Research Article

Received: 31 January 2024 / Accepted: 16 April 2024 / Published: 5 May 2024

The Relative Importance of Factors Influencing Saudi Arabia's Productivity

Amna Derdab[1]

Mohammad AlFadhli[2]

Shihanah Almutairi[1]

Ahmad Alsaber [1*]

Karim Ullah [3]

[1]College of Business and Economics,
American University of Kuwait,
15 Salem Al Mubarak St,
Salmiya, Kuwait
[2]The University of Adelaide, North Terrace,
Adelaide, SA, Australia,
South Australia
[3]Institute of Management Sciences,
Peshawar,
Pakistan
**Corresponding Author*

DOI: https://doi.org/10.36941/ajis-2024-0084

Abstract

A country's productivity reflects its current economic standing and where it could potentially grow in the future. This paper explains the relative significance of factors affecting the productivity of Kingdom of Saudi Arabia (KSA). The issue of productivity has been raised in the growing diversion of the economic literature to the development side, leaving little research on countries productivity as measured in gross domestic product (GDP), that provides empirical basses for the developmental debates. Eight important factors are researched for their relative explanation of the KSA's productivity, which include the spendings on i) education, 2) subsidies, 3) research & development, 4) physical capital, 5) health, 6) gender equality, 7) inflation, and 8) openness to trade. These factors are assessed using the Ordinary Least Squares (OLS) and combine autoregressive features with those of moving averages (ARIMA). The study has theoretical implications for raising fresh evidence for the relative importance of these factors of production for developing countries such as KSA. The relative significance of these factors also informs predictions and policy making for the efficient resource allocation of keeping in view the targeted productivity level while chasing developmental objectives, such as those envisioned for 2030 in KSA.

Keywords: *Productivity; Gross Domestic Product (GDP); Economic growth; Saudi Arabia*

1. Introduction

Productivity is an essential part of every country' development as it helps to know the current throughput and its future potential, impacting the standard of living in a country and its overall development (Chen et al., 2022). Productivity is commonly measured through gross domestic product (GDP) which consists of four components: net exports, private consumption, gross capital investments, and government expenditure (Ahmed & Miller, 2000). The recent debates, however, suggesting to go beyond GDP and taking more developmental aspects into considerations (Kubiszewski et al., 2013).

There is a critique of the GDP variable ignoring fundamental variables that may strongly affect the standard of living in a country along with reflecting the true welfare of the citizens of a country. Another prevalent productivity measure is the production possibility frontier model, which conveys the level of productivity in an economy. Economists may identify the range of values at which a nation's economy can best allocate its resources to generate the greatest number of goods. The country can only create more of one good if it produces less of another if the production level is on the curve. A way to produce more in an economy without having to compromise any good – which is what most of the extremely powerful countries are doing now– is through technological advancements. The extension of productivity to the developmental aspect has attracted research, but it also eluded the focus on the recent empirics of productivity, which may provide bases for the developmental debates to be more rational. This is particularly true, when the practice in the developmental countries, such as KSA, GDP is still used as measure of productivity and the relative importance of its factors supported with fresh evidence is of immediate significance. This study has therefore aimed to explain the relative significance factors affecting the KSA's GDP.

As per the World Bank Data, KSA's current GDP is projected to be $833Bn and the gross private investments account for 24% of GDP, government spending is 24.43% of the GDP and net exports are at $133.1Bn. These statistics showcase that KSA is currently doing well and it plans on improving even further. KSA plans to adopt a knowledge-based workers market that will function under a sustainable and diverse market. This will be achieved through its 2030 vision in which the country will strategize to increase its Foreign Direct Investments (FDI) from 3.8% to 5.7% of GDP in order to improve the standard of living. Furthermore, the government's revenue is currently at SAR 163 billion and aimed to increase it to SAR 1 trillion by 2030. Additionally, KSA has increased its expenditure on education, which is represented by the fact that it accounts for 7.8% of the country's GDP; this is higher than the average of Organization for Economic Cooperation and Development (OECD) countries where contribution to education is only at 5.2% of the GDP (The World Bank, 2015). Other important factors that could potentially account for productivity that are disregarded by GDP includes the welfare of people, income inequality, and externalities. The issue with externalities are though hard to track, since they are not considered in a market, yet still affect livelihood of the citizen. This research is however limited to the aggregate output as GDP. This research also take total factor productivity (TFP), which take productivity in relative term as is measure each factor of the productivity as percentage of the aggregate output. Next section review the literature to provide bases for further analysis of the KSA's productivity.

2. Literature Review

This literature review is arranged interactively/thematically (Neuman, 2014) on the ground of mostly discussed factors of a country's productivity. Literature has suggested many integral variables contribute to the productivity of a country.

First, education has been repeatedly expressed as determining a country's productivity variable is education. It has been recognized that highly educated workers earn higher wages than less-educated workers because they are simply more productive (Kampelmann et al., 2018). This also explains the wage inequality as it does not stem from unfairness, but rather from the rational strategies of firms (Lazear & Shaw, 2007). A key argument is that low-educated workers are too costly relative to their added value; this is why some firms would rather replace these workers with capital, outsourcing their labor to countries that provide cheaper labor, or hire higher-educated workers (Kampelmann et al., 2018). These points showcase the prominence of education and its effect on productivity. Workers with higher levels of education, training, and expertise are better able to progress technology and aid in the adoption of new technologies, particularly those from other countries (Benhabib & Spiegel, 1994; Im & Rosenblatt, 2015; Romer, 1990; Faisal et al., 2024))

Second, key variable in productivity is technology. The estimated production frontiers model can be used to identify the main drivers of productivity change: a technical change component that measures movements in the production frontier, a technical efficiency change component that measures movements towards or away from the frontier, and scale and mix efficiency change components that measure productivity gains associated with economies of scale and scope (O'Donell, 2014). The literature showed that technology and productivity have a positive relationship; an improvement in technology and technological innovation causes productivity to increase (AlShamali and AlMutairi, 2022). A nation can become more productive by being more efficient through technology. The first benefit of technological advancement would be the ability to produce more outputs with the same inputs such as labor and capital. The impact assembly lines had on the manufacturing and number of cars is a clear example. The standard of the goods and services produced in an economy would be the second advantage. The sophistication of the goods and services increases with the amount of technology. Costs are another significant benefit; they decrease with increasing technological sophistication. Certain sectors, such as manufacturing and agriculture benefit immensely from the development of technology and have also experienced breakthroughs due to technological advancements.

