

Pacifying the Pandemic Panic: An Application of Structural Break Analysis in Philippine Government Bond Yield Times Series Data

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Abstract

Amid the imposition of varying degrees of economic activity restrictions in the Philippines during the COVID-19 pandemic, there have been observable shifts in short-term trends in domestic local currency bond yields. These movements have been influenced by a combination of domestic and global macroeconomic developments. Notably, increases in the yields of local currency government securities were seen at the onset of the pandemic, as well as in March 2021 when rates tracked the uptick in their U.S. Treasury counterparts. Meanwhile, the spike in Philippine inflation mainly attributed to surging pork prices resulted in negative real yields starting in February 2021. Taking a long-term perspective, unconstrained Bai-Perron test for structural breaks was employed using monthly data on local bond yields and inflation after the Global Financial Crisis. Despite aforementioned short-term dynamics, results of this empirical study showed that there have been no structural breaks identified in nominal and real yields in the period covering the COVID-19 pandemic. Such results shed light on the effectiveness of the government's fiscal and monetary policy responses to combat the effects of the pandemic and maintain stability in the domestic financial markets.

JEL Classification: C61, E43, E44, E52, E62, G01

Keywords: structural breaks, COVID-19 pandemic, Philippine government bond yields

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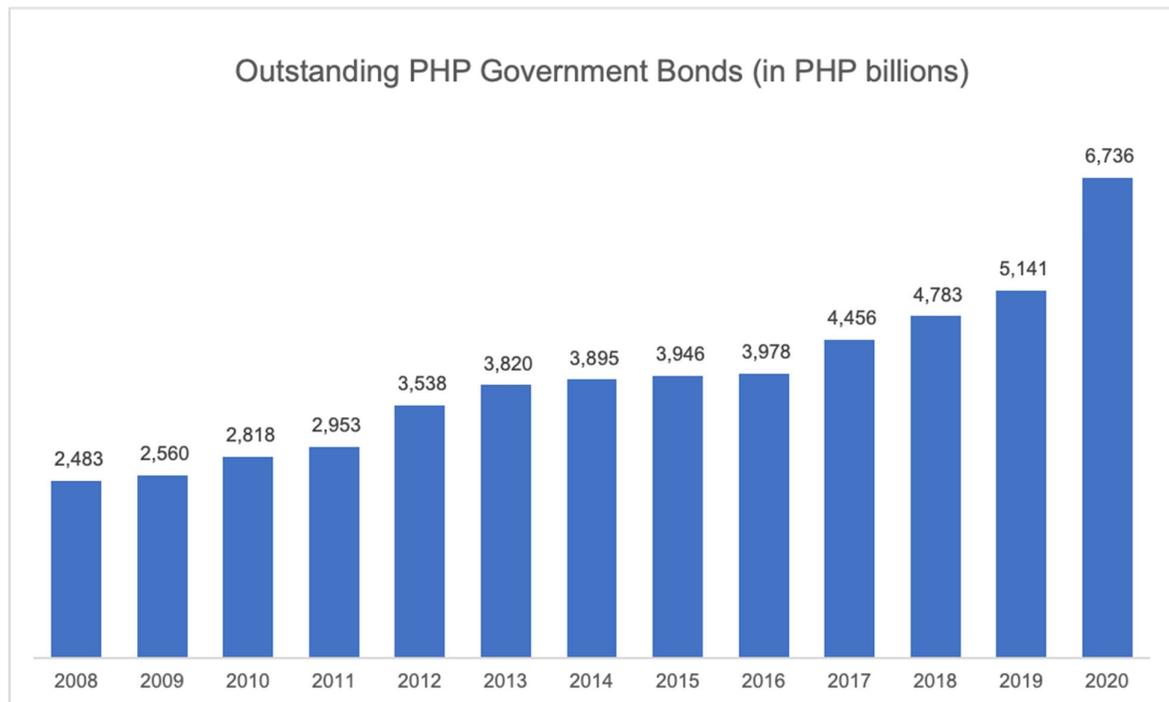
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I. Background

The increase in the National Government's (NG) deficit target in the current administration to 3.2% of GDP consequently pushed its annual funding program to record levels in recent years. To add to this, the COVID-19 pandemic widened the NG's deficit levels to around 9% of GDP, which further increased the NG's funding needs to the PHP 3-trillion level.

One of the key elements of the NG's debt management strategy is minimizing foreign exchange risk in its debt portfolio. As such, it seeks to fund around 75 to 80 percent of its annual borrowing requirements through domestic sources, mainly through the issuance of Government Securities (GS). With the increasing funding needs, it can be seen in Figure 1 that the local currency GS market has continuously increased in size, reaching a record-high of more than PHP 6.7 trillion in 2020.

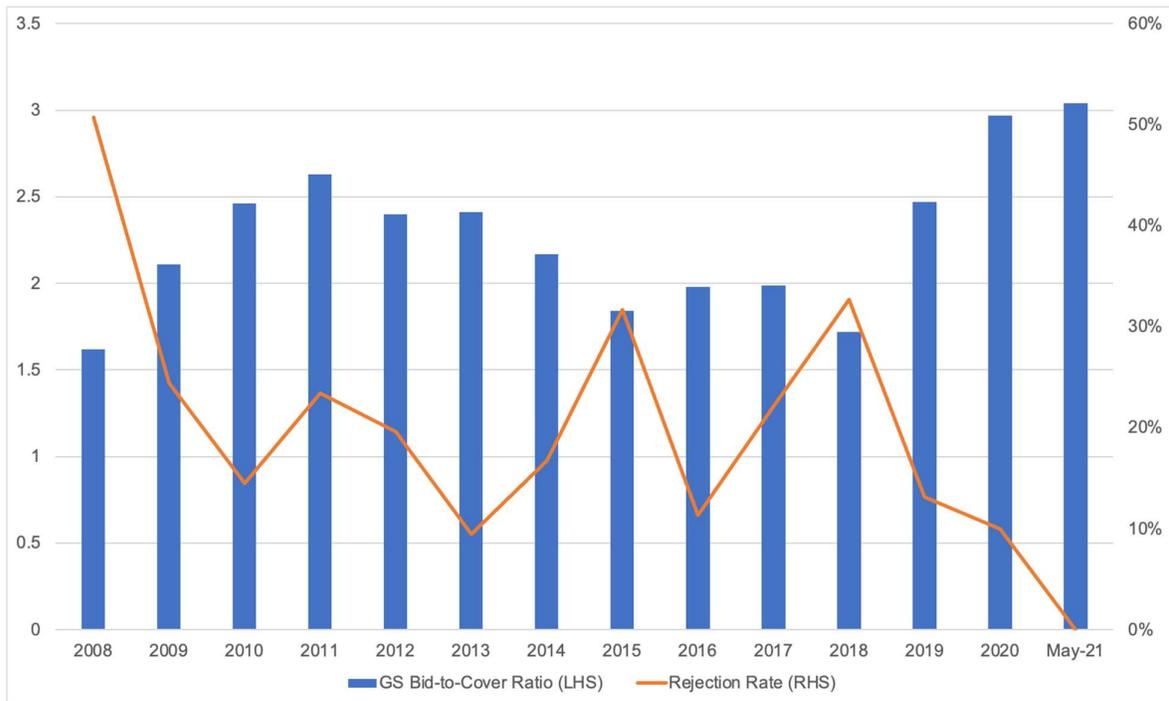
Figure 1. Outstanding PHP government bonds



