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A Cross Model Analysis of R&D, GDP, and IP Protection in Technology Transfer

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Abstract – We describe the factors that affect international technology transfer through the level of R&D expenditure, economic development, and Intellectual Property Rights (IPR) protection. Analyzing a large and diverse sample from the World Bank Development Indicators, national statistics on R&D, and the Global Competitiveness Index, the paper uses a gravity model with time-exporter and time-importer fixed impacts to identify variations in technology transfer. Poisson Pseudo Maximum Likelihood (PPML) degeneration examines royalty payments, and an augmented model includes the IPR quality and technology intensity. We found out that export of technology increases with increase in both R&D spending and R&D productivity while import of technology is higher and more probable in large and less remote countries. The extended model increases the fit from 45% to 57% by the inclusion of IPR protection, and technology intensity. The findings of decomposition analysis reveal that R&D and GDP have a high sensitivity to developed countries while remoteness and GDP have high sensitivity to developing countries. With respect to technology transfer, the study demonstrates that there are adverse effects of weak IPR protection and geographical isolation, which is evidenced by the large gaps for nations like India, China, and Turkey. The implications of these results for technology transfer strategy and the improvement of international cooperation are discussed.

Keywords – R&D Spending, GDP Per Capita, Intellectual Property Rights (IPR) Protection, Global Competitiveness Index.

I. INTRODUCTION

Technology is central in defining inequality within countries. The growth of human and physical capital is also relevant, but it does not define a large part of the economic differences in countries today [1]. The advancement of technology is not equal in all countries, and this affects the distribution of wealth in the world. Novel ICTs (Information and Communication Technologies) have advanced very fast and this has helped the United States (U.S) to overtake countries such as Japan in terms of income per capita. In particular, the U.S improved its lead over Jap an from 10% in 1990 to 20% in 1999, which could be attributed to the advancement in ICTs in the U.S [2]. Scholars in [3] have shown that the key sources of technology that give rise to productivity gains in OECD countries are external rather than domestic. The diffusion of technologies around the world is a crucial element in establishing the per capita income around the globe. Since developing countries devote a lesser fraction of their budget on basic science and innovations, with the majority of official research and development (R&D) investment in a few nations, these countries depend more on foreign productivity improvement sources than the OECD nations.

Technology diffusion refers to the spread and adoption of new technologies among individual enterprises or consumers inside a specific market, as well as across many markets [4]. The key aspects of this process are its temporal nature and the significant variation in the duration until broad adoption occurs for different technologies. The primary reasons for the slow adoption of novel technologies are the time required for the spread of information about the technology and the differences among individuals who adopt it. Those who perceive greater benefits from the new technologies are more likely to adopt them early on, while those who perceive fewer benefits may wait until the technology improves or becomes more affordable.

Studies have mostly concentrated on investigating the characteristics of the information dissemination process, as well as the factors that influence the choices made by enterprises and households when adopting new knowledge.

Since 1995, several developing nations have implemented reforms to their legislation pertaining to Intellectual Property Rights (IPR) [5]. Trade economists often believe that reforms in IPR increase the costs of imitating products, limit access to global knowledge, and put enterprises in poor countries at a disadvantage in global markets [6]. One crucial objective of IPR is to decrease the expenses associated with knowledge transfer [7]. Empirical research in [8, 9, 10, 11, 12] confirms that multinational companies enhance the transfer of knowledge by increasing Foreign Direct Investment (FDI) and licensing, particularly when local patent rights are strengthened [13]. The several economic literatures on diffusion have adopted varied perspectives on the actual scope of the phenomena, but we believe they all contribute to a broader understanding. There is a small amount of research that has examined the spread of new technologies from a global perspective. This research, such as the work of Callon and Rabeharisoa [14], explores where new technologies are created and how and why this evolves over time.

