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The Impact of Science, Technology, and Innovation on Economic Growth in the MENA Region

# INTRODUCTION

Science, Technology, and Innovation (STI) has become an important subject within the field of international political economy. Technology has changed our world impacted our lives in so many ways. Technology has increased access to information, education, and employment. However, the question remains: Does STI always spur economic growth? This study examines this question in the context of the Middle East and North Africa Region, and determines that STI does *not* have a positive correlation with economic growth in this region.

There are various explanations for these results. There could be a delayed effect of these STI indicators in the MENA region that has not yet appeared in the data. Or, it could be that the economic structure of MENA countries does not yet support privatization and competition. Without these characteristics, which are known to facilitate economic growth, it may be more difficult for STI indicators in the MENA region to successfully produce economic development.

This preliminary study illustrates that there is a negative and relatively insignificant relationship between STI and economic development in MENA countries. W hatever the reason may be, it is evident from this study that there is a very complicated relationship between STI and economic growth in MENA.

# LITERATURE REVIEW

In the field of political science, the relationship between economic development and STI has been frequently studied over the years. This literature review summarizes various authors and research institutions that have studied this subject. This review includes theories on the general relationship between STI and economic growth, as well as information on how political scientists have dealt with these two indicators in the MENA region.

STI & Economic Growth

 Various researchers and institutions have argued that Science, Technology, and Innovation drives economic growth. International institutions such as the United Nations, the World Bank, and IMF all purport that science, technology, and innovation are key factors for economic growth.

The United Nations represents a “traditional” model of science, technology, and innovation. The UN argues that STI growth leads to productivity growth, which then results in economic growth (Online Information Repository n.d.). The institution maintains that STI impacts the three pillars of economic growth: economic, social, and environmental.[[1]](#endnote-1) STI capacities, the UN underlines, are important prerequisites for structural and social transformation that enable economic growth, human development, and poverty reduction (Report of the Secretary-General).

The IMF agrees that the digital transformation of our world has the potential to promote economic growth, but not without reservations. An IMF article *entitled The Long and Short of The Digital Revolution*, by Martin Mühleisen, highlights the importance of digital technology and the spread of STI, but warns that all major technological changes are disruptive and may cause negative economic outcomes in the short run.

This article gives the advice “Adopt, but Adapt,” reminding us that new technologies can be disruptive, and therefore many benefits come not simply from “adopting” the new technology but “adapting” to them as well (Mühleisen 2018). In the short term, new technologies may in fact be disruptive, but in the long term, new technologies create new platforms for economic growth. The IMF concludes that long term benefits of new technologies are worth the wait due to the high level of economic growth the technology will eventually create (Mokyr 2018).

The World Bank similarly reports that digital technologies improve economic growth by promoting inclusion, efficiency, and innovation. STI, the institution claims, has boosted growth, expanded opportunities, and improved service. They also admit, however, that the dividends and benefits from digital technologies have not spread evenly across populations. As a solution, they propose measures such as strengthening regulations that ensure competition and adapting workers’ skills to the demands of new technologies (Kelly and Firestone 2016). Even though the World Bank concedes that the spread of digital technologies has not quite produced economic development for MENA countries in the past, they maintain that STI is still is a fundamental part of development when executed properly.

 In addition to these institutions, various authors important to the field have written about the traditional model of STI and economic growth. Robert Solow’s theory of economic growth insists that economic growth is caused by a combination of capital accumulation, population growth (which determines labor), and productivity, which he equates with technological progress. The Solow model posits that, in the long run, economies converge to their steady state equilibrium and that long-term economic growth is only achievable through technological progress (Solow Growth Model n.d.) (Acemoglu 2011).

In the book *Information Technology, Productivity, and Economic Growth: International Evidence and Implications for Economic Development*, Matti Pohjola prescribes that developing countries invest highly in information technology. He expresses that there is now a concern that information is becoming a factor, like income and wealth, that determine whether a country is categorizes as rich or poor. To prevent this from happening, Pohjola recommends that countries form national IT strategies to promote the use of new technologies (Pohjola 2001).

 This traditional model has been studied and updated by various authors over the last few decades. However, more updated models assert that the relationship between economic growth and STI is more complicated than the traditional model reports.