Source: AsianBondsOnline

The increase in the supply of GS in the domestic market has been supported by monetary policy actions of the Bangko Sentral ng Pilipinas (BSP), especially during the pandemic. With the cumulative 200-basis point cut in the policy rate, coupled with the 200-basis point reduction in the Reserve Requirement Ratio (RRR), demand for GS reached levels nearing those of the quantitative easing (QE) period in 2013, as evidenced by bid-to-cover ratios of the Bureau of the Treasury's (BTr) auctions. Moreover, rejection rates have been on a downward trend in recent years, as seen in Figure 2.

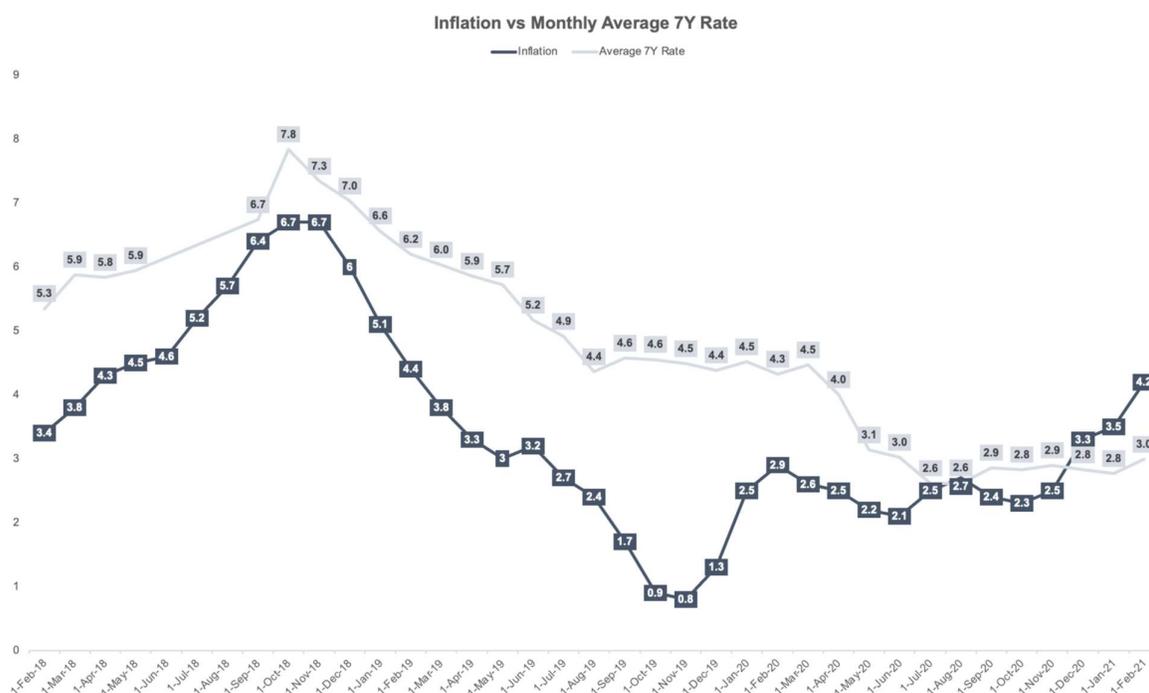
Figure 2. Bid-to-cover ratio and rejection rate of GS auctions



Over the past years, several factors have contributed to the movement in yields in the local currency bond market. In 2018, supply side pressures due to rising oil prices have driven inflation to a high of 6.7%, which has contributed to an increase in bond yields across the curve. When the BSP started hiking rates to address these inflationary pressures, bond yields then started to decline.

In the years thereafter, policy adjustments such as cuts in the RRR amid benign inflation have further driven bond yields down. This historical relation between inflation and bond yields is illustrated in Figure 3.

Figure 3. Inflation and monthly average 7-year rate



With changes in market conditions and international best practices, there have been significant adjustments in the BSP’s tools to carry out its monetary policy operations. This includes the introduction of the Term Deposit Facility (TDF) as it adopted the Interest Rate Corridor (IRC) system in 2016. Moreover, under Republic Act No. 11211, also known as “An Act Amending the New Central Bank Act” effective last 2019, the BSP gained an additional tool in its monetary policy arsenal - the issuance of its own securities. Given the nature of these instruments, there has been the risk of cannibalization in demand of investors between the BSP’s facilities and the BTr’s issuance of GS. This could potentially result in the distortion of the yield curve, particularly in the short end, affecting the price discovery of GS. However, the BSP and the BTr have established a high-level Liquidity Management Committee (LMC) to ensure that policy making and implementation affecting the overall system liquidity are harmonized. As an example, the two institutions ensure that no auctions overlap and that the tenor of the securities being issued are distinct.

Amid the pandemic, on the monetary policy side, the BSP has implemented several policy initiatives to ensure financial stability. The BSP has lowered both the policy rate and the reserve requirement ratio to bolster bank lending and economic activity. To provide liquidity support, the central bank has also been buying government securities in the secondary market. Moreover, BSP has lent support to the national government by extending provisional advances to the BTr. Aside from these measures, the BSP in its regulatory capacity has also incentivized lending to micro, small and medium enterprises, promoted the use of technology in delivering financial services and encouraged banks to grant flexible terms to their borrowers.

On the fiscal policy side, the Bayanihan to Heal as One Act passed in March 2020 provided emergency cash aid to low income families. The Bayanihan to Recover as One or Bayanihan 2 Law passed in September 2020 funded, among others, programs supporting healthcare

workers, freelancers, the self-employed, overseas Filipino workers affected by the government's deployment ban, as well as capital infusions to government financial institutions, and subsidies to agriculture, transportation, infrastructure and tourism sectors. Meanwhile, the 2021 national budget funded the purchase, storage and distribution of millions of doses of COVID-19 vaccines. Further, the Corporate Recovery and Tax Incentives for Enterprises (CREATE) Law reduced the corporate income tax for both big and small firms.

II. Related literature

As the COVID-19 pandemic is an ongoing phenomenon, the existing literature on its effect on financial markets is still limited.

