EXPLORING THE DYNAMIC RELATIONSHIP BETWEEN GROSS EXPENDITURE ON RESEARCH AND DEVELOPMENT (GERD) GROWTH AND HIGH-TECH EXPORTS: A CASE STUDY OF INDONESIA (2010-2020)

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Abstract

This study delves into the intricate relationship between research capacity, high-technology exports, and innovation in Indonesia. Leveraging data from the World Bank and UNESCO Institute of Statistics, encompassing variables such as Researchers per Million Inhabitants (RPMI), High-Technology Exports (Hi-Tech), Resident Patents (RP), Scientific and Technical Journal Articles (STJA), and Gross Expenditure on Research and Development (GERD) in US dollars, spanning 2010 to 2020, the study conducts correlation and linear regression analyses employing Smart-PLS 4. The findings reveal a negative correlation (-0.626) between RPMI and high-technology exports, signifying a prioritization of other economic sectors over high-tech exports for countries with greater research capacities. In contrast, positive correlations between RPMI and Resident Patents (0.741) and RPMI and STJA (0.886) underscore the pivotal role of research capacity in fostering innovation. Furthermore, a robust positive correlation (0.965) between RPMI and GERD emphasizes heightened research and development investments in countries with amplified research capabilities. The statistical results also indicate that research and development expenditure and scientific publications do not wield a significant impact on high-tech exports, suggesting a potential divergence between industrial and research policies. This underscores the necessity for policymakers to converge these policies, harnessing research capacity to stimulate high-technology production and export and foster sustainable economic growth in Indonesia.

Keywords: Gross Expenditure on Research and Development (GERD), High-tech exports, Scientific Publications, Researchers per Million Inhabitants, and Patent Resident.

Introduction

In today's rapidly evolving global economy, knowledge-based economic development has become a pivotal driver for enhancing productivity and achieving substantial growth in GDP for many industrialized nations. The shift towards knowledge-based economies has significantly impacted the way countries compete in the international market and has reshaped traditional economic paradigms. In this context, research and innovation play a crucial role in driving the growth of high-tech product exports, which offer higher value-added and can contribute significantly to a country's economic prosperity (Barkhordari et al., 2019; Kyriakopoulos, 2021; Miswaty, 2020; Moustapha & Yu, 2021).

The philosophy of knowledge-based economic development has been widely acknowledged and advocated for several decades. Industrialized countries such as the United States, Japan, South Korea, and Germany have harnessed the power of research and development (R&D) and innovation to drive economic growth and secure their positions as global leaders in technology and innovation (Kyriakopoulos, 2021; Nicolaides, 2014; Okokpujie et al., 2018; Personal & Archive, 2011).

A knowledge-based economy emphasizes the importance of investing in R&D, fostering innovation, and leveraging scientific advancements to create and commercialize new products and technologies. By nurturing an environment conducive to research and innovation, these countries have been able to propel their economies forward, diversify their exports, and enhance their global competitiveness. Knowledge-driven policies have facilitated the transition from labor-intensive industries to higher value-added industries, such as high-tech manufacturing and knowledge-intensive services (Choi et al., 2020; Collinge & Staines, 2009; Enache et al., 2009; Hemert, 2009; Hulten, 2013; Lajili, 2010; Pilipenko, 2015).

Notably, the success of knowledge-based economic development strategies is evident in the strong correlation between R&D investments and the growth of high-tech exports. Countries with higher R&D expenditure tend to produce more cutting-edge technologies, leading to an increase in high-tech exports, which command higher prices and contribute more significantly to the overall economic output(Meusburger, 2013).

This research paper aims to explore the dynamic relationship between the growth of Gross Expenditure on Research and Development (GERD) and the performance of high-tech exports in the context of Indonesia, a developing nation with great potential for economic advancement through knowledge-driven policies. The study will span the period from 2010 to 2020, analyzing data and trends to gain insights into how research and innovation have influenced the country's high-tech export sector.

In this research, the impact of research and innovation on high-tech exports will be examined through the consideration of four key variables in science and technology (The World Bank, 2023). To assess the impact of research and innovation on high-tech exports, stock traded value, and GDP, this study will consider four key variables:

1. Research and Development Expenditure (% of GDP): This indicator represents the proportion of a country's GDP invested in research and development activities. A higher percentage signifies a greater commitment to R&D, which often leads to increased technological capabilities and innovations.
2. Patent Applications of Residents: Patent applications are a critical measure of a country's ability to generate novel inventions. The high patent activity reflects a thriving innovation ecosystem and a focus on protecting intellectual property.
3. Scientific and Technical Journal Articles: The number of publications in scientific and technical journals reflects the level of research output and scientific advancements in a country. More publications indicate a stronger knowledge base and potential for innovation.
4. Researchers in R&D (per million people): This metric assesses the density of researchers engaged in R&D activities relative to the population. A higher number signifies a more extensive pool of talent dedicated to scientific research and innovation.

By exploring the interplay between these variables and high-tech exports, this research seeks to provide valuable insights into the relationship between knowledge-based economic development and export competitiveness.

One significant challenge in conducting this research is the limited availability of data on Gross Expenditure on Research and Development (GERD) and Researchers per Million Inhabitants (RPMI) for Indonesia from 2010 to 2020. Data gaps exist in both the World Bank and the UNESCO Institute of Statistics databases, making it necessary to employ interpolation techniques to fill in missing values. However, despite this limitation, the research will strive to provide a comprehensive analysis by utilizing advanced quantitative methods.

Literature Review

The Role of Research and Development in Economic Growth

Numerous studies have emphasized the crucial role of Research and Development (R&D) in driving economic growth and productivity (Abashah et al., 2019; Gustiani, 2019; JD et al., 2019; Joseph Prah, 2021; Marin & Šušić, 2021; Moustapha & Yu, 2021; Okokpujie et al., 2018; Phung et al., 2019; Soltanisehat et al., 2019). Romer introduced the concept of "endogenous growth theory," highlighting the role of technological progress and innovation as endogenous factors that contribute to long-term economic growth (Parente, 2001; Romer, 1997) (Cristescu & Nerișanu, 2021; Irmen & Tabakovic, 2020; Okokpujie et al., 2018; Schilirò, 2019; Yueping et al., 2021). According to this theory, investments in R&D lead to the creation of new knowledge, technologies, and innovations, which in turn boost productivity and create opportunities for sustained economic development (Arszułowicz, 2020; Block, 2012; Development & Studies, n.d.; Kim et al., 2018; Knauff & Karbowski, 2021; Sfar, 2021; Yazgan & Yalçinkaya, 2018). Empirical studies by Mankiw, Romer, Weil, Barro, and Sala-i-Martin (Barro, 1992; Klenow & Rodríguez-Clare, 1997; Sala-i-Martin, 1994, 2002; Sala-I-Martin, 1996) have provided evidence supporting the positive relationship between R&D expenditures and economic growth (Fischer, 2011; Yazgan & Yalçinkaya, 2018) (Minh et al., 2014). These findings underscore the importance of fostering a supportive environment for research and innovation to enhance a country's economic competitiveness and prosperity.

