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FORECASTING STUDENT MOBILITY FLOWS IN HIGHER EDUCATION: A CASE STUDY IN CHINA

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Abstract. *This study aims to tackle the issues of student inbound and outbound mobility. Takeing China as an example, this study employs the Ministry of Education's series data during 1950 to 2018 to explore the issues. Inbound mobility ratio, outbound mobility ratio, and net flow ratio were transformed and conducted by time series analysis. This study applies ARIMA to projecting fitted net flow ratios of the next decade. The findings suggest that generally, China has suffered negative net flow mobility until now and this trend would extend to the next decades, which further causes brain drain issues. This study demonstrates how the related ratios can be practiced in higher education to interpret the phenomena of global student mobility. The design of the study can provide an alternative approach to detect similar issues in higher education settings.*
Keywords: Brain drain, Higher education, Inbound mobility, Internationalization, Net flow ratio, Outbound mobility

1. **Introduction.** Internationalization in higher education is an irreversible development trend in the world, along with which, the international student mobility has become a significant phenomenon in the process. However, mass student mobility has also caused concerns, which was mentioned in the OECD's report [1]. OECD defines an international mobile student as an individual who has physically crossed an international border between two countries with the objective to participate in educational activities in a destination country where it is different from his or her country of origin [1]. Traditionally, student mobility has referred to two different types: inbound and outbound. Inbound mobile students mean students who move to a host country for the purpose of study or study-related activities (here refers to foreign students moving to China to study). Outbound mobile students indicate the students who leave their country to another country for the purpose of study or traineeship in the context of study (here refers to Chinese students going to study abroad) [2]. Therefore, determining how to create a meaningful map of student mobility has become an important component in higher education. The type of student mobility is dissimilar in different areas; for example, OECD countries receive more international students than the students they send to study abroad for tertiary education. According to OECD's report, 91% of OECD's outbound students study in another OECD country, and around 70% of OECD's inbound students come from non-OECD countries [3]. Across OECD countries in 2013, an average of 19% of international students came from neighboring countries that share land or maritime borders with the host country [4]. The number of international and foreign tertiary students has grown on average by 4.8% per year between 1998 and 2018. Currently, OECD countries are the study-abroad

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destinations of most foreign students around the world; nonetheless, non-OECD countries achieve the fastest growth of international students' enrollment in tertiary education [5].

Previous studies provide various perspectives on student mobility learning. For example, Larsen proposed an analysis through spatial, network, and mobility theories to broaden the theoretical framework for analyzing internationalization in higher education settings [6]; Rumbley and Altbach argued that the nexus between local and global is increasingly important to international initiatives of all kinds, and understanding this relationship is key to comprehending the increasingly complex nature of 21st century higher education internationalization [7]. Other researchers stressed that when attracting international students, institutions or universities should pay more attention on the opportunities and challenges in their campus life instead of the total number of enrollments merely [8]. Kritz explained that why students go abroad is due to the reason of limited learning positions in the mother country through analyzing the UNESCO data of 190 countries [9]. Furthermore, detecting international student mobility phenomena can also cause the brain drain issue in a specific higher education system [10-12]. However, there are few articles focusing on the mobile student from the time-series aspect. In this study, the longitudinal data may present a different point of view to address the student movement trends as well as provide a shred of strong evidence to reveal relevant theories and enlight future studies.