Benmelech and Tzur-Ilan (2020) examined the determinants of fiscal and monetary policies of 85 countries amid the COVID-19 pandemic. On the fiscal side, the authors observed that high-income countries deployed larger fiscal stimulus measures compared to their low-income counterparts, and that credit rating is the most significant determinant of fiscal spending, cautioning that countries with poor credit histories will not be able to deploy fiscal policy measures effectively during crises. On the monetary side, it was highlighted that high-income countries were more likely to use unconventional monetary policy tools, as they entered the pandemic with already low interest rates.

Hordahl and Shim (2020) focused on the behavior of bond portfolio outflows from emerging market economies (EMEs) in mid-March 2020, when the pandemic triggered sharp asset sell-off episodes. The authors highlighted that the association of bond portfolio outflows with currency depreciation and increasing domestic long-term interest rates was evident in a stark way during this period, albeit there is variation in the relationship across EMEs, depending on bond market depth, FX market functioning and sovereign risk. Further, policy actions to improve the depth and liquidity of bond and FX markets will be beneficial in the long run.

Meanwhile, Hofmann, et al. (2020) noted the importance of EMEs' monetary policy frameworks that are "equipped to address the feedback loop between exchange rate depreciation and capital outflows" in having a "better chance of weathering the financial fallout from the COVID-19 pandemic." The authors argued that EMEs may need to expand their toolkit, possibly through deploying balance sheets to provide targeted liquidity to market participants, intermediating in the repo market or by purchasing domestic bonds.

Eguren Martin, et al. (2020) mentioned that the "pressures on capital flows were amplified by a marked tightening in financial conditions, including strains in US dollar funding markets." The authors also noted that the extensive range of central banks' policy measures, which include interest rate cuts, enhanced liquidity facilities, large scale asset purchases and macro-prudential measures, helped to address the market disruption amid the pandemic.

On the use of structural break analysis, Kamber, et al. (2020) applied structural break tests in examining the driving forces of inflation in 47 economies for the sample period from 1996 to 2018. The study suggested that "structural changes in expected future inflation, domestic and foreign output gaps, and, to a lesser extent, exchange rates and oil prices can explain patterns of changes in the level and volatility of inflation across different economies." Moreover, as the

results suggested an increase in the importance of expected future inflation as a driver of inflation, “central banks should focus on inflation expectations as the key driver of inflation, but also allow for a substantial influence of the degree of economic slack both domestically and for major trading partners.”

In relation to the Bai-Perron test for structural breaks, which was applied in this research paper, Rapach and Wohar (2005) employed the said methodology to check for structural breaks in the long-term real interest rate and inflation of 13 advanced economies using quarterly data from 1960 to 1998. In this cross-country study, multiple structural breaks in both real interest rates and inflation were detected. Further, an increase (decrease) in the mean inflation rate typically corresponded to a decrease (increase) in the mean real interest rate. The results of the study signaled that the long-run Fisher effect,³ and in turn inflation neutrality in the long run, may not be observed.

Similarly, Clemente, et al. (2017) investigated the presence of the Fisher effect for advanced economies, particularly the Group of Seven (G7) countries, covering quarterly data from 1970 to 2015. Also using the Bai-Perron procedure for detecting structural breaks, the study yielded the same result as Rapach and Wohar (2005) - that there is no significant evidence of a total Fisher effect in the period selected. The paper concluded that different regimes exist in the relationship between nominal interest rates and inflation.

III. Significance

This study aims to examine both short-term and long-term dynamics of Philippine government bond yields, specifically in the context of the COVID-19 pandemic. It offers analyses regarding the relationship between yields and other macroeconomic factors during a crisis period, as well as the effectiveness of monetary and fiscal policy measures enacted to maintain the stability in the financial markets.

Having a deeper understanding of trends in bond yields provides valuable insights to issuers of sovereign and private sector debt to allow for strategic formulation of issuance and borrowing strategies to ensure that the issuers' funding requirements are met at the efficient cost given a prudent level of risk. This includes the selection of appropriate structures (e.g. interest rate type, currency) as well as the timing of issuances.

The study underscores the critical importance of a proactive approach of central banks towards policy formulation and implementation. Moreover, focus should also be placed towards keeping a strong coordination and feedback mechanism between the central bank and the national government to ensure that the two institutions carry out their unique mandates while keeping the financial system stable and avoiding liquidity concerns.

Results of this study are also of value for risk analysts for their trading strategies and risk management, and for investors in general.

³ The Fisher effect describes the relationship among interest rates (nominal and real) and inflation. Its simple form posits that the real interest rate equals the nominal interest rate minus the expected inflation rate.

Lastly, this paper seeks to contribute to the currently scant literature delving on the financial market implications of the pandemic.

IV. Scope

This research focuses only on local currency government bond yields issued by the Philippine government. Yields of corporate debt, for instance, while influenced by sovereign yields, may be driven more by idiosyncratic risk factors. On the date range, the structural break analysis takes into consideration the period after the Global Financial Crisis to limit the effect of that phase of market turmoil in the analysis. The cutoff date is selected based on the availability of data for the variables used. Meanwhile, regarding the Bai-Perron test, the method applied to test for multiple structural breaks, it is important to note that as with any statistical test, it relies on certain assumptions and features (e.g. using a dynamic programming approach, having non-symmetric confidence intervals). Moreover, this study focuses on analyzing the dynamics of yields, and does not cover forecasting of rates.

V. Methodology

For the short-term analysis of the developments during the COVID-19 pandemic, the data in Table 1 are sourced from Bloomberg for the period from January 2019 to March 2021. The graphs of these variables are also generated in Bloomberg.

Table 1. Variables for short-term analysis

Variable	Details	Frequency
PH Real GDP YoY	Philippines' year-on-year real GDP growth in percent	quarterly
USDPHP	closing price of 1 U.S. dollar in terms of Philippine pesos (PHP)	daily
PSEi	closing value of the Philippine Stock Exchange index	daily
PH Stringency Index	University of Oxford's metric incorporating containment and closure policies, economic policies and health system policies imposed by governments; metric for the Philippines	daily
1Y PHP Govt Bond Yield BVAL	1-year PHP-denominated government bond yield computed using Bloomberg Valuation (BVAL) methodology in percent	daily
3Y PHP Govt Bond Yield BVAL	3-year PHP-denominated government bond yield computed using Bloomberg Valuation (BVAL) methodology in percent	daily
10Y PHP Govt Bond Yield BVAL	10-year PHP-denominated government bond yield computed using Bloomberg Valuation (BVAL)	daily

	methodology in percent	
PH CPI YoY	Year-on-year change of the Philippines' headline consumer price index with 2012 as base year in percent	monthly
BSP Policy Rate	Bangko Sentral ng Pilipinas' overnight reverse repurchase rate in percent	daily
Money Supply M3 YoY	Year-on-year change of the Philippines' M3 in percent	monthly
Gross Total Loan Portfolio	Gross total loan portfolio of the Philippine banking system in thousands PHP	monthly
Banks Gross Loan Outstanding	Year-on-year change in commercial banks' gross loan outstanding (inclusive of central bank/repo placements)	monthly

Meanwhile, for the comparison of movements in yields with the Philippines' peers in the Southeast Asian region, the variables in Tables 2 and 3 are taken from Bloomberg.