Knowledge-Based Economic Development in Industrialized Countries

Knowledge-based economic development has been extensively adopted by industrialized countries to enhance their productivity and GDP significantly. Countries like the United States, Germany, and South Korea have implemented policies that prioritize investments in R&D, education, and technology to drive economic growth (Carrillo, 2015; Lopez-leyva & Mungaray-moctezuma, 2017; Moyo, 2018; Schilirò, 2013).

The success of countries like Japan and South Korea in transforming their economies through knowledge-based development has been well-documented (Feitosa, 2020; Hartmann et al., 2020; Hosono et al., 2020; Islamiyah et al., 2020). These countries have leveraged research and innovation to develop cutting-edge technologies and high-value-added products, positioning themselves as global leaders in various high-tech industries. Their experiences serve as valuable lessons for emerging economies like Indonesia, providing insights into the strategies and policy measures that can foster knowledge-based economic growth (Hasan, 2021; Lipsey & Sjöholm, 2011; Woo & Hong, 2010).

Impact of Research and Innovation on High-Tech Exports

Research and innovation play a critical role in determining a country's competitiveness in high-tech exports (Bayraktutan & Bldlrdl, 2018; Durmaz& Yildiz, 2020; Enjolras et al., 2019; Ismail, 2013; Meo & Usmani, 2014; Sandu & Ciocanel, 2014; Usman, 2017). Zou and Liu (2008) conducted a study on China's high-tech exports and found that R&D investments positively correlated with the export performance of high-tech products (X. Liu & Zou, 2008). Similarly, Yang (2004) analyzed the relationship between R&D expenditures and high-tech exports in Taiwan and observed a strong positive association, suggesting that increased R&D investments contribute to the growth of high-tech export capabilities (Durmaz & Yildiz, 2020; Hsu & Chuang, 2014; X. Liu & Buck, 2007; Sandu & Ciocanel, 2014; C. H. Yang et al., 2004, 2009). These findings emphasize the importance of investing in research and innovation to enhance a country's capacity to produce high-value-added products for the global market.

Knowledge Spillover and Technology Transfer

Knowledge Spillover and technology transfer are vital mechanisms through which research and innovation impact economic development (Davies et al., 2021; Djulius, 2017; Durmaz & Yildiz, 2020; Kathuria, 2001; Saggi, 2002; Scarrà & Piccaluga, 2022) (Audretsch et al., 2014). Rodríguez-Pose (2011) and Becker (2004) highlighted the importance of knowledge spillovers, where knowledge generated in one industry or firm spills over to other industries or firms, leading to cross-fertilization of ideas and innovations (Autant-Bernard & Lesage, 2011; Becker & Dietz, 2004; Durmaz & Yildiz, 2020; Lee et al., 2016; Rodríguez-Pose & Crescenzi, 2008; Wan & Liu, 2011). Furthermore, technology transfer enables the diffusion of advanced technologies from research institutions to industries, promoting the adoption of best practices and enhancing productivity (Blalock & Gertler, 2008; Javorcik, 2008) (Hoekman & Javorcik, n.d.). These processes facilitate the transformation of research outcomes into commercial products and technologies, which can contribute to the growth of high-tech exports.

Intellectual Property Rights and High-Tech Exports

Intellectual Property Rights (IPR) play a critical role in incentivizing research and innovation. Ivus (2010) explores the controversial impact of strengthening Intellectual Property Rights (IPRs) in developing countries, inspired by the WTO and the 1994 TRIPs agreement. Using a combination of theory and empirical analysis, the study examines how stronger IPRs affect international technology diffusion and the volume of high-tech exports into developing nations. The findings indicate that stronger IPRs encourage Northern firms to introduce new high-tech products in the South, leading to a rise in high-tech exports to developing countries. However, there may be a decrease in low-tech exports. Contrary to some concerns, the research suggests that international technology diffusion does not necessarily decrease with the strengthening of IPRs. Moreover, developing countries that enhanced their IPRs under the TRIPs agreement experienced a notable increase in high-tech imports, equivalent to a 13% rise in their annual value of high-tech imports (Ivus, 2010a, 2010b, 2011).

Combining the findings from multiple studies, Kabaklarli (2017) reveals that patent applications and Foreign Direct Investment (FDI) have a positive impact on high-tech exports and GDP growth rate, while investment shows a negative association with high-tech exports (Duran et al., 2017). On the other hand, Canals (2014) observes that IPR reform prompts an increase in intra-industry offshoring in High-tech industries (Canals & Şener, 2014). In contrast,

Shin (2016) highlights that IPRs act as a barrier to exports from developing countries and contribute to the middle-income trap phenomenon (Shin et al., 2016). Additionally, Yang (2009) concludes that stronger IPR protection enhances firms' ability to penetrate export markets, but excessively strong IPRs can lead to reduced competition and welfare (L. Yang & Maskus, 2009). These diverse findings underscore the complexity of the relationship between IPRs, high-tech exports, and economic development, calling for a nuanced and context-specific approach in policy formulation and implementation. Park and Lippoldt (2008) examined the relationship between IPR protection and high-tech exports in OECD countries and found that strong IPR protection positively influences the export of high-tech products (Park & Lippoldt, 2014). Effective IPR frameworks encourage firms to invest in R&D, as they provide legal protection against imitation and ensure that companies can fully exploit the commercial potential of their innovations. Strengthening IPR safeguards can, therefore, foster an environment conducive to innovation and enhance a country's high-tech export competitiveness.

The Indonesian Context

In the context of Indonesia, there is a growing recognition of the importance of research and innovation in driving economic growth (Lestari & Rahmawati, 2021). The Indonesian government has been actively promoting initiatives to strengthen R&D capabilities and encourage technology adoption (Lakitan, 2013; Nasir, 2014; Warganegara et al., 2013). The National Research and Innovation Agency (BRIN) has been instrumental in formulating policies to enhance research and innovation activities (Huda et al., 2020). However, limited research has been conducted on the specific impact of research and innovation on high-tech exports in Indonesia. This research aims to fill this gap and provide valuable insights into the dynamic relationship between GERD growth and high-tech exports in the Indonesian context.

Overall, the literature highlights the significant role of research and innovation in knowledge-based economic development and its impact on high-tech exports. By examining the experiences of industrialized countries and understanding the mechanisms through which research and innovation contribute to economic growth, this research seeks to shed light on potential strategies and policy measures that can propel Indonesia's high-tech export sector to new heights of prosperity and sustainability.

R&D Policy and Stock Market

The relationship between research and development (R&D) and the growth of stock traded value is a topic of considerable interest in the field of economics and finance (Apergis, 2015; Cannon & St. John, 2021; Ehie & Olibe, 2010; Johnson & Pazderka, 1993; T. C. Liu & Chen, 2010; Safitri et al., 2019).

