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Modeling the Economic Growth of the Philippines with Structural Change: A Case of the COVID-19 Pandemic

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ABSTRACT

The structural change brought about by the COVID-19 pandemic in the behavior of economic growth in the Philippines is not yet fully analyzed and understood. This paper answers whether the pandemic caused a regime switch in the gross domestic product (GDP) of the Philippines, and if it is cointegrated with the Peso-Dollar exchange rate, import, and the Philippine stock market, in the presence of a structural break. The period used is from the 1st quarter of 2012 until the 1st quarter of 2022. An ARDL model is then proposed that describes a linear relationship between the variables. Results from the analyses show that the variables are cointegrated with a structural break in the first quarter of 2020 using the Gregory-Hansen test of cointegration with regime shifts. However, the structural change does not have a significant relationship with GDP based on the long-run coefficients in the proposed model. Findings suggest that policymakers should monitor and adapt economic policies for structural changes and utilize econometric models sensitive to events that significantly disrupt the dynamic behavior of the economy of the country.
Keywords: *Structural change, ARDL model*

INTRODUCTION

The COVID-19 pandemic has brought worldwide economic disturbances since the onset of its effects during the first quarter of 2020. This was brought about by the extensive control and mitigation efforts taken by the affected regions such as Southeast Asia to slow down and contain the COVID-19 virus. Community lockdowns were imposed, and some businesses were ordered to halt their operations to reduce the rate of spreading the infection. In the Philippines, the enhanced community quarantine (ECQ) was imposed in the entire Luzon group of islands on March 16, 2020 (Fauzi & Paiman, 2020). The National Capital Region which has been the epicenter of the pandemic affected the adjacent provinces of Regions 3 and 4A. These regions contribute significant shares to the Philippines' total real GDP. Thus, the pandemic has significantly affected the economy as early as the first quarter of 2020 (Abueg, 2020). Lockdowns were negatively associated with economic activities. The unemployment rate in the Philippines rose to 17.6% in April 2020 with the lowest historical labor force participation rate of 55.6%. There is an observed drop in the household final consumption expenditure by 15.3% during the second quarter of 2020 as the pandemic has worsened both consumer and business confidence in the economy.

The Philippine economy recorded its first negative gross domestic product (GDP) growth rate during the first quarter of 2020 at -0.7%, the lowest since the Asian financial crisis in 1997. The Philippines has entered its deepest recession in post-war history with a 9.6% average decline in GDP. There had been an observable collapse in the major economic sectors: agriculture, forestry, and fishing (by 0.2%), services (by 9.1%), and industry (by 13.1%) (PSA). Exports and imports dropped during the first quarter of 2020 by 4.4%

and 8.7%, respectively. The industry and manufacturing, investments (on construction and durable equipment), and the trade sector were significantly affected. This implies a big loss of spending confidence among consumers and the business sectors, thereby resulting in economic collapse.

The bigger fall in imports compared to exports resulted in a trade surplus, and thus saved the foreign exchange, explaining partly the rising strength of the peso. The average peso-dollar exchange rate has declined starting in 2020 from an average of ₱51.80 in 2019 to ₱49.62 in 2020, and ₱49.25 in 2021. In 2022, significant spikes in the ₱-$ exchange rate are observed with a record-high exchange rate of approximately ₱57.00 in September 2022. Financial crises are associated with a significant increase in exchange rate entropy, reflecting instability in foreign exchange dynamics. Periods of economic uncertainty are preceded by periods of low entropy values, anticipating the onset of financial crises (Stosic, et. al. 2016).

The scenarios pose sudden (structural) changes in the movement of the concerned variables. Economic indicators such as trade values and foreign exchange dynamics are related to economic growth, and it is therefore important to study how sudden shocks affect the relationships. Investigating whether significant changes in the time series pattern or co-movements of such series will explain the sudden change of the response variable is also an interest. In Indonesia, the COVID-19 pandemic caused an economic contraction of 2.07%. Structural breaks in their economy through a Vector Error Correction (VEC) model using GDP, exports, and inflation as variables, were identified in the years 1989, 1998, and 2004 (Handayani, 2021). The impulse response function showed that economic growth will achieve stability within 5-10 years. In the case of Portugal, a linear regression model utilizing the natural logarithm of physical capita per worker with other variables on the supply and demand as controls was used to identify the structural break posed to their economy. Chow test showed that there were structural breaks in the fourth quarter of 2010 and the third quarter of 2020 (Santos, 2021). It was concluded that the structural break seen in Portugal's economic growth implies a permanent loss of productive capacity and a decrease in the output gap.

