World Journal of Engineering Research and Technology
WJERT
www.wjert.org
SJIF Impact Factor: 5.218

FORECASTING GENERAL AND VOCATIONAL SECONDARY STUDENTS AND SCHOOLS IN EGYPT BY USING ARIMA

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Article Received on 22/12/2018 **Article Revised on 12/01/2019** **Article Accepted on 03/02/2019**

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ABSTRACT

This paper aims to provide short term projection of general and vocational students and schools in Egypt by using ARIMA models. This study uses data during the period of 1987 to 2017 to forecast the period of 2018 to 2022. The study found ARIMA (1,1,0) suitable for general students and schools time series. While ARIMA (1,2,0) is suitable for vocational students and schools time series. The forecasting results revealed that during the next five years, the average change rate would be the same for the number of the students and schools in general secondary education. Where the real problem is that the average change rate in the number of vocational students is exceeding the one in the vocational schools. Which means that vocational education is deteriorating both in quality and quantity. Egypt needs to increase the number of vocational schools immediately in order to solve this problem.

KEYWORDS: Time Series Models, ARIMA, Vocational Secondary, General Secondary, Egypt, Education, Youth, Forecasting.

1-INTRODUCTION

Human capital is the key word in today's development economics. Investing in education and health are a way of bettering the lives of people especially in developing countries. The World Bank created the Human Capital Index (HCI) that oversees education and health data

for each country since that global research has linked them directly to productivity. Egypt has been ranked as a medium human development country. In 2017, Egypt's HCI value was equal to .696 which means that the productivity of Egyptians would nearly be 70% of what it could be like if they benefited from complete education and good health.

Egypt has many challenges with regards to human capital; such as high total fertility rate, growing labor force, high unemployment rate- especially among young people- and the poor quality of education and training. Since better education means better and more secured jobs, there is a lot that can be done regarding the quality of education.

Creating more and better jobs along with greater social welfare are among the aims of every country. Investing in human capital through education and health help nations succeed in the future. In this study the concept of human capital focuses on education only, while the health aspects are not taken into account.

2-OBJECTIVES

The main objective of this study is to model the general and vocational school students and the number of general and vocational schools in Egypt for the periods of 1987 to 2017, using Autoregressive Integrated Moving Average Models (ARIMA) to predict the students and the school numbers in both general and vocational secondary schools for the periods of 2018 to 2022. In other words, the main objective is to explore what is going to happen to the number of schools and students in both tracks; general and technical secondary and not why is this happening?

3-LITRETURE REVIEW

Reda (2012) investigated how education, innovation, and labor impact competitiveness for 25 countries including Egypt at the same stage of development that is factor-driven economies. The study found that improving the quality and quantity of education improves Egypt's competitiveness which in turn improves the real GDP growth. The study used the time series analysis for the period of 1980-2009 to assess the relationship between the real GDP growth and a set of corresponding indicators on education, labor and innovation. The results stressed on youth employment to achieve real GDP growth.

El-Hamidi (2006) identified the factors that influence people's choice between general and vocational education in Egypt. The study used the ordered logit model and it was found that

well educated families are more likely to choose general education. It was also found that vocational education offers higher returns (earnings) in comparison to general education for men not women.

Krafft (2013) compared the returns to formal vocational secondary education and the returns to vocational skills through other informal routes, such as apprenticeships in Egypt. The study used the panel data set and compared between siblings. The results showed that returns to vocational skills are even for recent graduates. It was also concluded that the formal vocational route is not the best route to prepare youth for employment.

Alquezar and Johansen (2010) intended to offer a clearer view of how education and training contribute to national economic competitiveness and how human capital is measured. The study also explained the difference between the two major international indices published by the World Economic Forum (WEF) and the Institute for Management Development (IMD). The study confirmed that both WEF and IMD followed the same premises and used the same data source. However, the methodologies were not identical. The main difference between the WEF and the IMD indices was how the indicators were weighted, which in turn depended on classifying countries according to their stage of development.

4- DATA AND METHODOLOGY

This research applied autoregressive integrated moving average (ARIMA) which is a common model for short-time forecasting. The ARIMA model is (p,d,q), in which (p) is the order of the autoregressive (AR) process, (d) is the number of differences and (q) is the order of the moving average (MA) process. The data used was based on the statistical year book published by the Central Agency Public Mobilization and Statistics (CAPMAS) during the period 1987 to 2017. Data were processed by the software E-views version 9.0 and SPSS version 24.