Economic factors that influence technology transfer across nations are significant to understand because they are a key to triggering international innovation and economic development. It is understood that such factors as R&D spending, GDP, and IPR protection are essential for technology transfer, yet the nature of their links and impacts have not been investigated adequately. This research will fill the gap by employing a large amount of data from various sources to analyze the link between economic fundamentals and efficiency of technology transfer for the purpose of improving international technology cooperation as useful for policy makers and firms. The remainder of the research has been organized in the following manner: Section II reviews various literature works concerning multi-model analysis of R&D, GDP, and intellectual property protection. Section III focusses on the data and methods, which further describes the gravity model, PPML regression for royalty payments, extended model, and decomposition and comparative analysis. Section IV presents a discussion of the findings of obtained in this research. Lastly, Section V summarizes the findings and provides a detailed review of the comparative analyses.

II.RELATED WORKS

According to Gómez-Herrera [15]. the gravity model is a commonly used method to study and forecast economic variables, specifically bilateral trade flows. In contrast to the prevailing belief among most trade experts, the gravity equation was first employed in the 19th century by Jacks, Meissner, and Novy [16] and Harrigan [17]. Nevertheless, the model's formal use may be traced back to the works of Audet [18], Burch et al. [19], and Barlas [20]. The first version of the model suggests that the bilateral exports from the origin to the destination may be described by the economic masses, which are represented by the income of merchants, as well as the geographical distance between them. The gravity model was first criticized for being theoretical, but because of its solid theoretical foundation and empirical ability to predict bilateral trade flows of various commodities under a variety of scenarios, it has gained widespread use in recent decades [21].

Goyeneche et al. [22] used the force of gravity in a comprehensive empirical analysis. Panagariya [23] define a significant advancement in terms of using empirical calculations to analyze overall trade flows and continues to be a highly regarded source of reference. The conventional gravity equation is denoted in Eq. (1).

$$Trade_{ij} = \alpha.\frac{GDP_i.GDP_j}{Distance_{ij}} \tag{1}$$

where, $Trade_{ij}$ refers to bilateral trade value among i and j, GDP_i and GDP_j represent the national incomes for countries i and j, respectively. Distance is a quantitative measure of the physical separation between the two countries and remains consistent. By applying the gravity model, as shown in Eq. (1), we can obtain the linear network, which is further understood using Eq. (2).

$$\log(Trade_{ij}) = \alpha + \beta_1 \log(GDP_i.GDP_j) + \beta_2 \log(Distance) + u_{ij} \tag{2}$$

The coefficients α, β_1 and β_2 need to be calculated. The error term, u_{ij}, accounts for any additional disturbances, occurrences, and latent variables that might influence the bilateral commerce between the two nations.

Eq. (2) is the fundamental gravity equation, which predicts that bilateral commerce is positively correlated with wealth and negatively correlated with distance. Long et al. [24] use a gravity model to evaluate the connection between commerce and the environment. Richar et al. [25] discover a negative correlation between air pollution and trade in worldwide cross-sectional data for the year 1990. Nevertheless, the research has faced criticism due to its absence of panel data. Karemera, Oguledo, and Davis [26] use a gravity model to analyze how political, economic, and demographic variables impact the magnitude and makeup of migratory streams from 70 countries to Canada and the US between 1976 and 1986. Ramos and Suriñach [27] use a gravity model to examine the patterns of migration between EU bordering countries (ENC) and the European Union (EU) from 1960 to 2010, including over 200 nations. The data indicate a significant rise in migration pressures from countries in the European Neighborhood and Partnership Instrument (ENC) to the EU.

The growing significance of the correlation between R&D expenditure and technology in the 2000s has brought attention to the debates around the influence of technical advancement on economic development [28]. Technological innovation has been widely acknowledged in the economics literature as a catalyst for economic growth and development, based on several theoretical and empirical research. Since the early 1990s there has been a widening gap in productivity and per capita national income growth rates between the developing and developed countries of the world [29]. These disparities provide a proof of the impact that technical advancement has on growth and development of any economy. It is possible to speak about a rather large amount of works that analyzing the connection between technical progress and economic development rather intensively. As empirical and theoretical analysis revealed, technological advancement and technological innovation affect economic growth to a significant extent [30]. However, there is inadequate literature that addresses the implications of economic development: theoretical as well as empirical. In this specific case, there is a need to determine if technical change and innovation play a role in growth of the economy.

