ICIC Express Letters
Part B: Applications
Volume **11**, Number **4**, April **2020**

ICIC International ©2020 ISSN 2185-2766
pp. **389–395**

FORECASTING HIGHER EDUCATION EXPANSION ON GENDER PARITY IN JAPAN AND KOREA

Tien-Li Chen[1] and Dian-Fu Chang[2,*]

[1]Doctoral Program of Educational Leadership and Technology Management
[2]Graduate Institute of Educational Policy and Leadership
Tamkang University
No. 151, Yingzhuan Road, Tamsui District, New Taipei City 25137, Taiwan
tienlin@ymail.com; *Corresponding author: 140626@mail.tku.edu.tw

Received October 2019; accepted January 2020

Abstract. *This study aims to explore the gender parity pattern in higher education through the longitudinal series data of Korea and Japan. Korea's gross enrollment ratio (GER) in higher education had reached 52% since 1995, ranking third in the world, behind the United States and Australia. In 2002, the GER in Japan also reached 50%, which implies moving to the universal stage as Trow's definition. This study chose Japan and Korea as targets to demonstrate their patterns in gender parity through higher education expansion. The enrollment data of higher education from 1971 to 2016 in Japan and Korea were collected from the World Bank. Using Becker's coefficient of discrimination (D) and Trow's three different stages, this study analyzes the trends of gender parity in the systems. To predict the D of Japan and Korea for the next 10 years, the fittest ARIMA model was built. The finding reveals the trend of gender parity with higher education expansion has achieved remarkable mileages. The predicted gender parity of higher education in Japan and Korea will reduce their discrepancies in next decade.*
Keywords: ARIMA, Coefficient of discrimination, Gender parity, Higher education expansion

1. **Introduction.** Japan and Korea are located at the north-eastern edge of Asian continent and share a great deal in terms of cultural and philosophical foundations. Therefore, there are some similarities between the two countries. For example, both in Japanese and Korean cultures, men are traditionally considered as breadwinners, whereas women are seen as housekeepers. The stereotype perception for gender roles that has been developed and standardized over a long time in the minds of Japanese and Korean people has been a major obstacle in the formation of a truly gender-equal society [1]. In Japan's history, especially in the early stage of creating modern education system, educational opportunity for females was considerably disadvantaged. The constitution of Japan, enacted after World War II, clearly stipulates respect for the individual and equality under the law. Since the constitution was written, Japan has pressed forward with laws to strive toward gender equality, and radically improved the legal status of women [2,3]. The Foundation Law for a Gender-Equal Society went into effect in June 1999 to comprehensively promote the state's, local governments' and citizens' measures pertaining to formation of a gender-equal society [4]. Tracing back to the background of Korea, tendencies to recognize female education as luxury persisted until 1971 [5]. Around 1975, women's humanitarian rights were called into attention, forming the notion that physiological differences between males and females should not manifest into social discrimination. In the seventies, it has shown the beginnings of a shift in the public perception of women, where society began to feel that women should also be raised to be competent and pursue careers. In the end of the 1980s, the education policy was drafted to include female education [6-10]. Japan and

DOI: 10.24507/icicelb.11.04.389

Korea have a long time of striving for gender parity in higher education. Gender parity is one of the key components used to determine equal opportunities for accessing higher education [11]. In this sense, this study selected Japan and Korea as research targets to tackle their gender parity patterns under the process of higher education expansion.

In Japan, the gross entrance ratio (GER) in higher education had been experienced over 15% in 1971, implying the system entered the mass higher education stage. For the past 30 years, the GER was over 50% in 2002, Japan's higher education system has moved to a universal stage. Whereas, it took 10 years moving from elite stage to mass stage (1971 to 1981) in Korea. Subsequently, not until 1995 did Korea's system enter the universal stage. Taken Japan and Korea as examples, this study explores gender parity patterns within the different expansion stages in both higher education systems. Did the expansion of higher education provide more appropriate equality opportunities for males and females? To clarify the gender parity structure with the higher education expansion, this study tries to answer the following research questions:

(a) What has changed on gender parity since higher education expanded in both countries?

(b) Which models can be used to predict the trends of gender parity in future?

(c) What kinds of gender parity patterns in both systems will be in next decade?

We apply Becker's coefficient of discrimination (D) to transform the patterns of gender parity in both higher education systems. The Ds in both Japan and Korea will be interpreted with their expanding trends. This study focuses on determining whether the systems are tended to provide gender friendly environment for students or not. The rest of this study is organized as follows: Section 2 presents the method, then the results will be addressed in Section 3, and finally the conclusion was drawn in Section 4.

