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Modeling Net Migration in the Philippines: Employing Linear Regression, and Time Series Analysis

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A B S T R A C T

This research addresses a critical gap in understanding migration dynamics in the Philippines. It models the net migration from 2000 to 2021 using various statistical methods and explores its relationship with unemployment rate, gross domestic product growth rate, labor force participation, and population growth. The study finds a significant linear relationship between unemployment rate and net migration in simple linear regression. In multiple linear regression, both unemployment rate and labor force participation statistically predict net migration. The research identifies moving average with an interval of 3 as the 'best fit' for the time series model, enabling the prediction of the net migration for 2024. By bridging gaps in existing literature and providing detailed insights into migration patterns, this research informs decision-making for population trends and migration management strategies.

Keywords: Philippines, Net Migration, Time Series Analysis, Linear Regression, Mathematical Modelling

1. Introduction

Migration is a fundamental aspect of human history, shaping societies and cultures across the globe. It refers to the movement of individuals or groups of people from one place to another, often in search of better opportunities, improved living conditions, or to escape adverse circumstances. Net migration is the net total of migrants during a specific period, calculated as the number of immigrants minus the number of emigrants, including both citizens and noncitizens. A positive Net Migration indicates that there is a higher influx of people immigrating into a country than those emigrating out of it. Conversely, a negative net migration signifies more people leaving the country than arriving.

Migration in the Philippines has emerged as a significant facet of its demographic transformations and economic development. Over time, the nation has witnessed fluctuating net migration, which have had discernible impacts on its population growth and workforce dynamics. Notably, data from the World Bank reveals substantial negative migration in the Philippines during the past two decades, particularly in the year 2014 (-23.789) in ten thousand. However, the subsequent year, 2015, marked a turning point, with the net migration becoming positive for the second time since 1996, reaching .6954 (compared to 5,539 in 1996 in ten thousand). This momentum persisted until 2017, after which the net migration reverted to negative values from 2018 to 2021.

Considering one of the possible factors of net migration in the Philippines is the unemployment rate of the country annually. The unemployment rate is determined by dividing the number of unemployed individuals by the number in the civilian labor force. While other studies examining the correlation between migration and unemployment predominantly concentrate on the effects of migration on labor markets. Nevertheless, a consensus on the specific direction and magnitude of the impact of both internal and international migration on unemployment has not been universally agreed upon. In the study of Ozekicioglu (2019) in investigation of the direction and size of the relationship between migration and unemployment in 23 selected OECD countries, the researcher found in panel data model that migration and economic growth have a negative and statistically significant effect on unemployment.

The Gross Domestic Product (GDP) Growth Rate also consider as one of the potentially the influences net migration in the country. (GDP) Growth Rate compares the year-over-year change in a country's economic output to measure how fast an economy is growing. Usually expressed as a percentage rate, this measure is popular for economic policymakers because GDP growth is thought to be closely connected to key policy targets such as inflation and unemployment rates. If GDP growth rates accelerate, it may be a signal that the economy is overheating, and the central bank may seek to raise interest rates. Conversely, central banks see a shrinking (or negative) GDP growth rate as a signal that rates should be lowered, and that stimulus may be necessary (Fernando, 2023).

Moreover, a higher labor force participation rate in a country can be considered a predictor of net migration because it indicates a greater availability of job opportunities, which can attract more people to move to in a country in search of work. According to the World Bank, the labor force participation rate is defined as the proportion of the population aged 15-64 that is economically active, encompassing all individuals who provide labor to produce goods and services during a specified period. The April 2020 Labor Force Survey conducted by the Philippine Statistics Authority revealed that in the

Philippines, approximately 32.7 million individuals, constituting 44.3 percent of the population aged 15 years and over, were not part of the labor force. This may indicate that the limited labor force participation may signal a lack of job opportunities or unfavorable economic conditions, potentially discouraging potential migrants from moving to the country in search of work. As this could lead to reduced net migration to the country as people may be less to not migrate to a place with limited employment prospects.

Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship (World Bank). Natural increase refers to the disparity between the number of births and deaths within a population, while the rate of natural increase represents the difference between the birthrate and the death rate. Given the typical fertility and mortality characteristics of the human species, excluding occurrences of catastrophic mortality, the potential range of rates of natural increase remains relatively narrow. Regarding migration, the rate of population growth encompasses both the rate of natural increase and the impacts of migration. Hence, a population experiencing a high rate of natural increase may be counterbalanced by substantial net out-migration, while a population with a low rate of natural increase may be offset by a significant influx of net in-migration. This comprehensive definition and understanding of natural increase and its interaction with migration are crucial in the study of population dynamics.