R&D investments have been recognized as essential drivers of innovation and technological advancements, which can have a direct impact on the financial performance and market perception of firms (Fu, 2007; Wang et al., 2013). Robust R&D activities are often associated with the development of novel products, services, and processes, leading to increased competitiveness and market share for companies. As a result, investors tend to view firms with strong R&D initiatives as more promising and potentially higher-yielding investment opportunities. Consequently, such positive market sentiment

Methodology

This research employs a correlation model and linear regression model to explore the dynamic relationship between various variables and their impact on high-technology exports in Indonesia from 2010 to 2020. The correlation model is used to examine the associations between the independent variables, namely Researchers per Million Inhabitants (RPMI), High-technology exports (Hi-Tech), Resident Patents (RP), Scientific and Technical Journal Articles (STJA), and Gross Expenditure on Research and Development (GERD) in US dollars. This model measures the strength and direction of the relationships between these variables, providing valuable insights into their interconnections.

The correlation model calculates the correlation coefficient, which quantifies the degree of linear relationship between pairs of variables. A positive correlation coefficient indicates a direct relationship, where an increase in one variable is associated with an increase in the other. Conversely, a negative correlation coefficient signifies an inverse relationship, indicating that an increase in one variable is related to a decrease in the other. A correlation coefficient close to zero suggests a weak or no linear relationship between the variables.

The correlation coefficient (r) between two variables X and Y is given by the formula:

$$r = \Sigma[(Xi - \bar{X})(Yi - \bar{Y})] / \sqrt{[\Sigma(Xi - \bar{X})^2 * \Sigma(Yi - \bar{Y})^2]} \quad \dots (1)$$

where Xi and Yi are individual data points, $\bar{X}$ and $\bar{Y}$ are the means of X and Y, respectively, and Σ represents the summation symbol.

The linear regression model, on the other hand, is employed to investigate the impact of the independent variables (RPMI, RP, STJA, and GERD) on the dependent variable (Hi-Tech exports). This model helps determine the strength and significance of the relationships between the variables and allows us to estimate the contribution of each independent variable to the variation in the dependent variable.

The linear regression equation can be expressed as:

$$Y = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \varepsilon \quad \dots (2)$$

where Y is the dependent variable (Hi-Tech exports), X1, X2, X3, and X4 are the independent variables (RPMI, RP, STJA, and GERD), respectively. β0 is the intercept, β1, β2, β3, and β4 are the coefficients representing the impact of each independent variable, and ε is the error term representing the unexplained variation in the dependent variable.
Utilizing Smart-PLS 4 for data computation and analysis allows for efficient and accurate handling of the correlation and linear regression models. Smart-PLS is a powerful statistical software that can effectively handle large datasets, conduct advanced statistical analyses, and provide valuable insights into the relationships between variables. The student version of Smart-PLS 4 enables researchers to perform comprehensive analyses and draw meaningful conclusions based on the collected data, contributing to the credibility and rigor of the research findings.

Result and Discussion

The data used in this research were sourced from the World Bank and the UNESCO Institute of Statistics, comprising essential variables such as Researchers per Million Inhabitants (RPMI), High-technology exports (Hi-Tech), Resident Patents (RP), Scientific and Technical Journal Articles (STJA), and Gross Expenditure on Research and Development (GERD) in US dollars, specifically for the case study of Indonesia over the period from 2010 to 2020. It is worth noting that some of the variables contained missing data, which prompted the utilization of interpolation techniques to estimate and fill in the gaps in this study. The interpolation method adopted ensures that the dataset is comprehensive and conducive to robust analyses, thereby enhancing the reliability and validity of the research findings. The data used in this study are shown in the table below.

Table 1. Data used from the World Bank and the Unesco Institute of Statistics, 2023

Hi-Tech	RP	GERD	STJA	RPMI
7,056,094,816	508	604,075,326	1404	96
7,277,410,746	533	714,375,283	1880	103
7,229,370,907	520	734,295,930	2024	110
6,492,910,377	663	1,551,291,032	2751	117
6,585,887,873	1058	2,048,873,938	4380	124
5,889,536,968	702	1,807,793,889	2043	131
5,415,601,725	1101	2,329,693,410	6734	138
5,971,475,926	2271	2,437,484,986	12432	145
6,382,014,753	1407	2,397,224,526	21264	152
6,281,266,981	3093	3,021,569,653	30446	159
6,408,687,624	1309	2,965,353,560	32554	166

Correlation Model

The correlation analysis in this study aims to understand the relationships between relevant variables, such as Researchers per Million Inhabitants (RPMI), High-technology exports (Hi-Tech), Resident Patents (RP), Scientific and Technical Journal Articles (STJA), and Gross Expenditure on Research and Development (GERD) in US dollars. By using Structural Equation Modeling (SEM) through SMART PLS software, we seek to gain insights into the patterns of associations between research and innovation capabilities and high-tech export activities, as well as their implications for a country's economic growth. This comprehensive correlation analysis is crucial in formulating appropriate policies to enhance competitiveness and innovation in the high-tech export sector of Indonesia. The findings will contribute to a deeper understanding of the dynamic relationships between the relevant variables and their potential role in driving sustainable and high-quality economic growth in Indonesia. Ultimately, this analysis will serve as the foundation for interpreting relevant research findings and advancing knowledge and technology development within the context of Indonesia.
The following table presents the results of the correlation analysis using SMART PLS 4:

Table 2. The correlation matrix relationships

	RPMI	Hi-Tech	RP	STJA	GERD
RPMI	1.000	-0.626	0.741	0.886	0.965
Hi-Tech	-0.626	1.000	-0.425	-0.258	-0.708
RP	0.741	-0.425	1.000	0.736	0.773
STJA	0.886	-0.258	0.736	1.000	0.816
GERD	0.965	-0.708	0.773	0.816	1.000

The correlation matrix displays the relationships between the variables analyzed using SMART PLS. The analysis of the correlation matrix reveals the following findings:

Researchers per Million Inhabitants (RPMI) and High-technology exports have a correlation coefficient of -0.626, indicating a moderate inverse relationship between the two variables. This suggests that as the number of researchers per million inhabitants increases, high-technology exports tend to decrease, and vice versa. It may imply that countries with higher research capacities prioritize other economic activities over high-tech exports.

Researchers per Million Inhabitants (RPMI) and Resident Patents exhibit a correlation coefficient of 0.741, suggesting a moderate direct relationship. As the number of researchers per million inhabitants increases, the number of patent applications also tends to increase. This correlation implies that countries with higher research capacities engage in more innovation activities, leading to an increase in patent filings.

Researchers per Million Inhabitants (RPMI) and Scientific and Technical Journal Articles display a strong positive correlation of 0.886. This indicates a significant direct relationship, suggesting that as the number of researchers per million inhabitants increases, the number of scientific and technical journal articles also tends to increase. Countries with higher research capacities produce more research publications.

Researchers per Million Inhabitants (RPMI) and GERD have a very strong positive correlation of 0.965, indicating a highly significant direct relationship. As the number of researchers per million inhabitants increases, the Gross Expenditure on Research and Development (GERD) in US dollars also tends to increase. This correlation indicates that countries with higher research capacities tend to invest more in research and development.

High-technology exports and Resident Patents exhibit a weak negative correlation of -0.425, suggesting an inverse relationship. As high-technology exports increase, the number of patent applications may decrease, and vice versa. This correlation implies that a focus on high-tech exports might lead to reduced patent activities, possibly due to other market competitiveness strategies.