Forecasting economic growth or modeling GDP while measuring the impact of the COVID-19 pandemic has been studied as well, as seen in the literature. For instance, Jena et al., (2021) used artificial neural network models to measure the impact of COVID-19 on some of the major economies such as the United States, Mexico, Germany, Italy, Spain, France, India, and Japan. Their findings show that the models utilized performed a forecasting error of <2% and further concluded that there was a trough during the April-June quarter on all of the major economies considered. A similar idea of this paper can also be seen in the study of Mella et al., (2021) but in the case of OECD countries using a linear regression model. Similar findings of COVID-19's significant impact on OECD countries were reported albeit a relatively low R^2 of 12.6% model performance. There is another earlier paper on the case of Eastern European countries by Vasiljeva et al., (2020) while a much more global scale of GDP modeling with effects of COVID-19 is done in the latest paper of Gagnon et. al., (2023) also using a linear regression model.

However, despite the extensive literature on modeling economic growth with the COVID-19 pandemic, there is a literature gap on economic modeling with the COVID-19 pandemic as a point of regime shift or structural break. The extent of the disruption brought about by the COVID-19 pandemic to the economy is clear, and the effect is global. We strongly claim that the pandemic caused structural break(s) in the economy in several ways such as disruption of supply chains, reduced consumer demand, increased unemployment, major changes in work patterns, and fiscal and monetary policy response, to name a few. Modern econometric models should include or incorporate relevant events that cause a break in the dynamic of the macroeconomic variables as it can provide deeper insights into the behavior of the macroeconomic variables that are being modeled.

So, in this study, we posit that the COVID-19 pandemic disrupted the dynamic behavior of the economic growth of the Philippines. The idea of incorporating the COVID-19 pandemic in an econometric model provides us with more insight and a more profound understanding of how economic growth behaves in the presence of the pandemic. The unique aspect of this study is that we do not pinpoint an exact point in time as to when the structural break of the economic growth caused the pandemic to start. By using appropriate statistical methodologies, structural breaks will be detected and checked whether they are consistent with when the pandemic started specifically when major national lockdowns took place.

This paper also serves as a response to one of the United Nations Sustainable Development Goals (UN-SDG) on “decent work and economic growth”. Every nation wants to achieve economic development and stability, and this study shows how the pandemic has changed patterns of economic growth by modeling GDP with structural breaks. Policymakers of the country can create plans to stabilize and encourage economic growth by examining these shifts, ensuring that the economic recovery is inclusive and sustainable.

Theoretical background

According to Torajo & Smith (2012), structural change is a change in the fundamental ways that an economy or market is run. From the subsistence level, which is focused on agricultural produce for domestic consumption, to a modern industrial economy with higher output for global consumption, the structural change model shows how a nation's economy changes. It is an important modeling technique that any thorough time-series analysis needs to take into account. A large body of research demonstrates both the existence of structural breaks in time series data and the detrimental consequences of ignoring them. Furthermore, because there are several statistical tests available, identifying structural discontinuities in a time series variable or a time series model is not difficult. Nonetheless, it is possible that various tests will yield disparate findings, and one of them could lead to subjectivity in the test selection process. Using structural break models is also problematic when a structural break test yields many breakpoints. In these cases, the model may become complex and parameter estimation may become challenging, which would go against the principle of parsimony. The model's several breakpoints may potentially lead to overfitting, which will reduce the model's dependability. Nevertheless, structural break models are still useful for examining variations, particularly in time series variables related to finance and the economy. When applied correctly and cautiously, they can offer significant insights into the dynamics of the time series data.

One crucial aspect of the process of economic development is the transformation of an economy's structure. An economy can experience growth through structural transformation because it encourages the reallocation of labor from low-productivity to high-productivity sectors, which improves and fully utilizes the use of available resources. Thind and Singh (2018) investigated the connection between growth and structural change in 15 of India's largest states throughout the 30 years from 1983–1984 to 2014–2015. Their objective was to ascertain whether these states' economic progress has been facilitated by structural changes. This was accomplished by breaking down each state's total increase in labor productivity into its contributions from structural and sectoral changes. The findings demonstrated that, apart from Maharashtra, structural changes have positively impacted growth in all the states under investigation. However, the contribution of within-sector changes is significantly more than that of structural changes.