Despite numerous studies exploring migration patterns in various contexts, the Philippines' net migration remains underexplored. While existing research offers insights into general migration drivers such as economic conditions, population growth, and labor force participation, a comprehensive analysis integrating multiple factors and employing time series analysis is lacking. The current literature inadequately examines the combined impact of crucial variables like unemployment rate, gross domestic product growth rate, labor force participation, and population growth on migration. Furthermore, there is a shortage of research systematically comparing distinct regression and time series models to identify the most suitable approach for predicting future migration in the Philippines. A comprehensive investigation that encompasses these elements and employs various analytical methodologies is needed to gain a more profound understanding of the country's net migration dynamics. This research seeks to bridge these gaps in knowledge, this research adopts a comprehensive approach to model and analyze the net migration in the Philippines. By employing advanced statistical methodologies such as linear regression, multiple linear regression, and time series analysis, the study aims to unravel the underlying trends in net migration from 2000 to 2021. Specifically, this study seeks to:

1. Determine the trend of Net Migration in the Philippines from 2000-2021.
2. Find if the net migration (in ten thousand) has a significant linear relationship with (1) Unemployment, total (% of total labor force), (2) GDP growth (annual %), (3) Labor force participation rate, total (% of total population ages 15-64), (4) Population growth (annual %), (5) Unemployment, total (% of total labor force), GDP growth (annual %), Labor force participation rate, total (% of total population ages 15-64), and Population growth (annual %).
3. Construct time series model of the Net Migration in the Philippines using the models (1) Linear, (2) Logarithmic, (3) Polynomial (quadratic, cubic, quartic, quintic, sextic), (4) Moving Average, (5) Exponential Smoothing and (6) Auto regression to predict the net migration for 2024.
4. Determine the best fit model and predict the net migration for 2024

2. Methodology

The data utilized in this study was sourced from the official website of the World Bank, a significant international financial institution renowned for providing comprehensive information on various economic indicators, including Net Migration, GDP growth rate, unemployment rate, population growth rate, and labor force participation rate. The World Bank's database encompasses a vast amount of historical data from numerous countries and regions, spanning several decades. This extensive dataset facilitated an in-depth analysis of how these economic indicators relate to changes in Net Migration. By leveraging data from the World Bank, the study gains enhanced credibility, as this trusted and widely used resource is relied upon by researchers, policymakers, and economists across the globe.

In determining the trend of percentage of Net Migration of the Philippines from 2000 to 2021, simple linear regression model was used to establish the trend of migration net inflows over the study period. The regression analysis provided insights into the direction and magnitude of the trend. The potential linear relationships between the Net Migration and several economic variables, including the unemployment, Gross Domestic Product (GDP) growth rate, Labor force participation rate, and Population Growth rate was explored utilizing simple linear regression in each dependent variable and multiple linear regression with all the dependent variables. To forecast the Net Migration for future years, we constructed time series models using various techniques, including logarithmic, linear, and polynomial (quadratic, cubic, quartic, quintic, sextic) models, as well as moving average, exponential smoothing, and auto-regression models. Furthermore, the chosen best fit model has led us to projecting the Net Migration for the year 2024.

3. Results

Objective 1

Determine the trend of Net Migration in Philippines from 2000 to 2021

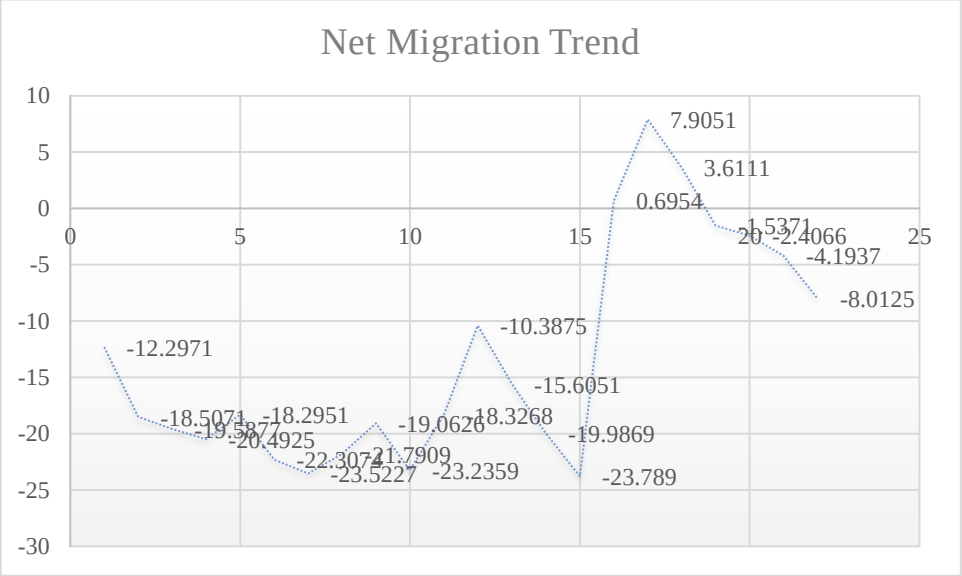

Figure 1. Trend of Net Migration in the Philippines from 2000 to 2021

Figure 1 shows the trend of net migration in the Philippines from 2000-2021.The chart presents that for the past two decades, Philippines has experienced predominantly negative migration rates, notably reaching a low point in 2014 at -23.789 (in ten thousand). However, in 2015, a turning point occurred with the net migration becoming positive, reaching .6954 (in ten thousand). This positive momentum continued until 2017, after which the net migration reverted to negative values from 2018 to 2021, suggesting more people emigrating (leaving the country) than immigrating (coming to the country).

Objective 2

Find if the net migration (in ten thousand) has a significant linear relationship with (1) Unemployment, total (% of total labor force) (2) GDP growth (annual %), (3) Labor force participation rate, total (% of total population ages 15-64) (4) Population growth (annual %), (5) Unemployment, total (% of total labor force), GDP growth (annual %), Labor force participation rate, total (% of total population ages 15-64), and Population growth (annual %).