High-technology exports and Scientific and Technical Journal Articles display a weak negative correlation of -0.258, indicating a slight inverse relationship. As high-technology exports increase, the number of scientific and technical journal articles may decrease, and vice versa. This correlation suggests that a focus on high-tech exports may lead to reduced research publication activities.

Linear Regression Model

The following is a diagram illustrating the relationships between independent and dependent variables using Smart PLS.

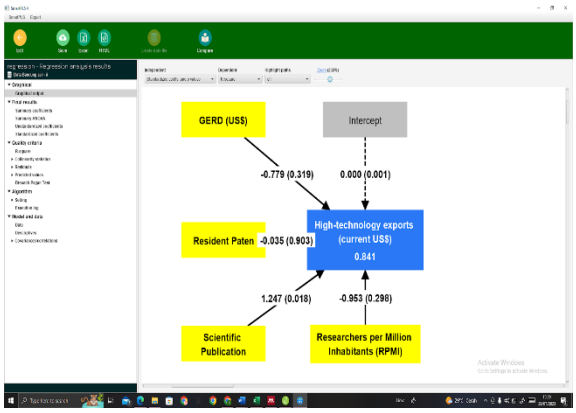

Figure 1. A diagram illustrating the relationships between independent and dependent variables.

High-technology exports and GERD show a strong negative correlation of -0.708, indicating a significant inverse relationship. As high-technology exports increase, the Gross Expenditure on Research and Development (GERD) in US dollars may decrease, and vice versa. This correlation suggests that countries focusing more on high-tech exports might invest less in research and development.

Overall, the correlation matrix provides valuable insights into the associations between the variables. The strong positive correlations between RPMI and both Scientific and Technical Journal Articles and GERD indicate a robust link between research capacity, research output, and investment. However, the negative correlations between high-technology exports and some variables suggest potential trade-offs or competing priorities in allocating resources for research and export activities. It is important to note that correlation does not imply causation and further analysis is needed to establish the underlying mechanisms driving these relationships

High-technology (Y) = -0.035 * RP - 0.779 * GERD + 1.247*STJA - 0.953 * RPMI + 0.000 (Intercept)

This model represents the relationship between the High-technology exports (current US$) and the four independent variables: Resident Paten, GERD (US$), Scientific Publication, and Researchers per Million Inhabitants (RPMI). The unstandardized coefficients show the change in the dependent variable for a one-unit change in each independent variable. The standardized coefficients indicate the relative importance of each independent variable in explaining the variation in high-technology exports. The intercept represents the constant value of the dependent variable when all independent variables are zero.

The table presents the unstandardized and standardized coefficients obtained from the SMART PLS 4 analysis, reflecting the relationship between the independent variables (Resident Paten, GERD (US$), Scientific Publication, and Researchers per Million Inhabitants (RPMI)) and the dependent variable (High-technology exports, current US$). Each coefficient provides essential information about the magnitude and direction of influence that the respective independent variable exerts on high-tech exports.

Resident Paten (Patent Applications)

The unstandardized coefficient for Resident Paten is -24780.044, with a standardized coefficient of -0.035. These results indicate that, for each unit increase in patent applications, high-technology exports decrease by 24780.044 units. The negative standardized coefficient implies a weak inverse relationship between patent applications and high-tech exports. This may suggest that countries with higher patent activity tend to focus less on exporting high-tech products, potentially due to a greater emphasis on protecting intellectual property and a preference for domestic market strategies.

Gross Expenditure on Research and Development

The unstandardized coefficient for GERD (US$) is -0.005, and the standardized coefficient is -0.779. This signifies that for each unit increase in Gross Expenditure on Research and Development, high-technology exports decrease by 0.005 units. The negative standardized coefficient indicates a substantial negative relationship between R&D investment and high-tech exports. This could imply that higher research and development investments are associated with a focus on developing domestic industries rather than exporting high-tech products.

Scientific and Technical Journal Articles

The unstandardized coefficient for Scientific Publication is 60459.289, with a standardized coefficient of 1.247. These results reveal that for each unit increase in the number of scientific publications, high-technology exports increase by 60459.289 units. The positive standardized coefficient suggests a robust direct relationship between research publications and high-tech exports. This implies that countries with more scientific publications tend to have a higher capacity to export high-value-added products resulting from their research outcomes.

Researchers per Million Inhabitants

The unstandardized coefficient for Researchers per Million Inhabitants (RPMI) is -23.675.907.707, with a standardized coefficient of -0.953. These findings indicate that for each unit increase in the number of researchers per million inhabitants, high-technology exports decrease by 23.675.907.707 units. The negative standardized coefficient denotes a significant inverse relationship between the density of researchers and high-tech exports. This correlation may suggest that countries with a higher concentration of researchers might prioritize domestic research and development activities over high-tech export ventures.
The intercept term is 9.896.090.306.536, representing the value of high-technology exports when all the independent variables (Resident Paten, GERD (US$), Scientific Publication, and RPMI) are zero.

In-depth Analysis

The Y regression model generated from the SMART PLS 4 analysis provides valuable insights into the relationships between the independent variables and the dependent variable, shedding light on the factors influencing high-technology exports. The observed negative coefficients for Resident Paten and GERD (US$) suggest that an increased focus on patent applications and research and development investments may lead to a decline in high-tech exports. This may indicate that countries with a stronger emphasis on protecting intellectual property and fostering domestic innovation might prioritize the development of domestic industries over exporting high-tech products.

Conversely, the positive coefficient for Scientific Publication highlights the significant positive impact of research publications on high-tech exports. This suggests that countries with a vibrant research community and a higher output of scientific and technical journal articles tend to have a competitive advantage in exporting high-value-added products resulting from their research findings.

Furthermore, the negative coefficient for Researchers per Million Inhabitants (RPMI) indicates that a higher density of researchers in a country might not directly translate into greater high-tech exports. This could imply that other factors, such as the alignment of research priorities and the allocation of resources, play a crucial role in determining a country's high-tech export performance.

Overall, the Y regression model offers valuable insights to policymakers and researchers, enabling them to make informed decisions concerning research and development investments, patent policies, and research publication strategies to enhance high-tech export performance and foster economic growth and innovation. It is important to consider these findings within the context of each country's specific circumstances and to conduct further research to validate the model's robustness and explore additional factors that may influence high-technology exports.

The limitations of the analysis should also be acknowledged. The regression model is based on correlation and does not imply causation. Moreover, the model's explanatory power may be influenced by other unobserved or unmeasured variables that were not included in the analysis. Future studies could consider incorporating additional economic, social, and political factors to better understand the complex dynamics affecting high-technology exports. Overall, the

findings contribute to the body of knowledge on the relationship between research and innovation activities and high-tech export performance, providing a foundation for evidence-based policymaking and strategic decision-making to promote economic growth and competitiveness in the global market.
Based on the results and in-depth analyses conducted in this research, several key conclusions can be drawn, shedding light on the complex relationships between research capacity, high-technology exports, and innovation activities in Indonesia.

The negative correlation coefficient of -0.626 between Researchers per Million Inhabitants (RPMI) and high-technology exports indicates a moderate inverse relationship. Countries with higher research capacities, as indicated by a higher number of researchers per million inhabitants, tend to have lower levels of high-tech exports. This suggests that these countries might prioritize other economic goals over high-tech exports, potentially due to their emphasis on other sectors or market demands.