The relationship between structural change and regional economic growth in Indonesia was examined in the study by Andriana et al. (2021) on the impact of structural change on regional growth. They measured structural change across 30 provinces from 2005 to 2018 using the shift-share approach, and they showed that while the trend toward an agricultural-services transition is slowing, structural change has happened in all provinces. This study demonstrated that structural change is a significant growth driver by using panel data models. Growth depends on structural change if productivity growth occurs within sectors. The study was unable to demonstrate that increased economic growth results from labor movement across industries. On the other hand, over the long run, the rise in productivity within sectors has a greater effect on regional growth.

The issue of how structural changes and economic growth relate to each other in the world economy and in Russia was examined in a study using several methodological frameworks. The paper also included an analysis of the complementarity of economic policy types, which aim to develop human capital, institutions, and macroeconomic stabilization—the building blocks of GDP growth—while using structural policy measures to kickstart growth (with stable fundamentals). New types of policies of this type, aiming at identifying sectors — drivers of economic growth based on a portfolio approach—have been identified in the research of Mironov & Konovalova (2019) on the structural changes in the global economy. Using a multisector adaptation of Thirlwall's Law, an early version of the Russian economic model was presented in each study. Additionally, they outlined a number of target criteria for the competitiveness indicators of the Russian economy's sectors, which gives them reason to believe that the country's growth rate will exceed the exogenously provided growth rate of the global economy.

In a study on the structural change taking place in Japan's post-World War II era of rapid economic growth, Esteban-Pretel & Sawada (2014) employed a two-sector neoclassical growth model with government policies to analyze the evolution of the Japanese economy during this period and to evaluate the role of such policies. Their model may reproduce the empirical behavior of the main macroeconomic variables. Three conclusions came from their investigation. First, price, investment subsidies, or industrial policy did not drive the postwar boom in the agriculture industry. Second, the presence of a labor mobility restriction would have had a substantial long-term level effect on output. Finally, TFP in the non-agricultural sector was a major factor in Japan's post-war quick rise.

Tarasyev et al., (2021) looked at the ideal investment distribution and the corresponding control issues for one-sector growth models. They examined a model with a linear production function to assess the feasibility of structural changes in an economy. By using dummy variables, a statistically significant period of change in the model can be found. This allows the model to be switched between modes, which leads to more accurate estimates of economic progress. by using the qualitative analysis of the Hamiltonian systems, solutions were found for each model mode in the optimal control problems. The solution to the optimal control problem involving many model modes over an infinite time interval was to glue the generated trajectories constantly. A comparison between the calculated model trajectory and statistical data indicates that the simulated patterns fairly accurately represent the real data. Model parameter adaptation to a new economic mode can be thought of as the process of learning the complete optimal control model. It enhanced the model's capacity to adjust to qualitative changes that affect estimates of economic development.

Hardt et al., (2020) examined the embodied labor productivity and embodied energy intensity in the UK and Germany's economic sectors between 1995 and 2011 using a multi-regional input-output model. They found five labor-intensive service industries that exhibit a modest increase in embodied labor productivity along with low embodied energy intensity. Nevertheless, the results showed that significant structural changes in these sectors would only result in minor reductions in energy footprints, despite their lower embodied energy intensities. They also suggested that labor-intensive service sectors in the UK have historically experienced higher rates of price inflation than other sectors. This backed up claims made in the literature that labor-intensive services are facing difficulties as a result of rising relative costs and pricing. This demonstrated the strong correlation between structural change and economic growth, which begs the question of how structural changes may be carried out in an economy that is not expanding.

However, numerous literatures have reported that the COVID-19 pandemic may cause deterioration in economic development in the short run. It interrupted the stability of enterprises in China, deteriorated the expectation and operational efficiency of enterprises, declined the growth rates of the incomes of individuals, increased the pressure on employment, and pushed up financial risks and debt (Luo et al., 2020). Borio (2020) demonstrated that the financial and economic crisis has caused structural discrepancies in the economy and these discrepancies are completely exogenous and highly uncertain and caused global consequences.

Thus, sustainable economic development has been more difficult than underneath the financial sector of each economy.