5-DISCUSSION AND RESULTS

According to the World Economic Forum (WEF) the Global Competitiveness Index (GCI), measures the competitiveness of countries through 12 pillars of competitiveness divided into three major groups. The WEF defines competitiveness as the set of institutions, policies, and all factors that determine the level of productivity of a country. The GCI uses human capital as the way leads to national competitiveness. The GCI emphasized on the importance of education in determining labor efficiency. The Egyptian economy according to GCI is

considered to be at the factor driven stage, in 2017/2018 the Egyptian rank of GCI was 100 out of 137 countries which is considered a very low ranking. Egypt ranked 100 in the higher education and training. Also, Egypt ranked 84 in the gross secondary education enrollment rate, while ranked 130 in the quality of the education system (World Economic Forum, 2018).

According to table 1, (appendix) the gross enrollment secondary ratio for boys was 67.7% (29.7 and 38 for general and technical respectively) and 67.4 % for girls (36.5 and 30.9 for general and technical respectively), while the world gross enrollment secondary ratio was 76.427% in 2016 which shows the low Egyptian enrollment rates. Also, these ratios indicate that technical education have more boys than general education and the opposite is true for girls. This phenomenon could be understood if the education is linked to work since Egyptian girls show higher enrollment rate in education at the secondary stage and low participation in workforce, and the opposite is true for boys. However, choosing the general or the technical path is not always an optional choice, but it depends mostly on the score of the final exams at the end of preparatory stage, where students who got higher test scores would go to general schools, which leads to more academic education (universities and higher institutions). While other students who got lower scores would go to technical schools (mainly three tacks; commercial, agricultural and industrial), which is a terminal path that leads to work. However, some families and young people prefer to choose the vocational path since it leads to work directly without any further education. The net enrollment secondary ratio for boys was 57.7% (26.9 and 30.8 for general and technical respectively) and 61.3% (33.7 and 27.6 for general and technical respectively), while the world net ratio was 65.646%. Apparently, girls preferred the commercial secondary schools over other technical paths. This might be because it is the easiest path for them to finish their education and get married. Also, Egyptian girls have poor participation in the labor force, while boys preferred industrial secondary schools in order to get a job after finishing the school.

Table 2 shows the distribution of labor force and unemployment percentages by the level of education. Apparently, the unemployment rate slightly declined from 13% to 12.5% in 2014 and 2016. The massive problem appears among the labor force where about two fifth of them have very poor education (illiterate, read and write and less than intermediate) throughout the three years, they would compose the highest probability of being employed. This might be because they cannot afford to be unemployed, and they most probably accept any job

regardless the low quality of the job or the low income. Surprisingly, technical school graduates have the second-high probability of being employed and have much higher probability of being unemployed at the same time during the three years among other educational levels. However, their employability is expected since their path is a terminal path which leads directly to work. On the other hand, their unemployability is a major problem for the Egyptian economy that has not been able to offer jobs for those young people. General and Azhar's students have both the lowest probabilities of being employed or unemployed since they are still studying. The same is true for the following educational stage. The other shocking fact is the higher unemployment rates among university graduates. However, those young well-educated people may be waiting for better job offers. This implies that Egyptian economy in both cases- technical and university graduates- could not offer enough jobs for those graduates. However, this unemployment problem is largely a result of a wild skill mismatch between the demand and supply of the labor market.

Table 3 represents the annual number of students in both general and vocational secondary schools in Egypt from the year 1987 until the year 2017. The number of students either in general or vocational schools in 2007-2009 were fitted because the actual students' number were affected by the cancelation of the sixth primary year in 1998, which came back in 2004/2005. The number of vocational students outnumbered the general students along the whole period. However, the gap has decreasing since 2013. On the other hand, unfortunately the number of vocational schools were not following the same pattern of constantly increasing number of vocational students although the vocational schools need to be increased since it has a higher unit cost than general secondary education. In other words, although the vocational students were much more than general students, the number of schools did not take the same pattern. The number of vocational schools were fluctuating. Yet, since 2003, the number was decreasing compared to the number of general schools. This means poorer quality of vocational education especially it has a higher unit cost than general schools despite the political support of vocational education.

First, the Augmented Dickey Filler (ADF) unit root test was applied- which is a formal test for stationary- to the four time series and the related results are reported in table 4. The level of stability was not significant for all series. In other words, the series were not stationary, and it is necessary to transform those series to make them stationary in order to apply the ARIMA models. Thus, to make the time series stationary, the first difference was calculated

and was significant only for both; series general students and vocational schools, which confirmed that the stationary was obtained. Then, the second difference was calculated and was significant for both; series general schools and vocational students which confirmed that the stationary was obtained for those time series.