On the other hand, the positive correlation coefficients of 0.741 and 0.886 between RPMI and Resident Patents, and RPMI and Scientific and Technical Journal Articles, respectively, highlight a direct relationship. Countries with more researchers per million inhabitants tend to exhibit higher levels of patent applications and produce more research publications. This finding underscores the role of research capacity in fostering innovation and knowledge creation, suggesting that countries with stronger research capabilities are more likely to generate intellectual property and contribute to scientific advancements.

The very strong positive correlation coefficient of 0.965 between RPMI and Gross Expenditure on Research and Development (GERD) reveals a highly significant direct relationship. Countries with higher research capacities tend to invest more in research and development activities, as reflected in the Gross Expenditure on Research and Development in US dollars. This implies that countries with a greater number of researchers per million inhabitants are more committed to funding and supporting research endeavors, which can lead to technological advancements and economic growth.

GERD and Scientific and Technical Journal Articles research capacity and innovation-related variables, the statistical results indicate that the variables related to research and development expenditure and science and technology, namely GERD and Scientific and Technical Journal Articles, do not show a significant impact on high-technology production and export. This finding suggests a potential divergence in policy priorities between industrial policy and science and technology policy over the studied period.

The lack of significant impact from research and development expenditure and scientific publications on high-tech exports could be indicative of a gap in the integration and alignment of industrial policy and research and innovation policy in Indonesia. It is possible that these policies have been developed and implemented separately, with limited coordination and synergy between them. This divergence could lead to missed opportunities to leverage research and innovation for the development and export of high-technology products, hindering the overall competitiveness of Indonesia in the global high-tech market.

Given these findings, it is crucial for policymakers to be more aware of the need to converge industrial policy and research and innovation policy to foster a more conducive environment for knowledge-based economic growth in Indonesia. A well-coordinated approach that integrates these two policy domains can lead to enhanced collaboration between industries and research institutions, promoting the adoption of cutting-edge technologies and innovations in high-tech production. This convergence can result in more effective utilization of research outcomes, translating into higher-quality and competitive high-tech exports.

To achieve this convergence, policymakers should prioritize initiatives that bridge the gap between industrial and research policies. This might involve fostering stronger collaboration between government agencies responsible for industrial development and research institutions to identify synergistic opportunities. Encouraging public-private partnerships and providing incentives for industries to invest in research and development activities can also contribute to a more integrated approach.

Additionally, enhancing the linkages between academia, industry, and government can foster knowledge and technology transfer, leading to the development of high-tech products that align with global market demands. Investing

in human capital development and supporting research in strategic areas can further bolster the innovation ecosystem and elevate the competitiveness of Indonesian high-tech exports.
In conclusion, the study's findings underscore the importance of aligning industrial policy and translate into tangible economic benefits, further solidifying Indonesia's position in the global knowledge-based economy.

Conclusion

In conclusion, the study's findings underscore the importance of aligning industrial policy and research and innovation policy to enhance Indonesia's knowledge-based economy. The correlation between research capacity and innovation-related variables highlights the significance of research capabilities in fostering innovation and knowledge creation. However, the lack of significant impact from research and development expenditure and scientific publications on high-tech exports indicates a need for a more integrated and coordinated approach to leverage research and innovation for economic growth.

By bridging the gap between industrial and research policies and fostering a convergence in policy priorities, Indonesia can unlock the full potential of its research capabilities and stimulate the development and export of high-value-added and competitive high-technology products in the global market. Policymakers should be proactive in aligning these policies to ensure that research and innovation efforts research and innovation policy to enhance Indonesia's knowledge-based economy. The correlation between research capacity and innovation-related variables highlights the significance of research capabilities in fostering innovation and knowledge creation. However, the lack of significant impact from research and development expenditure and scientific publications on high-tech exports indicates a need for a more integrated and coordinated approach to leverage research and innovation for economic growth.

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References (APA 7th edition)

Abashah, A., Shahriman, A. B., Basri, H. H., Razinda Tasnim, A. R., Harun, A., Razlan, Z. M., Hashim, M. S. M., & Wan, W. K (2019). Research & Development (R & D) in strategic production of a safest car. *International Journal of Supply Chain Management*, *8*(4), 1064–1067.

Apergis, N. (2015). Policy risks, technological risks and stock returns: New evidence from the US stock market. *Economic Modelling*, *51*, 359–365. https://doi.org/10.1016/j.econmod.2015.08.021

Arszułowicz, N. (2020). *Investments in R&D as a determinant of innovation in the economy*. 91–107. https://doi.org/10.15290/wpewbmn4.2020.07

Audretsch, D. B., Lehmann, E. E., & Wright, M. (2014). Technology transfer in a global economy. *Journal of Technology Transfer*. https://doi.org/10.1007/s10961-012-9283-6

Autant-Bernard, C., & Lesage, J. P. (2011). Quantifying knowledge spillovers using spatial econometric models. *Journal of Regional Science*, *51*(3), 471–496. https://doi.org/10.1111/j.1467-9787.2010.00705.x

Barkhordari, S., Fattahi, M., & Azimi, N. A. (2019). The Impact of Knowledge-Based Economy on Growth Performance: Evidence from MENA Countries. *Journal of the Knowledge Economy*, *10*(3), 1168–1182. https://doi.org/10.1007/s13132-018-0522-4

Barro, R. J. (1992). W4206.Pdf. In *American Economic Review* (Vol. 85, Issue 1, p. 37).

Bayraktutan, Y., & Bldlrdl, H. (2018). Innovation and high-tech exports in developed and developing countries. *Journal of International Commerce, Economics and Policy*, *9*(3). https://doi.org/10.1142/S1793993318500114

Becker, W., & Dietz, J. (2004). R&D cooperation and innovation activities of firms - Evidence for the German manufacturing industry. *Research Policy*, *33*(2), 209–223. https://doi.org/10.1016/j.respol.2003.07.003

Blalock, G., & Gertler, P. J. (2008). Welfare gains from Foreign Direct Investment through technology transfer to local suppliers. *Journal of International Economics*, *74*(2), 402–421. https://doi.org/10.1016/j.jinteco.2007.05.011

Block, J. H. (2012). R&D investments in family and founder firms: An agency perspective. *Journal of Business Venturing*, *27*(2), 248–265. https://doi.org/10.1016/j.jbusvent.2010.09.003

Canals, C., & Şener, F. (2014). Offshoring and intellectual property rights reform. *Journal of Development Economics*, *108*, 17–31. https://doi.org/10.1016/j.jdeveco.2014.01.001

Cannon, A., & St. John, C. (2021). Complements or conflicts: R&D and lean innovation approaches. *International Journal of Innovation Management*, *25*(4), 1–26. https://doi.org/10.1142/S1363919621500420

Carrillo, F. J. (2015). Knowledge-based development as a new economic culture. *Journal of Open Innovation: Technology, Market, and Complexity*, *1*(2). https://doi.org/10.1186/s40852-015-0017-5

