# Harvey's Revised Mental Model Applied to Brazil's Exchange Rate under unique economic events: the Covid-19 pandemic and the Russo-Ukrainian war

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**Abstract:** This article analyzes the exchange rate path in Brazil during the Covid-19 pandemic and the Russo-Ukrainian war using the dynamic for determining the exchange rate proposed by Harvey (2009). The Harvey mental model was reviewed to consider the targeting inflation framework, which guide the Central Bank's actions and influences financial market agents' expectations. Thus, the research question that guides this work is: Is it possible to understand the short-term dynamics of the nominal exchange rate in Brazil under the Covid-19 pandemic and the Russo-Ukrainian war using the revised Harvey model (2009)? Brazil was chosen as one of the largest countries in Latin America and one of the most important emerging countries. To answer the research question, a theoretical review was carried out regarding the exchange rate speculation strategies used by Keynes. Subsequently, Harvey's model was presented and amended to consider the role of the inflation targeting model in determining the short-term nominal exchange rate and the impact of these unique events. Then, an analysis of agents' expectations of the mental model variables and of the exchange rate dynamics was performed. The results suggest that the revised Harvey model (2009) is useful to understand the path of nominal exchange rate although, under the Covid-19 outbreak, agents wrongly predicted it.

**Keywords:** Post-Keynesian theory. Nominal exchange rate. Inflation targeting. Unique economic events.
**JEL Classification:** E12; E31; E43.

**Resumo:** Este artigo analisa a trajetória da taxa de câmbio no Brasil durante a pandemia da Covid-19 e a guerra russo-ucraniana utilizando a dinâmica de determinação da taxa de câmbio proposta por Harvey (2009). O modelo mental de Harvey foi revisado para considerar o arcabouço de metas de inflação, que orienta as ações do Banco Central e influencia as expectativas dos agentes do mercado financeiro. Assim, a questão de pesquisa que norteia este trabalho é: É possível compreender a dinâmica de curto prazo da taxa de câmbio nominal no Brasil sob a pandemia da Covid-19 e a guerra russo-ucraniana utilizando o modelo revisado de Harvey (2009)? O Brasil foi escolhido como um dos maiores países da América Latina e um dos mais importantes países emergentes. Para responder à questão de pesquisa, foi realizada uma revisão teórica sobre as estratégias de especulação cambial utilizadas por Keynes. Posteriormente, o modelo de Harvey foi apresentado e alterado para

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considerar o papel do modelo de metas de inflação na determinação da taxa de câmbio nominal de curto prazo e o impacto desses eventos únicos. Em seguida, foi realizada uma análise das expectativas dos agentes sobre as variáveis do modelo mental e sobre a dinâmica da taxa de câmbio. Os resultados sugerem que o modelo Harvey revisado (2009) é útil para entender o caminho da taxa de câmbio nominal, embora, durante o surto de Covid-19, os agentes o tenham previsto erroneamente.

**Palavras-chave:** Teoria pós-keynesiana. Taxa de câmbio nominal. Metas de inflação. Eventos econômicos singulares.
**Classificação JEL:** E12; E31; E43.

# 1. Introduction

The post-Keynesian theory of nominal exchange rate determination has been debated by several authors, such as Harvey (2009), Silva and Strachman (2021), and Araujo and Terra (2021). Harvey (2009) proposes a mental model that explains the determination of the nominal exchange rate in the short-term and elucidates how exchange market dealers anticipate exchange rate movements and earn profits from mounting speculative positions.

This paper is a study of the exchange rate path in Brazil under the Covid-19 pandemic and the Russo-Ukrainian war using the dynamics for determining the exchange rate proposed by Harvey (2009). To this end, the model was amended to consider the inflation targeting regime, which influences the monetary authority's decisions and financial market agents' expectations. Thus, the question that guides this work is as follows: Is it possible to understand the short-term dynamics of the nominal exchange rate in Brazil under the Covid-19 pandemic and the Russo-Ukrainian war using Harvey's (2009) revised model? Brazil was chosen because it is one of the largest countries in Latin America and one of the most important emerging countries, according to Economic Commission for Latin America and the Caribbean - ECLAC data (2022).

A theoretical review was conducted, starting with the exchange rate speculation strategies used by Keynes when he performed speculative operations in the foreign exchange market. Subsequently, Harvey's model is presented and amended to consider the role of the inflation targeting framework in determining the short-term nominal exchange rate. Then, an analysis of agents' expectations and the trajectory of the nominal exchange rate during the Covid-19 pandemic and the Russo-Ukrainian was performed.

The empirical strategy aims to identify how market expectations changed during these two unique events. Since short-term interest rate is assumed as the main driver of the nominal exchange rate path, the monetary policy framework, and the perspective of the Central Bank (CB) have a significant influence on market expectations. Therefore, we look at the documents released by the CB along with the market expectations survey over the factors that influences the nominal exchange rate according to Harvey's model. Together, these information feeds the mental model and drives the nominal exchange rate forecast and its dynamics.

In addition to this introduction, the second section discusses the main determinants of exchange rate fluctuations, considering Keynes' experience when he worked as an exchange rate and commodities speculator. The third section discusses Harvey's (2009) theoretical model introducing the inflation targeting regime, which is important for CBs and, consequently, for foreign exchange market participants. In the fourth section, we present the empirical strategy. In the fifth section, an empirical experiment is performed in which minutes and reports from the CB plus market participants expectations were used to interpret exchange rate movements in light of the proposed model. Finally, in the last section, some considerations about the study are discussed.