6. The ARIMA general and vocational students' models

Since the time series are now stationary, the Box-Jenkins methodology can be applied as a suitable technique for short run forecasting. Table 5 shows the two ARIMA models' statistics for general and vocational students. The ARIMA (1,1,0) was found to be the most suitable model for general students where the r-squared was equal to 98.3, while ARIMA (1,2,0) was found to be the most suitable model for the vocational students where the r-squared was equal to 89.4. Those models confirmed that the order of the autoregressive process is one for the two models, and the number of differences is one for the general students, and two for the vocational students, with no moving averages for both models. The table also shows that there were no autocorrelations between the residuals.

Parameter estimates in Table 6 were also found statistically significant for both ARIMA models for general and vocational students. The ARIMA models can be express as follows:

$$\hat{Y}_t = \mu + (Q+1)\, Y_{t-1} - Q\, Y_{t-2}$$

$$\hat{Y}_t = 37811 + 1.361\, Y_{t-1} - 0.361\, Y_{t-2}$$

$$\hat{Y}_t = \mu + (Q+2)\, Y_{t-1} - (Q+1)\, Y_{t-2}$$

$$\hat{Y}_t = 1739.8 + 1.5424\, Y_{t-1} - 0.5424\, Y_{t-2}$$

Figure 1 shows the residual graph of the two models (general and vocational students), where all residuals were within the limits (less than 0.5). Also, the using of Ljung-Box test confirmed that there was no autocorrelation between the residuals.

Figure 2 shows the observed values of the time series from 1978 to 2017 and the forecasting values for 2018 to 2022. The figure shows that the general students curve has an increasing trend, while the vocational students curve has a fluctuating trend. Table 7 shows the forecasting values of general and vocational students, and the upper and lower limits. The expected number of students for both tracks show that they are going to increase since the number of population at this age is increasing. However, the rate of annual change is decreasing (i.e. The rate of change in general students' model is 2.8 and 2.0 in 2018 and 2022

respectively, whereas the rate of change in vocational students' model is 4.2 and 3.9 in 2018 and 2022 respectively). This could mean that students may leave the schools without completing the secondary stage for many reasons. These reasons could be that their families could not be able to afford the education expenses any more, or the students join the workforce, or because of their poor performance at school, or their low expectation about the value of education since the unemployment rate are highest among the highly educated people. On the other hand, the rate of annual increase of expected vocational students are higher than those of general education which could de because vocational seems a faster way to get a job to escape from poverty or the unemployment trap either from families or students' point of view.

6.1. The ARIMA general and vocational schools' model

Table 8 shows the ARIMA models' statistics for general and vocational schools. The ARIMA (1,1,0) was found to be the most suitable model for general schools, whereas ARIMA (1,2,0) was the suitable for vocational schools. The r-squared were 99.7 and 84.6 respectively. There was no autocorrelation between the residuals.

Parameter estimates in Table 9 were also found statistically significant for both ARIMA models for general and vocational schools. The ARIMA models can be express as follows:

$$\hat{Y}_t = \mu + (Q+1)\, Y_{t-1} - Q\, Y_{t-2}$$

$$\hat{Y}_t = 85 + 1.507\, Y_{t-1} - 0.507\, Y_{t-2}$$

$$\hat{Y}_t = \mu + (Q+2)\, Y_{t-1} - (Q+1)\, Y_{t-2}$$

$$\hat{Y}_t = -4.4 + 0.323\, Y_{t-1} + 0.677\, Y_{t-2}$$

Figure 5 shows the residual graph of the two models (general and vocational schools) where all residuals were within the limits (less than 0.5). Also, the using of Ljung-Box test confirmed that there was no autocorrelation between the residuals.

Figure 7 shows the observed values of the time series from 1978 to 2017, and the forecasting values for 2018 to 2022. The figure shows that the general school curve has an increasing trend, while the vocational schools curve has a fluctuating trend (similar to both general and vocational students' curves).

Table 10 shows the forecasting values of general and vocational schools, and the upper and lower limits. The expected number of schools for both tracks is going to increase which is the same pattern as for the general and vocational students. Also, the rate of change is decreasing for both general and vocational schools (3.2 and 2.2 in 2018 and 2022 in general schools' model, and 2.2 and 1.4 in 2018 and 2022 in vocational schools' model). A very important conclusion is that the average change rate in the next five years for expected general students is 2.3 and the average expected school is 2.6 for the same period which means the school capacity would be slightly better in general education. Unfortunately, the same is not true in vocational education, where the average change rate is 4.0 and 1.8 in the expected vocational students' number and the expected vocational schools respectively. This means that there will be a major problem in the next five years in vocational secondary education concerning the school capacities and would eventually reduce the quality of vocational education.

Table 1: The gross and net enrollment general secondary and technical secondary ratios in Egypt (2016\2016).

