Box 1
Foreign Reserve Liquidity Indicators

Foreign reserves are managed according to three criteria: safety, liquidity, and return. Safety refers to adequate control of the risks to which the investments are exposed. Liquidity is the ability to convert invested resources into cash quickly and at low cost, while return is the capacity of financial assets to increase in value over time. This section describes the indicators used to monitor the liquidity of the international reserve investment portfolio.

The liquidity of financial markets can be measured through different dimensions:

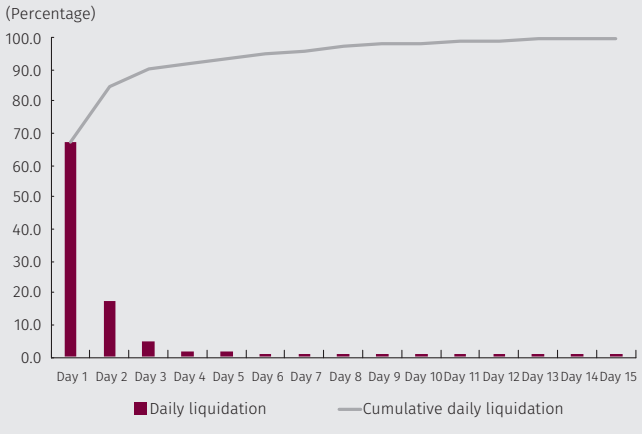
- **Tightness**: is defined as the difference between bid and ask prices; the smaller the difference, the more liquid the market.
- **Immediacy:** refers to the speed at which buy or sell orders are executed. The greater the speed, the better the liquidity of the market.
- **Depth:** refers to the existence of many buyers and sellers.
- **Breadth:** is the tendency of markets to remain unchanged despite the execution of large transactions.
- **Resilience:** is the capacity of the market to recover after stress scenarios or periods.

With these characteristics in mind, two types of indicators were defined to monitor the liquidity of the international reserve investment portfolio: 1) portfolio liquidation time, and 2) portfolio liquidation cost.

1. Portfolio Liquidation Time

The purpose of this indicator is to measure the number of days it would take to liquidate the portfolio, as well as the percentage of the portfolio that could be liquidated in a given number of days. Due to the extensive list of securities to which the portfolio is exposed, all the assets in the portfolio are grouped into different categories, according to the market [1] to which they belong and their maturity. The indicator is constructed for the different categories that have been defined.[2] It is based on an expert estimate[3] of the maximum amounts that could be sold daily without affecting market conditions. According to the category in which each security has been classified, as well as the maximum daily sale amount defined for that category and the amount of exposure to that security, the number of days required to sell the entire exposure is calculated. The results for each security are aggregated to obtain the results for each portfolio. According to Chart B1.1, the foreign reserve investment portfolio at the end of December 2020 could be liquidated, under normal conditions, in an estimated time of fifteen days. The percentage of the investment portfolio that can be sold each day and the accumulated percentage of sales up to that day is also shown. For example, 4% of the portfolio is sold on the third day, at which time 92% of the portfolio has been sold (72% on the first day, 16% on the second day and 4% on the third day).

Graph B1.1
Portfolio Liquidation Time



Source: *Banco de la República.*

2. Portfolio Liquidation Cost

The cost of liquidating the portfolio is calculated by adding the liquidation cost of each of the assets in the portfolio. This, in turn, is defined by the bid-ask spread on each security and the change in its valuation that may happen if it remains in the portfolio awaiting liquidation. The latter could occur if the entire exposure cannot be liquidated

1 (Box 1-1) For example, the classification by market may pertain to the type of sector to which the security belongs (government, corporate, quasi-government, etc.), and/or to the country (United States, Germany, United Kingdom, Japan, etc.).

2 (Box 1-2) Surveys are conducted with market experts such as trading counterparties, external managers and trading professionals of internally managed portfolios.

3 (Box 1-3) The information defined for each category will not necessarily reflect the performance of each of the securities, since it is a portrayal of the average characteristics of the group of issuers it represents.