One of these updated models appears in the article *Research and Development: Source of Economic Growth*. The authors, Ebru Beyza Bayarcelik and Fulya Tasel, assert that “technological progress” is one of the three pillars of economic growth, along with capital accumulation and population growth (Beyza Bayarcelik and Tasel 2012). They study indicators related to Research & Development (R&D) activities, such as number of R&D employees, R&D expenditures, and patents. The authors measure the relationship between these indicators and Gross Domestic Product (GDP). They find that there is a positive relationship between R&D and number of employees in R&D departments; and there is a negative relationship between GDP and number of patents. These results suggest that STI may be correlated increased employment, but not economic growth.

 Peter Howitt further explains a possible reason that the introduction of new technologies can be negatively correlated with economic growth in his article *Measurement, Obsolescence, and General Purpose Technologies*. He writes about General Purpose Technologies (GPTs), which are technologies that spread through a wide range of sectors in ways that drastically changes their production (Helpman 1998). In his article, Howitt asserts that “accelerated technological change” can cause disruptions in the status quo, leading to major dislocations and costly adjustments. This particularly occurs at the level of induvial households and business firms as they transition from an outdated GPT to a new one. (Howitt 1998). Howitt calculates that when the pace of technological progress rises by 50%, measured GDP declines by 8.5% after 22 years (Howitt 1998).

 Ethanan Helpman and Manuel Trajtenberg argue a similar point in their article *A Time to Sow and a Time to Reap: Growth Based on General Purpose Technologies.* The HT model proposes that the implementation of new GPTs can be very costly. This is because GPTs do not come “ready to use” off the shelf and require new intermediate goods to be produced before implementation. During the period between when a new GPT is introduced and once it raises productivity and profitability, national income tends to fall as resources are taken from production and put towards R&D activities focused on the development of new intermediate goods (Helpman and Trajtenberg 1998).

In their article *1974*, authors Jeremy Greenberg and Mehmet Yorukoglu agree with the previous authors about the disruptive nature of new technologies. These authors explain that productivity growth may stall following the introduction of a new technology as the economy gathers the investment, knowledge, and skills needed to get the new technology to its full potential. Because of this, it is not surprising that after a new technology is introduced, a combination occurs of rapid technological change, widening inequality, and a slowdown in productivity growth (Greenwood and Yorukoglu 1997).[[2]](#endnote-2)

These various authors and research institutions have illuminated the different arguments and theories that exist within the topic of STI and economic growth. While these authors deal with STI in general and not in a specific region, there is also ample discussion occurring in the field when it comes to STI in the MENA region specifically.

STI & Economic Growth in the MENA Region

 When discussing STI and economic growth within the MENA region, lack of privatization and competition as well as lack of government accountability jump out as major themes. In the UNESCWA report entitled *Innovation Policy for Inclusive Sustainable*

*Development in the Arab Region* highlights these themes and reports that the Arab region needs a “new social contract” with their governments if STI policies are to be effective in supporting entrepreneurship, education, R&D, and economic growth (Innovation Policy for Inclusive Sustainable Development in the Arab Region 2017). Without trust in MENA government, investors and inventors are reluctant to be in business with them.

 Privatization is also a concern covered in this report. Most businesses are publicly owned in the MENA region, meaning that competition is relatively low. UNESCWA suggests this may be one reason the spread of STI has not impacted economic growth to the degree that it has in other regions.

In addition, developing countries like ones in the MENA region tend to be at a trade disadvantage. While trade has opened over the last few decades due to globalization, tariffs against developing countries exports are still high which impedes industrialization efforts. The report suggests that for these reasons, the spread of STI in the MENA region has reportedly been unable to translate to steady economic growth (Innovation Policy for Inclusive Sustainable Development in the Arab Region 2017).

Another UNESCWA report on *The Digital Economy and the Arab Region* explains that information and communication technology employment has increased over the last decade in the MENA region. The digital economy and the pervasive use of ICTs has led to expanded opportunities and improved productivity. This report is able to effectively prove that ICT use has increased over the last decade in the MENA region but fails to prove that the digital economy is related to GDP growth.