Third, subsidies have also been related to productivity. While it is believed that subsidies help improve productivity, since subsidies allow for firms to produce at a lower price. However, despite this being a positive, it also has negative effects. Subsidies – although may be positive in developed countries and boost employment – are regarded as negative in developing countries (KSA is a developing country). This is due to the fact that European countries are exporting at prices that are much lower than the cost of production, which is harming markets in developing countries (Godfrey, 2002). An example of a country that is struggling is Mozambique in which approximately 80% of the population live in rural regions, where agriculture is the only source of employment. Sugar is a high-potential export crop that can help stabilize family incomes and enable livelihood diversification. However, the EU has become an obstacle in this sense because the exporting of European surpluses reduces Mozambique's exporting revenues (Godfrey, 2002). This finding implies that subsidies from developed countries influence developing countries negatively. Moreover, the literature also shows that despite subsidies having a positive effect on employment, it negatively affects Small to Medium sized Enterprises (SMEs') annual productivity growth (Karhunen & Huovari, 2015). Small to Medium sized Enterprises in developing countries are negatively affected due to developed countries overshadowing them with their exports, since the same products are being exported to developing countries at a lower price, inhibiting those SMEs from truly optimizing their levels of profit. The contrasting effects of subsidies show how an effect that may be harmful to one country is advantageous to another and how the developed countries are benefitting at the expense of developing countries.

Fourth, Research and Development (R&D) has also been observed contributing to productivity. A study in China shows that an increase in R&D will cause higher technological and commercialized innovation outputs compared to their non-supported counterparts (Howell, 2017). Despite the fact that this paper looks at productivity, research, and innovation at a firm level, it still reflects the economy as a whole. Physical capital is another significant variable when it comes to economic productivity. A positive relationship between physical capital and productivity was seen in India (Malik et al., 2021). It have also concluded that physical capital increases productivity and is one of the main drivers of productivity (Eder et al., 2022). Physical capital is defined as man-made tangible assets or inputs that facilitate the production of commodities and services. Physical capital augments labor and increases productivity by allowing for faster production of goods and services. It is regarded as one of the most important production factors in classical and neoclassical economics. Examples of physical capital would be machinery, buildings, cars, equipment, and other items.

Fifth, an integral variable that should not be disregarded, is health and its effect on productivity. Health improvements increase worker productivity. Healthy employees are often more productive, quicker learners, and more dedicated to developing their abilities. (Benhabib & Spiegel, 1994). Education and good health go hand in hand, strengthening the availability of a skilled workforce (Bloom et al., 2004; Knowles & Owen, 1995).

Sixth, another important factor is gender equality. The share of women in the active working population of the Middle East and Africa has increased significantly in recent decades (AlMutairi & Yen, 2022; Dai, 2022; Dedrick et al., 2013; Hamdan, 2016). When more women are given opportunities, and when they are more educated, productivity increases. An increase in female education can benefit social engagement and the health of civic society. Additionally, it helps extend viewpoints while making decisions, which can lead to better productivity (Geng & Kali, 2021; Loko & Diouf, 2021; Schober & Winter-Ebmer, 2011).

Seventh, and more surprisingly, the literature is inclusive towards the effect of inflation on productivity, in which findings found the relationship to be either positive or negative. A study in Pakistan revealed that inflation and productivity had a positive relationship (Hussain & Malik, 2011). Similarly, it has also been shown that inflation and productivity had a positive relationship in India (Saxena & Bansal, 2019). However, differing results occur when looking at Japan (Nagayasu, 2017). Trade has a positive effect on productivity. More open economies are more productive (Alcalá & Ciccone, 2004; De Loecker, 2013; Frankel & Romer, 1999; Hall & Jones, 1999).

Another study showcased that an increase in trade openness from an overall average of 85.7% over the 2000-2007 period to 98.4% over the 2008-2015 period, the overall average of 3.1% growth rate during the former period, plummeted to an average of just 0.5% during the latter period. This might somewhat reflect the so-called secular stagnation (Ali et al., 2020). This study was done for 27 countries and showcases that trade and export are insignificant and ambiguous. However, it has also been shown that exports are insignificant in relation to GDP (Mukit, 2021). Instead, long-term drivers of productivity were found to be innovation, education, and investment in physical capital.

3. Methodology

This study investigates the factors that affect productivity in *KSA*. While some may be accounted for in the Gross Domestic Product (GDP), some are neglected but do have a significant effect on the GDP and overall productivity of the country. The regression model utilized in this paper was one that composed of different independent variables and their effect on the dependent variable – which is productivity. These variables were based on what was found in the literature and each variable is a percentage. Most of the variables are a percentage of the overall GDP with a few exceptions (female participation is a part of the % labor force, inflation is measured by its percentage change in the consumer price index (CPI), and subsidies are measured through their percentage of government budget).

The variables in the model were then subjected to regression analysis, which has revealed the levels of impact and strength of relationships of the independent variables with the dependent variable, which is the GDP along the level of significance. While some variables were demonstrated to be not significant and others were demonstrated to have a considerable effect as shown in the results section. The associations between dependent variable, total factor productivity (TFP), and the independent variables are also investigated.

For measurement of the variables, secondary data from the World Bank and the FRED database were utilized to compile statistics the factors including GDP, EDU, THE, SUBS, PAT, HCS, and GEN as defined in the model. The data from these sources has enabled the research to identify trends in these variables and also the relative significance of each variable in its connection to the production.

The OLS model is utilized in this research paper, which is a regression estimation technique.

The model:

$$\mathbf{Prod = \beta 0 + \beta^{+}1Edu + \beta^{-}2Sub + \beta^{+}3RD + \beta^{+}4k + \beta^{+}5Hea + \beta^{+}6G + \beta^{\pm}7Inf + \beta^{\pm}8T + \varepsilon}$$

PROD: productivity (the dependent variable)
EDU: Education: measured as government expenditure on education (% of GDP)
SUB: Subsidies: measured as subsidies and other transfers (% of government budget)
RD: Research and development: R&D expenditure (% of GDP)
K: Physical capital: gross capital formation (% of GDP)
HEA: Health: current health expenditure (% of GDP)
G: Gender equality: women participation in labor force (% of total labor force)
INF: Annual Inflation: consumer prices for KSA, (% change in CPI)
T: [Openness to] Trade: trade (% of GDP)
ε: the error term

3.1 Statistical methods

A linear regression analysis was conducted to assess whether GDP, EDU, THE, SUBS, PAT, HCS, and GEN significantly predicted TFP. The assessment of normality was conducted by creating a Q-Q scatterplot, which involved displaying the quantiles of the model residuals against the quantiles of a Chi-square distribution (DeCarlo, 1997). In order to satisfy the assumption of normalcy, it is necessary for the residuals' quantiles to exhibit minimal deviation from the theoretical quantiles. Significant variations may suggest that the estimated parameters lack reliability. The Q-Q scatterplot of the model residuals is depicted in Figure 1. In addition, as a further robustness check, we implemented a beta-regression on the original TFP variable (i.e., without the log transformation). The beta-regression is, in fact, specifically devised for proportion-dependent variables. Overall, the three models provide similar results. All the data elaborations were performed in Stata 18 and SPSS 28.