	Gross enrollment ratio	Net enrollment ratio
General secondary Boys Girls	66.2 29.7 36.5	60.6 26.9 33.7
Industrial secondary Boys Girls	35 22 13	29.9 18 11.9
Commercial secondary Boys Girls	26.2 9.7 16.5	22.2 7.8 14.4
Agricultural secondary Boys Girls	7.7 6.3 1.4	6.3 5 1.3
Total Gross Enrollment ratio for Boys (general and technical) General Technical	67.7 29.7 38	
Total gross enrollment ratio for girls (general and technical) General Technical	67.4 36.5 30.9	
Total net enrollment ratio for boys (general and technical) General Technical		57.7 26.9 30.8
Total net enrollment ratio for girls (general and technical) General Technical		61.3 33.7 27.6

Calculated by the researcher based on data from the Statistical Yearbook 2017(CAPMAS).

Table 2: Percentage of labor force and unemployment by educational status in Egypt (2014-2016).

Educational status	% of labor force			% of unemployment		
Year	2014	2015	2016	2014	2015	2016
Illiterate	23.5	14.4	18.09	10.44	4.36	4.92
Read & write	9.13	10.05	10.04	6.09	4.5	4.03
Lower than Intermediate	11.63	13.78	13.80	10.32	9.57	9.55
Total	44.26	38.23	41.93	26.85	18.43	18.5
General and Azhar secondary	1.49	1.51	1.99	1.66	1.5	1.43
Technical Intermediate	31.7	33.09	32.50	39.75	43.61	43.98
Upper than Intermediate and lower than University	4.36	4.56	4.71	3.84	4.75	4.66
University and above	18.18	19.09	18.86	27.91	31.75	31.40
Unemployment rate				13.0	12.8	12.5

Calculated by the researcher based on data of the statistical yearbook (CAPMAS) 2015,2016,2017.

Table 3: General and vocational students and schools.

Year	General school students	Vocational school students	General schools	Vocational schools
1987	564,678	901,271	940	947
1988	555,247	929,177	994	1,265
1989	569,939	950,133	1,105	1,245
1990	576,435	1,026,159	1,145	1,385
1991	572,026	1,062,020	1,186	1,131
1992	727,690	1,403,273	1,295	1,196
1993	786,024	1,600,291	1,340	1,252
1994	844,358	1,797,308	1,384	1,308
1995	817,387	1,672,580	1,396	1,334
1996	830,562	1,788,394	1,452	1,668
1997	908,493	1,793,128	1,515	1,729
1998	968,708	1,852,332	1,562	1,767
1999	1,039,958	1,913,022	1,601	1,826
2000	1,087,503	2,051,460	1,661	1,882
2001	1,162,879	2,149,408	1,783	1,940
2002	1,249,706	2,214,152	1,942	1,959
2003	1,272,650	2,199,480	2,081	1,933
2004	1,299,233	2,090,008	2,170	1,868
2005	1,239,189	1,961,162	2,239	1,810
2006	1,173,811	1,793,609	2,291	1,801
2007	1,188,292	1,746,988	2,284	1,792
2008	1,202,773	1,700,367	2,332	1,790

2009	1,217,254	1,653,746	2,414	1,801
2010	1,231,735	1,607,125	2,632	1,829
2011	1,324,440	1,628,168	2,780	1,891
2012	1,390,262	1,686,859	2,874	1,929
2013	1,455,472	1,609,879	2,994	1,984
2014	1,535,064	1,645,750	3,114	1,995
2015	1,576,336	1,710,686	3,235	2,150
2016	1,641,218	1,793,108	3,334	2,204
2017	1,708,847	1,864,842	3,468	2,266

Source: CAPMAS statistical year book (1987-2017).

Students' Models

Table 4: Augmented Dickey-Fuller unit root tests for general and vocational students.

Augmented Dickey-Fuller test statistic		t-Statistic	Prob.*	different level
General	Student	-3.6079	0.012	first diff.
	School	-5.8736	0.001	second diff.
Vocation	Student	-8.5229	0.001	second diff.
	School	-6.5756	0.001	first diff.

Table 5: ARIMA general and vocational students model statistics.

	general students	vocation students
Model_1	ARIMA (1,1,0)	ARIMA (1,2,0)
Stationary R-squared	0.128	0.223
R-squared	**0.983**	**0.894**
MAE	31328	66677
Statistics	17.105	18.719
DF	17	17
Sig.	0.447	0.345

Table 6: Model parameters for general and vocational students.