Unemployment, total (% of total labor force)

Table 1. Significant linear relationship between unemployment rate and net migration

	Coefficients	Standard Error	t Stat	P-value
Intercept	37.411	7.102	5.268	0.000
Unemployment, total (% of total labor force)	-15.310	2.120	-7.223	0.000

F(1)=52.174, p=0.000

Table 1 shows that F (1) = 52.174 and p-value that is lesser than 0.05 which indicates that unemployment rate has a significant linear relationship with net migration, and unemployment rate is also a predictor of (p=0.000) of net migration.

GDP growth (annual %)

Table 2. Significant linear relationship between GDP growth and net migration

	Coefficients	Standard Error	t Stat	P-value
Intercept	-12.945	3.674	-3.523	0.002
GDP growth (annual %)	-0.060	0.621	-0.097	0.924

F (1) = 0.009, p-value= 0.924

Table 2 shows that F (1) = 0.009 and p-value that is greater than 0.05 which indicates that Gross Domestic Product growth rate has no significant linear relationship with net migration, and GDP Growth rate is also not a predictor of (p=0.924) of net migration).

Labor force participation rate, total (% of total population ages 15-64)

Table 3. Significant linear relationship between labor force participation and net migration

	Coefficients	Standard Error	t Stat	P-value
Intercept	132.181	75.397	1.753	0.095
Labor force participation rate, total (% of total population ages 15-64)	-2.328	1.207	-1.929	0.068

F (1) = 3.722, p-value= 0.058

Table 3 shows that F (1) = 3.722 and p-value that is greater than 0.05 which indicates that Labor Force Participation rate has no significant linear relationship with net migration, and Labor Force Participation rate is also not a predictor of (p=0.068) of net migration.

Population growth (annual %)

Table 4. Significant linear relationship between population growth and net migration

	Coefficients	Standard Error	t Stat	P-value
Intercept	27.724	20.491	1.353	0.191
Population growth (annual %)	-22.462	11.187	-2.008	0.058

F (1) = 4.032, p-value=0.058

Table 4 shows that F (1) = 4.032 and p-value that is greater than 0.05 which indicates that Population Growth rate has no significant linear relationship with net migration, and Population Growth rate is also not a predictor of (p=0.058) of net migration.

Unemployment, total (% of total labor force), GDP growth (annual %), Labor force participation rate, total (% of total population ages 15-64), and Population growth (annual %)

Table 5. Significant linear relationship between the dependent variable and independent variables.

	Coefficients	Standard Error	t Stat	P-value
Intercept	-126.740	72.501	-1.748	0.098
Unemployment, total (% of total labor force)	-21.915	3.354	-6.535	0.000
GDP growth (annual %)	-0.587	0.474	-1.238	0.232
Labor force participation rate, total (% of total population ages 15-64)	2.816	1.310	2.150	0.046
Population growth (annual %)	7.116	7.468	0.953	0.354

F (4) = 16.629, p-value=0.000

Table 5 shows that F (4) = 16.629 and p-value that is less than 0.05 indicates that there is a significant linear relationship between the dependent and independent variable. The independent variables that show to be a significant predictor of net migration are unemployment rate (p=0.000), and labor force participation rate (p=0.046). On the other hand, Gross Domestic Product Growth rate(p=0.232), and Population Growth rate (p=0.354) are not statistically a significant predictor of net migration.

This both corroborates and contrast in the findings of the study Kilic et al., (2019) that migration and economic growth have a negative and statistically significant effect on unemployment. Also, in the study of Brooks (2021), which have found that changes in GDP per capita and unemployment predict both positive and negative changes in net migration in different European countries, however the predicted changes are too small to be economically relevant. This also corroborates on the study of Theoharides, C. (2020), which the author found that a decreased in migration, the labor force participation will increase. In addition, in one of the results of the study of Ndiaye et al., (2016), it reveals that migration reduce labor force participation.

Hence, based on the findings and support from the related studies, unemployment rates and labor force participation rates indicate as a predictor of net migration. This implies that as unemployment rate increases, the net migration decreases which will have high negative values which means that there are more people leaving the country. Contrary, as the rate labor force participation increases the net migration also increase which indicates to have a lesser negative net migration, or will approach positive net migration, which means that more people are coming in the Philippines. Moreover, in Gross Domestic Product Growth rate, the findings in this research, and the related studies contradict, this implies that other variables may also play a role, explaining some non-significant predictors.

Objective 3

Construct time series model of the Net Migration in the Philippines using the models (1) Linear, (2) Logarithmic, (3) Polynomial (quadratic, cubic, quartic, quintic, sextic), (4) Moving Average, (5) Exponential Smoothing and (6) Auto regression to predict the net migration for 2024.

The following figure represents the trends of Net Migration over time using various mathematical methods.