The purpose of this study is to test the role of economic factors for the determination of fixed effects within the model of the gravity model of international technology transfer. Thus, using the evaluation of the fit of these variables, including R & D spending, GDP per capita, and remoteness, this research is to explore whether there is any gap between the model and the real world. The study further aims at assessing other factors such as intellectual property rights enforcement and structure of production to explain other factors that may have contributed to variations in technology diffusion. This paper would help further the literature by providing a systematic review on the factors stimulating technology transfer and improving the models utilized in the estimation of international technology flows.

III.DATA AND METHODS

Data Sources and Variables

Using the multiple data sources, this study assesses the extent to which economic factors capture patterns in international technology transfer. The World Bank Development Indicators offer data on GDP per capita, while national statistics are used to obtain data on R&D spending. These sources are basic indicators for evaluating economic activity and innovation potential in different countries. Further, the Global Competitiveness Index (GCI) is used to determine the quality of the IPR protection that is a significant factor of efficiency in the technology transfer. The IPR protection index of the GCI varies from 1 to 7, where a higher indication reveals better compliance with the IPR regime. Geographic distance data is applied to calculate the remoteness index as suggested by Huang, Lu, and Sellers [31]. This index is an indication of how much a country is cut off from the large markets and it is computed by Eq. (3).

$$Remoteness_j = \sum_i \left(\frac{Y_i}{\tau_{ij}}\right) \quad (3)$$

Here, T_{ij} refers to the geographical distance among j and i, Y_i refers to the GDP of i and Y_w is world GDP. This measure assists in capturing the economic and logistical pressures that exert a different country in attaining technology from markets all over the world. The technology intensity is also measured by the use of the PATTS dataset from the United States Patent and Trademark Office to reflect on a country's ability to acquire and apply technologies.

Gravity Model and Fixed Effects

Gravity model is used to analyze the technology transfer patterns, which includes time-importer and time-exporter fixed impacts. The model attempts to explain deviations from the identified economic factors of technology transfer. The primary regression equation that is used is Eq. (4).

$$Technology\ Transfer_{ij} + \alpha + \beta_1 + R\&D_i + \beta_2 + GDP_i + \beta_3 + Remoteness_i + \beta_4 + Size_j + \epsilon_{ij} \quad (4)$$

Here, i is the exporter and j the importer. To test the quality of the economic fundamentals to explain the fixed effects derived from the gravity model, Ordinary Least Squares (OLS) regressions are performed. Concisely, the regressions analyze the effects of:

Time-Exporter Fixed Effects

Eq. (5) provides a computation model that explores how R&D expenditure and efficiency affect the tendency of a country in exporting technology.

$$Exporter_T FE_i = \gamma_0 + \gamma_1 + Log(R\&D)_i + \gamma_2 + Log(Productivity)_i + \epsilon_i \quad (5)$$

Ti me-Importer Fixed Effects

Eq. (6) assesses how GDP, or the level of remoteness of a country, impacts the import of technology. The outcomes are shown in the **Tables 1** and **2**, revealing that time-exporter fixed effects have positive coefficients for R&D spending and productivity while coefficients for time-importer fixed effects are positive for GDP and negative for remoteness.

$$ImporterTimeFE_j = \delta_0 + \delta_1 Log(GDP)_j + \delta_2 Log(Remoteness)_j + \epsilon_j \quad (6)$$

Table 1. Economic Fundamentals and Time-Exporter Fixed Effects

	1	**2**
Log(R&D_expenditure)	.74*** (.021)	1.05*** (.046)
Log(GDP_pc_exporters)	.54*** (.040)	.41*** (.053)
K	-28.31*** (.43)	-35.42*** (.78)
Exporter_FE	No	Yes
N	1,099	1,099
R^2	.75	.99
*SE *p < .05, **p < .01, *** p < .001*		