Meanwhile, according to Junfeng et al., (2022), the majority of the prior body of literature has focused on how pandemic crises affect macroeconomic volatility and has found that these crises lead to a halt in economic development. Many scholars have attempted to investigate how fiscal and monetary policies affect the state of the economy during emergencies, but there is still a dearth of data assessing how structural change affects economic growth. Furthermore, little research has been done on how structural change affects economic growth in the context of the COVID-19 epidemic. As a result, the current work is crucial to expanding the body of knowledge regarding COVID-19 pandemic shock.

Objectives

The study aims to achieve the following objectives:

1. Classify whether the Philippine GDP, the peso-dollar exchange rate, import, and the Philippine stock market price values are stationary.
2. Postulate a linear model that describes the dynamic relationship between the variables mentioned above, with Philippine GDP as the dependent variable and the others as exogenous variables.
3. Identify the structural break periods of each of the variables as well as the structural break period of the Philippine GDP when expressed as a linear model from (2) and test whether the structural break period identified has a significant impact on Philippine GDP.
4. Taking into account all the analyses made from (1)-(3), conclude a final model that describes the dynamic relationship between the chosen variables.

METHODOLOGY AND MATERIALS

This study relied mainly on secondary sources of data collected from the national accounts of the Philippine Statistics Authority (PSA), the database of the Bangko Sentral ng Pilipinas (BSP), and stock prices from the Philippine Stock Exchange Inc. (PSEi). The period chosen for this study is from 2012 to 2022 where quarterly data on GDP, import, Peso-Dollar exchange rate, and stock prices were compiled from the mentioned sources. All the values are in real terms and have been transformed into their natural logarithms. The choice of the variables for formulating the model may impose endogeneity risks, i.e., the considered macroeconomic variables are correlated with the error term. A model with endogenous variables may result in a spurious model but with careful consideration of the choice of the macroeconomic variables, optimal choice of lag length by Schwarz information criterion, and by performing residual analyses through serial correlation and heteroskedasticity tests (Amess et al., 2015), endogeneity is avoided and corrected if necessary. The choice of imports, stock prices, and the exchange rate of the US dollar as predictors for the model postulated in this study is because these macroeconomic variables offer a more complete picture of the variables affecting economic performance. In particular exchange rates have an impact on inflation and trade balance, which in turn influences total economic growth. Conversely, imports have a direct bearing on GDP estimates and show patterns in investment and consumption. Additionally, stock prices affect corporate investment and consumer behavior in addition to acting as gauges of economic optimism. Economists and decision-makers can learn more about how financial and external factors impact GDP and the state of the economy by examining these variables.

a. Test of stationarity

We will begin with testing for the presence of unit root. Using nonstationary data makes it difficult to estimate parameters and regression analysis may result in spurious regression. Hence, before analysis, we have to determine first if the variables involved in this study are nonstationary. Though most of the studies utilizing time series data assume stationarity (Gujarati & Porter, 2003), most macroeconomic variables are nonstationary or integrated of the first order (Engle & Granger, 1987).

Although the ARDL model does not require pretesting stationarity, the model does not work if there are variables that are integrated of the second order or above (Pesaran et al., 2001). Hence, we test for the presence of unit root, and we can use the Augmented Dickey-Fuller test (Dickey & Fuller, 1979) or the Philips-Perron test (Philips & Perron, 1988). However, unit root tests are biased toward a false unit root when the data are stationary with a structural break (Perron, 1989). Furthermore, when the sample being examined includes economic events that have the potential to cause changes in the regime, rejection of a unit root may be suspected (Lee & Chang, 2005). To address this issue, we instead use a particular unit root with a break test (Vogelsang & Perron, 1998).

b. Cointegration

After testing stationarity with the presence of a structural break, we proceed with testing for cointegration also with the presence of a structural break or what is specifically known as the Gregory-Hansen test of cointegration with regime shifts (Gregory & Hansen, 1996). For regime shift models where the data dictate the date of the shift but the shift itself is unknown, this test is a residual-based cointegration test. Four models of a regime shift are examined in the test, based on whether the trend is incorporated in the cointegrating regression and if the shift impacts the slope or the intercept.