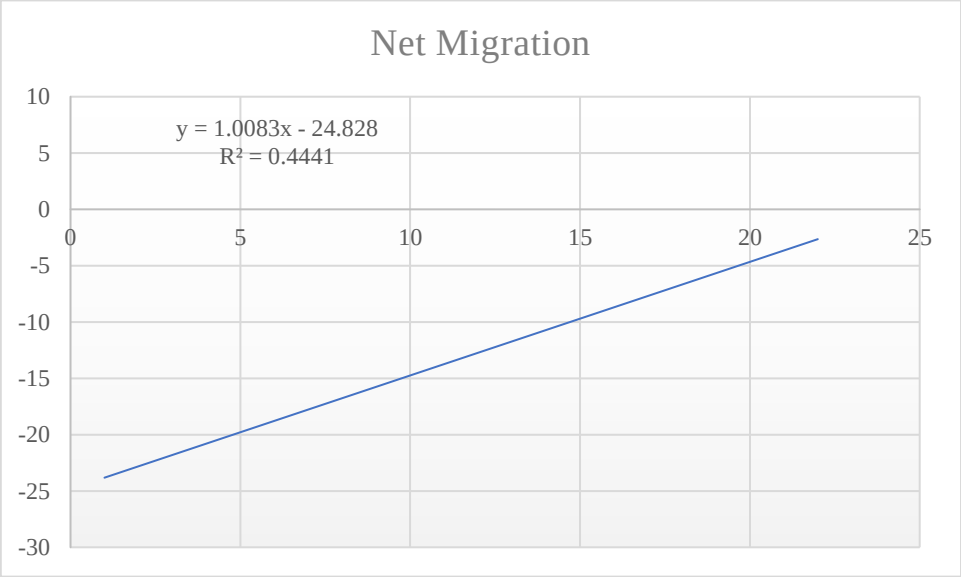

Figure 2. Linear Trend of Net Migration

Figure 2 shows the linear model of Net Migration in the Philippines from year 2000-2021 with, y = 1.0083x – 24.828 and an R^2 value of 0.4441 which indicates that around 44.41% of the variances in Net Migration can be explained by the linear model.

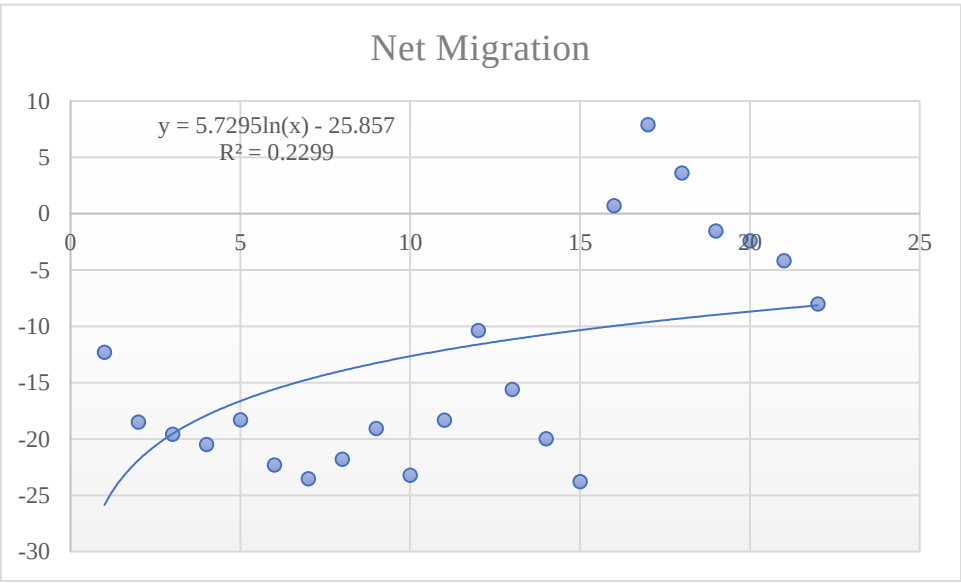

Figure 3. Logarithmic Trend of Net Migration

Figure 3 shows the logarithmic model of Net Migration in the Philippines from year 2000-2021 with, y = 5.7295ln(x) – 25.857 and an R^2 value of 0.2299 which indicates that around 22.99 % of the variances in Net Migration can be explained by the logarithmic model.

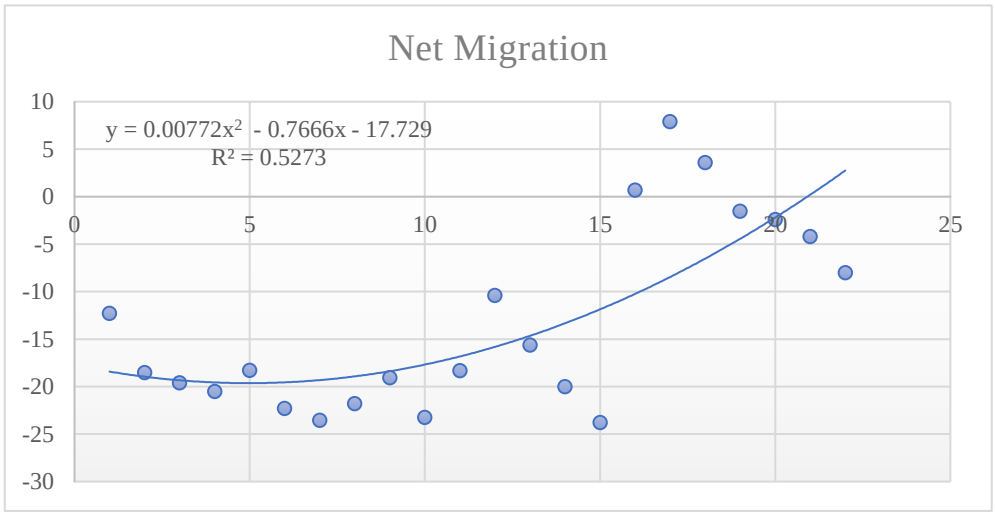

Figure 4. Quadratic Trend of Net Migration

Figure 4 shows the quadratic model of Net Migration in the Philippines from year 2000-2021 with, $y = 0.00772x^2 - 0.7666x - 17.729$ and an R^2 value of 0.5273 which indicates that around 52.73% of the variances in Net Migration can be explained by the quadratic model.