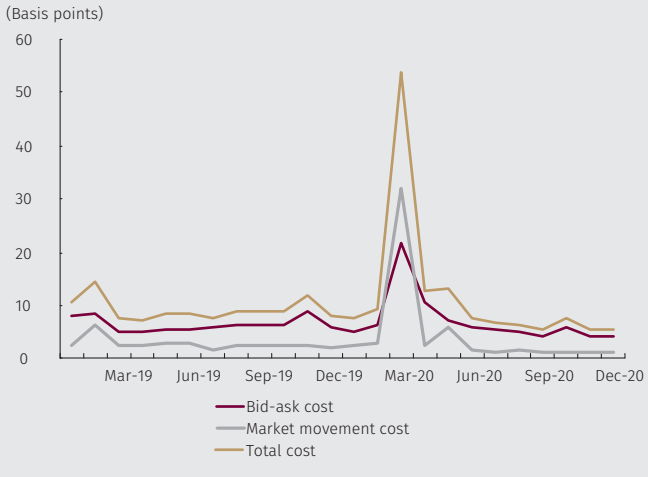
in a single day and the portfolio were to be exposed to unfavorable movement in the market price of that position. The following mathematical expression shows the different elements included in the liquidation cost indicator:

$$Liquidation\ cost = \sum_{i=1}^{N}\sum_{t=1}^{T} s_i * \alpha_{it} + (\alpha_{it} * \sigma_i * \sqrt{t})$$

where i is each issue in the portfolio, N is the number of issues, T is the total time to liquidate each issue, s_i is the bid-ask spread on the issue, α_{it} is the amount sold on day t of issue i, t is the day the issue is sold and σ_i is the daily volatility of the price of each issue. The parameters s_i and σ_i are obtained from the market information on each security that is available for the dates on which the indicator is calculated. Parameter α_{it} is calculated based on the maximum daily sale amount applicable to each security, as explained in the liquidation time indicator.

Accordingly, the defined cost function makes it possible to evaluate periodically the liquidity of the investment portfolio in two dimensions. The first is related to the spread between the purchase and sale of each issue, while the second is related to changes in the portfolio's liquidity due to increases in the volatility of each security because of movement in the market. The way market conditions affect the liquidity of the investment portfolio can be monitored as a result. Chart B1.2 shows how the liquidation cost evolved, in total and broken down by the bid-ask spread component, and the cost due to movement in the market. In it, one sees the onset of the Covid-19 pandemic, in March 2020, led the financial markets to times of stress, as reflected in their liquidity and, particularly, in the liquidation cost of the investment portfolio.

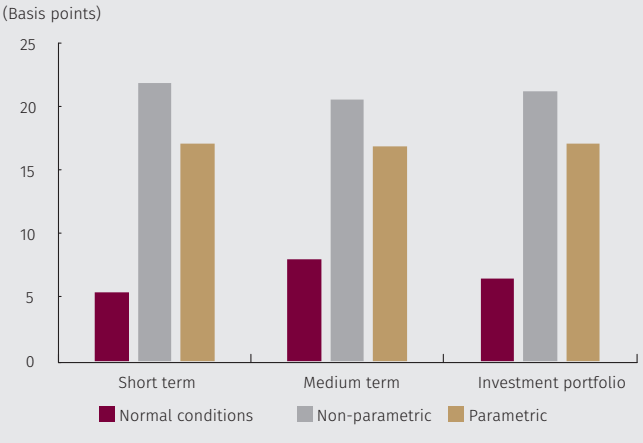
Graph B1.2
Portfolio Liquidation Cost



Source: *Banco de la República.*

The liquidity level of investments may vary according to market conditions. Therefore, it is important to examine both normal and extreme scenarios in an analysis of liquidity. To this extent, the Bank uses two methodologies to estimate the portfolio liquidation cost in a stress scenario. [4] The first assumes the bid-ask spread for each security is distributed normally, with mean and variance estimated based on the historical spread (parametric method). This method is used to find the bid-ask value that is one standard deviation above the mean of the distribution and would be equivalent to an extreme liquidation cost. With the second methodology, the 95th percentile of the historical bid-ask series for each security is obtained, without assuming any type of distribution (non-parametric method). Based on information at the end of December 2020, Chart B1.3 shows a comparison of the two measures used to simulate stress conditions with the liquidation cost under normal market conditions. As can be seen, the liquidation cost of the investment portfolio in a time of stress could increase more than twice the liquidation cost under normal market conditions.

Graph B1.3
Comparison of Liquidation Costs (Percentage of the Portfolio)



Source: *Banco de la República.*

In conclusion, the indicators used to monitor the liquidity of foreign reserve portfolios are as follows:

- Liquidation time
- Liquidation cost under normal conditions
- Liquidation cost under stress conditions (parametric)
- Liquidation cost under stress conditions (non-parametric)

4 (Box 1-4) A scenario is considered that demands total liquidation of the portfolio in one day and where, in turn, extreme values are observed in the bid-ask spread. So, the liquidation cost in the stress scenario does not incorporate the component associated with movements in price over time.