Table 2. Government bond yield data

Country	Details
Philippines	1-year, 3-year and 10-year PHP-denominated government bond yields computed using BVAL methodology in percent
Thailand	1-year, 3-year and 10-year THB-denominated government bond yields computed using Bloomberg Generic (BGN) methodology in percent
Indonesia	1-year, 3-year and 10-year IDR-denominated government bond yields computed using BGN methodology in percent
Vietnam	1-year, 3-year and 10-year VND-denominated government bond yields computed using BGN methodology in percent
Malaysia	1-year, 3-year and 10-year MYR-denominated government bond yields computed using BGN methodology in percent

Table 3. Policy rate data

Country	Details
Philippines	Bangko Sentral ng Pilipinas' overnight reverse repurchase rate in percent
Thailand	Bank of Thailand's overnight repurchase rate in percent
Indonesia	Bank Indonesia's 7-day reverse repurchase rate in percent
Vietnam	State Bank of Vietnam's refinancing rate in percent

Malaysia	Bank Negara Malaysia's overnight policy rate in percent
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For the calculation of the real yield buffer shown in Figure 11, the ASEAN real yields are based on 10Y BVAL rates of local currency government bonds, adjusted for actual year-on-year inflation rate. Furthermore, the Q2 CPI forecasts, including the worst case scenario, are based on Bloomberg estimates.

For the empirical long-term analysis of yields, the focus is on structural breaks, which mark significant changes in trends or relationships within regression models. As a longer time horizon must be considered in checking for structural breaks in Philippine government bond yields, the authors used monthly data after the Global Financial Crisis, i.e. from January 2009 to March 2021.

Taking into account liquidity and to represent tenors across the yield curve, 1-year, 3-year and 10-year nominal yields were used. The data for the period from January 2009 to October 2018 are Philippine Dealing System Treasury Reference Rates PM (PDST-R2), while the data for the remaining period are taken from Bloomberg and are computed using the BVAL pricing methodology.

Meanwhile, figures for inflation, which was represented by the year-on-year change in consumer price index with 2012 as base year, were also sourced from Bloomberg. Real yields for the three tenors are then computed by subtracting the inflation rate from the nominal yields.

Thereafter, the *breakpoints* function under the *strucchange* library in the software *R* was used to perform the Bai-Perron test for structural breaks in both nominal and real yields. Technical details of the said test can be found in Bai & Perron (2003). This statistical test relies on a dynamic programming approach to determine optimal breakpoints. As an advantage compared to other empirical tests for structural breaks (such as Chow test), the Bai-Perron methodology does not require the user to specify the dates to be checked. To note, the authors opted to not specify the maximum number of breakpoints. The breakpoints were then plotted in the corresponding time series data. Further, the 95% confidence interval for the breakpoints were computed and plotted using the *confint* function.

VI. Results

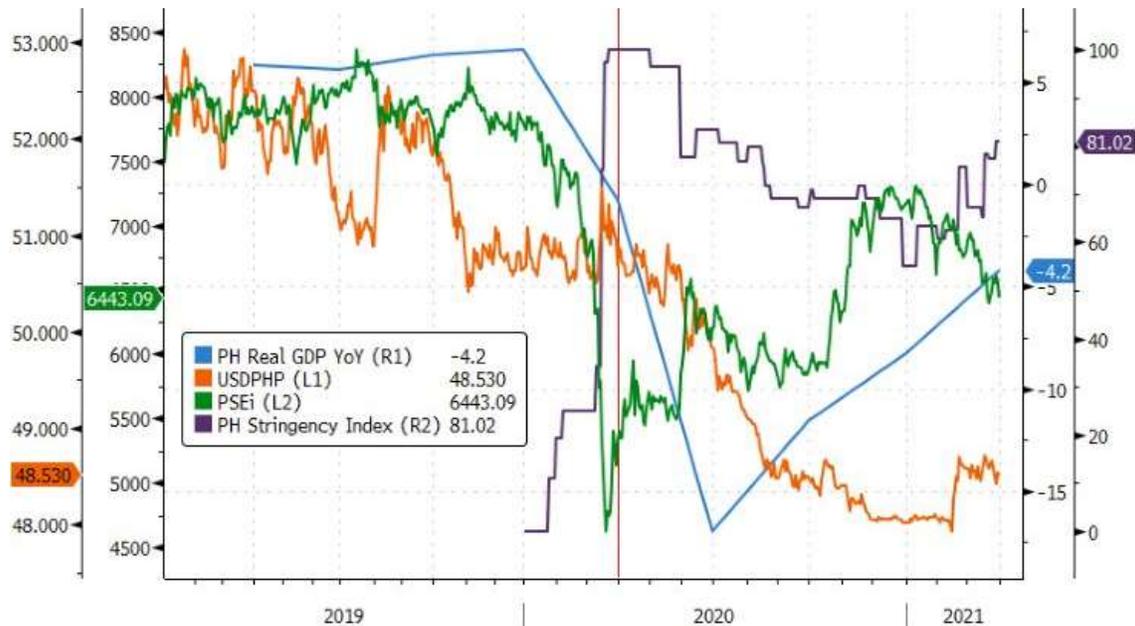
A. Pandemic period analysis for the Philippines

The restrictions brought about by the imposition of varying types of community quarantine in different areas in the Philippines have resulted in a slump in the country's GDP and a fall in its stock market index. Moreover, as the U.S. dollar inflows continued while imports weakened, the Philippine peso has seen a consistent appreciation in the period of the pandemic.

Then, as the number of COVID-19 cases in the country started to decrease, the government gradually relaxed some lockdown measures, as seen in the downward trend in the Stringency Index.⁴ Consequently, economic growth recovered, but still remained in the negative zone.

Moreover, the surge in cases in early 2021 has prompted the government to reimpose strict lockdown measures, resulting in the decline in Philippine stocks.

Figure 4. Real GDP growth, foreign exchange rate, stock index and stringency index



There has been an observable shift in the yield curve at the onset of the COVID-19 pandemic as the government announced lockdown measures, leading to uncertainty. With the BSP's proactiveness in responding to the shocks in the domestic financial market, yields started to go down in the following months and essentially normalized throughout the latter part of 2020. The risk-off sentiment and the flight to safety that persisted in 2020 pushed the demand for GS upward, which consequently drove yields down, with short term Treasury Bill rates even falling below the policy rate.

