial system that allows the portfolio to be evaluated on a daily basis, according to international standards, making it possible to follow the investment strategies in each of the markets.

In 2017, yields rose in the fixed income markets of the central economies due to the consistency in the economic recovery and had a negative impact on reserves results. This movement, however, was dominated by the gains with carry, leading to a positive interest rate result. The devaluation of the US dollar against its counterparts also led to a positive result for the reserves. Thus, the international reserves gained 2.27% in 2017. This value includes the External Management Program (PGER) as well as the BIS Investment Pool (BISIP) funds. The PGER ended on January 31st and had a result of 1.71% up to this date. The Bisip portfolio gained 3.31% in 2017.

The returns of the internally managed reserves, which account for 98% of the total reserves, are shown in Graph 4.1. The yield and currency return components are also shown in Graph 4.1.

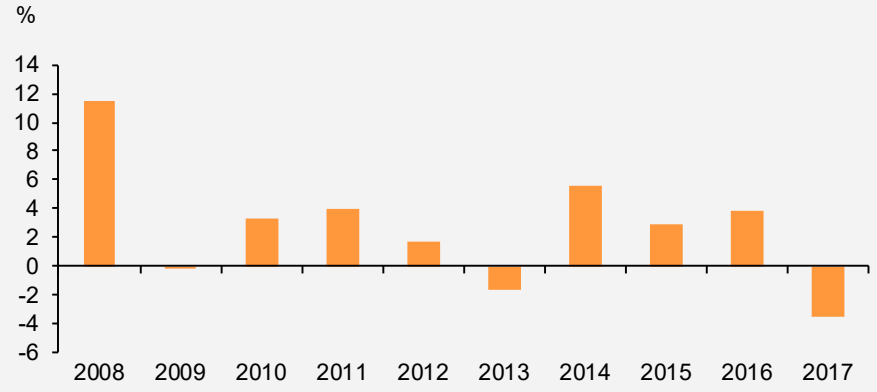
Graph 4.1 – Returns of the international reserves[1/]



Source: Central Bank of Brazil
1/ This refers to the internally managed portion of the reserves

On the other hand, when measured in Special Drawing Rights (SDR),[3] the return of the international reserves was -3.46%, reflecting the fact that the reserves have a higher percentage of US dollars than the SDR. In fact, at the end of 2017, 91.86% of the reserves were allocated in SDR currencies, although in a different proportion as that of the SDR. Graph 4.2 shows the returns of the reserves in SDR since 2008.

Graph 4.2 – Returns of the international reserves in SDR[1/]



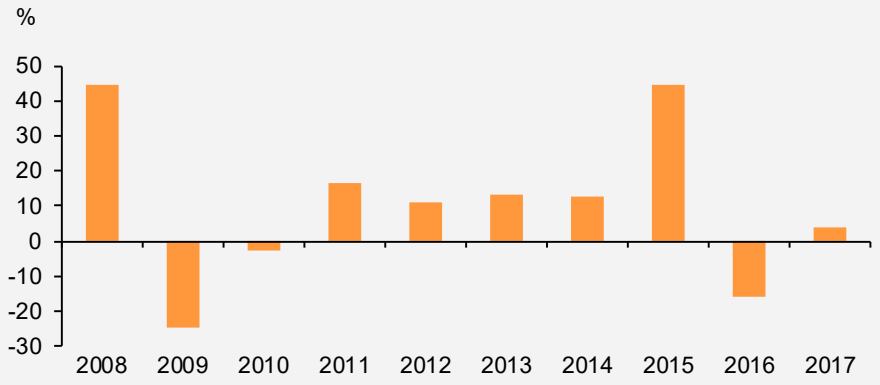
Source: Central Bank of Brazil
1/ This refers to the internally managed portion of the reserves.

Measuring the returns of the reserves in Brazilian Real brings yet another perspective into the evaluation of the performance. In this case, similarly to the measurement in US dollars, the return is dominated by the exchange rate between the Brazilian Real and the reserve currencies.

3 Currency basket defined by the IMF. The SDR is composed of US dollar (40.9%), euro (32.6%), sterling pound (8.1%), Japanese iene (7.4%) and renminbi (11.0%) – as of 12.30.17.

However, since the volatility of the Brazilian Real is significantly higher than that of the US dollar against other currencies, the return measured in this numeraire is even more influenced by the exchange rate fluctuations. The consolidated return of the reserves measured in Brazilian Real in 2017 was 3.80%. Graph 4.3 shows the returns in Brazilian Real over the past 10 years.