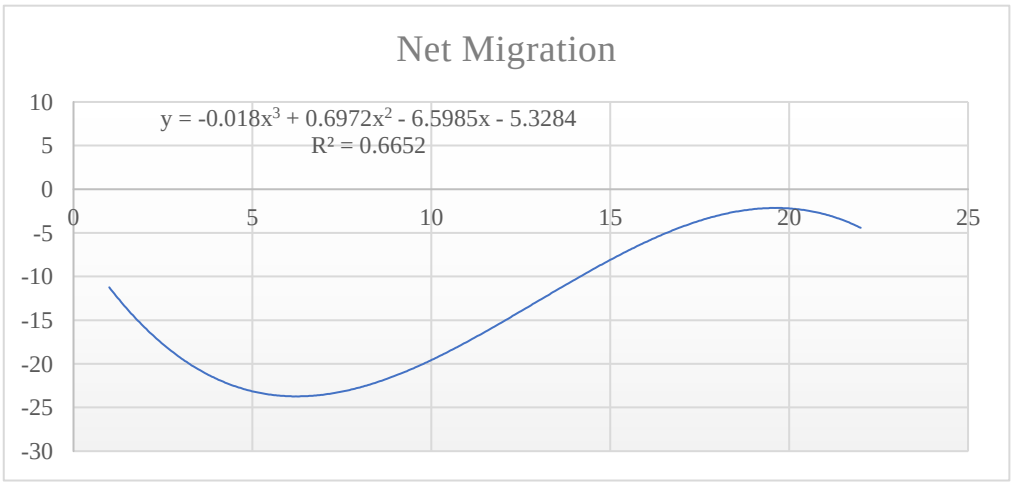

Figure 5. Cubic Trend of Net Migration

Figure 5 shows the cubic model of Net Migration in the Philippines from year 2000-2021 with, $y = -0.018x^3 + 0.6972x^2 – 6.5985x - 5.3284$ and an R^2 value of 0.6652 which indicates that around 66.52% of the variances in Net Migration can be explained by the cubic model.

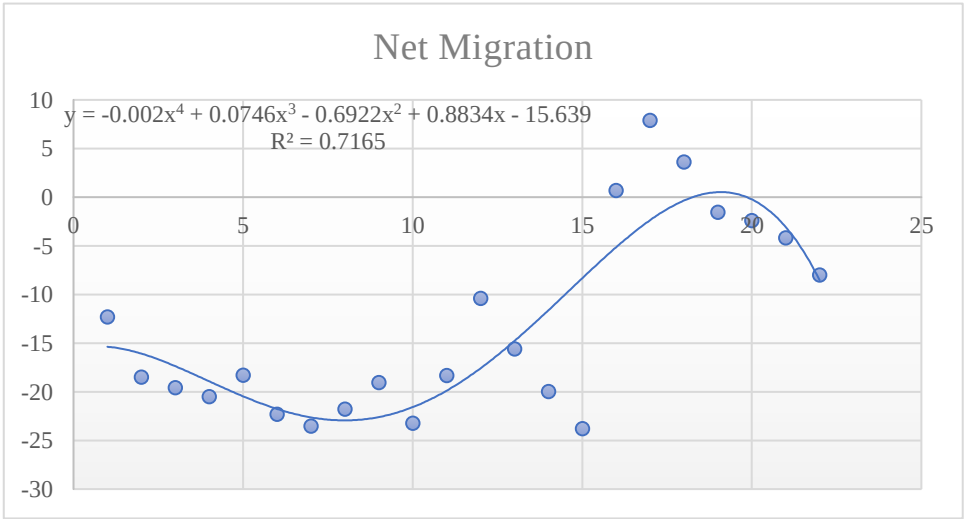

Figure 6. Quartic Trend of Net Migration

Figure 6 shows the quartic model Net Migration in the Philippines from year 2000-2021 with, $y = -0.002x^4 + 0.0746x^3 - 0.6922x^2 + 0.8834x - 15.639$ and an R^2 value of 0.7165 which indicates that around 71.65% of the variances in Net Migration can be explained by the quartic model.