## 2. Keynes macroeconomic foundations for speculation in exchange rates

Keynes speculated on exchange rates, trying to predict the direction of currencies to decide on which currencies he would go short and on which currencies he would go long (Cristiano; Marcuzzo, 2018; Skidelsky, 2005). To this end, he attempted to anticipate monetary policy decisions. Thus, understanding the determinants of interest rates in different countries becomes an important aspect for understanding the appreciation and devaluation of currencies.

In the mid-1920s, inflation was higher than interest rates in the United Kingdom; in this context, the British abandoned the gold standard in 1919 due to the fear of social destabilization. However, the British government aimed to return to the gold standard using the parity of the previous period (1917), for which a restrictive monetary and fiscal policy was implemented, causing a collapse in investment and an increase in unemployment (Skidelsky, 2005, p. 271).

Considering this, Keynes speculated on the exchange rate. Given that prices in the UK were rising faster than in the US, the pound sterling should have depreciated against the dollar. Inflation rates in France, Germany, and Italy were higher than that in the UK and therefore the

pound was expected to appreciate against these other currencies. From March 1919 to February 1920, the pound fell from $4.70 to $3.40, which generated a profit of £6,000 at the end of 1919 (Skidelsky, 2005, p. 273).

Keynes closely monitored stock and commodity prices. However, in terms of operational decision-making, Keynes's analysis was based on monetary policy and how this policy affected interest rates, international trade, and capital flow. Political conditions also influenced Keynes's predictions (Accominotti; Chambers 2016).

> the various uncertainties of financial and political risk, which the war has left behind, introduce a further element which sometimes quite transcends the factor of relative interest. The possibility of financial trouble or political disturbance, and the quite appreciable probability disturbance, and the quite appreciable probability of a moratorium in the event of any difficulties arising, or of the sudden introduction of exchange regulations which would interfere with the movement of balances out of the country, and even sometimes the contingency of a drastic demonetization (Keynes 1971, p.127).

Cristiano and Marcuzzo (2018) argued that Keynes, as an institutional investor, suggested that wise investors should doubt all things and constantly revise their ideas according to new events in the political world. Moreover, changes in economic variables, which can impact how CBs project inflation, and geopolitical events are also important for reviewing the economic scenario. Thus, Keynes's speculative strategy for currencies was based on an analysis of macroeconomic fundamentals, understood here as how changes in official interest rates, international trade, capital flows, and inflation could impact the exchange rate. In addition, he was aware of the impact of the attitude of Central Banks towards inflation and of geopolitical events on exchange rates (Accominotti; Chambers 2016; Cristiano; Marcuzzo, 2018).

## 3. Macroeconomic foundations for exchange rate speculation from the post-Keynesian perspective

Carvalho (2020) argued that when investors build economic scenarios, they understand that unforeseen events can change the scenario previously proposed. Thus, the decision to perform a certain action will depend on the degree of confidence that the agent has in the scenario created, given that it was done so with imperfectly formed information.

Even considering that the knowledge that supports investor decisions is fragile, confidence in the ability to identify the consequences and facts that influence the future will provide the basis for action. The formation of scenarios is based on two aspects: 1) factual data

and information, such as an economic indicator or the way in which CBs decide to determine the basic interest rates of the economy, and 2) products of the investor's imagination to complement information that does not exist at the time of decision-making (Carvalho, 2020).

Harvey (2009) devised a mental model to identify those factors that guide investor decisions on the foreign exchange market. Figure 1 represents this model, were $P$ stands for the prices, $y$ the GDP, $r$ the interest rate, $X$ exports, $M$ imports, $DFI$ represents direct investment flow, and $PFI$ portfolio investment flow. Finally, superscript $e$ represents expectations, $dom$, domestic economy, and $FX$, external economy (FX).

Figure 1 - Harvey's Mental Model - Basic Factors, Process and Forecast
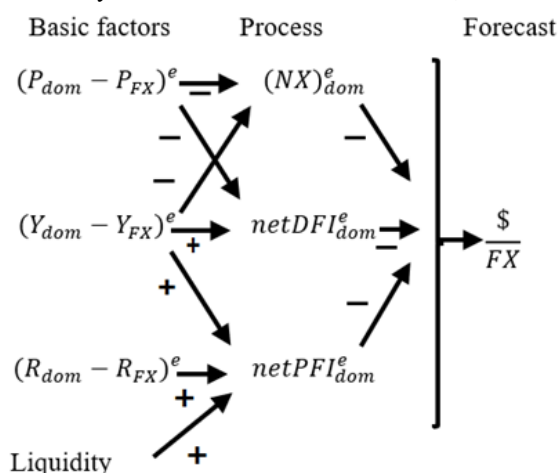


Source: Adapted from Harvey (2009, page 937).