Moreover, the Autoregressive Integrated Moving Average (ARIMA) model, which is a widely employed technique for time series forecasting, is utilized for the purpose of modelling time series data and generating forecasts. ARIMA models necessitate the temporal dimension as they are employed for the purpose of modelling time series data and generating predictions. ARIMA models need the time series to exhibit stationarity, which implies that the mean and variance should remain relatively constant throughout time. In order to account for the non-stationarity of the dataset employed in this study, differencing is applied to provide temporal stability. In order to mitigate the issue of non-stationarity in the dataset utilized for this study, the technique of differencing is implemented as a means to attain stationarity. The process of differencing entails utilizing the difference as a method to attain stationarity. The process of differencing entails subtracting successive observations in order to eliminate patterns or seasonality.

4. Results

The data collected for GDP exhibited an average value of 8.07, with a standard deviation (SD) of 13.43. The standard error of the mean (SEM) was calculated to be 2.93. The minimum and maximum values observed for GDP were -17.45 and 27.08, respectively. The distribution of the data was somewhat negatively skewed, with a skewness coefficient of -0.28. The median (Mdn) value for GDP was found to be 9.64. The kurtosis coefficient indicated a slight platykurtic distribution, with a value of -0.92.

The data collected for the variable "EDU" yielded a mean of 6.19, with a standard deviation of 1.20. The data collected for this study was analyzed using various statistical methods. The mean value was calculated to be 0.26, with a mean of 5.10 and a maximum of 8.50. The distribution was somewhat positively skewed, with a skewness coefficient of 0.53. The median value was found to be

5.90, with a kurtosis coefficient of -1.26.

The data for the variable "THE" had an average value of 0.69, with a standard error of 0.25. The data for the SUBS variable had an average value of 8.98, with a standard error of 3.14. The data for the Performance Assessment Test (PAT) had an average score of 443.86, with a mean of 93.63. The data for the HCS (Healthcare Satisfaction) study had an average observation value of 4.45, with a mean of 0.99 and a standard error of the mean of 0.22.

The data for the Total Factor Productivity (TFP) had an average value of 1.29, with a mean of 0.05. The skewness of the data was 0.14, indicating a little deviation from a perfectly symmetrical distribution. The median value for TFP was 1.23. The kurtosis of the data was calculated to be -1.43, suggesting a relatively flat distribution with thinner tails compared to a normal distribution. When the absolute value of the skewness exceeds 2, the variable is considered to exhibit asymmetry with respect to its mean. The summary data are presented in Table 1.

Table 1. Summary Statistics Table for Interval and Ratio Variables

Variable	*M*	*SD*	*n*	SE_M	Min	Max	Skewness	*Mdn*	Kurtosis
GDP	8.07	13.43	21	2.93	-17.45	27.08	-0.28	9.64	-0.92
EDU	6.19	1.20	21	0.26	5.10	8.50	0.53	5.90	-1.26
THE	0.69	0.25	21	0.06	0.29	1.30	0.74	0.65	0.29
SUBS	8.98	3.14	21	0.68	7.00	19.20	1.91	7.00	3.36
PAT	443.86	429.06	21	93.63	46.00	1,294.00	0.79	288.00	-0.90
HCS	4.45	0.99	20	0.22	2.97	6.26	0.53	4.23	-1.03
GEN	15.28	1.67	21	0.36	13.60	20.90	2.06	14.80	4.47
TFP	1.29	0.25	21	0.05	0.95	1.67	0.14	1.23	-1.43

A Pearson correlation analysis was performed to examine the relationships between GDP, EDU, THE, SUBS, PAT, HCS, GEN, and TFP. The strength of the connections was assessed using Cohen's standard, which categorizes coefficients into three effect sizes. Coefficients ranging from .10 to .29 are considered minor effect sizes, coefficients ranging from .30 to .49 are considered moderate effect sizes, and coefficients over .50 are considered big effect sizes (Cohen, 2013)(Cohen, 1988).

Table 2. Pearson Correlation Matrix Among GDP, EDU, THE, SUBS, PAT, HCS, GEN, and TFP

Variable	1	2	3	4	5	6	7	8
1. GDP	-							
2. EDU	-.26	-						
3. THE	-.26	.07	-					
4. SUBS	-.30	-.13	-.07	-				
5. PAT	-.40	.43	.17	.46*	-			
6. HCS	-.58*	.50*	.18	.27	.86*	-		
7. GEN	-.39	.23	.08	.56*	.82*	.55*	-	
8. TFP	.41	-.13	-.25	-.54*	-.89*	-.72*	-.71*	-

Note. *$p<0.05$

The examination of the correlations' results was conducted using a significance level of α = .05. A noteworthy inverse relationship was identified between Gross Domestic Product (GDP) and Human Capital Score (HCS), exhibiting a correlation coefficient of -.58. This correlation coefficient suggests a substantial impact size. The statistical analysis yielded a p-value of .007, suggesting statistical significance. The 95.00% confidence interval for the correlation coefficient ranged from -.82 to -.19. This observation implies an inverse relationship between GDP and HCS, where an increase in GDP is associated with a drop in HCS. The study found a significant positive correlation between the level of education (EDU) and healthcare services (HCS), indicating that an increase in EDU is likely to be associated with an increase in HCS. A moderate effect size was observed between SUBS and PAT, suggesting that as SUBS increases, PAT also increases. A positive correlation was found between SUBS and GEN, indicating a positive correlation between the growth in SUBS and the increase in GEN. A negative relationship was found between SUBS and Total Factor Productivity (TFP), indicating a negative relationship between SUBS and TFP. A significant positive correlation was found between PAT and HCS, indicating a positive correlation between the rise in PAT and the corresponding increase in HCS. A positive correlation was found between PAT and GEN, indicating a positive correlation between the growth in PAT and the increase in GEN. A negative relationship was found between PAT and TFP, indicating a negative relationship between the growth in PAT and the fall in TFP. A noteworthy positive correlation was identified between HCS and GEN, with a correlation coefficient of .55, which suggests a substantial impact size ($p = .013$, 95.00% CI = [.14, .80]). This observation implies that there is a positive correlation between the increase in HCS and the corresponding increase in GEN. A substantial inverse association was identified between HCS and TFP, exhibiting a correlation coefficient of -.72, denoting a considerable effect magnitude ($p < .001$, 95.00% CI = [-.88, -.40]). This observation implies that there is a negative relationship between human capital stock (HCS) and total factor productivity (TFP). A noteworthy inverse relationship was identified between GEN and TFP, exhibiting a correlation coefficient of -.71, denoting a substantial effect size ($p < .001$, 95.00% CI = [-.87, -.39]). This observation implies that there is a negative relationship between the rise in GEN and the decrease in TFP. No more noteworthy relationships were identified. The results of the correlations are presented in Table 2.