c. Causality: The Autoregressive Distributed Lag (ARDL) Model

We postulate a linear ARDL model to estimate the short and long-run causality between GDP, import, Peso-Dollar exchange rate, and stock prices. This is after we find out that there is a presence of cointegration with a structural break within the variables. Note that ARDL itself does not take into account the structural breaks in its system; thus, we include a dummy variable as an additional exogenous variable to represent the breakpoint in the series. Hence, the ARDL model will be postulated as follows:

$$\Delta log\ Y_t = \alpha + \sum_{k=1}^{s} \lambda_{1k} \Delta\ log\ Y_{t-k} + \sum_{k=0}^{m} \lambda_{2k} \Delta\ log\ IMP_{t-k} + \sum_{k=0}^{p} \lambda_{3n} \Delta\ log\ EXCH_{t-k} + \sum_{k=0}^{r} \lambda_{4k} \Delta\ log\ PSE_{t-k} + \delta_1 Y_{t-1} + \delta_2\ log\ IMP_{t-1} + \delta_3\ log\ EXCH_{t-1} + \delta_4\ log\ PSE_{t-1} + \delta_5 D_Y + \varepsilon_t \quad (1)$$

where Δ is the difference operator and Y represents the economic growth measured by gross domestic product (GDP). The result of $Z_\alpha(\tau)$, $Z_t(\tau)$, and $ADF(\tau)$ will tell us what the breakpoint is and the dummy variable D_Y will represent the structural break in the model, hence, it takes the value of 0 before the break point, and 1 otherwise. The coefficients λ_1, λ_2, λ_3, and λ_4 represent the long-term coefficients while δ_1, δ_2, δ_3, δ_4, and δ_5 represent the short-term coefficients. The values (s, m, p, r) are the selected number of lags.

We then go ahead and estimate the model for error correction. The error correction model will enable us to determine the feedback effect, adjustment effect, or error correction coefficient, which indicates the amount of the disequilibrium being corrected, as well as the short-run, "immediate" impact that a change in the exogenous variable(s) will have on a change in the dependent variable. The F-statistic on the explanatory variables indicates the short-run causal influence, while the t-statistic on the coefficient of the lag error-correction term represents the long-term causal relationship (Odhiambo, 2009). Thus, the error correction ARDL model (1) is specified as follows:

$$\Delta\ log\ GDP_t = \alpha_0 + \sum_{i=1}^{n} \beta_i \Delta\ log\ IMP_{t-i} + \sum_{i=1}^{n} \gamma_i \Delta\ log\ EXCH_{t-i} + \sum_{i=1}^{n} \zeta_i \Delta\ log\ PSE_{t-i} + \eta ECT_{t-1} + \varepsilon_t \quad (2)$$

The ECT term's inclusion in the model demonstrates how the explained variable varies in both the long-run and short-run models (Masih & Masih, 1997). This illustrates the extent to which the variable is being adjusted for any variability in the previous time (Khan & Khan, 2018). The value η must be of negative value and close to zero to signify the lower level of convergence in the face of disequilibrium.

RESULTS

d. Descriptive Statistics

The descriptive statistics are displayed in Table 1.

Table 1. Descriptive statistics

	$log\ GDP$	$log\ IMP$	$log\ EXCH$	$log\ PSE$
Mean	15.20391	13.93469	3.861399	8.843236
Median	15.23625	14.03000	3.876727	8.862830
Maximum	15.47528	14.34779	3.980605	9.036489
Minimum	14.88329	13.39368	3.706347	8.495904
Std. Dev	0.158481	0.298418	0.079404	0.129080
Skewness	-0.278426	-0.352158	-0.334285	-0.855179
Kurtosis	2.099495	1.737906	1.850921	3.318502
Jarque-Bera	1.915028	3.568608	3.019253	5.170734
Probability	0.383846	0.167914	0.220992	0.075368
Sum	623.3604	571.3223	158.3173	362.5727
Sum Sq. Dev.	1.004650	3.562129	0.252203	0.666461

Table 1 shows that the mean value of $log\ GDP$ is 15.204 and is positive with a maximum value of 15.475. This shows that the logarithm values are positive on average and is the same with the other variables. The variables also exhibit slight negative skewness with varying degrees of kurtosis but are otherwise normally distributed.

e. Test of Stationarity

Testing for the presence of unit root in this study includes assuming the presence of a structural break. Standard Augmented Dickey-Fuller test or Phillips-Perron test could have been biased when used, in a way that these tests do not consider regime switch in the data. Note that we test stationarity since we cannot have a variable with a second order of integration