Recently, news media has been fascinated with the MENA tech boom. Reporters often write about how technology is at the forefront of the region’s momentum (Bradford 2016). The region is coming to be regarded as an “untapped, rapidly growing opportunity,” with %815 million invested into MENA startups in 2016, which saw a 70% increase in the value of tech investments in the region (Blatteis 2017). The spread of digital technology in the MENA region has greatly encouraged entrepreneurship, which is essential to economic growth (Ghandour 2012).

The MENA region is positioning itself as a hub for innovation and growth. This has produced a high level of entrepreneurial activity and availability technologies that lower the costs and barriers to starting a business. This analysis suggests that perhaps the MENA region has not yet seen the full effects of the technological boom. It is possible that economic growth will be a long-term result of the tech boom and the entrepreneurship opportunities it has created.

# METHOD

As previously stated, the purpose of this study is to examine the statistical relationship between economic growth and indicators of science, technology, and innovation. To perform this task, 155 regressions were calculated using 15 indicators and 29 countries over the past 69 years. Data included is based on data availability of STI indicators in MENA countries within the World Bank Database.

Since this is a broad survey, I included a large number of STI indicators. Some indicators measure trade in STI, some measure investment, and others measure details such as the number of researchers and technicians within a specific country.

The independent (x) variables are as follows: Charges for intellectual property, High-tech exports, ICT goods exports, ICT goods imports, ICT service exports, Medium & high-tech exports, Medium & high-tech industry, Patent applications, Private Investment in ICT, Public-Private Investment in ICT, R&D gov't expenditure, Researchers in R&D, Scientific & technical journal articles, Technicians in R&D, Trademark applications.[[3]](#endnote-3)

To represent economic growth, GDP growth is used as the dependent (y) variable in this study. This indicator calculates the difference in a nation’s GDP from one year to another. By using GDP growth, we can gather information on not the size of the economy, but the *growth* of the economy.

First, I gathered all available data for each indicator, each country, and for the time period included in this study. Then, I performed 155 linear regressions to examine the direction and strength of the relationship between STI indicators and economic growth. Finally, I gathered the results, which are included in the following section.

# RESULTS

Out of the 155 regressions ran, 125 of the regressions showed p-values under 0.05, meaning that there is not a significant relationship between those 125 STI indicators and GDP growth in the MENA region. Only 30 of the regressions had a p-value of less than 0.05, meaning that only 30 regressions showed significance. Figure 1 includes these 30 regressions. These results indicate that the spread of science, technology, and innovation in the MENA region is correlated with economic growth.[[4]](#endnote-4)

In addition, out of the 30 regressions that showed significant results, only four show positive correlations. See Figure 2. 26 of the regressions showed negative correlations. This means that even when there does seem to be a relationship between economic growth and STI indicators, the relationship indicates that the spread of STI has a negative impact on economic development in the MENA region.

The regression ran on ICT service exports in all MENA countries shows a significant but negative relationship with GDP growth. Information and communication technology service exports include computer and communications services (telecommunications and postal and courier services) and information services (computer data and news-related service transactions) (ICT service exports (BoP, current US$) n.d.). This study indicates that, as these exports increase, GDP growth in the MENA region declines.[[5]](#endnote-5)

Tunisia held the largest number of significant regressions. A total of seven indicators produced regressions that showed a significant but negative correlation STI and economic growth in the MENA region. These indicators are: Scientific & technical journal articles, High-tech exports, ICT goods exports, ICT service exports, Medium & high-tech exports, Patent applications, Trademark applications. Most of these indicators focus on technology imports and exports. Jordan also held some interesting results, with one significant negative correlation and two significant positive correlations. Both Tunisia and Jordan have greatly invested in their ICT sectors, so more research needs to be performed in order to uncover the reason behind these peculiar results.

These results uncover a complex relationship between STI and economic growth. Since all MENA countries have placed a premium on STI investment, these results are not quite expected. In the following section, I discuss why these results may have occurred and present ideas for future research on the topic.

# DISCUSSION

 The results of this study not corroborate the traditional model that STI investment leads to productivity which produces economic growth. In fact, the results show that there is a negative relationship in many MENA countries between STI and economic growth. There are various possible explanations for this. Based on some of the research previously done on General Purpose Technologies, a possible underlying cause of these results could be that the economic effects of STI growth are delayed and have yet to appear. The MENA region is closer to the beginning of its “tech boom.” Entrepreneurship is on the rise. But the full and positive economic effects of the spread of STI are yet to come.