2. **Method.**

This section addresses how the series data were collected and transformed. This study employed the concept of time series analysis. The GER data were collected from the World Bank, and it is covering the period from 1971 to 2016 [12]. We applied Becker's coefficient of discrimination (D) to interpret the issue of gender parity in both higher education systems. The ARIMA model in Minitab was used to conduct the trends analysis with D.

2.1. **Becker's coefficient of discrimination (D).**

This study applied Becker's formula of D to represent the equality of opportunity in the higher education systems. The interpretation of the differences in gender parity in the higher education settings is from 1971 to 2026. The D is defined as follows:

$D = (EM/EF) - 1$

EM: the education opportunities for males in higher education;

EF: the education opportunities for females in higher education.

The positive calculated D implies the females' education opportunities less than males'. Whereas, the negative D means that the education opportunities are more favored for females [11,13-15]. If D becomes zero or nearly zero, it means the education opportunities for males and females are equal. The calculated D will be used to represent the index of gender parity in the higher education systems.

2.2. **Predicting the trend of D by ARIMA.**

The study followed the ARIMA model predicting the trends of D for the next decade. Before using the model for forecasting, the proposed model will be checked for its adequacy. Based on the assumption of ARIMA model, the residuals left over after fitting the model are simply white noise. This was done through examining the ACF and PACF on the residuals [16]. This study followed the ARIMA model building process checking 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, where:

p is the number of autoregressive terms,
d is the number of no-seasonal differences needs for stationarity, and
q is the number of lagged forecast error in the prediction equation.

This study also considered the Box-Pierce Chi-square statistics to check the residual are independent; this study compares 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 [17]. In this study, the analyses are carried out using the Minitab statistical package.

3. Results.

3.1. The trends of GER from 1971 to 2016.

Figure 1 shows the GER of males and females in Japan's and Korea's higher education systems. The trend of GER is classified into three stages, namely elite stage (stage one), mass stage (stage two), and universal stage (stage three) as Trow's definition [18]. In Japan, GER in stage one was below 25% (before 1976), GER in stage two (25%-50%) was from 1976 to 2002, and GER in stage three (over 50%) happened after 2002. In Japan, GER of males was much greater than that of females before 1992. The male students were much more than females in earlier of mass education. However, that GER gap between the male and female has shown diminishing since 1993, implying that the female students have increased in the higher education. In Korea, GER in stage one (below 15%) was in 1982, GER in stage two (15%-50%) was from 1982 to 1996, and GER in stage three (over 50%) was in 1996. GER raised from 15% (1982) to 50% (1996), it is amazing the system only spent 14 years. Then, the GER reached 85% in 2003, growing rapidly to increase 35% within the 8 years. In 2008, the GER even exceeded 100%.

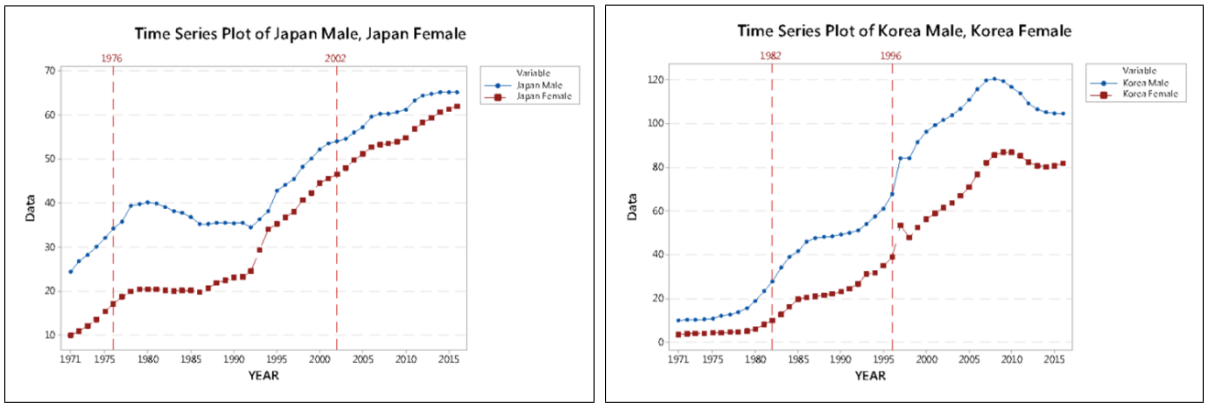

FIGURE 1. The GER of males and females in higher education from 1971 to 2016

3.2. The trends of D index.

Due to the fact that the wider economy had speeded up, the pace of change in higher education such that women now comprise over 50 percent of university students in most developing countries over the last 50 years [19]. Based on the expansion, the study analyzed the difference in gender parity of Japan's and Korea's higher education from 1971 to 2016.