Graph 4.3 – Returns of the international reserves in Brazilian Real[1/]

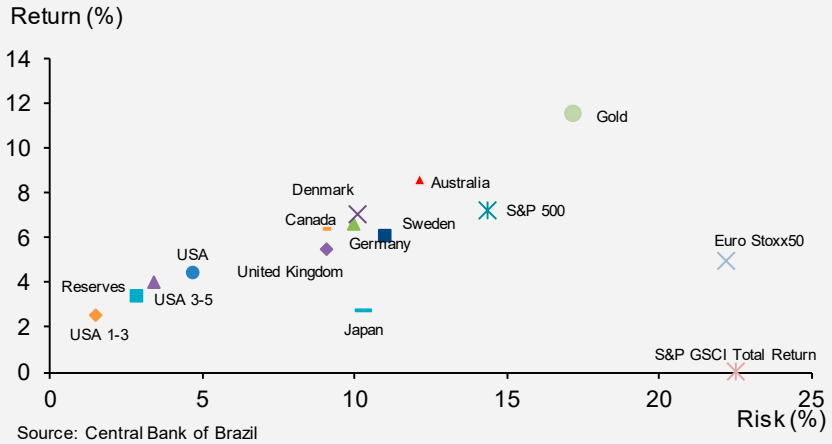


Source: Central Bank of Brazil
1/ This refers to the internally managed portion of the reserves.

4.1 Risk-return profile

This section compares the risk-return profile of the international reserves investments in the period from July 2001 to December 2017 across some asset classes. The BCB has a long-term investment horizon and the analysis of the risk-return profile is performed based on monthly values obtained from the management system. Graph 4.4 shows the annualized average return and the standard deviation for several asset classes. The US treasury bonds are represented by the 1-3 year maturity bond index (USA 1-3), the 3-5 year maturity bond index (USA 3-5) and by the entire US yield curve (USA). Sovereign bond indices from Germany, the United Kingdom, Canada, Denmark, Sweden, Australia and Japan are also shown in the graph. In addition, the gold, S&P 500, Euro Stoxx 50 and DJ-UBS commodity indices were also included. The graph makes it possible to compare the risk-return profile of the reserves with that of these indices, using the US dollar as the base currency. The returns are consistent with the investment policies and with the risk- return preference of the Board of Governors.

Graph 4.4 – Risk (%) *vs.* return (%) profile[1/2/]



Source: Central Bank of Brazil
1/ Average return compared to standard deviation (% anually) from Jul/2001 to Dec/2017. US Dollar is base currency.

Annex

Note

This annex presents tables with the data used for the graphs shown in this report. It does not include the data from chapter 1 and Section 4.1, as they can be obtained from historical series available to the public. The numbers of the tables are the same of the graphs presented in the report.

The tables use managerial data with respect to the operations performed in the international reserves management process.

Table 2.1 – Foreign Currency Allocation[1/]

Period	USD	EUR	JPY	GBP	CAD	AUD	Gold	Others
2008	89.1%	9.4%	1.0%	0.0%	0.0%	0.0%	0.5%	0.0%
2009	81.9%	7.0%	0.8%	3.7%	3.5%	1.9%	0.5%	0.7%
2010	81.8%	4.5%	0.9%	2.7%	6.1%	3.1%	0.5%	0.4%
2011	79.6%	4.9%	1.0%	3.0%	6.0%	3.1%	0.5%	1.9%
2012	77.4%	5.2%	2.3%	3.0%	6.0%	3.0%	1.0%	2.1%
2013	77.7%	5.7%	2.0%	3.2%	5.8%	2.7%	0.8%	2.1%
2014	79.7%	4.5%	1.3%	3.1%	6.0%	2.7%	0.7%	2.0%
2015	83.0%	4.6%	1.8%	3.0%	4.3%	2.7%	0.7%	0.0%
2016	83.5%	4.4%	2.1%	2.6%	4.4%	2.6%	0.7%	-0.3%
2017	82.3%	5.0%	1.8%	2.8%	4.5%	2.9%	0.8%	0.0%

1/ Reserves in cash concept (end of period data)

Table 2.2 - Asset Allocation[1/]