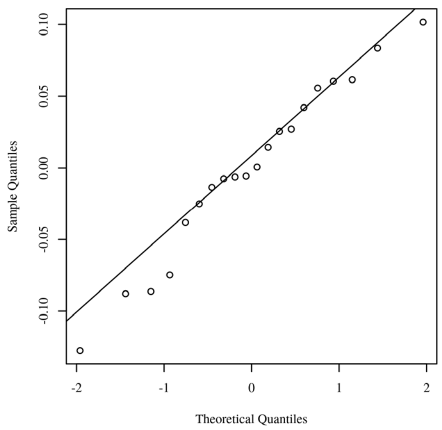

Figure 1. Q-Q scatterplot for normality of the residuals for the regression model.

The study utilized a Shapiro-Wilk test in order to assess the possibility that the residuals of the model were generated by a normal distribution (Razali & Wah, 2011). The statistical analysis using the Shapiro-Wilk test did not yield significant findings at a significant level of .05 ($W = 0.97$, $p = .764$). This finding implies that it is possible that the residuals of the model were generated by a normal distribution, so demonstrating that the condition of normality is satisfied.

The assessment of homoscedasticity involved the creation of a scatter plot depicting the residuals in relation to the anticipated values (Bates et al., 2014; Field, 2017; Osborne & Walters, 2002). The condition of homoscedasticity is satisfied when the data points exhibit a random distribution pattern, characterized by a mean of zero and the absence of any discernible curvature. The scatterplot in Figure 2 displays the relationship between the anticipated values and the residuals of the model.

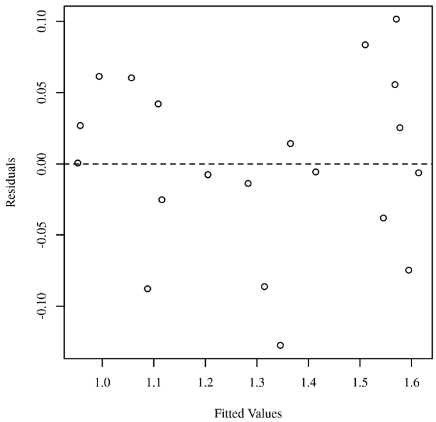

Figure 2. Residuals scatterplot testing homoscedasticity

In order to ascertain influential points, Studentized residuals were computed and afterwards plotted the absolute values against the corresponding observation numbers (Field, 2013; Pituch & Stevens, 2015). The computation of studentized residuals involves the division of the residuals of a statistical model by the estimated standard deviation of the residuals. A Studentized residual with an absolute value larger than 3.58, corresponding to the 0.999 quantile of a t distribution with 19 degrees of freedom, was deemed to exert a considerable effect on the outcomes of the model. The observations are depicted in Figure 3 by a plot of the Studentized residuals. Each point with a Studentized residual larger than 3.58 is accompanied by a designated observation number.

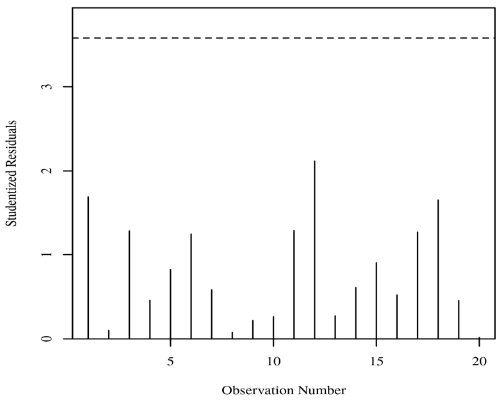

Figure 3. Studentized residuals plot for outlier detection

Moreover, a Durbin-Watson test was undertaken in order to evaluate the level of autocorrelation present within the residuals. The obtained result did not reach statistical significance, with a Durbin-Watson test statistic of 1.70 and a p-value of .074. This indicates that there is limited evidence to support the presence of autocorrelation among the residuals.

The findings from the linear regression analysis yielded statistically significant results, as evidenced by the substantial F-value (F(7,12) = 25.39, p < .001). The coefficient of determination (R2 = .94) indicates that roughly 93.67% of the variability in TFP can be accounted for by the independent variables, namely GDP, EDU, THE, SUBS, PAT, HCS, and GEN. The Gross Domestic Product (GDP) was shown to have a substantial predictive effect on Total Factor Productivity (TFP), with a regression coefficient (B) of 0.005. This relationship was supported by a t-value of 2.09, indicating statistical significance. However, the p-value of 0.059 suggests that the relationship may not be statistically significant at conventional levels. This finding suggests that, on average, a marginal rise of one unit in GDP is associated with a corresponding increase of 0.005 units in the value of total factor productivity (TFP). The level of education (EDU) was shown to have a substantial positive effect on total factor productivity (TFP), with a regression coefficient (B) of 0.07. This effect was supported by a t-value of 3.25, indicating a statistically significant relationship. The p-value of .007 further confirms the significance of the relationship between education and total factor productivity. This finding suggests that, on average, a single-unit rise in the variable EDU is associated with a 0.07 unit increase in the variable TFP. The variable "THE" did not have a significant effect on the prediction of TFP, with a regression coefficient of -0.06 (t = -0.74, p = .475). Based on the provided sample, it can be concluded that a marginal increase of one unit in THE variable does not provide a statistically significant impact on TFP. The results indicate that the variable SUBS did not have a significant effect on the prediction of TFP (B = -0.01, t(12) = -1.33, p = .207). Based on the analysis of the provided sample, it can be concluded that a marginal increase of one unit in SUBS does not provide a statistically significant impact on TFP. The Physical Activity Test (PAT) demonstrated a significant association with Total Factor Productivity (TFP), as indicated by the regression coefficient (B = -0.001, t(12) = -5.15, p < .001). This finding suggests that, on average, a marginal increase of one unit in the variable of interest (PAT) is associated with a drop in the value of the dependent variable (TFP) by 0.001 units. The results of the study indicate that HCS had a significant effect on TFP (B = 0.15, t(12) = 2.09, p = .059). This finding suggests that, on average, a one-unit rise in HCS is associated with a corresponding increase of 0.15 units in the value of TFP. The variable "GEN" had a strong predictive relationship with TFP, as indicated by the regression coefficient (B = 0.13, t(12) = 2.86, p = .014). This finding suggests that, on average, a single unit rise in GEN is associated with a 0.13 unit increase in the value of TFP. The findings of the regression model are presented in Table 3.