Table 2. Breakpoint unit root test: Innovation outlier model

Variables	ADF test statistic	Breakpoint date	Remarks
$log\ GDP$	-15.38441***	2020Q1	$I(1)$
$log\ IMP$	-10.83731***	2020Q2	$I(1)$
$log\ EXCH$	-4.953564***	2018Q3	$I(1)$
$log\ PSE$	-5.659612***	2020Q1	$I(1)$

****at 1% level of significance **at 5% level of significance*

Table 3. Breakpoint unit root test: Additive outlier model

Variables	ADF test statistic	Breakpoint date	Remarks
$log\ GDP$	-10.39790***	2018Q2	$I(1)$
$log\ IMP$	-9.001908***	2016Q2	$I(1)$
$log\ EXCH$	-5.083496***	2018Q3	$I(1)$
$log\ PSE$	-5.412763***	2019Q4	$I(1)$

****at 1% level of significance **at 5% level of significance*

Results show that all variables are integrated of the first order for both innovation and additive outlier models. Lag length $k = 0$ was chosen for the exogenous variables while $k = 9$ was used for $log\ GDP$ for the IO model. On the other hand, $k = 0$ was also chosen for $log\ IMP$ and $log\ EXCH$ for the AO model while $k = 8$ and $k = 1$ were the chosen lag lengths for $log\ GDP$ and $log\ PSE$ respectively. The Schwarz information criteria (SIC) was utilized to automatically select the k max in order to prevent the loss of power and multicollinearity issues that are typically linked to high k max values.

f. Test of cointegration

A cointegration test with regime shift based on Gregory-Hansen has been used, for all possible breakpoints (2012Q1-2022Q1) which include the estimation of Z_α, Z_t, and ADF. The level shift trend model was used. We present these results in the following table:

Table 4. Gregory-Hansen test for cointegration with regime shifts

	Test statistic	Breakpoint	Date	Asymptotic Critical Values		
				1%	5%	10%
ADF	−13.05***	33	2020Q1	−6.05	−5.57	−5.33
Z_t	−18.69***	33	2020Q1	−6.05	−5.57	−5.33
Z_α	−73.88***	33	2020Q1	−70.27	−59.76	−54.94

Based on all three statistics, cointegration exists between the variables, and the first quarter of 2021 was identified as the significant breakpoint date. This break refers to the time when there has been a surge in COVID-19 cases. Multiple business establishments, offices, workplaces, and schools were forced to close and cities were on lockdown, to contain the virus. Economic activities were inevitably hampered, and it caused many individuals to rely on government rations since they could not go outside for work and worse, some were laid off from their jobs.

g. The ARDL model

A dynamic error correction model can be estimated when the variables exhibit at least one cointegration relationship (Engle & Granger, 1987). As a result, we estimate the error correction model and it will be estimated using an autoregressive distributed lag model. The choice of the model is because of its inherent parsimonious nature as it assumes a linear relationship between the variables, and it allows for a structural relationship between the variables. One may opt for a nonlinear ARDL but so far in the literature available, it is challenging to justify or to prove inherent nonlinearity between the considered macroeconomic variables for this study. On the other hand, a simple (non-structural) ARIMA model is too rudimentary and will not be able to capture a more comprehensive layout of the GDP's dynamic behavior.

For the ARDL model, the estimation of the error correction model will give the short-run elasticity of GDP for exchange rate, import, and stock prices. We present the result of the estimation below:

Table 5. Long-term elasticities

Variables	Coefficient	Std. error	t-stat	Prob.	95% conf. interval	
$log\ IMP$	1.2725540	0.6478	1.96	0.064	−0.0834	2.6286
$log\ EXCH$	−3.080032	2.3540	−1.31	0.206	−8.0070	1.8469
$log\ PSE$	0.2069678	0.1618	1.28	0.216	−0.1316	0.5456
(2020Q1-2022Q1)	−0.0660904	0.0861	−0.77	0.452	−0.2463	0.1141

The estimated coefficients are not significant in the long run. Hence, import, exchange rate, and stock price values, together with the structural break starting from 2020Q1 do not exhibit significant long-run causality to GDP. Even the error correction term in the error correction model is insignificant.

Table 6. Error correction model

Variables	Coefficient	Std. error	t-stat	Prob.	95% conf. interval	
IMP	−0.368477	0.1556	−2.37	0.029	−0.0834	2.6286
$EXCH$	0.819569	0.3561	2.30	0.033	−8.0070	1.8469
$\nabla log\ PSE$	−0.0645993	0.0911	−0.71	0.487	−0.1316	0.5456
Constant	3.99819	2.8970	1.38	0.184	−0.2463	0.1141
ECT	−0.5259492	0.3408	−1.54	0.139	−1.2393	0.1874

This implies that either the exogenous variables are misspecified or the structural break should not be included in the model. Hence, we see what happens with the estimates if the structural break is not included at all. The new estimation is shown in the tables below.