Period	Sovereigns	Agencies	Supra-nationals	Bank Deposits	Deposits in supra. CB	Others
2008	78.5%	7.1%	13.0%	0.4%	0.5%	0.6%
2009	89.8%	4.0%	1.9%	1.2%	2.4%	0.6%
2010	80.2%	5.9%	1.8%	1.2%	10.2%	0.7%
2011	83.5%	7.1%	4.4%	0.3%	3.8%	0.8%
2012	89.9%	3.2%	1.2%	0.4%	4.1%	1.2%
2013	91.2%	2.3%	1.0%	0.3%	3.5%	1.7%
2014	90.0%	2.7%	1.3%	0.2%	3.7%	2.1%
2015	88.5%	2.6%	1.0%	0.2%	4.5%	3.3%
2016	88.7%	1.6%	0.7%	0.2%	7.9%	0.9%
2017	87.6%	1.6%	0.7%	0.7%	8.5%	0.9%

1/ Rerserves in cash concept (end of period data)

Table 2.3 – Asset Allocation[1/]

US$ millions

Period	Sovereigns	Agencies	Supra-nationals	Bank Deposits	Deposits in supran. CB	Others
2008	154,511.58	13,915.91	25,516.99	785.14	990.22	1,199.83
2009	208,014.34	9,176.61	4,481.27	2,779.93	5,665.67	1,468.41
2010	226,098.54	16,584.11	5,120.38	3,334.38	28,714.64	2,053.62
2011	287,583.91	24,522.50	15,167.37	1,150.16	13,196.73	2,767.35
2012	322,808.50	11,472.40	4,423.14	1,485.20	14,614.54	4,374.62
2013	314,166.09	7,956.67	3,605.44	919.47	11,961.18	5,996.00
2014	315,597.47	9,477.06	4,419.05	827.55	12,944.62	7,456.84
2015	305,183.33	8,866.73	3,493.59	533.12	15,526.57	11,341.63
2016	313,064.35	5,640.11	2,467.90	713.05	27,766.31	3,316.77
2017	321,978.04	5,897.99	2,709.60	2,399.18	31,177.89	3,218.04

1/ Reserves in cash concept (end of period data)

Table 2.4 – Average term of investment[1/]

Period	Years
2008	3.04
2009	1.63
2010	1.85
2011	2.75
2012	2.79
2013	2.02
2014	2.11
2015	1.97
2016	1.88
2017	1.69

1/ Reserves in cash concept (end of period data)

Table 2.5 – Average term of investment[1/]

Period	Years
2008	2.88
2009	2.21
2010	1.68
2011	2.65
2012	2.78
2013	2.52
2014	1.99
2015	2.07
2016	1.93
2017	1.81

1/ Reserves in cash concept (annual average)

Table 3.1 – International Reserves VaR[1/]

Peiod	Total VaR (%)	Interest rate VaR (%)	Currency VaR (%)
2008	8.4	8.1	1.7
2009	4.1	3.3	2.5
2010	2.6	1.6	2.4
2011	3.1	2.5	2.8
2012	2.2	1.7	2.1
2013	2.6	1.5	2.0
2014	1.9	1.0	1.5
2015	3.0	1.4	2.4
2016	2.4	1.2	2.0
2017	2.0	0.8	1.5

1/ Yearly average for each year of the annualized daily VaR.

Table 3.2 – Forex stress test [1/]

Variation	Result
	US$ billions
-30.0%	-19.56
-20.0%	-13.04
-10.0%	-6.52
-5.0%	-3.26
5.0%	3.26
10.0%	6.52
20.0%	13.04
30.0%	19.56

1/ Impact of the exchange rate variations against the US dollar on the value of the reserves, as of 12.30.2017.

Table 3.3 – Interest rate stress test[1/]

Variation	Result
	US$ billions
0.5%	-0.2
1.0%	-0.5
1.5%	-0.8
2.0%	-1.2
2.5%	-1.6
3.0%	-2.1
4.0%	-3.2
5.0%	-4.6

1/ Impact of parallel shifts of the yield curves on the value of the international reserves, as of 12.30.2017.

Table 3.4 – Liquidity risk[1/2/]

Period	Sovereigns (%)	Supranationals (%)	Agencies (%)
2012	0.04	0.20	0.20
2013	0.04	0.13	0.10
2014	0.03	0.08	0.06
2015	0.03	0.12	0.09
2016	0.03	0.13	0.10
2017	0.03	0.12	0.10

1/ Values correspond to their respective portfolios
2/ Claculated as the average bid-ask spread.