This mental model is comprised of basic factors that impact the processes, generating the forecast scenario of the market participants. These basic factors are the expectation of the difference between internal and external prices, the expectation of growth of the internal and external economy, the expectation of the difference between internal and external interest rates, and liquidity. For instance, an expectation of an increase in relative prices, meaning the increase in internal prices in relation to external prices, has a negative impact on net exports (difference between exports and imports). At the same time, direct investments would be reduced, as it would be more expensive for resource-seeking investors to acquire inputs in the country. Therefore, agents would forecast an exchange rate depreciation (Harvey, 2009).
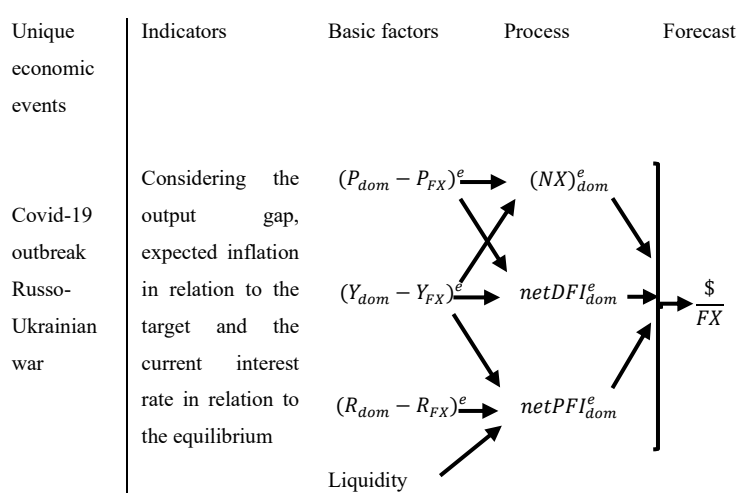
The author claims that the most important basic factor is the relative interest rate. A rise in interest rate differential would make interest-bearing assets more attractive, leading to portfolio capital flows. As a consequence, agents would forecast an exchange rate appreciation.

In addition, to track basic factors and process, market participants use a set of indicators: "These are the evolving set of determinants thought to reflect, affect or predict the base factors and sometimes the process themselves. These can include central bankers' speeches, political news, unique economic events and so on" (Harvey, 2009, p. 936).

To some extent, Harvey's model resembles Keynes's strategy as an investor, emphasizing interest rates and new events that could change the economic scenario. Overall, the model considers all the main drivers used by Keynes, i.e., interest rates, portfolio flows, inflation, and international trade.

Nevertheless, we will propose a slight amendment in this model to accomplish two goals. First, the mental model should consider the indicators that guide monetary authorities' decision. Second, we will emphasize the two major unexpected events of the last few years, the Covid-19 outbreak and the Russo-Ukrainian war.

Figure 2 - Revised Mental Model - Basic factors, process, indicators, and politics

| Unique economic events | Indicators | Basic factors | Process | Forecast |
|---|---|---|---|---|
| Covid-19 outbreak Russo-Ukrainian war | Considering the output gap, expected inflation in relation to the target and the current interest rate in relation to the equilibrium | $(P_{dom} - P_{FX})^e \rightarrow$ $(Y_{dom} - Y_{FX})^e$ $(R_{dom} - R_{FX})^e \rightarrow$ Liquidity | $(NX)^e_{dom}$ $netDFI^e_{dom}$ $netPFI^e_{dom}$ | $\dfrac{\$}{FX}$ |

Source: Adapted from Harvey (2009, page 937)

Most CBs operate under an Inflation Target Regime (ITR), in which the monetary authority set the short-term interest rate to control inflation. In doing so, the Taylor rule is usually followed, based on the equilibrium interest rate (neutral interest rate), that is, an interest rate at which the monetary policy is neither contractionary or expansionary; the output gap (difference between the actual output of an economy and its potential output); and the difference between the expected inflation rate and the inflation target (Taylor, 1999, 2001). The model assumes that if the expected inflation rate is above the inflation target, the CB may increase the

domestic interest rate, causing the difference between the domestic interest rate and the international interest rate to increase. This could lead to capital inflows, which in turn, could contribute to inflation control. Taylor (2001, p. 266) argued: "The appreciation of the exchange rate today (period t, say) will increase the probability that the central bank will lower the interest rate in the future (period t + 1, say)."

Therefore, the output gap, the neutral interest rate, and the expected inflation are main drivers of monetary authorities' decisions. Even if the CB places different weights on each of them, these indicators are still closely monitored. Consequently, market dealers must follow them in order to anticipate monetary authority decisions. For instance, suppose that the Brazilian GDP is much lower than its potential (a negative output gap). Therefore, although market participants may expect an inflation above the target, they may not bet on a rise of the interest rate. Now assuming that the interest rate is well under its equilibrium level, agents may change their positions. Hence, the CB view over these variables are the indicators of the mental model.

Moreover, over the last years, the world experienced unique economic events, including the Covid-19 pandemic and the invasion of Ukraine by Russia. These events had a significant impact on the world economic outlook and on the dynamics of the exchange rate. In fact, some studies (Iyke *et al.*, 2022; Salisu *et al.*, 2022; Iyke, 2020) provided evidence that these events contain valuable information that can be used to forecast the exchange rate path. Thereby, they were included in the mental model.

## 4. Empirical strategy

To identify how the revised Harvey model (2009) applies to the Brazilian Real, we will rely on the following strategy. First, we will check the main dates related to Covid-19 pandemic and to the Russo-Ukrainian war. In the case of Covid, we will look at the number of deaths and identify when this unique economic event started in Brazil.