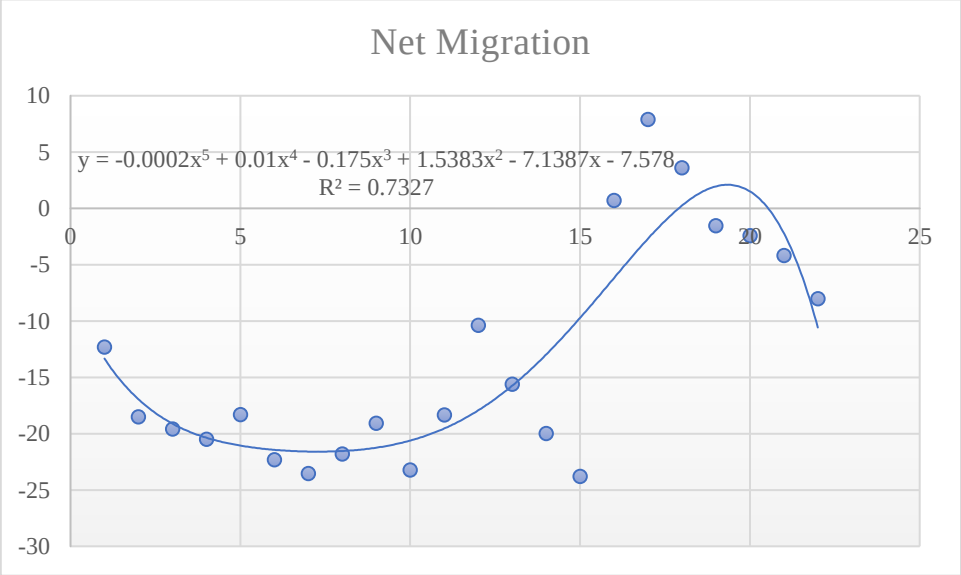

Figure 7. Quintic Trend of Net Migration

Figure 7 shows the quintic model of Net Migration in the Philippines from year 2000-2021 with, $y = -0.0002x^5 + 0.01x^4 - 0.175x^3 + 1.5383x^2 - 7.1387x - 7.578$ and an R^2 value of 0.7327 which indicates that around 73.27% of the variances in Net Migration can be explained by the quintic model.

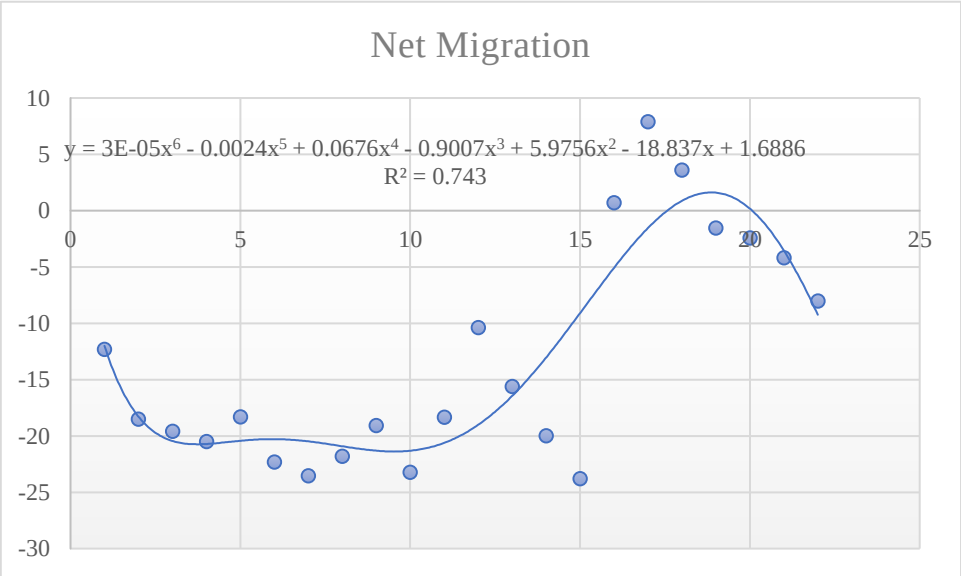

Figure 8. Sextic Trend of Net Migration

Figure 8 shows the sextic model of Net Migration in the Philippines from year 2000-2021 with, $y = 3E-05x^6 - 0.0024x^5 + 0.0676x^4 - 0.9007x^3 + 5.9756x^2 - 18.837x + 1.6886$ and an R^2 value of 0.743 which indicates that around 74.3% of the variances in Net Migration can be explained by the sextic model.

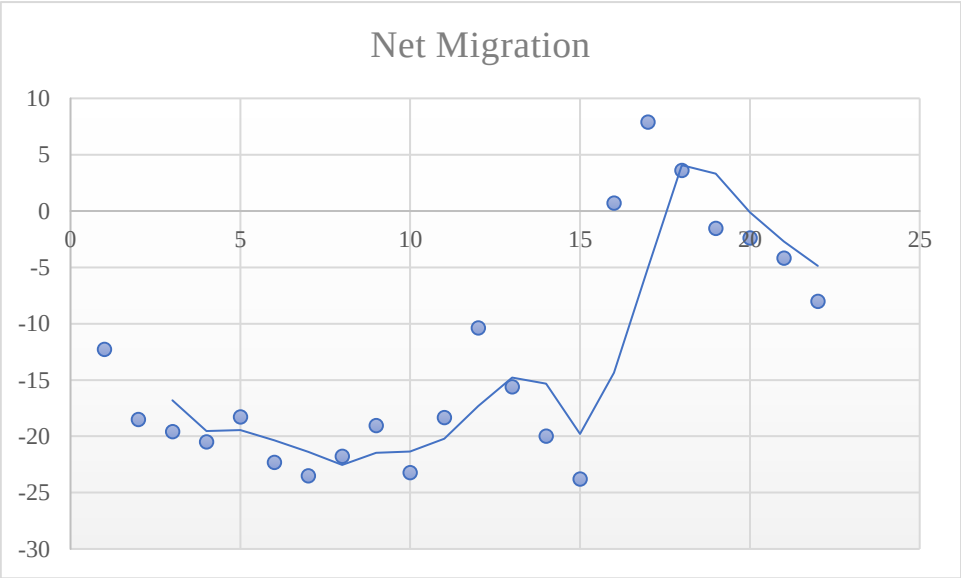

Figure 9. Moving Average Trend of Net Migration

Figure 9 shows the moving average model at interval 3 of Net Migration in the Philippines from year 2000-2021.