Table 2. Economic Characteristics and Gravity Time-Importer Fixed Effects

	1	**2**
Log(GDP_importers)	.381*** (.0731)	-.172*** (.0251)
Log(Remoteness_importer)	-.56*** (.0741)	-.77 (.0483)
K	-2.032 (3.192)	16.431*** (1.461)
Importers_FE	No	Yes
N	1,0982	1,099
R^2	.691	.991
*SE *p < .05, ** p < .01, *** p < .001*		

PPML Regression for Royalty Payments

In an attempt to examine the link between economic factors and royalty payments, a Poisson Pseudo Maximum Likelihood (PPML) regression is used. This method is appropriate for count data and handles heteroskedasticity. The regression equation used is Eq. (7).

$$Royalties_{ij} = \emptyset_0 + \emptyset_1 + R\&D_i + \emptyset_2 + GDP_i + \emptyset_3 + Remoteness_j + \emptyset_4 + Size_j + \epsilon_{ij} \quad (7)$$

The regression findings presented in the first column of **Table 2** show that all the constants bear the right sign and are statistically significant at 1% level. This means that those countries which spend more on R&D and have higher GDP and also those which are closer to the major markets make more technology transfer and pay more royalties.

Extended Model with Additional Factors

To enhance the model performance, a few more variables are included like IPR protection and production structure. From the GCI, the IPR protection index is also incorporated since the quality of the enforcement of IPR affects the attractiveness of the country to foreign technology. The production structure is evaluated using the technology intensity that is obtained by multiplying industry-level value-added data with the number of the US patents in those industries. The extended model is represented by the following regression Eq. (8).

$$\begin{aligned} Royalties_{ij} &= \lambda_0 + \lambda_1 + R\&D_i + \lambda_2 + GDP_i + \lambda_3 + Remoteness_j \\ &+\lambda_4 + Size_j + \lambda_5 + IPR\ Quality_j + \lambda_6 + Technology\ Intensity_j + \epsilon_{ij} \end{aligned} \quad (8)$$

Shmueli [32] indicate that the additional variables are significant and have the signs hypothesized. Economies with a stronger IPR regime and those that are dedicated in technology-intensive industries receive more technology. In fact, the introduction of these variables raises the R^2 from 0. 45 to 0. 57, which enhances the goodness of fit, and underlines the role of IPR quality and production structure in determining technology transfer.

Decomposition and Comparative Analysis

To compare which factors are relatively more important, the R^2 values from the regression are broken down. This analysis is done separately for developed and developing countries. It shows that exporter factors like research and development expenses and GDP per capita explain much of the differences in technology transfer especially to the developed nations. On the other hand, the characteristics of importers such as remoteness and GDP of the importing country are more important for developing countries. The structure production and IPR enforcement quality are especially important for understanding the transfer of technology from developed to developing nations. A rough calculation reveals that in view of the current level of IPR enforcement, nations like China, Indonesia, India, and Turkey have received less in terms of technology transfer than they would have had there was perfect IPR protection. This calculation shows the significant effect of IPR quality on the level of technology transfer.

IV.RESULTS AND DISCUSSION

In this section, we assess the extent to which the economic parameters in Eq. (10) may account for the various elements of Eq. (9). Subsequently, we detect disparities among the data and the model and investigate the influence of various channels that are not accounted for by the model in causing such differences.

$$RP_{ni,t} = \exp\left[rta_{ni,t} + S_{it} + F_{nt} + d_{ni} + u_{ni,t}\right] \tag{9}$$

where $u_{ni,t}$ is a residual. The national trade agreement has technology-related measures pertaining to patents and intellectual property rights, as discussed by Martínez-Zarzoso and Chelala [33].