To track the indicators of the model, we will check the CB's quarterly Inflation Reports (IR), which present the policy guidelines adopted by the Monetary Policy Committee (Copom). In this report, they occasionally release estimations about the output gap and the equilibrium interest rate. Also, we will look at the Copom's minutes, which explain the reasons underlying CB decisions over the interest rate. In addition, in these documents and in the market

expectation survey (Focus Report) we will check if the CB believes that inflation expectations are anchored, i.e., if the expected inflation rate is above or below the established target. Furthermore, we need to know how the CB evaluated the external scenario, specifically the United States economic outlook and if they believe that the Federal Reserve Board would change its basic interest rate. In general, the main goal here is to build a scenario considering the CB framework and opinion, since it is responsible for setting the short-term interest rate.

Then, we will analyze how these two events influenced investors' expectations (the basic factor and the process of the model), which is tracked by the Brazilian CB. Every week it publishes the Focus Report, summarizing the statistics calculated over market expectations for the year. It includes market expectations for inflation, GDP growth, exchange rate, DFI flows, trade balance (NX) and interest rates (Selic). The report is released every Monday based on data collected in the last thirty days. In addition, to take into account the liquidity, one of the basic factors of the model, we looked at the Chicago Board Options Exchange's Volatility Index (VIX), a well-known risk aversion indicator. When it increases, the liquidity decreases.

The final step is to compare the exchange rate movements and the results of the basic factors and process to the market expectations. This exercise aims to verify if the forecast by agents impacted the exchange rate value. We use data from the CB to get the short-term interest rate, portfolio flows (PFI), DFI flows, and the daily commercial exchange rate; data from the Brazilian Institute of Geography and Statistics (IBGE) for GDP growth and inflation rate; and data from the Ministry of Development, Industry, Trade and Services (MDIC) for the trade balance.

## 5. Applying the revised mental model for Brazil under Covid-19 pandemic and the Russo-Ukrainian war

One of the most important derivatives is the future exchange rate. These are currency purchase and sale contracts signed in the present but with settlement dates in the future. Dollar futures contracts in Brazil were launched in 1986. One of the main features of the exchange rate is that its settlement does not involve the physical delivery of currency. Its settlement is made in Reais at the exchange rate of Reais per dollar, which is defined by the average rate of the last day of the contract (Prates, 2015).

In Brazil, since the future exchange rate market is much more liquid than the spot one, the exchange rate is priced in the former and then transmitted to the latter (Rossi, 2016, 2015). The futures exchange rate is adjusted daily in the adjustment price, which is the average of the price times the volume of contracts in the time window between 3:50pm and 4pm. On the following day, all market participants will have their positions (long or short) at the settlement price (B3). This means that there is a large volume of liquidity in the settlement price, which market participants have an interest in defending or breaking. Thus, the starting point for the change of scenario is the adjustment.

## 5.1 Exchange rate under the Covid-19 pandemic

The Covid-19 pandemic had an enormous impact on Brazil. More than 700,000 people died. At its worse, hospitals did not have enough beds to accommodate all the patients. In Manaus, North of Brazil, there was not enough oxygen for treatment and many died at home. Overall, it was an absolutely tragedy.

This shocking outcome was due to negligence by the federal government, represented by president Jair Bolsonaro. He minimized the disease's risks and the adoption of science-based prevention measures. In this context, city mayors and states governors were responsible for establishing these policies, including lockdowns. In addition, the Brazilian government delayed buying the vaccine and to making it available for Brazilians (Paula *et al*., 2023; Campos, 2020).

There was a peak of deaths in April 2020. In the previous month, March 2020, many state governors adopted lockdown policies. The state of São Paulo, the major economic region of Brazil, announced it in 21 March 2020. From then on, the largest number of deaths occurred in March 2021, and in February 2022 due to the spread of Omicron Variant (Fiocruz, 2022), although, to a certain extent, waves of the Covid-19 pandemic were no longer an unexpected event. Therefore, to assess the impact of an unexpected event on the exchange rate we will consider only the first months of 2020.

First, we look at the Brazilian CB's reports and minutes to understand its view over the indicators. We will analyze each indicator separately.

**Output Gap:** In the December 2019 CB IR, they argued that the output gap was highly negative, according to the capacity utilization rate and to the unemployment rate. Therefore, there was enough room to grow without demand pressures on prices. In the Copom minutes of

3 February 2020, members highlighted that the economic slack may have been smaller than estimated due to supply constraints. In the March IR, the monetary authority reviewed its GDP growth forecast from 2.2% to nil due to the expected impact of Covid-19. In the next meeting, on 18 March 2020, they argued that measures of economic slack had become outdated due to the Covid-19 pandemic, also forecasting a demand shortage in the near future.

**Equilibrium interest rate:** In the December 2019 CB IR, they discussed the Brazilian structural interest rate. Using information from the Focus Survey, they calculated the implicit structural rate[3]. The estimations suggested a downward trend of the structural rate over the years, reaching 2.9% per year (p.y.) in November 2019. In the meeting of 5 February, Copom members reduced the interest rate by 0.25% percentage points (p.p.) less than the previous meeting (-0.5 p.p.). However, in the next meeting (18 March), under the impact of Covid-19, they decided to lower the interest rate by 0.5 p.p. based on the need to adopt a stimulative monetary policy, i.e., interest rates below the structural level. At that time, the interest rate was set at 3.75% p.y. Considering that the expected inflation was near 3% p.y., the real rate (0.75% p.y.) was below the neutral rate.

**Expected inflation vs. inflation target:** the first Focus Market Readout of 2021 was published on 3 January. At that time, the median for the market expected inflation for 2020 was 3.6% p.y., decreasing to 2.9% p.y. two months later. Therefore, the market expected inflation to be under the target (4% p.y.). In the Copom minutes of 3 February, members assessed that the inflation was anchored and ratified this view in the next meeting's minutes.