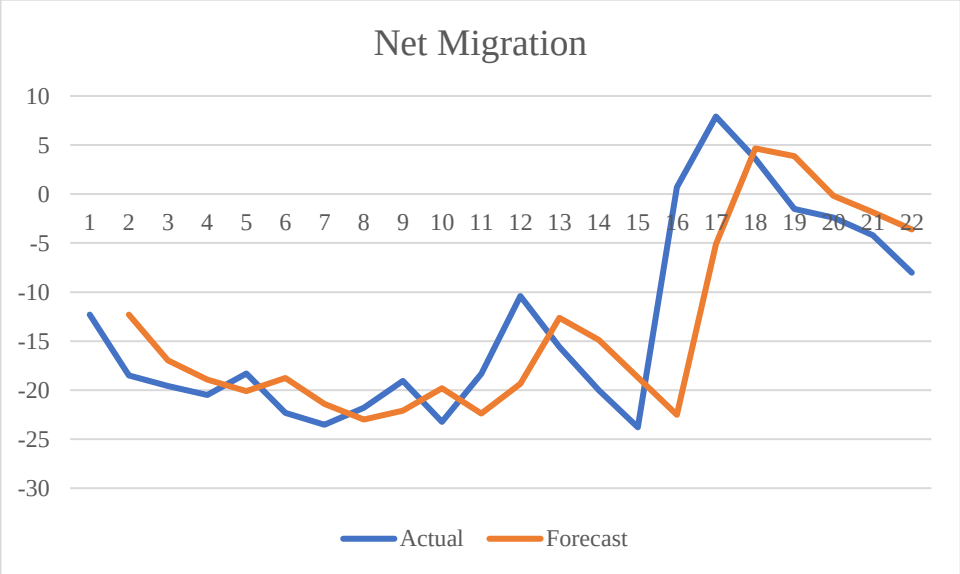

Figure 10. Exponential Smoothing Trend of Net Migration

Figure 10 shows the exponential smoothing model of Net Migration in the Philippines from year 2000-2021.

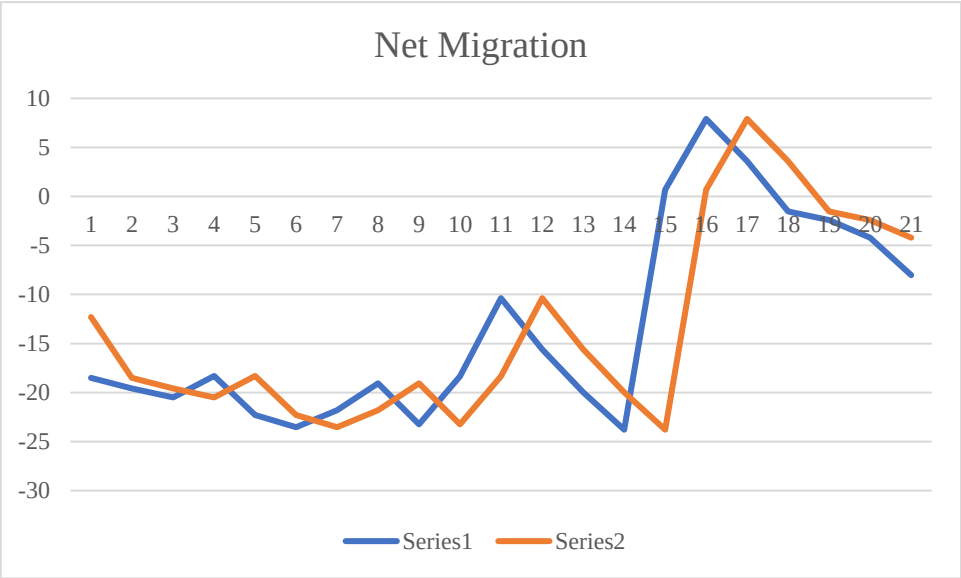

Figure 11. 1st Autoregression Model of Net Migration

Figure 11 shows the 1st Autoregression model of Net Migration in the Philippines from year 2000-2021 with, y=-2.91675+0.768521x and an R^2 =0.583 which indicates that around 58.3% of the variances in Net Migration can be explained by the 1st autoregression model.

Objective 4

Determine the best fit model and predict the Net Migration in the Philippines for the year 2024.

Table 6. Model and Prediction

Model	**Equation**	**R^2**	**Standard Error**	**Predicted Net Migration in the year 2024**
Linear	y = 1.0083x - 24.828	0.4441	7.50640313	0.3795
Logarithmic	y = 5.7295ln(x) - 25.857	0.2299	8.835025059	-7.414450961
Quadratic	$y = 0.0772x^2 - 0.7666x - 17.729$	0.5273	6.921637899	11.371
Cubic	$y = -0.018x^3 + 0.6972x^2 - 6.5985x - 5.3284$	0.6652	5.825645792	-15.7909
Quartic	$y = -0.002x^4 + 0.0746x^3 - 0.6922x^2 + 0.8834x - 15.639$	0.7165	5.387656064	-41.804
Quintic	$y = -0.0002x^5 + 0.01x^4 - 0.175x^3 + 1.5383x^2 - 7.1387x - 7.578$	0.7327	6.423018264	-5.858
Sextic	$y = 3E\text{-}05x^6 - 0.0024x^5 + 0.0676x^4 - 0.9007x^3 + 5.9756x^2 - 18.837x + 1.6886$	0. 743	8.640174236	-514.95515
Moving Average Interval=3	-	-	1.813784361	-8.0125
Exponential Smoothing Damping Factor=0.75	-	-	2.252247	-3.81589
1st Autoregression	y=-2.91675+0.768521x		0.583	6.672028 16.296275