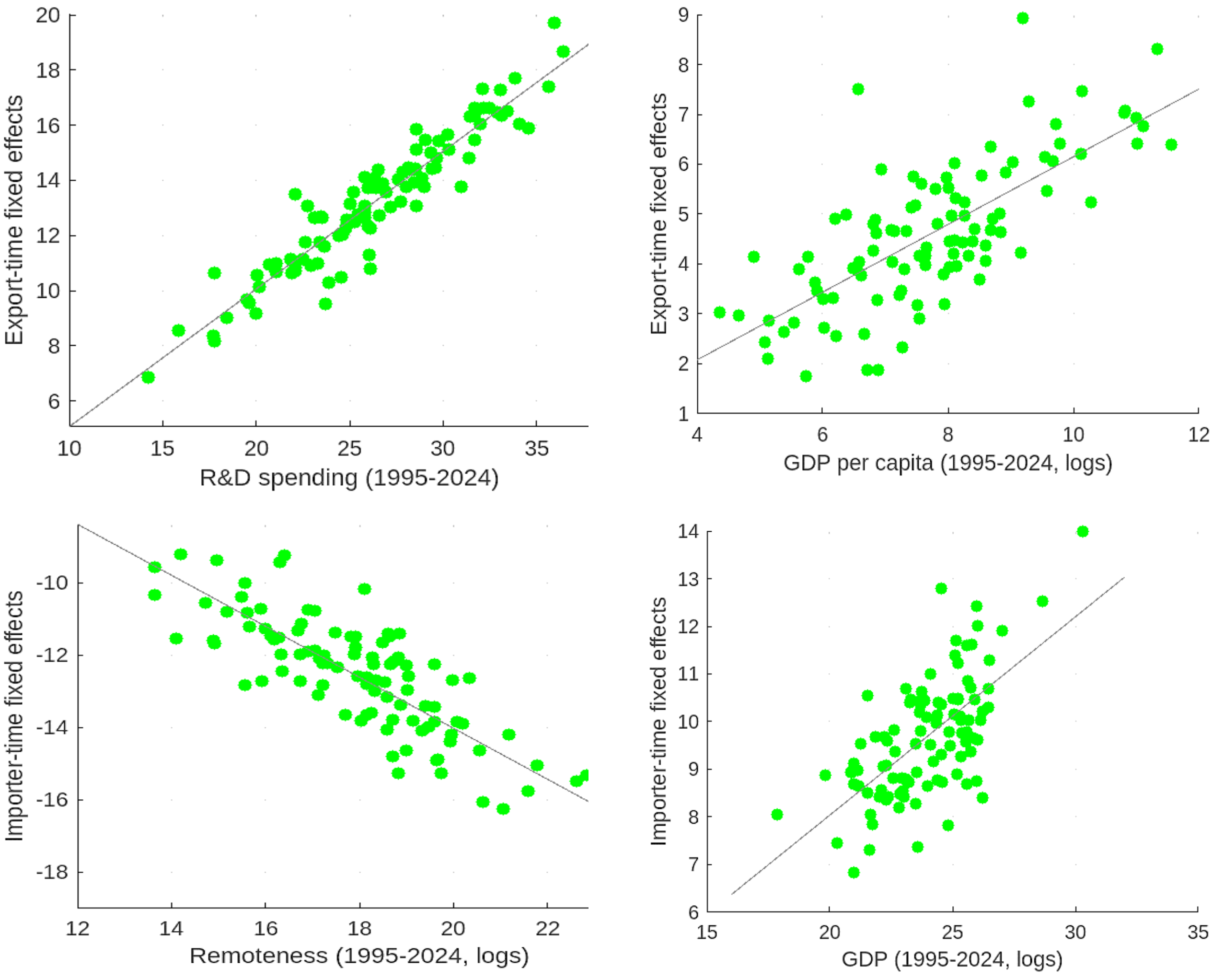

Fig 1. Gravity Fixed Impacts and The Economic Foundations of The Model

Asymmetric nation-pair fixed impacts are permitted, with a total of 13 allowed. The coefficient of determination for the regression is 0.98. Initially, we assess the model's ability to forecast outcomes using the economic essentials in Eq. (10), which may be expressed in logarithmic form.