**External scenario:** in the IR of March, the CB emphasized that due to global shocks, especially the Covid-19 pandemic, global financial conditions were more challenging and the appetite for riskier assets declined substantially. This report stressed that the Federal Reserve (FED) reduced its rate by 1.5 p.p. and the consumption in the United States showed signs of moderation, which should intensify due to the pandemic. Hence, it concluded that there was no sign of inflation pressures there, which remained below the monetary policy target (2% p.y.). In the Copom minutes of March, they emphasized that the pandemic was causing a significant global growth slowdown, a fall in commodity prices, and an increase in asset prices volatility.

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[3] They considered market expectations of inflation and interest rate for three calendar-years.

Nevertheless, the additional provision of monetary stimulus in major economies might partially offset these effects.

In sum, from the Brazilian CB's perspective, if there were some doubts regarding the magnitude of the monetary policy stimulus before the Covid-19 pandemic, in March it became clear that they should cut the interest rate more aggressively. All the indicators suggested that there was enough room to do so: the output gap was negative, and the expected inflation was anchored. It is important to note that, in Brazil, the Copom started reducing the short-term interest rate many years ago. After the Brazilian economic crisis (2015-2016), when the GDP fell by 6.8% and Brazilian economic growth stagnated (2017-2019), the Copom reduced the interest rate from 13.75% p.y. at the beginning of September 2017 to 4.5% p.y. at the end of November 2019.

Using the revisited Harvey model, under the unexpected event of Covid-19 pandemic and considering the indicators that guide CB decisions, market participants should revise their basic factors expectation. That is, the expected Brazilian GDP growth for 2020 should be lower, as well as inflation and interest rates. In addition, liquidity would be negatively impacted due to the increasing uncertainty.

As a consequence, the process of the mental model would change: less capital would move to Brazil, including foreign direct investments and portfolio ones. Additionally, since commodities prices decreased and Brazilian exports are concentrated in commodities, agents would foresee a smaller trade surplus.

The Focus Readouts between January and March 2020 show that in March, a few weeks before the adoption of lockdown policies in many Brazilian states, market participants revised their expectations. Regarding basic factors, they forecasted lower inflation, lower GDP growth and lower interest rates for 2020. In relation to the inflation rate, there was already a downward trend expectation since the beginning of the year, which increased in March. At the same time, the liquidity, measured by the VIX, decreased substantially from the middle of February to the end of March, going from 14.83 on 18 February to 82.69 on 16 March.

Table 1 - Market Expectations for 2020 for the National Index of Price to the Ample Consumer - IPCA (%), GDP growth (%), interest rates (%), trade balance (US$ billions), Direct Foreign Investment - DFI (US$ billions) and exchange rate (R$/US$) – Brazil – 01/01/2020 to 03/31/2020

| Market Expectations | Jan 3 | Jan 10 | Jan 17 | Jan 24 | Jan 31 | Feb 7 | Feb 14 | Feb 21 | Feb 28 | Mar 6 | Mar 13 | Mar 20 | Mar 27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Basic Fators | | | | | | | | | | | | | |
| IPCA (%) | 3,6 | 4 | 3,6 | 3,5 | 3 | 3,3 | 3,2 | 3,2 | 3,2 | 3,2 | 3,1 | 3 | 2,9 |
| GDP growth (%) | 2,3 | 2 | 2,3 | 2,3 | 2 | 2,3 | 2,2 | 2,2 | 2,2 | 2 | 1,7 | 1,5 | -0,5 |
| Interest rate (%) | 4,5 | 5 | 4,5 | 4,3 | 4 | 4,3 | 4,3 | 4,3 | 4,3 | 4,3 | 3,8 | 3,8 | 3,5 |
| Process | | | | | | | | | | | | | |
| Trade Balance (US$ billion) | 38 | 37 | 37 | 37 | 37 | 36 | 35 | 37 | 37 | 36 | 36 | 35 | 35 |
| DFI (US$ billion) | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 |
| Forecast | | | | | | | | | | | | | |
| Exchange rate (R$/US$) | 4,1 | 4 | 4,1 | 4,1 | 4 | 4,1 | 4,1 | 4,2 | 4,2 | 4,2 | 4,4 | 4,5 | 4,5 |

Source: Own elaboration based on Focus Readout from Brazilian Central Bank.

Looking at the mental model process, the lack of variation in market participants expectations is outstanding. They did not revise their expectations on DFI flows and only slightly revised their expectations of trade balance surplus in March, from US$ 37 billion to US$ 35 billion. Unfortunately, there is no record for portfolio investments expectations, but as lower interest rates and GDP growth were expected by the market, one can assume that portfolio investments would decrease.

Finally, the exchange rate forecast for the end of 2020 started changing in the middle of February. It is important to note that by the beginning of that month the exchange rate was already over R$ 4.2 (Figure 3). Despite this, market participants forecasted that it would reach R$ 4.2 in the end of 2020. Then, in March, they revised it to R$ 4.5, even though it was already above R$ 5.

Figure 3 - Nominal exchange rate (sales) – daily average – R$/US$ – 02/01/2020 to 31/03/2020



Source: Own elaboration based on Brazilian Central Bank.