3.2.1. *The trend of D in Japan 1971-2016.* In an effort to be a Gender-Equal Society, Japan's government made the laws about the gender parity after World War II. In 1999, the Foundation Law for a Gender-Equal Society was made, and the effect could be shown on gender parity of higher education expansion. Figure 2 shows the D had been declining from 1971 to 2016. In stage one the average was at 1.308. Later, the D dropped below 1% in stage two with the average at only 0.583. The enrollment ratio of males in higher education was slightly more than that of females. In stage three, the average of D is closer

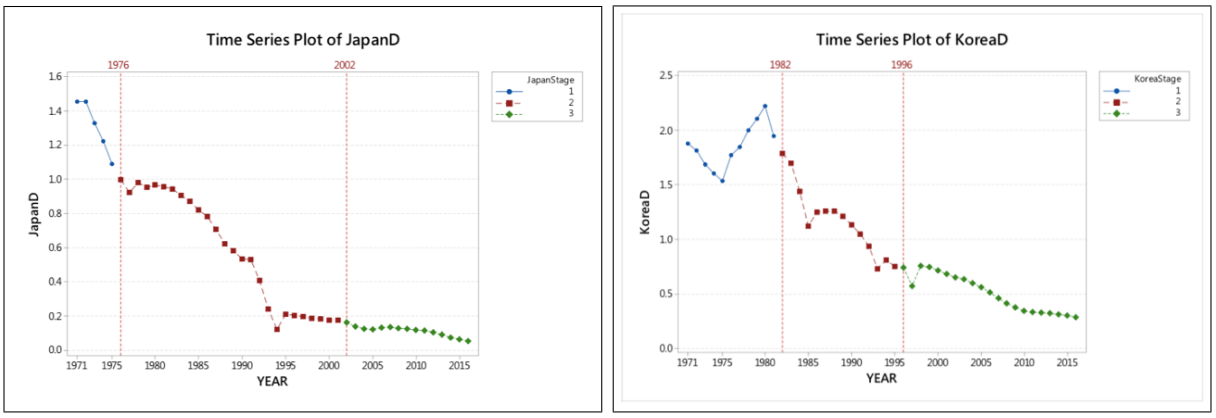

FIGURE 2. The D index of higher education from 1971 to 2016

to nearly zero (0.111), showing that the system of higher education in Japan has gone forward of gender parity.

3.2.2. *The trend of D in Korea 1971-2016.* Figure 2 shows that the D was over 1.5 in stage one with the average at 1.855, where the enrollment ratio of males was much higher than that of females. Around 1975, women's humanitarian rights were called into attention. Later, Korea's government drafted the education policy to include female education in 1980s. Obviously the average of D dropped down to 1.172, seeing the increase of females in enrollment ratio after 1980. In stage three, the D performed an obvious downward trend, falling below 1 with the average at 0.506. In both Japan and Korea, the trend shows that the D has fallen to zero, signifying that the system of higher education has provided gender parity environment for students.

3.3. **Interpretation of the D by ARIMA.** The ACF and PACF indicated that ARIMA$(1,1,0)$ could be used to predict the series of Japan's D index, and ARIMA model $(2,1,2)$ could be used to predict the series of Korea's D index. The residuals follow a white noise process. The final estimates parameters for percent of D index are shown in Table 1. The ACF and PACF diagrams of the residual values are returned in Figure 3 and do not show any discernible pattern due to the fact that their autocorrelation and partial autocorrelation fit the requirement with 5% limits.