As we know, China has become a rapidly developing country which is competitive and potential in various aspects. In global higher education settings, China has been keeping in a position of providing a large number of outbound students in the past decades. For example, in 2019, more than 660 thousand Chinese students are studying overseas. The inbound mobile students in China increased from 25 thousand in 2000 to 333 thousand in 2019 [13]. Even though China's higher education has moved to universal stage since 2018, the outbound student mobility has shown sustainable growth in last decades; moreover, the inbound mobile students are relatively fewer than that of the outbound. This phenomenon has not been addressed with proper methods in previous literature; thus, the pattern of this mobility remains unclear [10,11]. In this study, we intend to develop index format to detect the trend of student mobility in China and handle the brain drain issue for the system. Taking China as an example, firstly, this study can provide an innovative model to investigate the net flow of student mobility and interpret the pattern which can reflect the landscape of internationalization of a specific higher education system. Secondly, the result of net flow forecasting can provide useful information for policymakers at an institutional or national level. Thirdly, this study will suggest an algorithmic model to tackle similar issues in other higher education settings. The sample data of inbound and outbound mobile students mainly comes from China National Bureau of Statistics. Based on above demonstration, the research questions are addressed as follows.

a) What trends will be observed in the numbers of inbound, outbound mobile students, and the mobility ratio?

b) What is the trend of net flow ratio in China?

c) How to explore the brain drain phenomenon through the numbers of outbound and return students?

d) What is the net flow ratio of China forecasted by distinct models in next decade?

In this paper, the structure is as follows. First, we define the data and select formula to calculate the inbound mobility ratio, outbound mobility ratio and net flow ratio. Second, we display the result of trends and the forecasting. Finally, the conclusions are drawn.

2. Method.

2.1. Data collection.

This study collects the relevant student mobility data from China National Bureau of Statistics, Ministry of Education of the People's Republic of China and

National Statistic Gazette on the Educational Undertaking [14-17]. The data related to the numbers of inbound and outbound students has been double-checked with the official publications or online websites. Undesirably, the inbound mobility data have missing values from 1967 to 1971. In our later statistic procedure, this study treats them as the missing data with voids in the figures of analysis.

2.2. **Data transformation.** This study focuses on the inbound and outbound mobile students in higher education. We tackle the data transformation with ratio formats following the OECD's definition. Three key ratios have been transformed, which are inbound mobility ratio, outbound mobility ratio, and net flow ratio [18].

- Inbound mobility ratio = 100 × [Total number of students from abroad studying in a given country (inbound students)]/[Total tertiary enrollment in that country]
- Outbound mobility ratio = 100 × [Total number of students from a given country studying abroad (outbound students)]/[Total tertiary enrollment in that country]
- Net flow ratio = 100 × [[Total number of tertiary students from abroad studying in a given country (inbound students)] − [Number of students at the same level of education from that country studying abroad (outbound students)]]/[Total tertiary enrollment in that country]
- Number of return refers to outbound mobility students going back to China after they finish academic degree in other countries.

2.3. **Building ARIMA model.** The study employs the ARIMA model process to build predicted trend of net flow ratio for the next decade. Before using the suggested model for forecasting, the proposed model is verified for its adequacy [19-21]. Firstly, this study adopts the ARIMA model building process to check the series data whether it is stationary or non-stationary series. Typically, a non-seasonal ARIMA model is classified as an "ARIMA(p, d, q)" model, a seasonal ARIMA model is classified as "ARIMA(p, d, q) $^*(P, D, Q)_s$" [22]. The fitted ARIMA(p, d, q) model is as follows: p is the number of autoregressive terms, d is the number of non-seasonal differences needs for stationarity, and q is the number of lagged forecast errors in the prediction equation.

Secondly, based on the assumption of ARIMA model, the residuals left over after fitting the model are simply white noise. This was done by examining the ACF and PACF on the residuals [23]. Using the Box-Pierce Chi-square statistics to check the residuals, we find they are all independently distributed. We then compare the p-value to the significance level for each Chi-square statistic; usually, a significant level of .05 (denoted as α) works well. Basically, the p-values for the Ljung-Box Chi-square statistics are all greater than .05 [24]. In this study, the analyses are carried out using the Minitab statistical package [25].