ARIMA Model Parameters			Estimate	SE	t	Sig.
General students	Constant		**37811**	12391	3.051	0.005
	AR	Lag 1	**0.361**	0.177	2.043	0.049
	Difference		**1**			
Vocational students	Constant		**1739.8**	13366.0	0.130	0.897
	AR	Lag 1	**-0.458**	0.170	-2.697	0.012
	Difference		**2**			

$$\hat{Y}_t = \mu + (Q+1)\, Y_{t-1} - Q\, Y_{t-2}$$

$$\hat{Y}_t = 37811 + 1.361\, Y_{t-1} - 0.361\, Y_{t-2}$$

$$\hat{Y}_t = \mu + (Q+2)\, Y_{t-1} - (Q+1)\, Y_{t-2}$$

$$\hat{Y}_t = 1739.8 + 1.5424\, Y_{t-1} - 0.5424\, Y_{t-2}$$

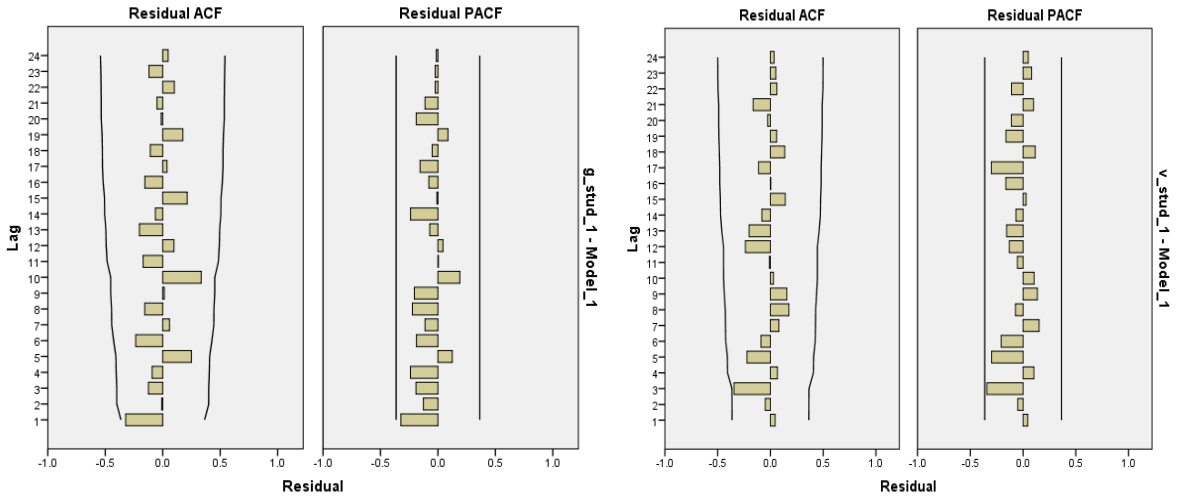

Figure 1: ACF and PACF graphs of the residual's series for general and vocational students.

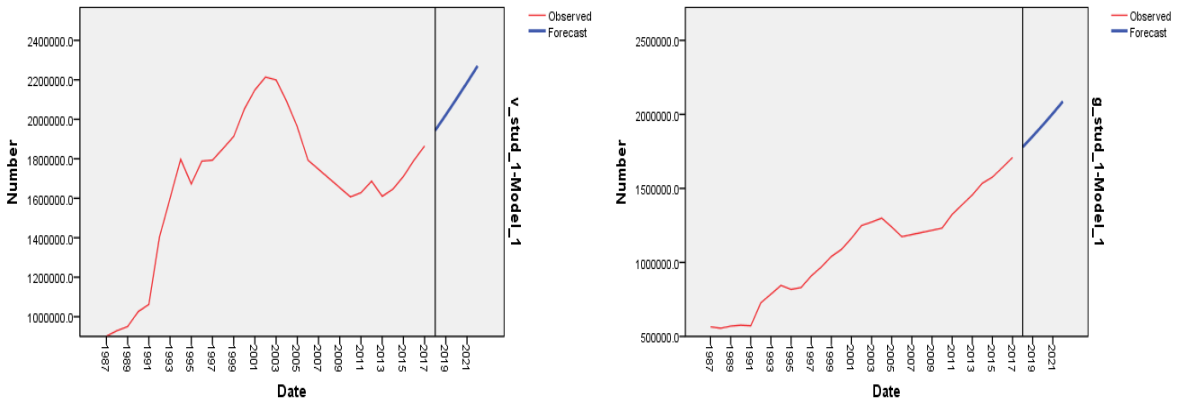

Figure 2: The graph of the observed and forecasted values for general and vocational students.

Table 7: Forecasting general and vocational students for 2018-2022.