Choi, Y. J., Huber, E., Kim, W. S., Kwon, H. Y., & Shi, S. J. (2020). Social investment in the knowledge-based economy: new politics and policies. *Policy and Society*, *39*(2), 147–170. https://doi.org/10.1080/14494035.2020.1782577

Collinge, C., & Staines, A. (2009). Rethinking the knowledge-based economy. *Built Environment*, *35*(2), 165–172. https://doi.org/10.2148/benv.35.2.165

Cristescu, M. P., & Nerişanu, R. A. (2021). Sustainable development with schumpeter extended endogenous type of innovation and statistics in european countries. *Sustainability (Switzerland)*, *13*(7). https://doi.org/10.3390/su13073848

Davies, G. H., Flanagan, J., Bolton, D., Roderick, S., & Joyce, N. (2021). University knowledge spillover from an open innovation technology transfer context. *Knowledge Management Research and Practice*, *19*(1), 84–93. https://doi.org/10.1080/14778238.2020.1746204

Development, A., & Studies, L. (n.d.). *Key words: R&D policy, regional CGE, smart growth, Poland*. 1–13.
Djulius, H. (2017). Foreign Direct Investment and Technology Transfer: Knowledge Spillover in the Manufacturing Sector in Indonesia. *Global Business Review*, *18*(1), 57–70. https://doi.org/10.1177/0972150916666878

Duran, M., Üçler, Y., & Kabaklarli, E. (2017). the Determinants of High-Technology Exports: a Panel Data Approach for Selected Oecd Countries. *DIEM : Dubrovnik International Economic Meeting*, *3*(1), 888–900.

DURMAZ, A., & YILDIZ, Ü. (2020). THE IMPACT OF INNOVATION IN THE PROCESS OF HIGH TECHNOLOGY EXPORTS: AN ANALYSIS ON BRICS COUNTRIES. *Uluslararası İktisadi ve İdari İncelemeler Dergisi*, 0–3. https://doi.org/10.18092/ulikidince.734893

Ehie, I. C., & Olibe, K. (2010). The effect of R&D investment on firm value: An examination of US manufacturing and service industries. *International Journal of Production Economics*, *128*(1), 127–135. https://doi.org/10.1016/j.ijpe.2010.06.005

Enache, E., Marin, C., & Vechiu, C. (2009). THE IMPORTANCE OF THE KNOWLEDGE BASED ECONOMY Elena Enache, Carmen Marin, Camelia Vechiu "Constantin Brâncoveanu" University from Pitești, Faculty of Management-Marketing in Economic Affairs Brăila. *SSRN Electronic Journal*, 1–7. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1524767

Enjolras, M., Camargo, M., & Schmitt, C. (2019). Are High-Tech Companies More Competitive Than Others? An Empirical Study of Innovative and Exporting French SMEs. *Technology Innovation Management Review*, *9*(1), 33–48. https://doi.org/10.22215/TIMREVIEW/1210

Feitosa, P. H. A. (2020). Creating your own path to move beyond the middle-income trap: Lessons from korea. *Nova Economia*, *30*(Special Issue), 1145–1167. https://doi.org/10.1590/0103-6351/6293

Fischer, M. M. (2011). A spatial Mankiw-Romer-Weil model: Theory and evidence. *Annals of Regional Science*, *47*(2), 419–436. https://doi.org/10.1007/s00168-010-0384-6

Fu, X. (2007). Foreign direct investment, absorptive capacity and regional innovation capabilities: Evidence from China. *Oxford Development Studies*, *36*(1), 89–110. https://doi.org/10.1080/13600810701848193

Gustiani, S. (2019). Research and Development (R&D) Method As a Model Design in Educational Research and Its Alternatives. *Holistics Journal*, *11*(2), 12–22. https://jurnal.polsri.ac.id/index.php/holistic/article/view/1849

Hartmann, D., Zagato, L., Gala, P., & Pinheiro, F. L. (2020). Why Did Some Countries Catch-Up, While Others Got Stuck in the Middle? Stages of Productive Sophistication and Smart Industrial Policies. *SSRN Electronic Journal*, 1–28. https://doi.org/10.2139/ssrn.3570727

Hasan, Z. (2021). Indonesian Economic Diversification As an Emerging Markets Country To Drive Economic Growth. *HUMAN FALAH: Jurnal Studi Ekonomi Dan Bisnis Islam*, *8*(2), 549–564. https://doi.org/10.30829/hf.v8i2.9088

Hemert, V. (2009). Knowledge investments, business R&D and innovativeness of countries. A qualitative meta-analytic comparison. *VU Research Portal*. https://research.vu.nl/ws/files/2432925/rm 2009-41.pdf
Hoekman, E. B., & Javorcik, B. S. (n.d.). *Global 36126*.

Hosono, A., Page, J., & Shimada, G. O. (2020). Workers, managers, productivity: Kaizen in developing Countries. *Workers, Managers, Productivity: Kaizen in Developing Countries*, 1–327. https://doi.org/10.1007/978-981-15-0364-1

Hsu, J., & Chuang, Y. P. (2014). International technology spillovers and innovation: Evidence from Taiwanese high-tech firms. *Journal of International Trade and Economic Development*, *23*(3), 387–401. https://doi.org/10.1080/09638199.2012.725755

Huda, N., Pawennei, I., Ratri, A., & L. Taylor, V. (2020). *MAKING INDONESIA'S RESEARCH AND DEVELOPMENT BETTER Stakeholder Ideas and International Best Practices*. https://www.ksi-indonesia.org/assets/uploads/original/2021/02/ksi-1613637314.pdf

Hulten, C. (2013). Stimulating Economic Growth through Knowledge-Based Investment. *OECD Science, Technology and Industry Working Papers*, *2013/02*(2), 38.

Irmen, A., & Tabakovic, A. (2020). Factor Income Distribution and Endogenous Economic Growth: Piketty Meets Romer. *Economic Inquiry*, *58*(3), 1342–1361. https://doi.org/10.1111/ecin.12850

Islamiyah, A. N., Priyanto, N. M., & Prabhandari, N. P. D. (2020). Diplomasi Budaya Jepang dan Korea Selatan di Indonesia tahun 2020: Studi Komparasi. *Jurnal Hubungan Internasional*, *13*(2), 257. https://doi.org/10.20473/jhi.v13i2.21644

Ismail, N. W. (2013). Innovation and High-Tech Trade in Asian Countries. *International Conference on Recent Developments in Asian Trade Policy and Integration, University of Nottingham Malaysia Campus*, *1998*, 1–19. https://www.nottingham.ac.uk/gep/documents/conferences/2013/malaysia-conference/normaz-wana-ismail.pdf

Ivus, O. (2010a). Do stronger patent rights raise high-tech exports to the developing world? *Journal of International Economics*, *81*(1), 38–47. https://doi.org/10.1016/j.jinteco.2009.12.002

Ivus, O. (2010b). Do stronger patent rights raise high-tech exports to the developing world? *Journal of International Economics*, *81*(1), 38–47. https://doi.org/10.1016/j.jinteco.2009.12.002

Ivus, O. (2011). Trade-related intellectual property rights: Industry variation and technology diffusion. *Canadian Journal of Economics*, *44*(1), 201–226. https://doi.org/10.1111/j.1540-5982.2010.01629.x