3. **Results.** This section will answer the research question as the following: Research Question (a) is answered by Sections 3.1 and 3.2, which presents the *increasing* trends of inbound, outbound students as well as the inbound and outbound mobility ratios. Question (b) is answered by 3.3, which illustrates the *overall declining* net flow ratio. Regarding Question (c) 3.4 shows the deteriorative issue of brain drain phenomenon. As for Question (d) 3.5 demonstrates the negative term in the prediction of net flow ratio with a fitted model.

3.1. **Trends of inbound and outbound students.** In 2002, the higher education gross entrance ratio in China was over 15%, which implied that the expanded higher education system was going to the mass stage as Trow's classification [26]. Figure 1 exhibits that when the system moved into the mass stage, both outbound and inbound students have been increasing rapidly in last two decades. The result reveals the number of increasing

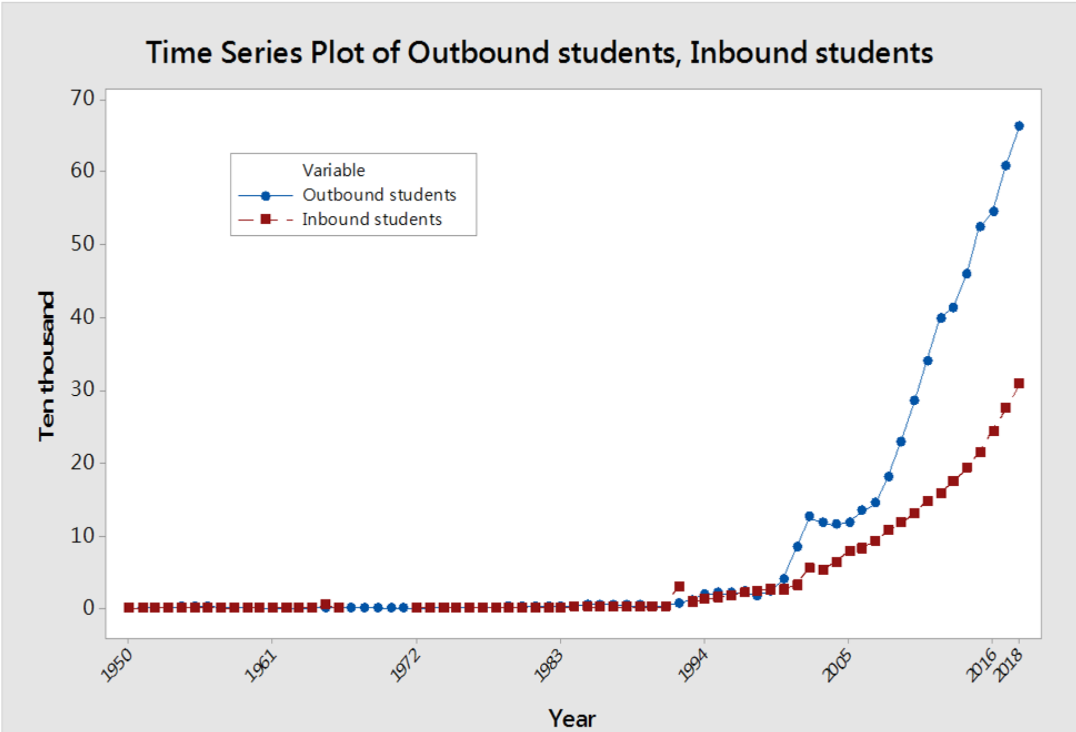

FIGURE 1. The increasing inbound and outbound students in China

outbound students is larger than that of inbound students. It reflected on the expanding higher education with active inbound and outbound mobility growth.

3.2. **Trends of inbound and outbound mobility ratio.** We apply the formula of mobility ratio to transforming the numbers of inbound and outbound mobility students. In this case, the ratios of outbound mobility are usually higher than inbound mobility. Typically, the ratios reflect the fluctuations of mobility more accurately. Figure 2 indicates the trends of inbound and outbound mobility ratios from 1950 to 2018 in China.