Model		2018	2019	2020	2021	2022	2018	2019	2020	2021	2022	Average
General students	Forecast	1757432.9	1799137.6	1838355.7	1876675.3	1914670.1	2.8%	2.4%	2.2%	2.1%	2.0%	2.3%
	UCL	1847829.6	1951832.5	2042082.1	2123377.1	2198660.3	8.1%	5.6%	4.6%	4.0%	3.5%	5.2%
	LCL	1667036.3	1646442.7	1634629.4	1629973.5	1630680.0	-2.4%	-1.2%	-0.7%	-0.3%	0.0%	-0.9%
Vocational students	Forecast	1944002.3	2022300.4	2103528.9	2185952.4	2270364.9	4.2%	4.0%	4.0%	3.9%	3.9%	4.0%
	UCL	2156921.1	2413695.9	2729476.1	3072743.5	3449514.7	15.7%	11.9%	13.1%	12.6%	12.3%	13.1%
	LCL	1731083.4	1630904.9	1477581.6	1299161.2	1091215.2	-7.2%	-5.8%	-9.4%	-12.1%	-16.0%	-10.1%

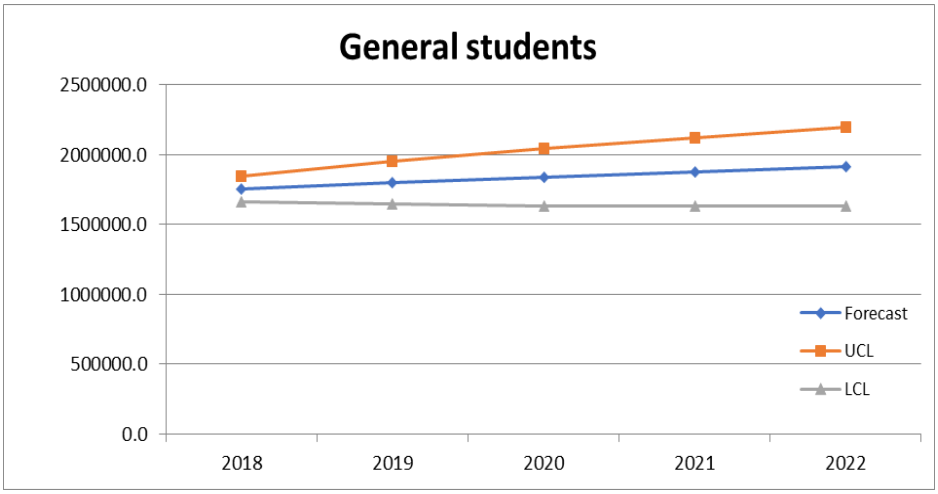

Figure 3: Forecasting general school students and the upper and lower limits.

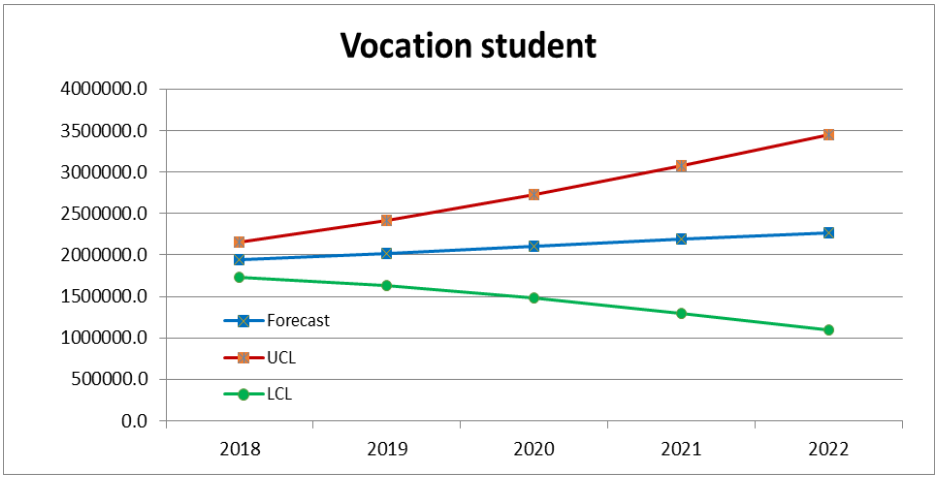

Figure 4: Forecasting vocational school students and the upper and lower limits.

Schools' models

Table 8: ARIMA general and vocational schools model statistics.

Model Statistics		
	General secondary school	**Vocation secondary school**
Model_1	ARIMA(1,1,0)	ARIMA(1,2,0)
Stationary R-squared	0.258	0.325
R-squared	**0.997**	**0.846**
MAE	31.873	75.033
Statistics	9.446	7.627
DF	17	17
Sig.	0.925	0.974

Table 9: Model parameters for general and vocational schools.