Table 7. Long-term elasticities: Structural break excluded

Variables	Coefficient	Std. error	t-stat	Prob.	95% conf. interval	
$log\ IMP$	0.827671	0.1245	6.65	0.000	0.5679	1.0874
$log\ EXCH$	−1.517512	0.5197	−2.92	0.008	−2.6017	−0.4333
$log\ PSE$	0.214012	0.1013	2.11	0.047	0.0027	0.4253

Table 8. Error correction model: Structural break excluded

Variables	Coefficient	Std. error	t-stat	Prob.	95% conf. interval	
IMP	−0.4339672	0.1506	−2.88	0.009	−0.7482	−0.1198
$EXCH$	0.5274485	0.2872	1.84	0.081	−8.0070	1.8469
$\nabla log\ PSE$	−0.1183734	0.0835	−1.42	0.171	−0.1316	0.5456
Constant	6.648527	2.1598	3.08	0.006	−0.2463	0.1141
ECT	−0.8670884	0.2313	−3.75	0.001	−1.2393	0.1874

Re-estimation of the ARDL model without the structural break yielded better significant estimates. The estimated coefficients of the long-run relationship are significant for import, exchange rate, and stock price. Results show that a 10% increase in the import GVA will result in an 8.28% increase in the GDP. A similar positive long-run relationship can also be noted where a 10% increase in the stock prices will result in a 2.14% increase in the GDP. However, we see that a 10% increase in the exchange rate between the Philippine peso and the US dollar will result in a 15.18% decrease in the GDP.

On the other hand, results of the re-estimated short-term elasticities are presented in the error correction model in Table 8. The error correction term shown in the model has a significant negative sign that signifies a stable long-run equilibrium. Moreover, the estimated error correction term coefficient is equal to -0.8671 implies that previous quarterly deviations from long-run equilibrium are corrected at a speed of 86.71%. We also see that a 10% increase in the import GVA is associated with a 4.3% decrease in the GDP in the short run.

h. Residual diagnostics

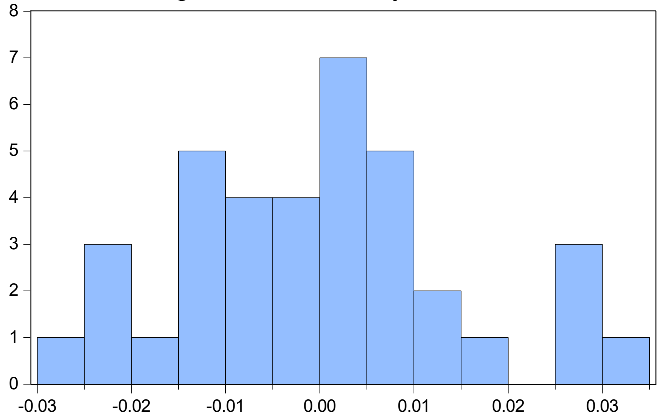
The table below shows the results of diagnostics from the residuals of the estimated model.

Table 9. Residual diagnostics: Serial correlation and heteroskedasticity

	F-statistics	Prob.
Breusch-Godfrey Serial Correlation LM Test	1.671358	0.2056
Breusch-Pagan-Godfrey Heteroskedasticity Test	1.408306	0.2320

We see that based on F-statistics of both the serial correlation and heteroskedasticity tests that the model does not suffer from serial correlation and is homoscedastic. Heteroskedasticity and non-constant variance of residuals would imply that the model postulated is incorrect in explaining the dynamics of the variables chosen, or that the exogenous variables are misspecified. We also see that the residuals of the model are normally distributed from the figure below through the Jarque-Bera test of normality. This implies that the assumption that we have for the model is valid and the model inference is also valid.