$$\log\left(RP_{ni,t}\right) = S_{it} + F_{nt} + d_{ni}. \tag{10}$$

where $S_{it} = log\left(\lambda_i \left(\frac{Y_{it}}{L_{it}}\right)(Y_{it}^{r})^{\beta_r}\right)$ and $F_{nt} = \log\left(\prod_{nt}\right)$ we evaluate Y_{it}^{τ} it using information on R&D expenditure, and $\frac{Y_{it}}{L_{it}}$ using dataset on GDP per capita. We provide a metric to assess a country's success based on its size, measured by GDP, and its distance from other lucrative markets. The measure of remoteness is calculated using a method outlined by Deng, “Bryan” Jean, and Sinkovics [34], and Eq. (11).

$$Rem_i = \sum_j \frac{\tau_{ij}}{Y_j/Y_W}, \tag{11}$$

where τ_{ij} represents the geographic distances between j and i, Y_w is the global GDP, $Y_w = \sum_j Y_j$, and , Y_j is the GDP of j, The inference is that larger nations (hence the hypothesis posits that nations with greater internal markets and proximity to other larger marketplaces are more lucrative. **Fig 1** illustrates the relationships between time-importer and time-exporter fixed impacts obtained from the economic fundamentals and the gravity regression of the main model.

Each individual point in the diagram represents a specific combination of a country and a year. The upper two panels indicate a distinct positive correlation between both the exporter's expenditure and the time-exporter fixed impacts on research and development and its GDP per capita. Countries that are exceptionally inventive and industrious are more inclined to export technology, resulting in higher royalty expenditures received. The lower two panels also conform to the model. The bottom-left panel illustrates a negative correlation between the distance of a knowledge importer from its prospective markets and the time-importer fixed impacts. Consequently, the likelihood of receiving foreign technology decreases as the distance increases. The panel in the bottom-right corner indicates that nations of greater size have a higher probability of acquiring foreign technology.