3.3. **Net flow ratio.** In this study, the net flow ratio transformation follows the OECD's suggestion and we calculate the ratio from 1950 to 2018 of China. Based on the data transformation, a singular point of the net flow ratio is 1.0679 of 1992, which has been found there was a special policy intervention for attracting foreign students to come to China. After that year, the net flow ratio has shown a declining trend, see Figure 3. The result reveals that China's higher education system reflects a trend with negative net flow ratio. For a long run, China may confront brain drain issue.

3.4. **The exploration of the brain drain phenomenon.** We check the brain drain phenomenon with outbound students minus the number of returns to tackle the issue. It is a rough estimated model for detecting the issue. The result uncovers that when the higher education system moves into the mass stage, the brain drain issue is going to worsen. The issue of brain drain in China has been demonstrated in Figure 4. In this case, the data in 1966-1969 and 1972-1973 are unavailable.

3.5. **Forecasting the net flow ratio in China.** As the data transformation for net flow ratio, this study conducts the ARIMA to build the forecasting model. We select two fitted models in terms of ARIMA$(1, 1, 1)$ and ARIMA$(0, 1, 1)$ to address the trend of net flow ratio. Table 1 shows the parameters of ARIMA in both models are significant with alpha < 0.05 and one regular difference. Use the Box-Pierce Chi-square statistics to check the residuals which are all independently distributed in terms of the insignificant p-values in the selected models (see Table 2).