Table 10. Residual diagnostics: Normality



Series: Residuals	
Sample 2013Q1 2022Q1	
Observations 37	
Mean	9.15e-15
Median	0.000785
Maximum	0.031221
Minimum	-0.027424
Std. Dev.	0.014482
Skewness	0.342051
Kurtosis	2.796555
Jarque-Bera	0.785300
Probability	0.675265

DISCUSSIONS

This study serves as a preliminary investigation of how the current COVID-19 pandemic affects the economic behavior of the Philippines considering selected variables such as import, the Peso-Dollar exchange rate, and the stock market. For this purpose, the empirical analysis was based on the data for 12 years beginning from 2012 until the first quarter of 2022. The analysis was two-fold: first, structural breaks were identified individually through innovation outlier and additive outlier models. A test of cointegration with the presence of structural break was also performed to test the presence of a long-run equilibrium relationship when regime shift is also considered. Second, a linear autoregressive distributed lag (ARDL) model was estimated from the data to describe a linear relationship that is present between the variables and estimate the long and short-run elasticities of the exogenous variables towards GDP.

The empirical evidence indicates that all the variables are integrated of the first order with a structural break that is consistent with the COVID-19 pandemic outbreak except for the Peso-Dollar exchange rate. There is also evidence of a stable long-run relationship between GDP, import, Peso-Dollar exchange rate, and the stock market, also with a structural break identified when the pandemic started. Estimates from the ARDL show, however, that including the pandemic period in the model is misspecified which means that even though evidently, the pandemic triggered a structural break in the GDP, it does not necessarily significantly affect GDP in any way. The alternative is to exclude the inclusion of the COVID-19 pandemic in the model and indeed, better estimates were seen. Estimates from the new ARDL model show that import has a significant positive effect on economic growth. The reason for this is that the Philippines is an import-dependent nation, with integrated circuits ($12.3B), refined petroleum ($5.61B), broadcasting equipment ($2.89B), office machine parts ($2.45B), and automobiles ($2.16B) being its top import commodities (OEC, 2021), and an increase in import spending of these commodities is associated with an increase in output or production of import-reliant domestic goods. Meanwhile, the negative long-run effect of the Peso-Dollar exchange rate is also inferred from the model since an increased exchange rate decreases capital spending on import-reliant goods and inhibits production, especially for domestic producers who rely on imported goods for their businesses. The possible interrelationship between import, exchange rate, and GDP is a limitation of this study.

With these results, we suggest that policymakers craft several preventive measures in case a similar catastrophic event like the COVID-19 pandemic may occur again in the future. It is good that, based on our investigation, the disruption did not significantly affect economic growth, but the significant presence of this disruption means that the effects of the pandemic lockdown may hurt our economy anew if certain preventive measures are not put into place. Note however that a bill was already proposed by the late Sen. Miriam Defensor Santiago entitled "An Act Strengthening National Preparedness and Response to Public Health Emergencies" in 2005, but unfortunately, this bill is yet to be approved by the president. This bill needs to be reviewed by the congress and enacted as soon as possible.

We also want to conclude that the findings were consistent with Handayani (2021) albeit utilizing a different model. Their study may be replicated in the case where we want to identify possible directional causality of the variables. Similar results can also be seen in the study of Fernandes et al., (2023) in the case of Euro Area countries of the existence of structural breaks in the time of the COVID-19 pandemic using a second-order Markov process model. Structural break points in the GDP model using MIDAS regression analysis were also consistent with the pandemic period in China as evidenced in the paper of Gunay et al., (2021). However, in these two studies mentioned, no exogenous variables are introduced, as such, their models are non-structural compared to our study. Lastly, the positive long-run effect of the Philippine stock market on economic growth is consistent with Balaba (2017). This study further strengthens this claim by including the presence of structural breaks in the stock market. In the Philippines, PSE serves as a barometer in the level of confidence in the economy. Decreased performance of PSE results to companies and individual consumers decreased spending that in turn declines economic activity. Hence, the Philippine stock market is indeed a significant indicator of economic performance.

For future works, a panel time series model that aggregates gross regional domestic products (GRDP) across all regions of the country is of great interest as it may give us a clearer picture and reveal subtle nuances that were not shown in this study, i.e., on how GRDPs in-between regions including relevant macroeconomic variables interact also checking for structural breaks and its overall impact on the economic growth. Another possible development for this study which was not performed is the inclusion of other macroeconomic variables such as inflation or poverty index but an econometric model that accommodates time series variables with varying frequencies should be used and for this time, even though those models exist, they do not apply yet in cases where structural breaks are present. Finally, a replication or a case study for other developing countries or even the individual regions in the Philippines are possible directions for this paper hereafter.

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