Despite the CB signaling that it would keep reducing the interest rate, market expectations did not follow it, assuming there was a higher floor to the Brazilian interest rate. During the Covid-19 outbreak, agents had difficulty anticipating CB decisions, so it decided to implement the forward guidance later in the year. The short-term interest reached 2% p.y. by the end of the year. In addition, market participants had difficulty anticipating the impact of the pandemic on inflation and on the GDP. In 2020, the Brazilian economy shrank by 3.3% and the inflation hit 5.4%. In March, neither the CB nor market participants foresaw the significant GDP decrease in 2020 and underestimated the inflation rate, getting the basic factors movements wrong.

In relation to the process, they did not adjust expectations on the DFI flows nor on the trade balance, revealing that they could not foresee the impact on them. By the end of the year, the trade balance reached US$ 50 billion, positively impacted by the rise of commodity prices; and the DFI reached US$ 38 billion, below market expectations (US$ 80 billion). Summing up these flows, they were also below market expectations. In addition, since they got the basic factors wrong, one can also assume they did not expect a significant fall in portfolio flows. Comparing to the previous year, portfolio flows decreased from US$ 19 billion to US$ 12

billion. By the end of the year, the nominal exchange rate was over R$ 5.19, much higher than agents' forecast.

Considering that they did not anticipate the fall in the GDP and interest rate, agents' forecasts was in line with the mental model. That is, the exchange rate would not have depreciated so much if the basic factors had followed market participants' beliefs, since portfolio flows would only have decreased moderately. However, as the outcomes from the pandemic along with the CB strategy became clearer, agents had to review their expectations and as consequence the dynamic of the nominal exchange rate.

## 5.2 Exchange rate under the Russo-Ukrainian war

On 24 February 2023, Russia invaded Ukraine. This war is still going on and in the first months it had a massive impact on the world economy. Both countries are important commodities suppliers. After the invasion, the United States, the European Union, and other Western countries introduced or significantly incremented commercial sanctions on Russia. It included cutting off major Russian banks from the global messaging network for international payments, freezing assets on the Russian Central Bank, export and import controls, among others. Hence, the war generated supply chain problems and impacted commodity prices (Liadze *et al*., 2022).

Since the war began in February, we will focus on the first months of 2022. It is important to note that at this time there was another wave of Covid-19, but the death rate decreased due to the vaccination and a less lethal virus variant (Fiocruz, 2022). We begin looking at the indicators.

**Output gap:** in the December 2021 CB IR, it noted that the rise of the interest rate coupled with the perspective of higher than expected interest rates would interrupt the output gap closing throughout 2022. Indeed, the gap projection for this year went from -1.2% to -2.1%. Therefore, from the CB's perspective, the output gap was still negative, meaning that demand side pressures on prices were limited. In the March 2022 IR, again the CB remarked that the output gap continued on a widening movement in 2022, reaching -2.3% in the end of the year. The main reason underlying this projected outcome was the rise of the interest rate. In addition, economic uncertainty due to the conflict between Russia and Ukraine negatively affected the

output gap. In the Copom minutes of February and March of the same year, members did not mention the output gap, indicating that their decisions did not take this variable into account.

**Equilibrium interest rate:** in the December 2021 IR, the CB presented a model to estimate the neutral interest rate. Over the years (2003 to 2021), it showed a process of decline, but a slight increase at the margin, estimated at 3.6% p.y. In the next IR, they assumed a neutral interest rate of 3.5% p.y. in their projections. In the Copom 2 February 2022 minutes, members mentioned that uncertainties regarding the fiscal framework assigned a greater probability of higher neutral interest rate scenarios. This view was endorsed in the 16 March minutes.

**Expected inflation vs. inflation target:** in the December 2021 IR report, the CB had already noted that inflation expectations for 2022 increased significantly and was above the target. The CB model also showed the rise on the probabilities of inflation exceeding the upper limit of the target in 2022. In the Copom 2 February 2022 minutes, members stressed that fiscal risks could raise the possibilities of de-anchoring inflation expectations. This was the main reason that led the CB to tighten the monetary policy, i.e., to ensure convergence inflation over the relevant timeframe and anchored long-term inflation expectations. In this meeting, the Copom increased the Selic rate by 1.5 p.p. to 10.75% p.y. Considering the expected market inflation above 5% p.y., the monetary policy was above the neutral rate (the real rate was around 5.75% p.y.). In the March 2022 IR , this concern resurfaced since market and CB estimations for inflation in 2022 were well above the target. One of the reasons underlying this review was the strong rise of oil prices due to the war. In the next meeting, on 16 March, Copom raised the interest rate by 1 p.p. to 11.75% p.y. because of the de-anchoring of long-term inflation expectations. This action was aimed at curbing secondary shocks of the supply issues related to the war.

**External scenario:** in the March 2022 IR, the CB underlined that the global outlook had deteriorated significantly because of the conflict between Russia and Ukraine. In particular, the supply shock could increase the ongoing inflationary pressures. They also mentioned that the new Covid-19 Omicron variant had had a smaller impact on the economy than originally anticipated. Regarding the United States economy, the CB noted that it remained on a consistent recovery trajectory, with the unemployment rate reaching 3.8% on February 2022. In addition, the inflation rate hit 6.1% in January, considerably higher than the 2% target. In this context, the FED was expected to increase the interest rate; the median expectations of the Federal Open

Market Committee (FOMC) was a cumulative raise of 1.75% p.p. in 2022 and 2.75% p.p. by the end of 2023.The risks associated with a faster monetary tightening in the US was already mentioned the 2 February minutes. In the 16 March minutes, Copom members showed concern about the price of oil and its impact on the projected inflation.