ARIMA Model Parameters			Estimate	SE	t	Sig.
General schools	Constant		**85**	15	5.527	0.000
	AR	Lag 1	**0.507**	0.165	3.070	0.005
	Difference		**1**			
Vocation schools	Constant		**-4.4**	13.0	-0.336	0.739
	AR	Lag 1	**-0.677**	0.138	-4.915	0.000
	Difference		**2**			

$$\hat{Y}_t = \mu + (Q+1)\, Y_{t-1} - Q\, Y_{t-2}$$

$$\hat{Y}_t = 85 + 1.507\, Y_{t-1} - 0.507\, Y_{t-2}$$

$$\hat{Y}_t = \mu + (Q+2)\, Y_{t-1} - (Q+1)\, Y_{t-2}$$

$$\hat{Y}_t = -4.4 + 0.323\, Y_{t-1} + 0.677\, Y_{t-2}$$

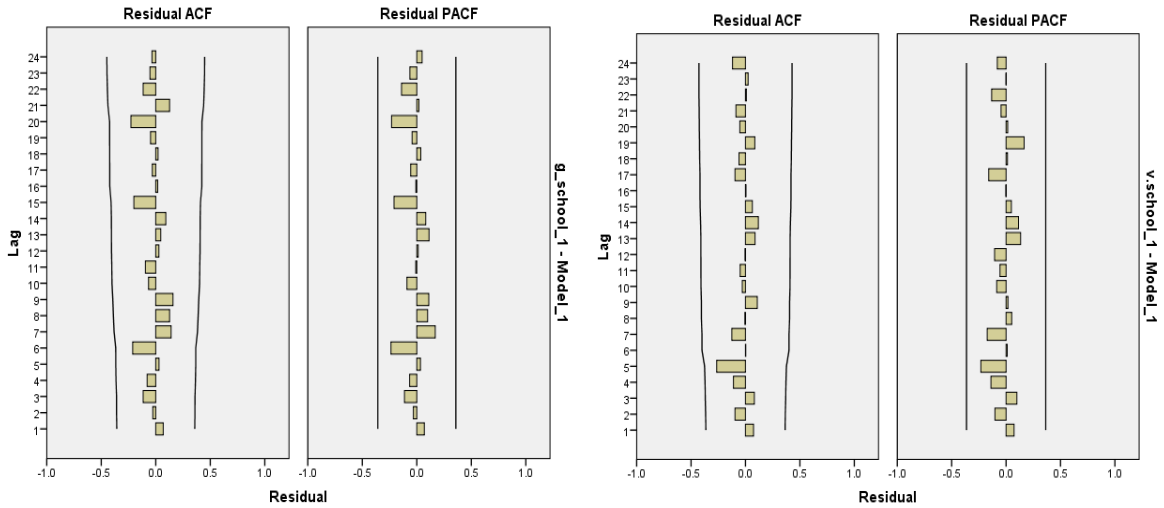

Figure 5: ACF and PACF graphs of the residual series general and vocational schools.

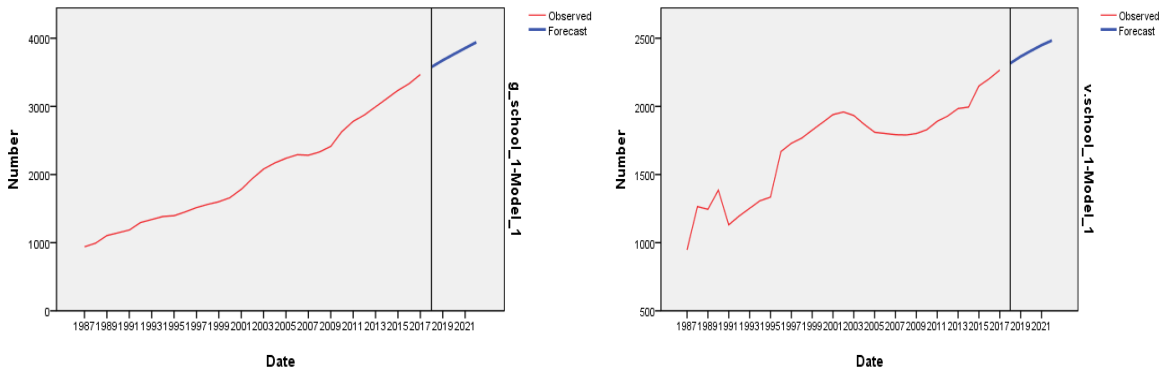

Figure 6: The graph of the observed and forecasted values for general and vocational schools.

Table 10: Forecasting general and vocational schools for 2018-2022.