Table 3. Results for Linear Regression with GDP, EDU, THE, SUBS, PAT, HCS, and GEN predicting TFP.

Variable	*B*	*SE*	90.00% CI	β	*t*	*p*
(Intercept)	-1.19	0.86	[-2.74, 0.35]	0.00	-1.38	.192
GDP	0.005	0.003	[0.0008, 0.010]	0.28	2.09	.059
EDU	0.07	0.02	[0.03, 0.10]	0.32	3.25	.007
THE	-0.06	0.08	[-0.20, 0.08]	-0.06	-0.74	.475
SUBS	-0.01	0.008	[-0.02, 0.003]	-0.13	-1.33	.207
PAT	-0.001	0.0002	[-0.002, -0.0008]	-1.88	-5.15	< .001
HCS	0.15	0.07	[0.02, 0.28]	0.63	2.09	.059
GEN	0.13	0.05	[0.05, 0.21]	0.59	2.86	.014

Note. Results: $F(7,12) = 25.39$, $p < .001$, $R^2 = .94$
Unstandardized Regression Equation: TFP = -1.19 + 0.005*GDP + 0.07*EDU - 0.06*THE - 0.01*SUBS - 0.001*PAT + 0.15*HCS + 0.13*GEN

The model chosen for the time series analysis was ARIMA(0, 1, 0). The estimated variance (volatility/white noise/σ^2) in the model was 0.004. The table of coefficients for the ARIMA model is presented in Table 4.

Table 4. Coefficient Table for the ARIMA model.

Variable	*B*	*SE*	*t*	*p*
GDP	0.005	0.002	2.35	.043
EDU	-0.008	0.02	-0.46	.654
THE	-0.001	0.03	-0.03	.977
SUBS	-0.002	0.003	-0.48	.645
PAT	-0.0008	0.0002	-3.37	.008
HCS	0.12	0.07	1.75	.114
GEN	0.02	0.02	1.50	.168

Note: df = 9; σ^2 = 0.00351.

Model Covariates. Covariates were added to estimate the effects of each external variable on the time series. GDP significantly predicted TFP after differencing, B = 0.005, $t(9)$ = 2.35, p = .043, indicating that on average, a one-unit increase in GDP will the value of TFP after differencing. EDU did not significantly predict TFP after differencing, B = -0.008, $t(9)$ = -0.46, p = .654, indicating that on average, a one-unit increase in EDU does not have a significant effect on TFP after differencing. THE did not significantly predict TFP after differencing, B = -0.001, $t(9)$ = -0.03, p = .977, indicating that on average, a one-unit increase in THE does not have a significant effect on TFP after differencing. SUBS did not significantly predict TFP after differencing, B = -0.002, $t(9)$ = -0.48, p = .645, indicating that on average, a one-unit increase in SUBS does not have a significant effect on TFP after differencing. PAT significantly predicted TFP after differencing, B = -0.0008, $t(9)$ = -3.37, p = .008, indicating that on average, a one-unit increase in PAT will the value of TFP after differencing. HCS did not significantly predict TFP after differencing, B = 0.12, $t(9)$ = 1.75, p = .114, indicating that on average, a one-unit increase in HCS does not have a significant effect on TFP after differencing. GEN did not significantly predict TFP after differencing, B = 0.02, $t(9)$ = 1.50, p = .168, indicating that on average, a one-unit increase in GEN does not have a significant effect on TFP after differencing.

Forecast. The forecast for the ARIMA model was compared to the observed data starting at time 2016 to check the validity of the model. The results comparing the predictions against the observed data can be seen in Table 5. Figure 4 shows the observed and predicted values for the time series analysis. The 95% CI for the ARIMA model predictions can be seen in Figure 4.

Table 5. ARIMA Model Accuracy Comparing Observed and Forecasted Values.

ME	RMSE	MAE	MPE	MAPE
0.13	0.16	0.14	13.26	13.55

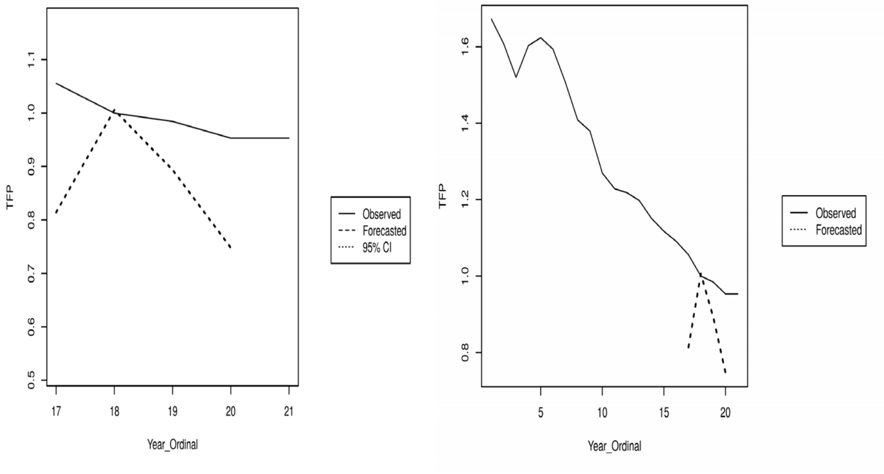

Figure 4. Observed and forecasted values for TFP and Forecast plot for the predicted future values for TFP with a 95% CI

5. Discussion

The regression provided mixed results – many of which support what was found in the literature review, while many refuted it. **GDP**: for every 1 increase in GDP (in US dollars, millions), there is a 0.01 increase in productivity (all else held constant). This result matches the literature and corresponds with what is aforementioned in the paper. GDP is utilized as a measure of productivity in countries through its variables and it is safe to say that – with this result – using GDP is an accurate measure. This also shows that GDP and production have a positive relationship.