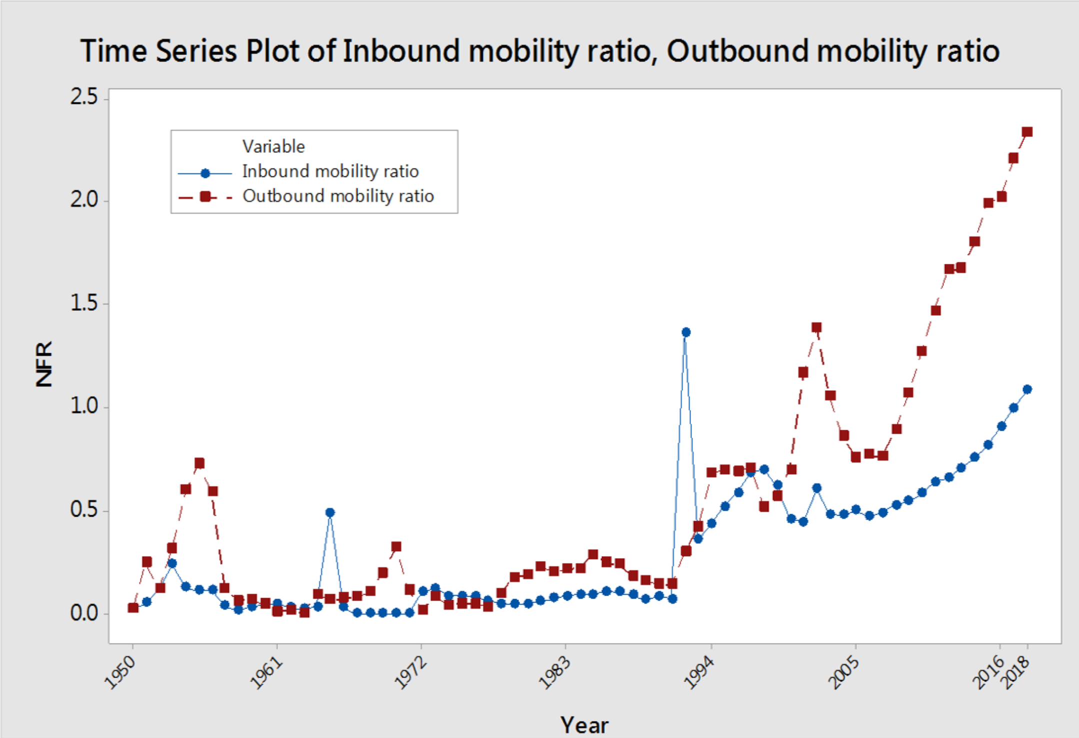

FIGURE 2. Comparing the ratios of inbound and outbound mobility

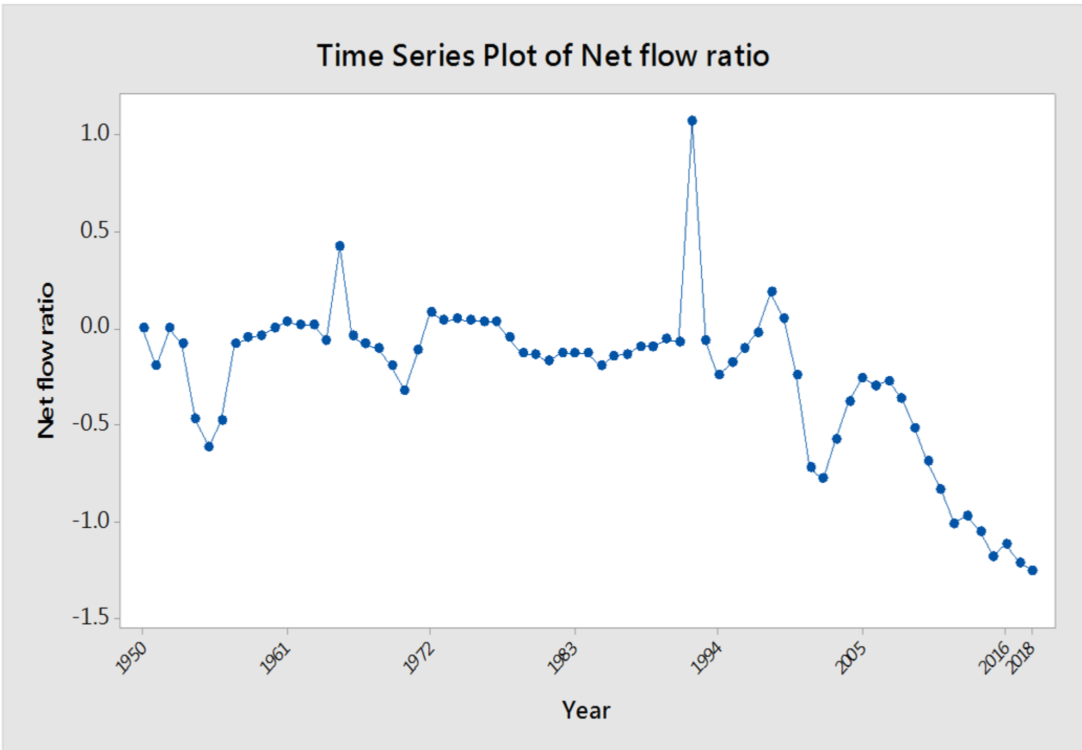

FIGURE 3. The trend of net flow ratio in China

The suggested models for predicting the net flow ratio in the next decade are displayed in Table 3. Considering the actual value of net flow ratio in 2018 is -1.2525, the result of ARIMA$(0, 1, 1)$ model has shown the trend more smoothly (see Figure 5). Both models present the net flow ratio of China which would enlarge with a negative term in next