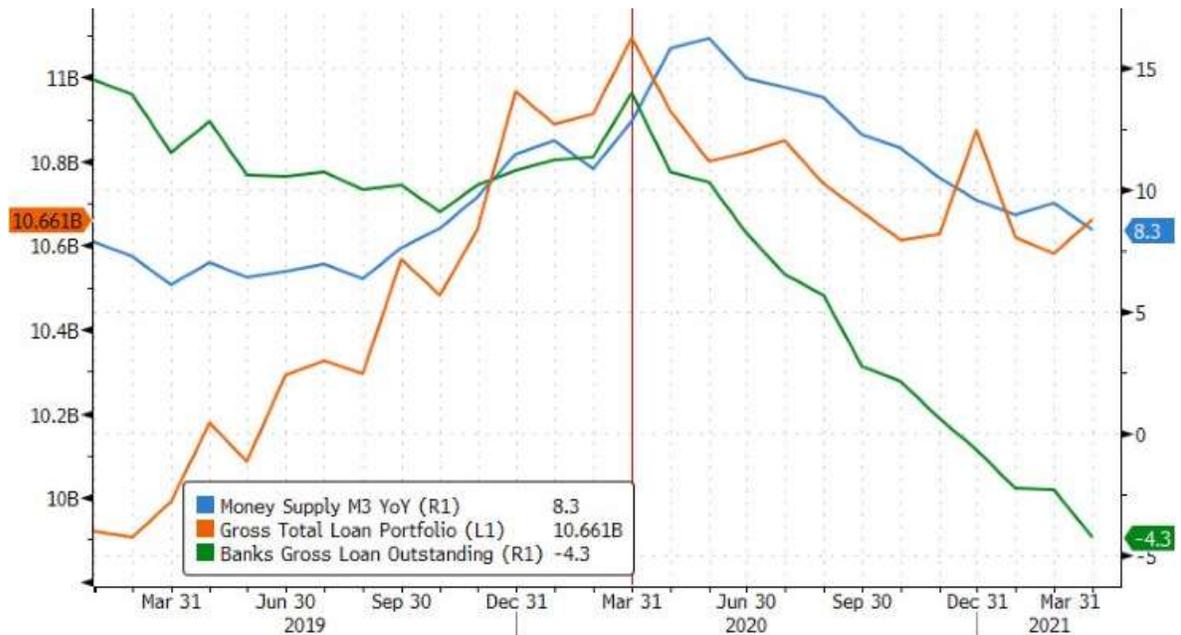
While domestic liquidity remains healthy in Q1 2021, there has been a prominent increase in bond yields and a steepening of the curve as inflation reached 4.7% and U.S. Treasuries rallied amid the announcement of Biden's stimulus programs.

⁴ The University of Oxford's Stringency Index is a gauge incorporating the number and strictness of government policies, including containment and closure policies, economic policies and health system policies.

Figure 5. PHP government bond yields, inflation and policy rate



Figure 6. Liquidity indicators



Following the accommodative policy adjustments of the BSP amid the pandemic, domestic money supply has grown to record levels. However, it can be observed that in the case of the Philippines, this has not translated to a parallel increase in outstanding loans by banks. This may be attributed to the fact that consumers or investors are not accessing loan facilities from banks given the business environment outlook amid the quarantine restrictions that are in place. As such, it can be argued that bulk of the liquidity being released by way of the BSP's policy actions has remained in the banks themselves. This excess liquidity in the books of

banks have then been channeled into the BSP's deposit facilities as well as the GS auctions of the BTr, contributing to the decline in yield levels, especially in short-term rates.

B. Comparison with regional peers

Generally, movements of yields in countries within the Association of Southeast Asian Nations (ASEAN) during the pandemic have been similar, which may be attributed to the similarly accommodative monetary policy of the region's central banks in support of their respective economies amid the pandemic. It can also be seen from Figures 7 to 9 that the rally in U.S. Treasuries in Q1 2021 has affected other ASEAN bond markets, not just the Philippines.