EDU is significant as p-value is 0.006 (at 5%). **EDU:** for every 1 increase in education expenditure (% total of GDP), productivity increases by 0.07 (all else held constant). The literature emphasized the importance of education in regard to productivity in a country. The outcome shown from the regression further proves this point. Education is quite significant, especially since the p-value is accurate at 5%, not 10%. As education and the emphasis on education increases in KSA, productivity will also increase.

SUBS are not significant as p-value is 0.211. This conveys that subsidies have no effect on productivity in KSA. The outcome for subsidies in this situation is not very surprising as there were not consistent with the results regarding this variable. Although it is negative in developing countries, it is positive in developed countries (Godfrey, 2002).

HCS is significant as p-value is 0.059 (at 10%). **HCS:** for every 1% increase in health expenditure, which is measured in the % of GDP on healthcare, productivity increases by 0.15. (All else held constant). The literature review accentuated the significance of health on productivity and how it is a determinant factor of productivity; the result of this regression simply supports this. The healthier the workers, the more productive they are, which in turn will increase the overall productivity in a country.

GEN is significant as p-value is 0.014 (at 5%). **GEN:** for every 1% increase in women participation in the labor force (% of total labor force having females), productivity increases by 0.13 (all else held constant). This result coincides with the literature and shows that women's participation in the labor force is a determinant factor in productivity. When females are provided with more opportunities and when their level of education increases, this will increase the number of women in the labor force, which in turn will increase productivity.

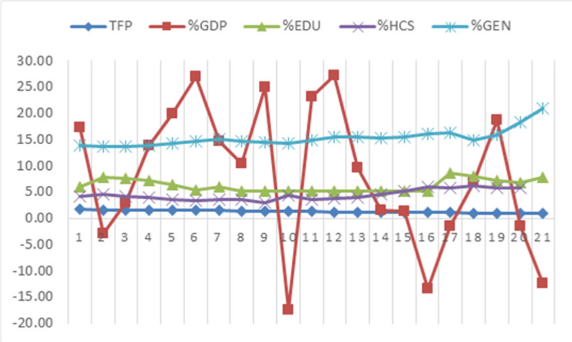

Figure 5: Correlation Between Determinant Variables and Total Factor Productivity

The graph shown above (figure 5) displays the determinant variables and their correlation with the Total Factor Productivity (TFP). The TFP is quite stable and does not undergo any extreme fluctuations. The independent variables all show a slow increase occurring. There is an increase with %GEN that is women's participation in the labor force (see figure 7). A sharp increase of women participation is seen occurring after 2018. %EDU also faces a significant increase from 2016 to 2018 as it is 6% during 2016 and 8.5% during 2018 (see figure 8).

The variable that faces an extreme fluctuation is GDP. This volatility and drastic instability are attributed to KSA's dependency on exporting oil and being a rentier economy. The 2030 vision and diversification in the economy will allow for more stability to occur in regard to GDP along with obtaining an even higher rank in terms of GDP and global standing.

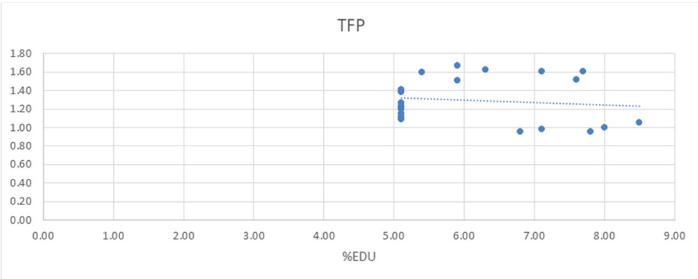

Figure 6: Correlation Between Total Factor Productivity and Education

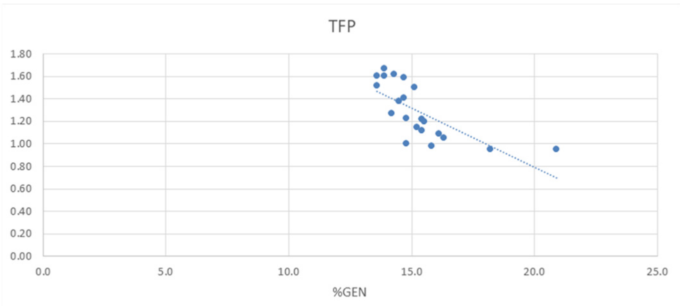

Figure 7: Correlation Between Total Factor Productivity and Gender

Figure 6&7 showcase two determinant variables that have the biggest significance (education is significant at 1% and women in the labor force is significant at 5%). These two graphs both have different steepness, and each one showcases a different result. Figure 6, which is education and total factor productivity (TFP), is quite flat. This could showcase that TFP, and education do not have a strong correlation regardless of the literature review shown and the p-value obtained from the data. Figure 7 shows the relationship between total factor productivity and gender – women and their participation in the labor force. Although this graph may show a stronger relationship (as opposed to the graph before it), it shows a negative relationship between TFP and female participation in the labor force. This contrasts with the literature published (Geng & Kali, 2021; Loko & Diouf, 2021; Schober & Winter-Ebmer, 2011) and the results diverge from what was published. While it was a claim that productivity and female participation in the labor force were parallel to each other, it seems that they are indirectly proportional, for every increase in female participation in the labor force, the productivity decreased.

6. Limitations

This research has studied the relative significance of the factors affecting the KSA's productivity measured in GDP. The model is excessive in terms of rigorously reported generalized factors of productivity. Despite these important insights, it is also important to acknowledge the limitations that may affect the generalizability of the finding. During the study, reliable sources such as the World Bank and FRED database were used to gather data. However, there were still some gaps in the information, particularly when analyzing the education sector and the government's expenditure on education as a percentage of the total GDP. Despite the missing data, the findings were still significant. The problem of missing data is not rare, but it was addressed in a logical way. The existing data was examined, and it showed a gap between 2009 and 2015. To determine the possible magnitude and direction of change in education expenditure as a percentage of GDP, the percentage change in GDP was analyzed. This percentage change was a reliable indicator to determine if the change would be positive or negative. The lack of data availability also affected the issue of subsidies in KSA. Prior to 2010, there was no data available on subsidies, so an accurate substitute was used instead. This substitute was obtained by analyzing the percentage change in GDP, which is the same method used earlier.

Some of the limitations also arise from the research design. As the study is a single case of KSA, and the factors are adopted from the broader and abstract literature on productivity. This focal approach is good for achieving higher relevance of the results for the practical application of the results but can also limit the generalizability into other contexts. Moreover, the reliance on GDP as the primary measure of productivity, though common, overlooks the multidimensional aspects of economic growth and well-being that alternative metrics might reveal. Additionally, the absence of longitudinal data restricts the ability to observe the evolution of productivity factors over time, potentially masking the effects of policy changes and economic developments. Moreover, the research design, oriented towards generalized productivity factors derived from broader literature, may not account for unique, context-specific drivers essential for comprehensively understanding productivity dynamics within the Kingdom. These limitations can be overcome in future research could enhance the generalizability, depth, and applicability of findings to broader economic theories and policy-making processes.