Table 3.5 – Distribution by counterparty type

Period	Agencies	Supranationals	Sovereigns	Financial Institutions	Central Banks
2008	7.1%	13.5%	78.5%	1.0%	0.0%
2009	4.0%	4.4%	89.8%	1.8%	0.0%
2010	5.9%	7.2%	80.8%	1.2%	4.8%
2011	7.2%	6.1%	84.2%	0.3%	2.2%
2012	3.2%	2.9%	91.0%	0.4%	2.4%
2013	2.3%	2.5%	92.8%	0.3%	2.1%
2014	2.3%	2.8%	91.4%	0.5%	3.0%
2015	2.8%	1.9%	91.5%	0.5%	3.4%
2016	2.1%	2.1%	89.8%	0.5%	5.5%
2017	1.7%	1.5%	89.0%	0.7%	7.1%

Table 3.8 – Total credit risk exposure with money market operations[1/2/]

Period	Supranationals	Financial Institutions	Central banks
2008	990	1,045	-
2009	5,666	3,073	-
2010	15,155	3,350	13,560
2011	5,624	1,152	7,573
2012	5,967	1,485	8,654
2013	4,830	1,833	9,424
2014	5,233	1,863	10,395
2015	3,556	551	11,853
2016	3,948	1,598	18,862
2017	2,697	2,490	26,095

1/ Values in US$ millions (yearly averages).
2/ Deposits, repurchase agreements, forex.

Table 4.1 – Returns of the international reserves[1/]

Period	USD Return (%)	Interest rate return (%)	Exchange rate return (%)
2008	9,37	9,79	-0,42
2009	0,80	0,07	0,73
2010	1,82	1,85	-0,03
2011	3,60	3,76	-0,16
2012	1,84	1,57	0,27
2013	-1,46	-0,33	-1,14
2014	-0,64	1,40	-2,03
2015	-1,60	0,58	-2,18
2016	0,70	1,07	-0,37
2017	2,27	0,74	1,53

1/ This refers to the internally managed portion of the reserves.

Table 4.2 – Returns of the international reserves in SDR[1/]

Period	Return in SDR (%)
2008	11,54
2009	-0,12
2010	3,27
2011	3,92
2012	1,73
2013	-1,66
2014	5,62
2015	2,88
2016	3,80
2017	-3,46

/1 This refers to the internally managed portion of the reserves

Table 4.3 – Returns of the international reserves in Brazilian Real[1/]

Period	Return in BRL (%)
2008	44,32
2009	-24,91
2010	-2,57
2011	16,64
2012	10,95
2013	12,96
2014	12,67
2015	44,68
2016	-15,95
2017	3,80

/1 This refers to the internally managed portion of the reserves

Glossary

The definitions present the unique objective of helping the general understanding of the concepts described in the report.

Active management
Particular way of financial management in which it is tried to anticipate movements of market, variations of liquidity and other dynamic facts, with the objective of obtaining a better risk adjusted return in relation to the benchmark.

Benchmark
It is a reference portfolio that is typically used as representation of the choice of risk and return of the investor.

CDS
Credit Default Swap. Financial instrument through which it is possible to buy or sell insurance against default of assets issued by companies or countries.

CRB
Commodity Research Bureau. Commodities index price daily evaluated by Thomson Reuters/Jefferies.

Default
Technical situation in which the debtor does not fulfill a contractual obligation.

Government agencies
They are agencies sponsored by governments with the objective of supporting strategic areas of the economy as construction, education etc.

Money market
Segment of the financial market compounded by short-term assets (until one year) and usually of major liquidity, such as commercial papers, certificates of negotiable deposits (CDs), treasury bills, buybacks agreements (repos), etc.

Rating
Grade given by a risk agency that expresses the credit risk of institutions, countries and assets.

Rating Agencies
They are agencies, usually private, which rate the credit risk of institutions, countries and assets.

Spread
Price difference between the quotations for buying and selling an asset or between quotations of two different assets.

Supranationals
Papers issued by multilateral organisms, such as the International Monetary Fund (IMF), the Interamerican Bank for Development (BID), the Bank for International Settlements (BIS), the World Bank (Bird) etc.

Swift
Society for Worldwide Interbank Financial Telecommunications. It is a global system of telecommunications whose main objective is to provide message service, which enables the Central Bank of Brazil to settle operations with international reserves.

Treasuries/T-bills
Debt instruments issued by the North American Treasury. Treasury bills (T-bills) are issued with up to one-year term and do not pay coupons before maturity. The other treasuries (bonds and notes) are issued with a higher term and pay coupons periodically.

Value at Risk
Estimated value for the investment loss, in a certain time horizon, with a given confidence level.

VIX
Implicit volatility index, based upon S&P500 calls.

Volatility
Degree of prices variability or assets returns.

Yield
Profitability. Dividend or interests paid as percentage of the current value.

BANCO CENTRAL DO BRASIL