Figure 7. 1-year government bond yields



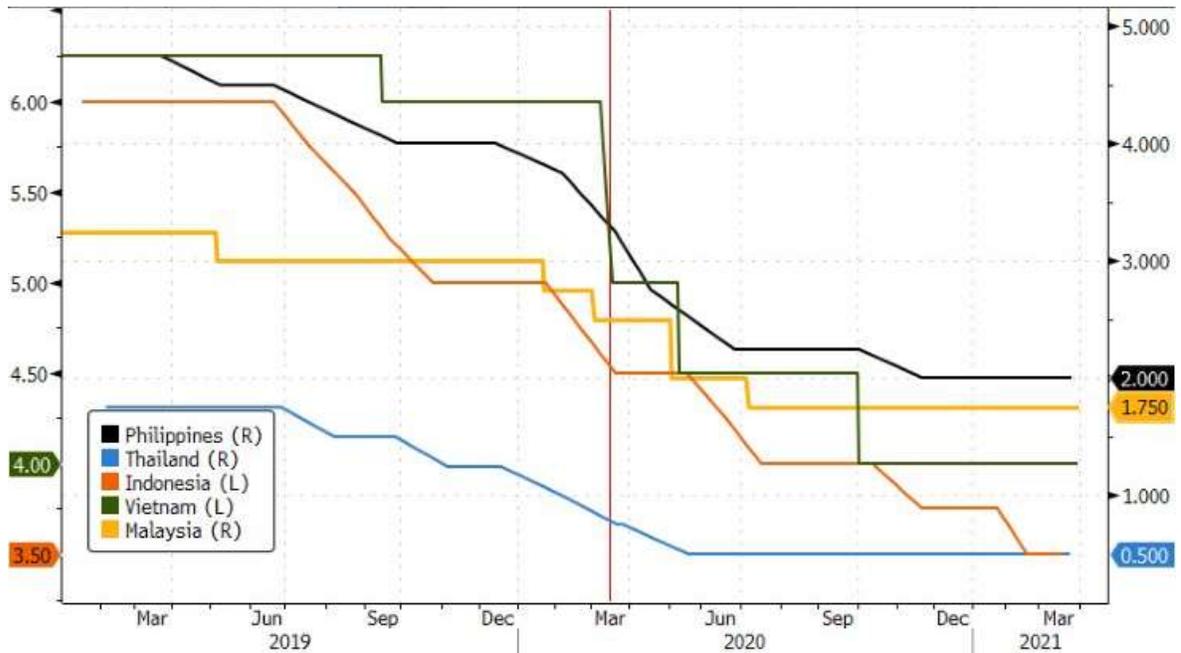
Figure 8. 3-year government bond yields



Figure 9. 10-year government bond yields

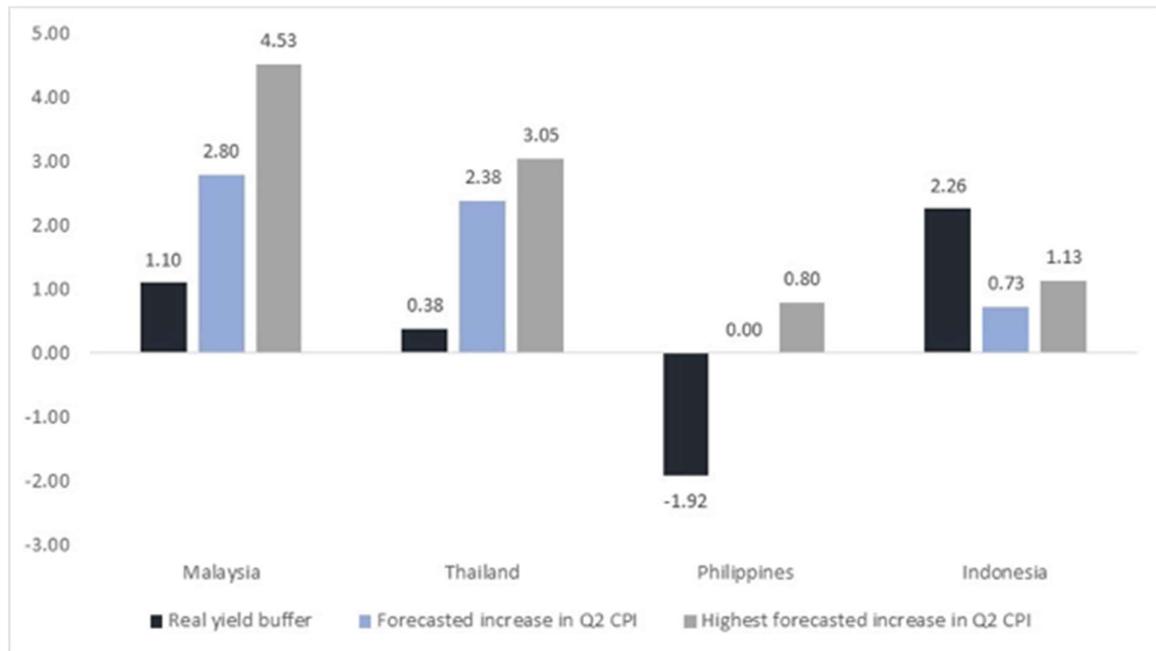


Figure 10. Policy rates



While there has been an observable co-movement of nominal bond yields in the different ASEAN economies, real rates tell a different story.

Figure 11. Real yield buffer



In Figure 11, the real yield buffer is the current maximum possible decrease in 10-year rates that will bring the current real yield to its 10-year average. In the case of the Philippines, current inflation levels and persistently low bond yields means that real yields are already in the

negative zone, hence the negative buffer. Despite the Philippines having the only negative real 10-year yield among its peers, it has the least risk of an inflation shock in Q2 that can potentially erode the returns of investors. To illustrate, for Malaysia, a 4.53% inflation rate (worst case) will put its 10-year real yield to 343 basis points below the 10-year mean.

C. Structural break analysis

Taking a long-term perspective, the results of the unconstrained Bai-Perron test for structural breaks in 1-year, 3-year and 10-year local currency Philippine government bond yields (both nominal and real yields) are presented in Figures 12 to 17. The horizontal axis pertains to time (the number of months after January 2009, the start of the data set), while the vertical axis pertains to yields expressed as percentage. The dotted lines represent the breakpoints identified by the test, with corresponding 95% confidence intervals visualized in red lines.