 It is also important to note that digital technology is a GPT. As authors Howitt, Helpman, and Trajtenberg point out, GPTs are disruptive and can lead to short term economic decline as the economy transitions from one economy to the next. This could mean that ICT sectors in the MENA region, since it is still at its early stages of development. As this new GPT is implemented and time accrues, the economy can then be expected to improve once all the investments in the new technology, both monetary and knowledge related, are paid off. Researchers should continue studies on the relationship between STI and economic growth in the MENA region into the future to discover if this theory actually matches reality.

Another possible explanation for the results of this study could be that the MENA region is preoccupied by issues that limit the effectiveness of STI, particularly issues of privatization and government accountability. First, the lack of trust in the government undermines private investment and limits the number of new companies willing to do business in the region. Then, privatization is further discouraged by the tendency of MENA countries towards publicly owned enterprises.

 Due to the lack of privatization in MENA countries, competition between businesses is not encouraged. Without competition, efficiency and effectiveness of a process or product is compromised. Once privatization takes hold of the region, the implementation of new technologies may be able to have a positive impact on economic growth in the region.

 Since there are so many potential explanations for the results found in this study, more research is needed to hone in on the finer points and trends of STI and economic growth in the region. The intention of this broad-based study is to take a preliminary exploration into the subject of STI and economic growth, but further research and more time is required to come to stable conclusions about the relationship between STI and economic development in MENA.

# CONCLUSION

Presently, there seems to be a negative and relatively nonsignificant relationship between STI indicators and GDP growth in MENA nations. This study provides a broad overview of the relationship between these indicators that can be used by other researchers in the future to build upon.

 This study produces unexpected results, and more research is required to understand these results. There are various possible reasons for these results. The negative and weak relationship may be due to the disruptive power of GPTs, the lack of privatization in the region, or may be due to other factors not studied in this report. Whatever the case may be, it will be impossible to determine the cause of these results without further studying these indicators within the MENA region.

# APPENDIX

Figure 1

|  |  |  |
| --- | --- | --- |
| Total # of regressions | Total with p<0.05 | Total without p>0.05 |
| + | - | + | - |
| 155 | 4 | 26 | 41 | 84 |