Model		2018	2019	2020	2021	2022	2018	2019	2020	2021	2022	Average
General students	Forecast	3578	3675	3767	3855	3941	3.2%	2.7%	2.5%	2.3%	2.2%	2.6%
	UCL	3665	3834	3988	4131	4267	5.7%	4.6%	4.0%	3.6%	3.3%	4.2%
	LCL	3490	3517	3545	3578	3616	0.6%	0.8%	0.8%	0.9%	1.0%	0.8%
Vocational students	Forecast	2315	2366	2408	2449	2483	2.2%	2.2%	1.8%	1.7%	1.4%	1.8%
	UCL	2552	2759	3043	3329	3654	12.6%	8.1%	10.3%	9.4%	9.8%	10.0%
	LCL	2078	1973	1773	1568	1313	-8.3%	-5.1%	-10.1%	-11.6%	-16.3%	-10.3%

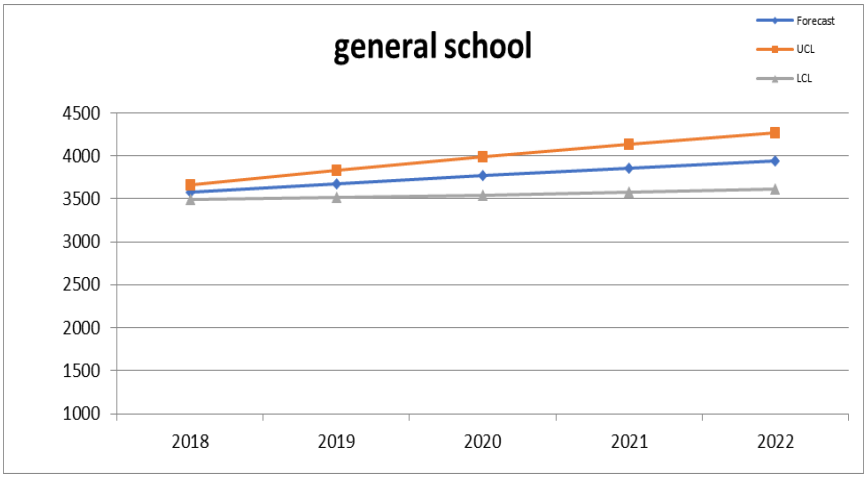

Figure 7: Forecasting general schools and the upper and lower limits.

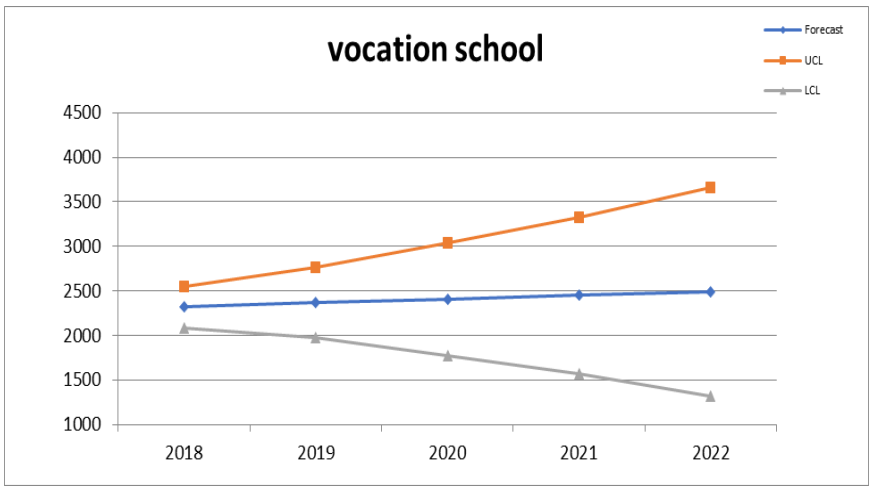

Figure 8: Forecasting vocational schools and the upper and lower limits.

7-CONCLUSION AND RECOMMENDATION

According to the previous time series modeling, the number of schools must be increased in both; general and vocational secondary tracks as a first step to absorb the expected number of students especially in vocational schools which have a greater percentage of the Egyptian students and have higher unit cost than the general track. Also, this needed increase in the number of schools will raise the quality of education in the secondary education stage which eventually will increase the youth employability. In other words, there is a need to raise the

quality and quantity of secondary education both in general and vocational education. Also, more attention would be necessary for vocational education since it has a greater number of students, and since vocational track leads directly to work, which would decrease unemployment. Egypt must invest in education and training since it is the only way to increase the potential of Egyptian young people. Increasing expenditure in education and training also leads to greater productivity and competitiveness, which would eventually improve the Egyptian economy and society.

8-FUTURE WORK

Applying ARIMA models would be desired in higher education, mainly among university graduates. Also, more aspects of quality of education besides number of schools; such as updating the curriculums, improving the school infrastructure, improving the teacher's skills, should be examined.

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