Figure 12. Structural breaks in 1-year nominal yields

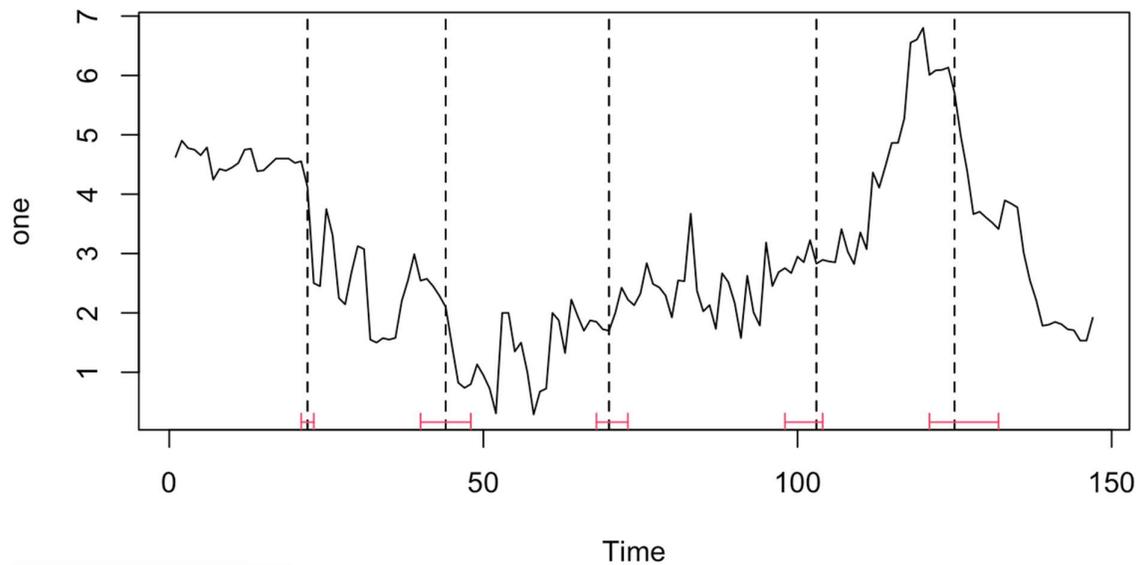


Figure 13. Structural breaks in 3-year nominal yields

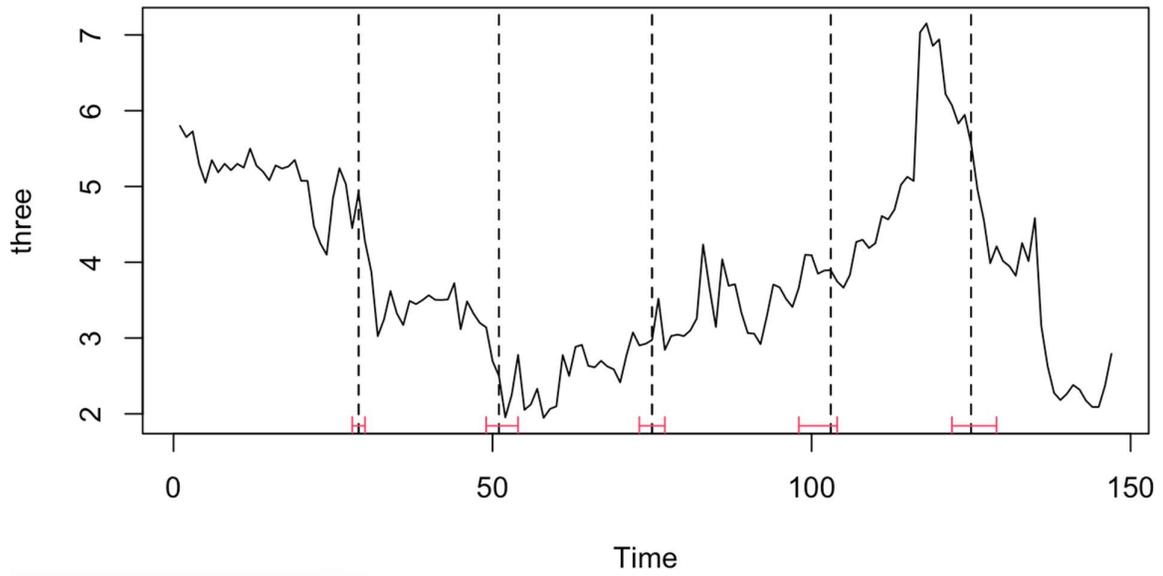


Figure 14. Structural breaks in 10-year nominal yields

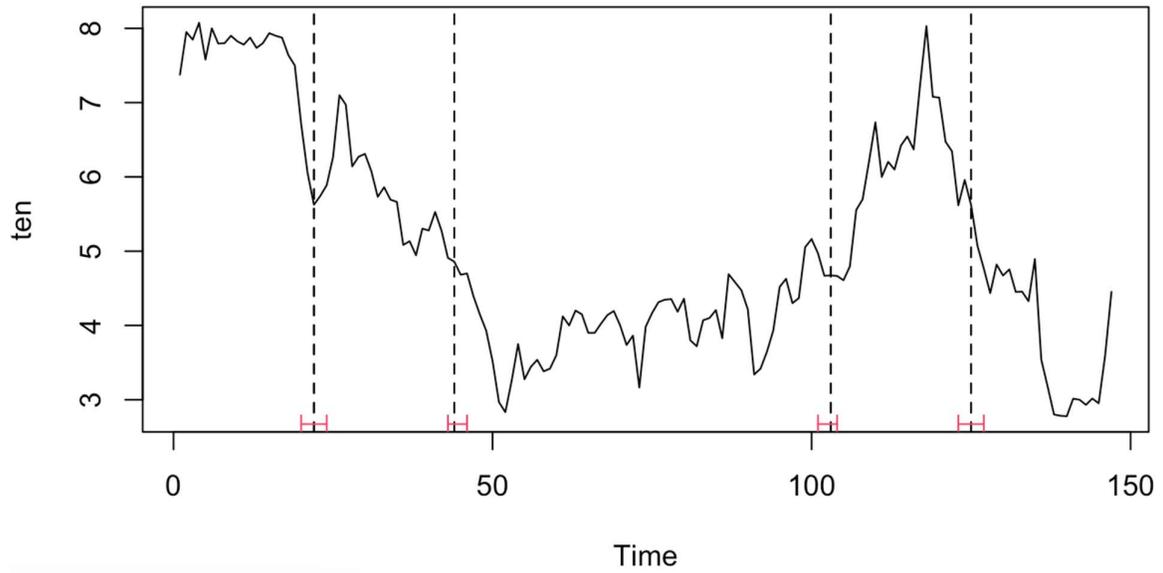


Figure 15. Structural breaks in 1-year real yields

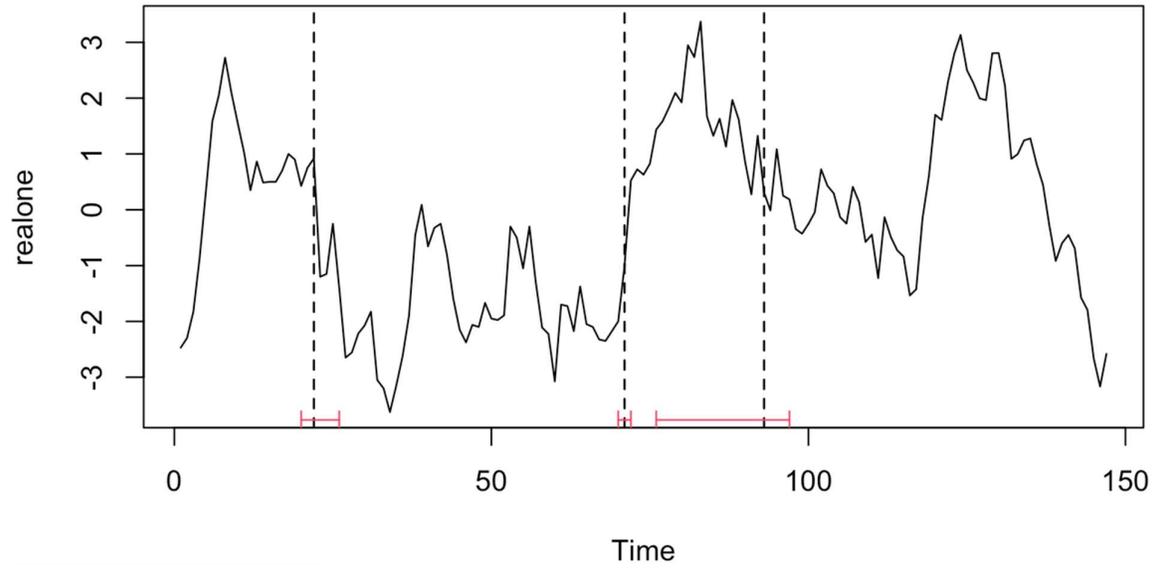


Figure 16. Structural breaks in 3-year real yields

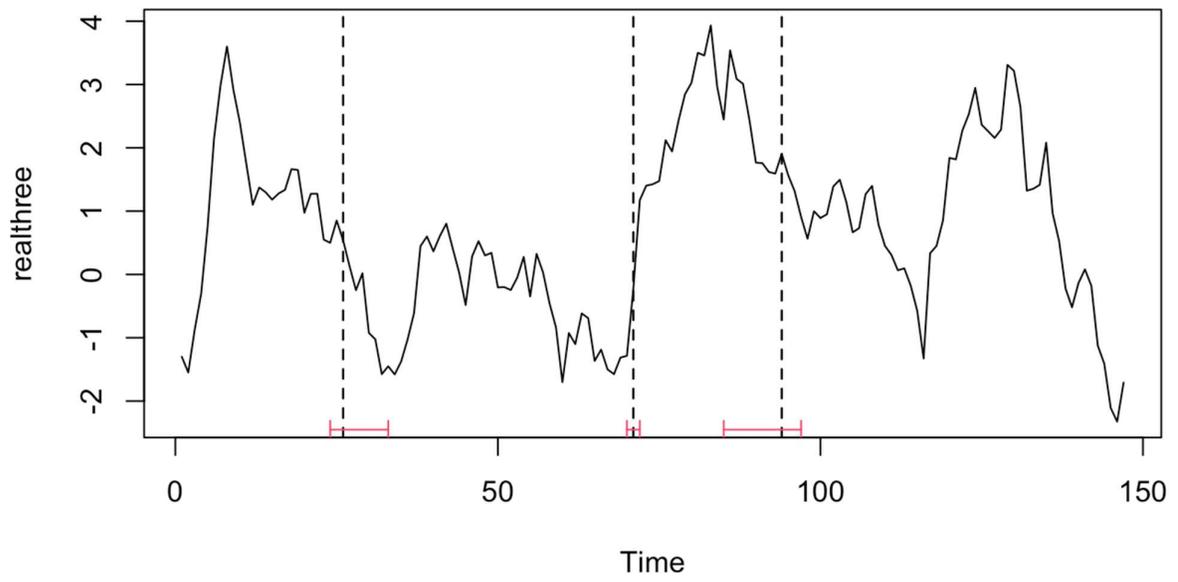
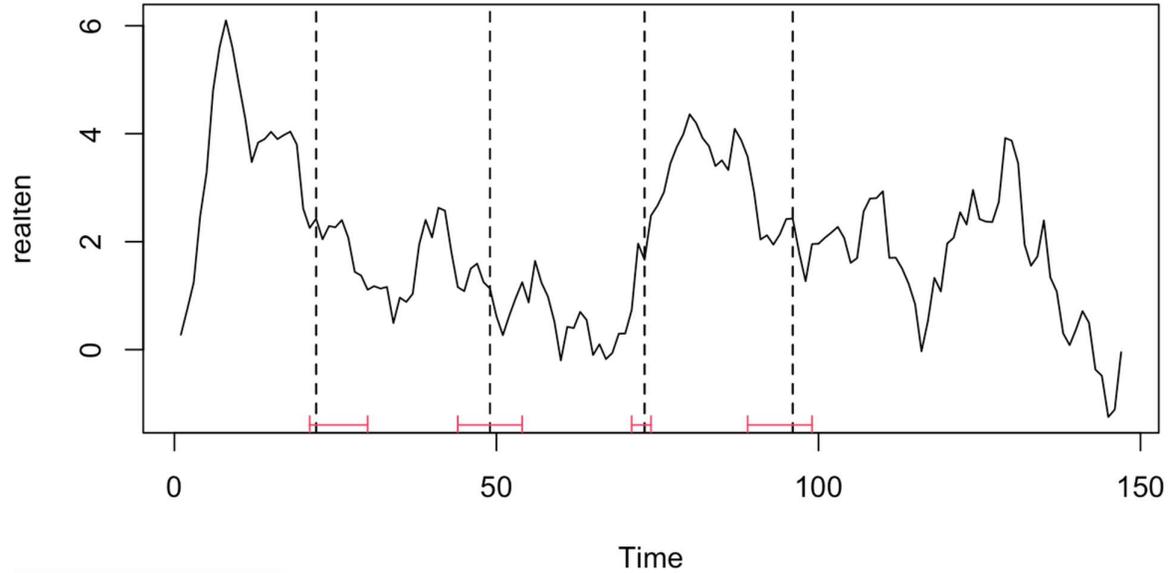


Figure 17. Structural breaks in 10-year real yields



The dates corresponding to the breakpoints in the figures above for nominal and real yields are summarized in Tables 4 and 5.

Table 4. Breakpoints for nominal yields

1-year nominal yields	3-year nominal yields	10-year nominal yields
October 2010	May 2011	October 2010
August 2012	March 2013	August 2012
October 2014	March 2015	July 2017
July 2017	July 2017	May 2019
May 2019	May 2019	

Table 5. Breakpoints for real yields

1-year real yields	3-year real yields	10-year real yields
October 2010	February 2011	October 2010
November 2014	November 2014	January 2013
September 2016	October 2016	December 2014
		December 2016

Notably, there are no structural breaks identified in the results of the unconstrained Bai-Perron test that fall within the period of the COVID-19 pandemic for all three tenors in both nominal yields and real yields.

Following the spike in yields in March 2021 when the pandemic hit, the yields have decreased, consistent with and, to a major extent, due to the accommodative monetary policy stance undertaken by the BSP to counter the tightening of financial conditions, as evidenced by a cumulative decrease in the policy rate of 200 basis points since February 2020. This stance was maintained even amid the increase in inflation in 2021 that is mainly attributed to surging pork prices due to the outbreak of African swine fever, with officials highlighting that inflation will be best addressed by interventions on the supply side and not by raising interest rates.

Moreover, nominal yields are coming from a period of multiple-year highs around late 2018 to early 2019, so the increase in yields within the pandemic period may not be considered a significant break in the trend, including the uptick in nominal yields in 2021 along with the increase in yields in major economies such as the U.S. due to the reflationary trading environment.