Figure 2

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Country** | **Indicator** | **n** | **F** | **Prob > F** | **Adjusted R Sq.** | **Coefficient** | **Standard****Error** | **t** | **p** |
| Algeria | ICT goods imports | 17 | 7.68 | 0.0142 | 0.2946 | + | 0.2260243 | 2.77 | 0.014 |
| Algeria | Trademark applications | 51 | 5.99 | 0.018 | 0.0907 | - | 0.0002593 | -2.45 | 0.018 |
| Bahrain | ICT goods imports | 17 | 12.78 | 0.0028 | 0.424 | - | 0.3537827 | -3.57 | 0.005 |
| Egypt | R&D gov't expenditure | 18 | 12.57 | 0.002 | 0.4251 | - | 1.582342 | -3.68 | 0.002 |
| Egypt | High-tech exports | 24 | 4.34 | 0.049 | 0.1269 | - | 1.095724 | -2.08 | 0.049 |
| Jordan | Scientific & technical journal articles | 14 | 17.32 | 0.0013 | 0.5566 | - | 0.0014813 | -4.16 | 0.001 |
| Jordan | ICT goods exports | 17 | 12.39 | 0.0031 | 0.4159 | + | 0.3293128 | 3.52 | 0.003 |
| Jordan | ICT goods imports | 17 | 22.73 | 0.0002 | 0.5759 | + | 0.2790158 | 4.77 | 0 |
| Kuwait | Scientific & technical journal articles | 14 | 10.87 | 0.0064 | 0.4317 | - | 0.0115165 | -3.3 | 0.006 |
| Kuwait | ICT service exports | 14 | 14.83 | 0.0023 | 0.5527 | - | 0.0897169 | -3.85 | 0.002 |
| Lebanon | ICT service exports | 16 | 6.25 | 0.0255 | 0.2591 | - | 0.6073196 | -2.5 | 0.025 |
| Morocco | Charges for Intellectual Property | 10 | 28.45 | 0.0007 | 0.7531 | - | 3.79E-08 | -5.33 | 0.001 |
| Morocco | High-tech exports | 19 | 5.08 | 0.0378 | 0.1846 | + | 1.13E-08 | 2.25 | 0.038 |
| Morocco | Scientific & technical journal articles | 14 | 7.71 | 0.0167 | 0.3405 | - | 0.0003551 | -2.78 | 0.017 |
| Oman | ICT goods imports | 16 | 6.17 | 0.0262 | 0.2565 | - | 0.6859133 | -2.48 | 0.026 |
| Qatar | Scientific & technical journal articles | 14 | 8.56 | 0.0127 | 0.3678 | - | 0.0041726 | -2.93 | 0.013 |
| Qatar | ICT goods imports | 13 | 11.24 | 0.0064 | 0.4605 | - | 2.009496 | -3.35 | 0.06 |
| Qatar | Medium & high-tech industry | 15 | 4.62 | 0.0511 | 0.2052 | - | 0.0890193 | -2.15 | 0.051 |
| Syria | Medium & high-tech industry | 18 | 6.39 | 0.0224 | 0.2407 | - | 0.1838721 | -2.53 | 0.022 |
| Tunisia | scientific & technical journal articles | 14 | 9.43 | 0.0097 | 0.3932 | - | 0.0003474 | -3.07 | 0.01 |
| Tunisia | High-tech exports | 28 | 5.55 | 0.0263 | 0.1443 | - | 0.2428893 | -2.36 | 0.026 |
| Tunisia | ICT goods exports | 17 | 5.98 | 0.0273 | 0.2374 | - | 0.2064248 | -2.45 | 0.027 |
| Tunisia | ICT service exports | 42 | 8.41 | 0.006 | 0.1531 | - | 0.1171511 | -2.9 | 0.006 |
| Tunisia | Medium & high-tech exports | 26 | 6.52 | 0.0174 | 0.181 | - | 0.0390424 | -2.55 | 0.017 |
| Tunisia | Patent applications | 49 | 6.83 | 0.012 | 0.1084 | - | 0.009252 | -2.61 | 0.012 |
| Tunisia | Trademark applications | 46 | 5.43 | 0.0244 | 0.0897 | - | 0.0002858 | -2.33 | 0.024 |
| Yemen | High-tech exports | 15 | 15.95 | 0.0015 | 0.5164 | - | 1.090202 | -3.99 | 0.002 |
| ALL | ICT service exports | 258 | 4.44 | 0.0362 | 0.0132 | - | 0.0585076 | -2.11 | 0.036 |

Figure 3

|  |  |
| --- | --- |
| Short Title | Full Indicator Title |
| Charges for intellectual property | Charges for the use of intellectual property, receipts (BoP, current US$) |
| High-tech exports | High-technology exports (% of manufactured exports) |
| ICT goods exports | ICT goods exports (% of total goods exports) |
| ICT goods imports | ICT goods imports (% total goods imports) |
| SICT service exports | ICT service exports (% of service exports, BoP) |
| Medium & high-tech exports | Medium and high-tech exports (% manufactured exports) |
| Medium & high-tech industry | Medium and high-tech Industry (% manufacturing value added) |
| Patent applications | Patent applications, residents |
| Private Investment in ICT | Investment in ICT with private participation (current US$) |
| Public-Private Investment in ICT | Public private partnerships investment in ICT (current US$) |
| R&D gov't expenditure | Research and development expenditure (% of GDP) |
| Researchers in R&D | Researchers in R&D (per million people) |
| Scientific & technical journal articles | Scientific and technical journal articles |
| Technicians in R&D | Technicians in R&D (per million people) |
| Trademark applications | Trademark applications, direct resident |

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1. These are the three pillars according to the United Nations. [↑](#endnote-ref-1)
2. Also see Greenwood and Rebelo 1997 [↑](#endnote-ref-2)
3. See Figure 3 in the Appendix for a list of indicators [↑](#endnote-ref-3)
4. The R-squared values tend to be low. This is because there are many more factors that influence GDP than just STI. [↑](#endnote-ref-4)
5. More research needs to be done on this regression to gather further insights into these results. [↑](#endnote-ref-5)