7. Future Studies

The limitations of this research presented in the previous section provide future research opportunities for enhancing both implications as well as theorization of this study.

Firstly, the study is a single case of KSA and in the future, a multiple-country design can provide more robust and generalizable results in terms of theorization and generalizability. Such an attempt will enhance the study's implications for other countries as well as for times as well.

Secondly, the GDP-based productivity will make more sense if the results are connected with other developmental concerns such as human development, environmental development, and social development. The research may correlate these developmental perspectives and indices with the productivity results of this study to provide more impactful grounds or the KSA's development plans in the future.

Thirdly, a comparative analysis across multiple countries could illuminate how similar or divergent factors affect productivity in varied economic and developmental contexts, offering insights into universal drivers of productivity as well as those unique to specific environments. Additionally, a longitudinal approach, tracing the evolution of productivity factors over time, would not only allow for the assessment of policy impacts but also provide a dynamic view of economic transformations and their effects on productivity.

Fourthly, in an era marked by rapid technological advancements, a focused investigation into the impact of digitalization, innovation, and technology adoption on productivity across sectors could uncover strategies for harnessing technology for economic growth. Lastly, adopting a mixed-methods approach, which integrates qualitative analyses with quantitative data, could offer deeper insights into the complex mechanisms and contextual influences behind the observed statistical relationships. Such comprehensive and nuanced research efforts would significantly contribute to the development of more effective economic policies and strategies for enhancing productivity, particularly in the context of achieving the ambitious goals outlined in Saudi Arabia's Vision 2030.

8. Policy Implications

In spite of these limitations the study provide important empirically based guidelines for the development related policies in the KSA. Two findings of the study are particularly important for the policies in the KSA.

Firstly, the study suggest that subsidies provided by the government to different sectors are not relating to the productivity of the Kingdom. Literature though suggests the same work for the productivity in the developed countries. It is therefore important the government may consider transforming the support systems from subsidies into any other kinds of support such as investment in education to provide more skilled workforce for the enhancing productivity as the same has proved to be positively affecting the productivity.

Secondly, the women participation in the workforce has shown significantly affecting the country's productively. Therefore, both public and private institutions be encouraged to enhance the women inclusion into the productive workforce as the same will enhance the kingdom productivity. In this regard the women capabilities may require mass-level trainings so to make the women activity participant in the productivity of the Kingdom.

9. Recommendations

The results of this study can lead us to important implications for managing a country's productivity in the future. The results highlight how education has a major effect on productivity. To provide the labor force with the skills required for a contemporary economy, policymakers should prioritize expenditures in education, concentrating on both the quantity and quality of education. Moreover, increasing digital literacy and technology usage in all industries may boost productivity increases. This includes promoting innovation, assisting in the transfer of technology from foreign sources, and supporting research and development initiatives.

Furthermore, the empirical findings demonstrate how gender equality increases production. Increasing the number of women in the workforce via policy may be a key factor in raising productivity. This entails taking down obstacles that prevent women from finding work, supporting work-life balance, expanding women's access to leadership and entrepreneurship possibilities, and guaranteeing equal compensation for equal labor. In addition to increasing productivity, these measures advance social justice and inclusivity.

The paper also highlights the significance of trade openness and diversity in raising productivity. Due to Saudi Arabia's present reliance on oil for its economy, diversifying the country's economy into industries like manufacturing, services, and tourism may lessen its exposure to changes in the price of oil and open up more steady development prospects. Policies that promote trade openness, strengthen the business climate, and draw foreign direct investment, particularly in technology-intensive industries should be in place to facilitate this diversification. A coordinated strategy that synchronizes educational changes with labor market demands, promotes an inclusive and fair workplace and strategically broadens the economic base is needed to put these policy proposals into practice. By building a more diverse, sustainable, and productive economy, such initiatives may help Saudi Arabia achieve its Vision 2030 objectives.

10. Conclusion

This paper focuses on the relative significance of the factors affecting the KSA's productivity. As recent research has moved towards various dimensions of development, there is still a paucity of literature understanding the exclusive and up-to-date productivity status of various countries. This study provided the relative importance of factors responsible for the KSA's productivity such as health, education, technology, subsidies, and others. The relative importance of the factors on the latest data can help both theorists and economic policymakers to locate and compare the emergent status of KSA's productively and thus make empirically based arguments for any potential shift in the economic debates and policies. As the current debates are more focused on the developmental side of the economics literature, the fresh evidence on productivity can prove to be a timely check of the productivity baseline for informing the developmental debates. Therefore, the productivity baseline is correlated with human, social, and environmental development indicators.

Author Contributions: Conceptualization, A.D., A.A. and S.M.; methodology, A.D.; software, A.A.; validation, S.M., and K.A.; formal analysis, A.A.; investigation, S.M. and M.F.; resources, M.F.; data curation, A.D.; writing—original draft preparation, K.A.; writing—review and editing, K.A. and S.M.; visualization, A.A. and A.D.; supervision, S.M.; project administration, A.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data Availability Statement: Data sharing is not applicable to this article as no new data were created or analysed in this study. Data from the World Bank and the FRED database

Conflicts of Interest: The authors declare no conflict of interest.

Acknowledgment: This publication was made possible by the support of the AUK Open Access Publishing Fund.