Therefore, for the CB, inflation was a massive concern. The main problem was the long-term inflation expectations, which were well above the target. In addition, the FED would increase the short-term interest rate and the neutral interest rate was increasing at margin. In this scenario, following the CB's framework, it would have to increase the interest rate.

The CB started increasing the interest rate in March 2021, from 2% p.y. to 2.75% p.y. Until the end of that year, the interest rate reached 9.25% p.y. between the end of 2020 and the end of 2021, the nominal exchange rate went from R$ 5.19 to 5.58. Thus, despite the massive increase in the interest rate, the exchange rate devaluated. From then on, it appreciated.

According to the revised Harvey model and the CB's perspective, during the Russo-Ukrainian war, market participants should foresee an increase in expected inflation and an interest rate increase. However, the rising inflationary pressures could intensify the interest rate hike in the United States, so that the interest rate differential would not have experienced a drastic change.

 According to the CB framework, the impact of the war on the GDP would be negative. Nevertheless, since Brazil is a major exporter of commodities and is located far from the war, its effects could be positive. On one hand, higher commodity prices might stimulate the related sectors and capital could move from emerging countries near the conflict to Brazil. On the other hand, the interest rate rise could cool down the economy and liquidity would be negatively impacted due to the increasing risk. Moreover, in 2022 the vaccination rate against Covid-19 was high, leading to many economic activities being resumed. This could also push economic growth.

In this scenario, considering that the Brazilian CB started rising the interest rate considerably earlier than the FED and signaled that it would continue doing so, portfolios flows should increase. The GDP growth expectation could contribute to this result and might encouraged DFI flows. Nevertheless, the inflation rise should act in the opposite direction. Regarding the trade balance, the increase of commodity prices (including oil) would have a

positive impact, since Brazil is a net commodity exporter. In total, the basic factors from the mental model suggest that capital should flow to Brazil and appreciate the exchange rate.

The Focus Readout from the first three months of 2022 shows that expected inflation grew continuously, increasing after the beginning of the war. In the same vein, market participants also changed their expectation over the interest rate after the war, betting on a 13% p.y. terminal rate by the end of the year. Also, the expected GDP growth slightly changed from 0.3% p.y. to 0.5% p.y. At the same time, although the liquidity (VIX index) decreased after the war, a couple of weeks later it returned to the same level of the beginning of the year.

Table 2 - Market Expectations for 2022 for the IPCA(%), GDP growth (%), interest rate (%), trade balance (US$ billions), FDI (US$ billions) and exchange rate (R$/US$) – Brazil – 01/01/2020 to 30/03/2020

| Market Expectations | Jan 7 | Jan 14 | Jan 21 | Jan 28 | Feb 4 | Feb 11 | Feb 18 | Feb 25 | Mar 4 | Mar 11 | Mar 18 | Mar 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Basic Factors | | | | | | | | | | | | |
| IPCA (%) | 5,03 | 5,09 | 5,15 | 5,38 | 5,4 | 5,5 | 5,6 | 5,6 | 5,65 | 6,45 | 6,59 | 6,86 |
| GDP growth (%) | 0,28 | 0,29 | 0,29 | 0,3 | 0,3 | 0,3 | 0,3 | 0,3 | 0,42 | 0,49 | 0,5 | 0,5 |
| Interest rate (%) | 11,8 | 11,8 | 11,8 | 11,8 | 12 | 12,3 | 12 | 12 | 12,3 | 12,8 | 13 | 13 |
| Process | | | | | | | | | | | | |
| Trade Balance (US$ billion) | 55,5 | 56 | 56 | 57,2 | 58 | 58,4 | 64 | 64 | 64 | 63,5 | 64,5 | 65 |
| DFI (US$ billion) | 58 | 58 | 58 | 60 | 60 | 60 | 60 | 60 | 60 | 59 | 59,1 | 59 |
| Forecast | | | | | | | | | | | | |
| Exchange rate (R$/US$) | 5,6 | 5,6 | 5,6 | 5,6 | 5,6 | 5,58 | 5,5 | 5,5 | 5,4 | 5,3 | 5,3 | 5,25 |

Source: Own elaboration based on Focus Readout from the Brazilian Central Bank.

According to the mental model, a higher than expected GDP would encourage DFI flows, but a higher than expected inflation rate would have the opposite effect. Looking at market expectations on DFI flows, we note that they did not change significantly, so that these effects might offset each other. In addition, a higher inflation rate should have a negative impact on the trade balance. However, since inflationary pressures were caused by higher commodity prices, and Brazil is a net exporter of commodities, agents forecasted a higher trade balance surplus. In addition, a higher interest rate would draw portfolio flows. Therefore, the basic

factors would have a positive impact on the process and consequently on the exchange rate forecast. In this vein, market participants' forecast of the exchange rate went from R$ 5.6 at the beginning of the year to R$ 5.25 at the end of March. When the war began, the nominal exchange rate devaluated from R$ 5.02 to 5.14 (Figure 4). However, until the end of the month, it was already close to R$ 4.7.