Javorcik, B. S. (2008). Can survey evidence shed light on spillovers from foreign direct investment? *World Bank Research Observer*, *23*(2), 139–159. https://doi.org/10.1093/wbro/lkn006

JD, H., IC, R., F., V., & JF, U. (2019). The Development of Scientific Growth in Latin America and the Caribbean. An Economic and Social Approach. *World Journal of Social Sciences and Humanities*, *6*(1), 1–7. https://doi.org/10.12691/wjssh-6-1-1

Johnson, L. D., & Pazderka, B. (1993). Firm value and investment in R&D. *Managerial and Decision Economics*, *14*(1), 15–24. https://doi.org/10.1002/mde.4090140103

Joseph Prah, G. (2021). Does Research and Development Expenditure Incite Quality of Economic Growth? Evidence from China. *Journal of Finance and Economics*, *9*(4), 155–160. https://doi.org/10.12691/jfe-9-4-5

Kathuria, V. (2001). Foreign firms, technology transfer and knowledge spillovers to Indian manufacturing firms: A stochastic frontier analysis. *Applied Economics*, *33*(5), 625–642. https://doi.org/10.1080/00036840121940

Kim, W. S., Park, K., Lee, S. H., & Kim, H. (2018). R & D investments and firm value: Evidence from China. *Sustainability (Switzerland)*, *10*(11), 1–17. https://doi.org/10.3390/su10114133

Klenow, P. J., & Rodríguez-Clare, A. (1997). The Neoclassical Revival in Growth Economics: Has It Gone Too Far? *NBER Macroeconomics Annual*, *12*, 62–103. https://doi.org/10.1086/654324

Knauff, M., & Karbowski, A. (2021). R&D Investments in Markets with Network Effects. *Journal of Industry, Competition and Trade*, *21*(2), 225–250. https://doi.org/10.1007/s10842-021-00357-5

Kyriakopoulos, G. L. (2021). Globalized inclination to acquire knowledge and skills toward economic development. *WSEAS Transactions on Business and Economics*, *18*, 1349–1369. https://doi.org/10.37394/23207.2021.18.125

Lajili, K. (2010). Human capital and knowledge governance. *International Journal of Strategic Change Management*, *2*(4), 312. https://doi.org/10.1504/ijscm.2010.035849

Lakitan, B. (2013). Connecting all the dots: Identifying the "actor level" challenges in establishing effective innovation system in Indonesia. *Technology in Society*, *35*(1), 41–54. https://doi.org/10.1016/j.techsoc.2013.03.002

Lee, K., Choo, K., & Yoon, M. (2016). Comparing the productivity impacts of knowledge spillovers from network and arm's length industries: Findings from business groups in Korea. *Industrial and Corporate Change*, *25*(3), 407–427. https://doi.org/10.1093/icc/dtv036

Lestari, C. D., & Rahmawati, F. (2021). Measuring the Impact of Technology, Politics, and Human Resources on Inclusive Economic Growth in Indonesia. *EcceS (Economics, Social, and Development Studies)*, *8*(1), 65. https://doi.org/10.24252/ecc.v8i1.20427

Lipsey, R. E., & Sjöholm, F. (2011). Foreign direct investment and growth in East Asia: Lessons for Indonesia. *Bulletin of Indonesian Economic Studies*, *47*(1), 35–63. https://doi.org/10.1080/00074918.2011.556055

Liu, T. C., & Chen, Y. J. (2010). Research and development investment strategy and market performance. *Social Behavior and Personality*, *38*(2), 227–236. https://doi.org/10.2224/sbp.2010.38.2.227

Liu, X., & Buck, T. (2007). Innovation performance and channels for international technology spillovers: Evidence from Chinese high-tech industries. *Research Policy*, *36*(3), 355–366. https://doi.org/10.1016/j.respol.2006.12.003

Liu, X., & Zou, H. (2008). The impact of greenfield FDI and mergers and acquisitions on innovation in Chinese high-tech industries. *Journal of World Business*, *43*(3), 352–364. https://doi.org/10.1016/j.jwb.2007.11.004

LOPEZ-LEYVA, S., & MUNGARAY-MOCTEZUMA, A. B. (2017). Knowledge-Based Economy as a Foundation for the Economic Development of Countries. *Management Dynamics in the Knowledge Economy*, *5*(4), 481–501. https://doi.org/10.25019/mdke/5.4.02

Marin, S., & Šušić, M. (2021). Investment in research and development and their impact on economic growth (GDP growth) of Bosnia and Herzegovina. *Journal of Process Management. New Technologies*, *9*(1), 1–12. https://doi.org/10.5937/jouproman9-30184

Meo, S. A., & Usmani, A. M. (2014). Impact of R&D expenditures on research publications, patents and high-tech exports among european countries. *European Review for Medical and Pharmacological Sciences*, *18*(1), 1–9.

Meusburger, P. (2013). Relations Between Knowledge and Economic Development: Some Methodological Considerations. *Knowledge and Space*, *5*, 15–42. https://doi.org/10.1007/978-94-007-6131-5_2

Minh, N. K., Minh, N. K., & Khanh, P. Van. (2014). Expanded Barro Regression in Studying Convergence Problem. *American Journal of Operations Research*, *04*(05), 301–310. https://doi.org/10.4236/ajor.2014.45029

Miswaty, M. (2020). Organization Climate, Internal Knowledge Transfer, Innovation and its impact on The Financial Performance. *Proceeding: Islamic University of Kalimantan*, *2020*, 219–224. https://ojs.uniska-bjm.ac.id/index.php/PIUOK/article/view/4012%0Ahttps://ojs.uniska-bjm.ac.id/index.php/PIUOK/article/download/4012/2631

Moustapha, M. A. M., & Yu, Q. (2021). Innovation Effect Through Research and Development on Economic Growth in 35 Oecd Countries. *Journal on Innovation and Sustainability RISUS*, *11*(4), 159–166. https://doi.org/10.23925/2179-3565.2020v11i4p159-166

Moyo, T. (2018). Development of human capital for industrialisation: Drawing on the experiences of best performers. *Africa Development*, *43*(2), 107–128.

Nasir, M. (2014). Government Expenditures on Education, Research and Development (R&D) and Their Impacts on the Indonesian Economy. *Jurnal Pencerahan*, *8*, 55–66. https://jurnal.unsyiah.ac.id/JPP/article/view/2043%0Ahttps://jurnal.unsyiah.ac.id/JPP/article/download/2043/2002

Nicolaides, A. (2014). Research and Innovation – the drivers of economic development. *African Journal of Hospitality, Tourism and Leisure*, *3*(2), 1–16. www.ajhtl.com

Okokpujie, I. P., Fayomi, O. S. I., & Leramo, R. O. (2018). The Role of Research in Economic Development. *IOP Conference Series: Materials Science and Engineering*, *413*(1). https://doi.org/10.1088/1757-899X/413/1/012060

Parente, S. (2001). The failure of endogenous growth. *Knowledge, Technology & Policy*, *13*(4), 49–58. https://doi.org/10.1007/bf02693989

Park, W. G., & Lippoldt, D. (2014). Channels of technology transfer and intellectual property rights in developing countries. *Intellectual Property for Economic Development*, *62*, 33–89. https://doi.org/10.4337/9781782548058.0

Park, W. G., & Lippoldt, D. (2014). Channels of technology transfer and intellectual property rights in developing countries. *Intellectual Property for Economic Development*, *62*, 33–89. https://doi.org/10.4337/9781782548058.00008

Personal, M., & Archive, R. (2011). *Munich Personal RePEc Archive Knowledge-based Economic Development as a Unifying Vision in a Post-awakening Arab World Knowledge-based Economic Development as a Unifying Vision in a Post-awakening Arab World*. *30305*.