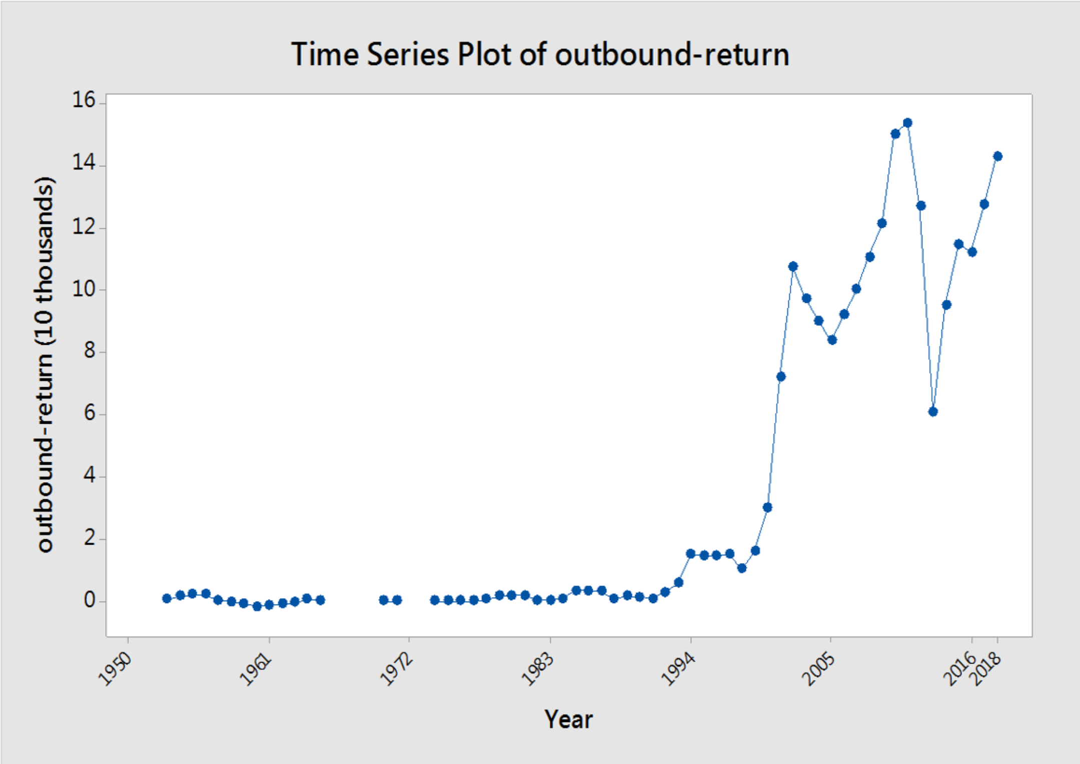

FIGURE 4. The number of brain drains in China from 1953 to 2018

TABLE 1. The parameters of suggested ARIMA models

ARIMA(1, 1, 1)	**Coef.**	**SE Coef.**	***t*-value**	***p*-value**
AR(1)	0.459	0.220	2.09	0.041
MA(1)	0.800	0.156	5.12	0.000
Constant	−0.008	0.006	−1.38	0.174
ARIMA(0, 1, 1)	**Coef.**	**SE Coef.**	***t*-value**	***p*-value**
MA(1)	0.365	0.115	3.19	0.002
Constant	−0.017	0.0188	−0.93	0.358

Differencing: 1 regular difference;
Number of observations: Original series 69 (1950-2018), after differencing 68

TABLE 2. Box-Pierce Chi-square statistics for checking the residuals in the models

ARIMA(1,1,1) Lag	12	24	36	48	**ARIMA(0,1,1)** Lag	12	24	36	48
Chi-square	4.05	9.09	22.81	35.62	Chi-square	10.36	15.09	29.51	47.16
DF	9	21	33	45	DF	10	22	34	46
p-value	0.908	0.988	0.908	0.840	*p*-value	0.409	0.858	0.687	0.425

decade. This finding suggests that China has been suffering brain drain issue and will continue this situation in the future.