TABLE 1. Final estimates of D in Japan and Korea

Japan ARIMA$(1,1,0)$	**Coef.**	**SE Coef.**	***t*-value**	***p*-value**
AR (1)	0.4256	0.1382	3.08	0.004
constant	−0.017435	0.006886	−2.53	0.015
Korea ARIMA$(2,1,2)$	**Coef.**	**SE Coef.**	***t*-value**	***p*-value**
AR (1)	−1.2074	0.1685	−7.16	0.000
AR (2)	−0.2101	0.1845	−1.14	0.262
MA (1)	−1.5300	0.0001	−27846.30	0.000
MA (2)	−0.5681	0.0856	−6.64	0.000
constant	−0.08818	0.04963	−1.78	0.083

Note. Differencing: 1 regular difference; Original series 46, after one differencing

Moreover, Ljung-Box test was used to provide an indication of whether the model was correctly specified. In this study, Ljung-Box Chi-square statistics demonstrate the models meet the assumptions that residuals are independent (see Table 2). Basically, a significant level of .05 (denoted as α) works well. In this study, the p-values for the Ljung-Box Chi-square statistics are all greater than .05.

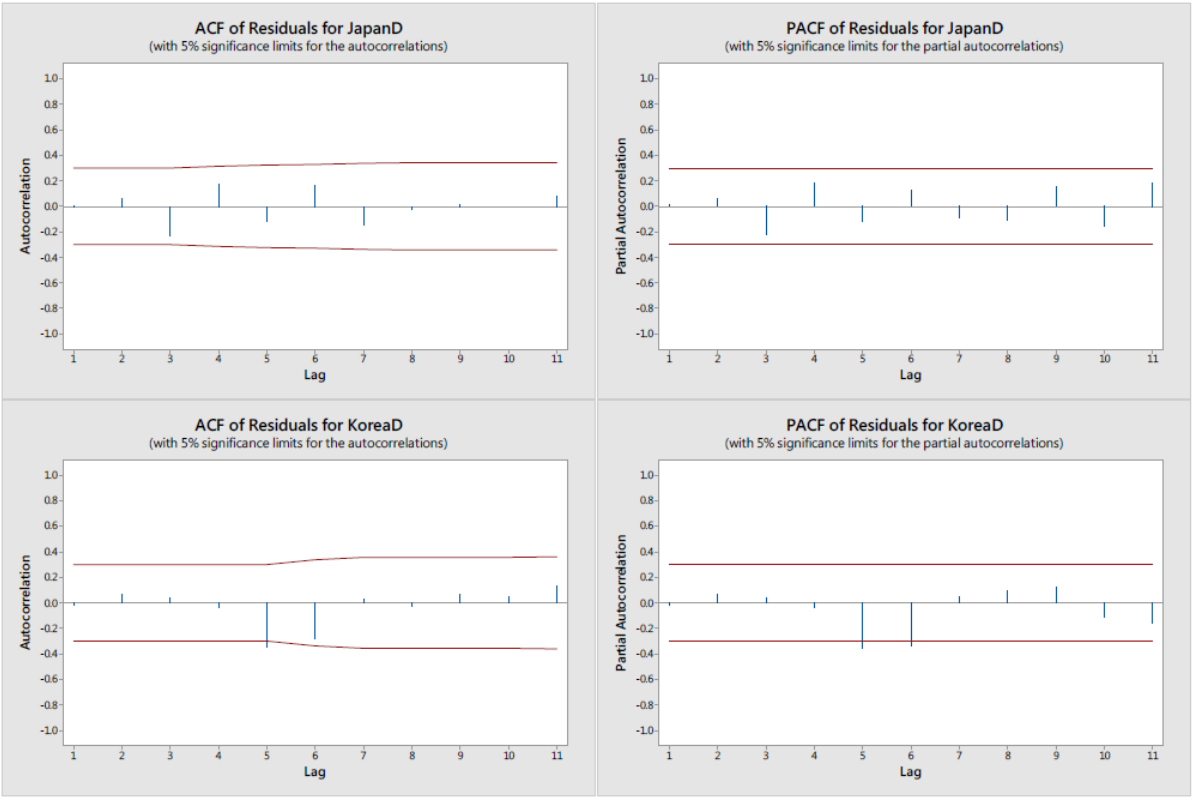

FIGURE 3. Checking the D index with ACF and PACF

TABLE 2. Modified Box-Pierce Chi-square statistics for ARIMA models

Japan Lag	12	24	36	48
Chi-square	8.5	24.9	26.0	*
DF	10	22	34	*
p-value	0.578	0.302	0.834	*
Korea Lag	12	24	36	48
Chi-square	13.2	20.8	22.8	*
DF	7	19	31	*
p-value	0.067	0.349	0.857	*

Note: * represents the value is not available.

The results of forecasting 10 years (2017-2026) in both series of the D are displayed in Figure 4 and Table 3. According to the result of the ARIMA$(1, 1, 0)$ model, the predicted Ds might be located in the range from 0.0286 to -0.2386 in Japan (see Table 3). The predicted Ds of Korea with ARIMA$(2, 1, 2)$ might be located in the range from 0.228205 to -0.0886, meaning the system will favor females in the future.