Figure 4 - Nominal exchange rate (sales) – daily average – R$/US$ – 03/01/2022 to 31/03/2022
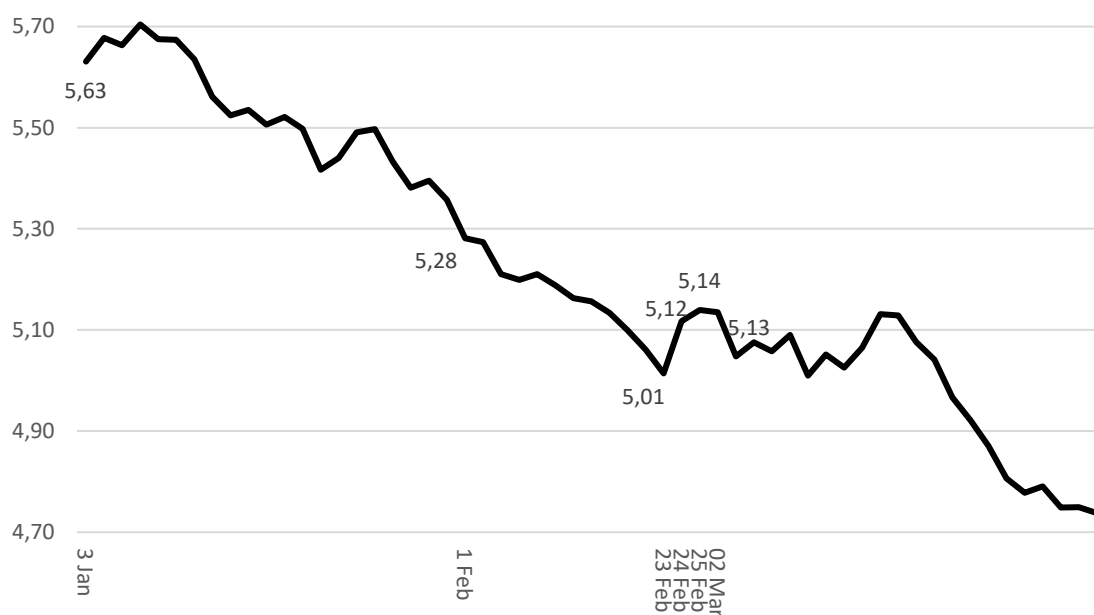


Source: Own elaboration based on Brazilian Central Bank data.

This time, agents were correct and the exchange rate closed at R$ 5.22 at the end of the year. The interest rate closed at 13.75% p.y. and the inflation rate at 5.8% p.y., near the market forecast. However, the GDP grew 2.9%, which was considerably higher than market expectations. This result was fueled by the return of service sector activities and by fiscal policies adopted by the federal government. In 2022, general elections were held in Brazil and the incumbent president Jair Bolsonaro tried to become reelected by any means possible, but failed.

By the end of the year, the trade balance was US$ 61 billion and the DFI was US$ 87 billion. The former was near the agents' forecast, the latter was much above it. This helped to appreciate the exchange rate. Along with it, FPI flows changed from –US$ 8 billion in 2021 to +US$ 4 billion in 2022.

In this event, again, the mental model resembles market participants' heuristic technique to forecast the exchange rate. This time, the basic factors and related process worked as predicted by the model. Even though agents could not correctly anticipate all basic factors, they could accurately forecast the exchange rate. Therefore, their expectation of the nominal exchange rate for 2022 helps to explain its dynamics during the beginning of the war.

## 6. Conclusion

This paper aimed to study the exchange rate dynamics during the Covid-19 pandemic and the Russo-Ukrainian war using the dynamics for determining the exchange rate proposed by Harvey (2009). We began with a theoretical review of the exchange rate speculation strategies used by Keynes. Then, we reviewed Harvey's model to consider the inflation targeting regime, which guide CBs' decisions, and to take into account these unique economic events. Thus, the research question that guided this research can be expressed as follows: Is it possible to understand the short-term dynamics of the nominal exchange rate in Brazil during the Covid-19 pandemic and the Russo-Ukrainian war using the revised Harvey model (2009)? The answer to this question is positive, but it is important to qualify it.

During the Covid-19 pandemic, market participants changed their expectation in relation to the basic factors and to the process of the model, thereby reviewing their exchange rate forecast. However, they were incorrect, underestimating inflation and overestimating interest rates and GDP growth. They also incorrectly predict the process of the model, with the sum of the DFI and the trade balance surplus being lower than predicted. Therefore, they did not foresee the large exchange rate devaluation. That is, the influence of their expectations on the nominal exchange rate was limited due to the high uncertainty environment.

In the Russo-Ukrainian war, agents also changed their expectations and reviewed the exchange rate forecast. Except for GDP growth, this time they got the basic factors correct. They also correctly predicted the trade balance, but failed to estimate the DFI, which was greater than expected. Nevertheless, they correctly estimated the exchange rate. This time agents' expectation influenced the nominal exchange rate path.

In general, the CB perspective on the indicators had a mixed impact on agents' expectations on short-term interest rates. In the first case, the CB signaled that it had enough room to cut the interest rate if necessary. Nevertheless, marked participants did not foresee that

they would pursue this path until achieving 2% p.y. In the second case, the CB mentioned that it would raise the interest rate and market participants accepted it. It is important to note that the Covid-19 pandemic increased uncertainty considerably more than the Russo-Ukrainian war. Thus, we argue that the mental model proposed by Harvey (2009) can improve the understanding of reality when the inflation targeting regime is considered, which is important for determining the behavior of central banks, the interest rates of countries and, therefore, nominal exchange rates.

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