Phung, T. D., Thuy Van, V. T., Thuong, T. T. H., & Ha, N. T. T. (2019). Innovation and economic growth: The contribution of institutional quality and foreign direct investment. *Asian Economic and Financial Review*, *9*(11), 1266–1278. https://doi.org/10.18488/journal.aefr.2019.911.1266.1278

Pilipenko, E. (2015). Knowledge-Based Economy as a Basis for the Long-Term Strategy of the Development of the Society. *Modern Economy*, *06*(08), 888–894. https://doi.org/10.4236/me.2015.68084

Rodríguez-Pose, A., & Crescenzi, R. (2008). Research and development, spillovers, innovation systems, and the genesis of regional growth in Europe. *Regional Studies*, *42*(1), 51–67. https://doi.org/10.1080/00343400701654186

Romer, P. (1997). The origins of endogenous growth. *A Macroeconomics Reader*, *8*(1), 3–22. https://doi.org/10.4324/9780203443965.ch26

Safitri, V. A., Sari, L., & Gamayuni, R. R. (2019). Research and Development, Environmental Investments, to Eco-Efficiency, and Firm Value. *The Indonesian Journal of Accounting Research*, *22*(03), 377–396. https://doi.org/10.33312/ijar.446

Saggi, K. (2002). Trade, Foreign Direct Investment, and International Technology Transfer: A Survey. *The World Bank Research Observer*. https://doi.org/10.1093/wbro/17.2.191

Sala-i-Martin, X. (1994). Cross-sectional regressions and the empirics of economic growth. *European Economic Review*, *38*(3–4), 739–747. https://doi.org/10.1016/0014-2921(94)90109-0

Sala-i-Martin, X. (2002). Fifteen years of new growth economics: what have we learned? *Journal Economía Chilena*, 41–60. http://www.bcentral.cl/estudios/banca-central/pdf/v6/041_060saliimartin.pdf

Sala-I-Martin, X. X. (1996). EUROPEAN ECONOMIC REVIEW Regional cohesion: Evidence and theories of regional growth and convergence. *European Economic Review*, *40*, 1325–1352.

Sandu, S., & Ciocanel, B. (2014). Impact of R&D and Innovation on High-tech Export. *Procedia Economics and Finance*, *15*(14), 80–90. https://doi.org/10.1016/s2212-5671(14)00450-x
Scarrà, D., & Piccaluga, A. (2022). The impact of technology transfer and knowledge spillover from Big Science: a literature review. *Technovation*, *116*(June), 102165. https://doi.org/10.1016/j.technovation.2020.102165

Schilirò, D. (2013). Knowledge-based economies and the institutional environment. *Theoretical and Practical Research in Economic Fields*, *III*(1). https://doi.org/10.2478/v10261-012-0004-3
Schilirò, D. (2019). The Growth Conundrum: Paul Romer's Endogenous Growth. *International Business Research*, *12*(10), 75. https://doi.org/10.5539/ibr.v12n10p75

Sfar, D. B. (2021). Managerial Discretion: The Relationship Between Investments in R & D and Performance - Revisited: Case of Tunisian Enterprises. *Journal of Management and Strategy*, *12*(1), 17. https://doi.org/10.5430/jms.v12n1p17

Shin, W., Lee, K., & Park, W. G. (2016). When an Importer's Protection of IPR Interacts with an Exporter's Level of Technology: Comparing the Impacts on the Exports of the North and South. *World Economy*, *39*(6), 772–802. https://doi.org/10.1111/twec.12338

Soltanisehat, L., Alizadeh, R., & Mehregan, N. (2019). Research and development investment and productivity growth in firms with different levels of technology. *Iranian Economic Review*, *23*(4), 795–818. https://doi.org/10.22059/ier.2019.72991

The World Bank. (2023). *The World Bank Indicators*. Https://Data.Worldbank.Org/Indicator. https://data.worldbank.org/indicator

Usman, M. (2017). Impacto das exportações de alta tecnologia no crescimento econômico: evidências empíricas do Paquistão. *Journal on Innovation and Sustainability. RISUS ISSN 2179-3565*, *8*(1), 91. https://doi.org/10.24212/2179-3565.2017v8i1p91-105

Wan, Y., & Liu, H. (2011). Research about relation of knowledge spillover and technology innovation. *2011 International Conference on Remote Sensing, Environment and Transportation Engineering, RSETE 2011 - Proceedings*, 604–607. https://doi.org/10.1109/RSETE.2011.5964349

Wang, C. H., Lu, Y. H., Huang, C. W., & Lee, J. Y. (2013). R&D, productivity, and market value: An empirical study from high-technology firms. *Omega (United Kingdom)*, *41*(1), 143–155. https://doi.org/10.1016/j.omega.2011.12.011

Warganegara, D., Saputra, M., & Anggraini, Y. (2013). State-Owned Enterprises and Corporate Governance Strength: Evidence from Indonesia. *International Journal of Management and Business Research*, *3*(4), 325–335.

Woo, W. T., & Hong, C. (2010). Indonesia's economic performance in comparative perspective and a new policy framework for 2049. *Bulletin of Indonesian Economic Studies*, *46*(1), 33–64. https://doi.org/10.1080/00074911003642237

Yang, C. H., Chen, J. R., & Chuang, W. Bin. (2004). Technology and export decision. *Small Business Economics*, *22*(5), 349–364. https://doi.org/10.1023/B:SBEJ.0000022213.61143.37
Yang, C. H., Motohashi, K., & Chen, J. R. (2009). Are new technology-based firms located on science parks really more innovative?. Evidence from Taiwan. *Research Policy*, *38*(1), 77–85. https://doi.org/10.1016/j.respol.2008.09.001

Yang, L., & Maskus, K. E. (2009). Intellectual property rights, technology transfer and exports in developing countries. *Journal of Development Economics*, *90*(2), 231–236. https://doi.org/10.1016/j.jdeveco.2008.11.003

Yazgan, Ş., & Yalçinkaya, Ö. (2018). The Effects of Research and Development (R&D) Investments on Sustainable Economic Growth: Evidence from OECD Countries (1996-2015). *Review of Economic Perspectives*, *18*(1), 3–23. https://doi.org/10.1515/revecp-2018-0001

Yueping, L., Xiaoxing, J., & Min, Z. (2021). The Effects of Biased Technical Progress with Endogenous Growth on Factor Shares. *Academic Journal of Business & Management*, *3*(2), 74–85. https://doi.org/10.25236/ajbm.2021.030214.