4. **Conclusions.** The study used Becker's coefficient of discrimination (D) to interpret the issue of gender parity in higher education. The ARIMA modal is a useful way to tackle the series issue, as well as predicting the trends of D for next decade. For the first purpose, the study explored whether the system of higher education would provide more appropriate equality opportunities for males and females as it expands. According to the trend of D in Japan and Korea, it demonstrates that the D has remained nearly zero and continued to drop towards zero, meaning the system in higher education is more favorable for female students. The second purpose of the study was to project the trends of gender parity in the higher education for next decade. By using the ARIMA model to predict the D in next decade, this study found the Japan's D and the Korea's D will be below zero.

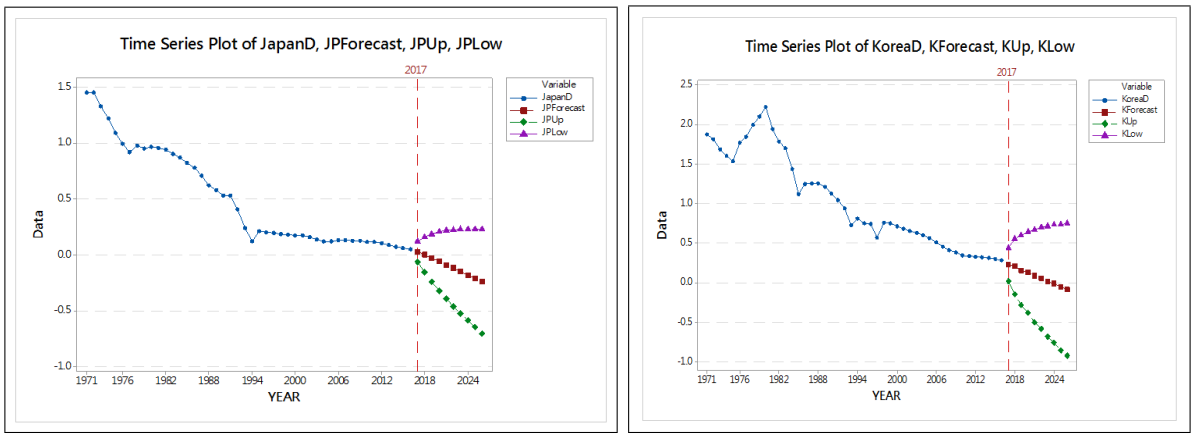

FIGURE 4. The trends of Japan's D and Korea's D from 1971 to 2026

TABLE 3. The prediction of Japan's and Korea's D from 2017 to 2026

Year	Forecast D for Japan	Japan_low 95%	Japan_up 95%	Forecast D for Korea	Korea_low 95%	Korea_up 95%
2017	0.028608	−0.06194	0.119152	0.228205	0.01766	0.438749
2018	0.001667	−0.156	0.159332	0.203567	−0.14555	0.55268
2019	−0.027233	−0.24176	0.187289	0.156468	−0.286	0.598931
2020	−0.056967	−0.32014	0.206207	0.130331	−0.38572	0.646384
2021	−0.087055	−0.39269	0.218584	0.083603	−0.50093	0.668132
2022	−0.117294	−0.46075	0.226165	0.057333	−0.58448	0.699146
2023	−0.147598	−0.52533	0.230135	0.010688	−0.68741	0.708783
2024	−0.177928	−0.58716	0.231305	−0.015655	−0.76237	0.731065
2025	−0.208271	−0.64678	0.230241	−0.06223	−0.85784	0.733376
2026	−0.238618	−0.70459	0.22735	−0.088641	−0.92725	0.749964

In Japan, the D below zero is predicted to happen in 2019, meaning the number of female students in higher education will be more than the male students, and the D of Korea will be below zero in 2024. The gender parity indices (Ds) in higher education have shown a decreasing trend. The phenomena could be explained by the effect of higher education's "expanded out". The expansion has caused the system favors female participation.

Although the quantitative approach was limited by the data set, the explanation of the trends provides a longitudinal perspective for reviewing the effect on gender parity of expanded higher education. The study analyzed the trends of D in Japan and Korea from 1971 to 2026, which will provide useful information for the related policy makers. In future, gender equality could be one of crucial issues in higher education settings; it should be considered both system and institution levels to deal with the issues of the trends.

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