Table 6 presents the various models used to predict net migration. Upon exploration and analyzing the different models, it is evident that the moving average model with an interval of 3 demonstrates the best fit, as indicated by its lowest standard error (1.814) compared to the other models. A lower standard error suggests that the model's predictions are more accurate and closely align with the actual observed values. For instance, the predicted net migration for 2024 (-8.0125) using the moving average model with an interval of 3 shows a greater reliability as it closely matches the actual observed net migration. On the other hand, some of the other predicted net migration values for 2024 from various models appear unrealistic, particularly with notably high negative net migration (indicating very low people immigrating into the country). Models like the quartic and sextic polynomial models demonstrate relatively high R-squared values (0.7165, and 0.743, respectively), indicating good performance in fitting the data. However, excessively high-degree polynomials can lead to overfitting and may not generalize well, as evidenced by their predictions for 2024 (-41.804, and -514.95515,

respectively), which are unrealistically negative and far from the observed actual data for the past 5 years. In contrast, the moving average model with an interval of 3 shows to be more effective in capturing underlying patterns and trends in net migration. By utilizing historical data points from the three most recent time periods to make predictions, this model smoothest out short-term fluctuations and provides a more stable trend, which likely contributes to its superior performance.

Considering the growth of net migration, the moving average model appears to be the most reliable choice when compared to the polynomial models and other models included in the table. Its ability to provide more accurate and stable predictions makes it a suitable option for forecasting net migration trends.

4. Summary of Findings

1. The trend of Net Migration from 2000 to 2021 shows fluctuations in the net migration over the years, with periods of negative net migration (more people leaving the country) than positive net migration (more people migrating to the Philippines).
2. The study finds a significant linear relationship between unemployment rate and net migration in simple linear regression. However, in multiple linear regression, both unemployment rate and labor force participation statistically predict net migration. While Gross Domestic Product (GDP) Growth rate and Population Growth rate appears to be not a statistically significant predictor of net migration.
3. The time series models using Net Migration in the Philippines from 2000 to 2021 are y = y = 1.0083x - 24.828 for linear, y = 5.7295ln(x) - 25.857 for logarithmic, $y = 0.0772x^2 - 0.7666x - 17.729$ for quadratic, $y = -0.018x^3 + 0.6972x^2 - 6.5985x - 5.3284$ for cubic, $y = -0.002x^4 + 0.0746x^3 - 0.6922x^2 + 0.8834x - 15.639$ for quartic, $y = -0.0002x^5 + 0.01x^4 - 0.175x^3 + 1.5383x^2 - 7.1387x - 7.578$ for quintic, $y = 3E\text{-}05x^6 - 0.0024x^5 + 0.0676x^4 - 0.9007x^3 + 5.9756x^2 - 18.837x + 1.6886$ for sextic. Additionally, using interval 3 for moving average, and a damping factor of 0.75 for exponential smoothing obtain the least standard error. While first autoregression gives better r squared and least standard error among other autoregression.
4. The best fit model is Moving Average with an interval 3. Using this model, the total net migration in the year 2024 will decrease to -8.0125(in ten thousand).

5. Conclusions

This research bridges the gaps in knowledge, in which, in-depth investigations into the net migration in the Philippines from 2000 to 2021 shows that over the years, there were more people leaving the country than people migrating to the Philippines as evidence with the negative net migration.

Also, the efforts to reduce unemployment and enhance labor force participation could have a positive impact on controlling migration flows and retaining skilled workers within the country. While Gross Domestic Product growth and population dynamics are essential factors, other social, political, and environmental factors may play a more influential role in shaping migration patterns. Understanding these multifaceted drivers is crucial for formulating comprehensive migration policies.

Moreover, exploring models such as simple linear regression, multiple linear regression, and time series models can offer valuable options for analyzing and predicting specific data, such as net migration. These diverse analytical approaches can enhance the accuracy and depth of understanding in studying migration patterns and its possible predictors.

Furthermore, the forecasted decline in net migration using the Moving Average model to -8.0125 net migration (in ten thousand) for the year of 2024 suggests a potential of a little bit of increase in immigrants in the country.

Recommendations

This study recommends that policy makers make efforts for Unemployment and Labor Force Interventions in which to prioritize efforts to reduce unemployment and enhance labor force participation to control migration flows and retain skilled workers within the country. Also, use of various time series model is strongly recommended when analyzing model changes or trends over time. For further research, considering multifaceted factors, adopt a comprehensive approach to migration policies, recognizing that migration patterns are influenced by a multitude of factors, including social, political, and environmental drivers. Additionally, the data available in net migration is limited to 2021, for further studies, it is highly beneficial to explore data including year 2022, as this period may have an impact on the net migration in the following years. Furthermore, using a longitudinal study to better understand the long-term impacts of migration policies and interventions, longitudinal studies tracking migrants' experiences and outcomes over time are recommended.

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