It should be noted that the stability in yields can also be attributed to the proactive issuance and debt management strategy of the BTr. Through rejections in auctions in 2020 when bid rates are significantly higher than secondary levels, the BTr has managed the increase in rates. Furthermore, the BTr has also made adjustments in the tenors, frequency, and volume of its GS auctions to ensure that market rates do not significantly move.

The results of this empirical study suggest that the tools employed by policy makers amid the COVID-19 pandemic have been effective in maintaining stable and orderly financial market conditions in the Philippines.

VII. Conclusions and recommendations

The Philippine financial market, specifically the country's sovereign debt space, was not spared by uncertainties brought by the COVID-19 pandemic. While this space has experienced episodes of increasing yields, including one at the onset of the crisis, and in 2021 when rates tracked yields of major markets such as the U.S. amid reflationary expectations, policy makers in the Philippines have been systematically nimble in implementing accommodative monetary and fiscal policy measures to address tightening liquidity and avoid market disruption.

For the long-term analysis of local currency Philippine government bond yields taking into account the period after the Global Financial Crisis, the Bai-Perron test for structural breaks was applied to both nominal and real yields. The results of the empirical test showed that there are no structural break points identified in the period covering the pandemic, suggesting that the policies enacted have been effective in preventing turmoil in the market.

For further analysis, recommendations for future studies include bivariate or multivariate structural break analysis (e.g. using error correction models) involving yields and other financial and macroeconomic indicators such as inflation, economic growth, money supply

and foreign exchange rate. Employing Markov switching methods may also be explored to model possible nonlinearity in the time series. Meanwhile, the structural break analysis can also be applied to the Philippines' peers in the Southeast Asian region for empirical comparison. Further, once countries around the world have achieved herd immunity levels, the period covered may be extended and the results revisited.

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