References

Ahmed, H., & Miller, S. M. (2000). Crowding-out and crowding-in effects of the components of government expenditure. *Contemporary Economic Policy*, *18*(1), 124–133. https://doi.org/10.1111/j.1465-7287.2000.tb00011.x

Alcalá, F., & Ciccone, A. (2004). Trade and productivity. *Quarterly Journal of Economics*, *119*(2), 613–646. https://doi.org/10.1162/0033553041382139

Ali, M. A., Alam, K., Taylor, B., & Rafiq, S. (2020). Does ICT maturity catalyse economic development? Evidence from a panel data estimation approach in OECD countries. *Economic Analysis and Policy*, *68*, 163–174. https://doi.org/10.1016/j.eap.2020.09.003

Benhabib, J., & Spiegel, M. M. (1994). The role of human capital in economic development evidence from aggregate cross-country data. *Journal of Monetary Economics*, *34*(2), 143–173. https://doi.org/10.1016/0304-3932(94)90047-7

Bloom, D. E., Canning, D., & Sevilla, J. (2004). The effect of health on economic growth: A production function approach. *World Development*, *32*(1), 1–13. https://doi.org/10.1016/j.worlddev.2003.07.002

Chen, Q., Johnson, E. S., Bernal, D. E., Valentin, R., Kale, S., Bates, J., Siirola, J. D., & Grossmann, I. E. (2022). Pyomo.GDP: an ecosystem for logic based modeling and optimization development. *Optimization and Engineering*, *23*(1), 607–642. https://doi.org/10.1007/s11081-021-09601-7

Cohen, J. (2013). Statistical Power Analysis for the Behavioral Sciences. In *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Routledge. https://doi.org/10.4324/9780203771587

Dai, M. (2023). Recent developments on trade and inequality. *Journal of Economic Surveys*, *37*(5), 1636–1659. https://doi.org/10.1111/joes.12546

De Loecker, J. (2013). Detecting learning by exporting. *American Economic Journal: Microeconomics*, *5*(3), 1–21. https://doi.org/10.1257/mic.5.3.1

Dedrick, J., Kraemer, K., & Shih, E. (2013). Information technology and productivity in developed and developing countries. *Journal of Management Information Systems*, *30*(1), 97–122. https://doi.org/10.2753/MIS0742-1222300103

Eder, A., Koller, W., & Mahlberg, B. (2022). Economy 4.0: employment effects by occupation, industry, and gender. *Empirica*, *49*(4), 1063–1088. https://doi.org/10.1007/s10663-022-09543-y

Field, A. (2013). Discovering statistics using IBM SPSS statistics. In *Statistics* (Vol. 58). North American edition. Sage Publications.

Frankel, J. A., & Romer, D. (1999). Does trade cause growth? *American Economic Review*, *89*(3), 379–399. https://doi.org/10.1257/aer.89.3.379

Geng, D., & Kali, R. (2021). Trade and innovation: Unraveling a complex nexus. *International Journal of Innovation Studies*, 5(1), 23–34. https://doi.org/10.1016/j.ijis.2021.01.001

Godfrey, C. (2002). Stop the dumping! How EU agricultural subsidies are damaging livelihoods in the developing world. *Oxfam Briefing Paper*, *31*. http://www.oxfam.org/eng/pdfs/pp020111_Stop_the_Dumping.pdf

Hall, R. E., & Jones, C. I. (1999). Why do some countries produce so much more output per worker than others? *Quarterly Journal of Economics*, *114*(1), 83–116. https://doi.org/10.1162/003355399555954

Hamdan, B. S. S. (2016). The Effect of Exports and Imports on Economic Growth in the Arab Countries: A Panel Data Approach. *Journal of Economics Bibliography*, *3*(1), 63–73. https://doi.org/10.1453/jeb.v3i1.600

Howell, A. (2017). Picking 'winners" in China: Do subsidies matter for indigenous innovation and firm productivity?' *China Economic Review*, *44*, 154–165. https://doi.org/10.1016/j.chieco.2017.04.005

Hussain, S., & Malik, S. (2011). Inflation and Economic Growth: Evidence from Pakistan. *International Journal of Economics and Finance*, *3*(5). https://doi.org/10.5539/ijef.v3n5p262

Im, K. S., & Rosenblatt, D. (2015). The impact of trade on productivity: Evidence from firm-level data. *The Review of Economics and Statistics*, *97*(1), 234–248.

Kampelmann, S., Rycx, F., Saks, Y., & Tojerow, I. (2018). Does education raise productivity and wages equally? The moderating role of age and gender. *IZA Journal of Labor Economics*, *7*(1). https://doi.org/10.1186/s40172-017-0061-4

Karhunen, H., & Huovari, J. (2015). R&D subsidies and productivity in SMEs. *Small Business Economics*, *45*(4), 805–823. https://doi.org/10.1007/s11187-015-9658-9

Knowles, S., & Owen, P. D. (1995). Health capital and cross-country variation in income per capita in the Mankiw-Romer-Weil model. *Economics Letters*, *48*(1), 99–106. https://doi.org/10.1016/0165-1765(94)00577-O

Kubiszewski, I., Costanza, R., Franco, C., Lawn, P., Talberth, J., Jackson, T., & Aylmer, C. (2013). Beyond GDP: Measuring and achieving global genuine progress. *Ecological Economics*, *93*(September), 57–68. https://doi.org/10.1016/j.ecolecon.2013.04.019

Lazear, E. P., & Shaw, K. L. (2007). Personnel economics: The economist's view of human resources. *Journal of Economic Perspectives*, *21*(4), 91–114. https://doi.org/10.1257/jep.21.4.91

Loko, B., & Diouf, M. A. (2021). Revisiting the Determinants of Productivity Growth: What's New? *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1493542

Malik, M. A., Masood, T., & Sheikh, M. A. (2021). Econometric Analysis of Total Factor Productivity in India. *The Indian Economic Journal*, *69*(1), 88–104. https://doi.org/10.1177/0019466220988066

Mukit, M. M. H. (2021). An Econometric Analysis of the Macroeconomic Determinants Impact of Gross Domestic Product (GDP) in Bangladesh. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3767899

Nagayasu, J. (2017). Regional inflation, spatial locations and the Balassa-Samuelson effect: Evidence from Japan. *Urban Studies*, *54*(6), 1482–1499. https://doi.org/10.1177/0042098016629915

Neuman, W. L. (2014). *Social research methods: qualitative and quantitative approaches*. Pearson.

O'Donell, R. (2014). A critique of the ergodic/nonergodic approach to uncertainty. *Journal of Post Keynesian Economics*, *37*(2), 187–209. https://doi.org/10.2753/PKE0160-3477370201.2015.11082987

Pituch, K. A., & Stevens, J. P. (2015). Applied Multivariate Statistics for the Social Sciences. In *Applied Multivariate Statistics for the Social Sciences: Analyses with SAS and IBM's SPSS, Sixth Edition* (6th ed.). Routledge. https://doi.org/10.4324/9781315814919

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, *98*(5), S71–S102. https://doi.org/10.3386/w3210

Saxena, H., & Bansal, P. K. (2019). Relationship between Economic Factors and Economic Growth. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3319961

Schober, C., & Winter-Ebmer, R. (2011). The impact of trade on productivity: A review of the literature. *The World Economy*, *34*(3), 437–455. https://doi.org/10.1111/j.1467-9701.2010.01337.x

The World Bank. (2015). World Bank Data. In *The World Bank Group*. http://data.worldbank.org/