4. **Conclusion.** China's higher education system has moved to the universal stage in 2018. The capacity of higher education has reached the level of advanced countries. In this study, we found that even though the higher education system has been expanded and provided more learning opportunities, the number of students participating in global mobility has risen rapidly. Following the inbound or outbound student mobility, the

TABLE 3. Forecasts of net flow ratio from 2019 to 2028 with two suggested models

Year	ARIMA(1, 1, 1)	95% limits		ARIMA(0, 1, 1)	95% limits	
		Lower	Upper		Lower	Upper
2019	−1.19391	−1.66327	−0.724556	−1.25237	−1.73191	−0.772820
2020	−1.17530	−1.73746	−0.613128	−1.26982	−1.83778	−0.701866
2021	−1.17506	−1.78474	−0.565387	−1.28728	−1.93163	−0.642930
2022	−1.18327	−1.82560	−0.540941	−1.30474	−2.01734	−0.592137
2023	−1.19536	−1.86427	−0.526447	−1.32220	−2.09706	−0.547333
2024	−1.20923	−1.90183	−0.516631	−1.33965	−2.17214	−0.507172
2025	−1.22392	−1.93860	−0.509231	−1.35711	−2.24347	−0.470749
2026	−1.23898	−1.97473	−0.503228	−1.37457	−2.31172	−0.437419
2027	−1.25422	−2.01029	−0.498143	−1.39203	−2.37735	−0.406703
2028	−1.26953	−2.04533	−0.493741	−1.40948	−2.44073	−0.378235

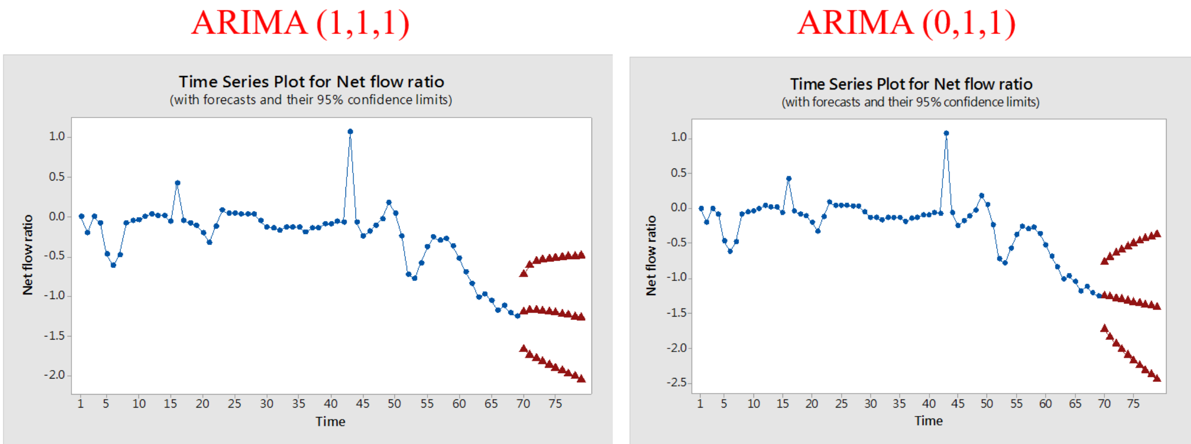

FIGURE 5. Comparing ARIMA(1, 1, 1) and ARIMA(0, 1, 1) for predicting net flow ratios

binary notion to recognize internationalization can provide a meaningful perspective to investigate the mobility issue in higher education. This study finds that the changing trend of Chinese outbound student mobility conveys more and more students pursuing overseas study progressively. This study suggests that the net flow ratio is a useful tool to determine the patterns of student mobility in a specific country; it also offers a function to reveal the brain drain issue. The projected net flow ratio can be a signal for policy intervention in higher education.

This study demonstrates how the related ratios can be transformed in higher education to interpret the phenomena of global mobility and predict its future trend as well as suggests the extensive use of the research design to detect similar issues in higher education settings. The findings can enhance the knowledge of relevant field and contribute practical values for policymakers. It is well known that the sudden international event will affect the ordinary student global mobility. Currently, in the shadow of COVID-19, China could not be an exception during the pandemic recovery. Therefore, for future studies, we suggest the exploration of the related impact factors in higher education which leads to mobility fluctuations to illuminate the causation with respect to student mobility issues.

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