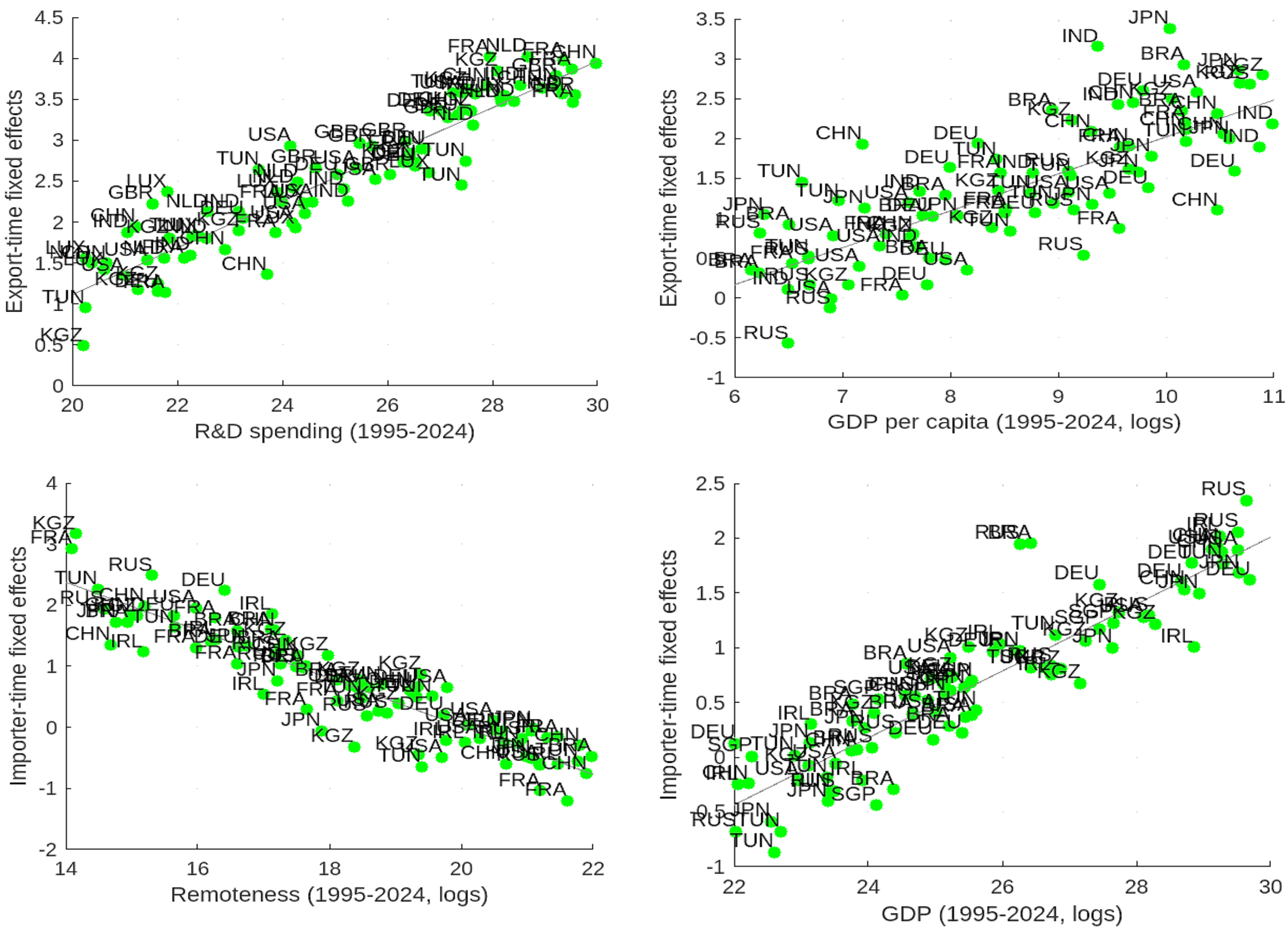

Fig 2. Economic Elements and Fixed Gravity Impact From 1995 to 2024

The relationship between time-exporter fixed impacts and exporter productivity and R&D expenditures as well as the relationship between time-importer fixed impacts and time-importer and remoteness index are depicted in **Fig 1**. Each dot symbolizes a specific combination of a country and a year. **Fig 2** replicates the graphs seen in **Fig 1** by calculating the average values for each nation over time. Japan and the U.S. are the major technological exporters, meaning they have the highest mean exporter fixed impacts. Additionally, they have the highest levels of productivity and R&D investment. The top three countries importing technology are the US, Japan, and Ireland, with the highest average importer fixed impacts. Japan and the US possess a lower remoteness index and highest GDP [35]. Ireland stands up as an exception in terms of its distant location index and GDP, since it is not among the most lucrative nations [36]. However, it is noteworthy that Ireland is one of the primary beneficiaries of foreign knowledge. The relationships between exporter fixed impacts and the productivity and R&D expenditures of the exporter as well as the importers' size and remoteness index are shown in **Fig 2**. Each dot on the graph represents a nation, and the data is an average from 1995 to 2024.

To be more precise, we conduct an OLS regression analysis on the fixed effects of time-importer and time-exporter from the gravity model. This reversion is conducted using the economic essentials predicted by Eq. (10), which are the same variables shown in **Fig 1**. **Table 1** and **Table 2** provide the findings. **Table 1** demonstrates that the exporter's investment in research and development (R&D) and their output have a statistically significant and a favorable impact on exporters' fixed impacts over time, in line with the model. The predicted constant on the logarithm of R&D expenditure is around 0.73. The predicted constant for the natural logarithm of output is around 0.551. The two factors account for 76% of the variance in the time-exporter fixed impacts.

The time-exporter fixed outcomes from the gravity regression are used to regress the exporter's log of productivity and R&D logs. According to findings in **Table 2**, distance has a statistically significant negative influence and importer size has a positive, numerically substantial impact on the effect on the time-importer fixed impacts. While the constant remoteness index log, calculated as in Eq. (11), is -0.55, the projected constant on importer's log GDP is approximately 0.38. According to the model, on average, bigger nations get more technology from outside; on the other hand, distant countries receive less technology since they are less lucrative due to their proximity to small countries or distance from large countries. Approximately 70% of the variance in the time-importer fixed impacts may be explained by these two factors together. Lastly, the influencers knowledge diffusion constraints governing bilateral fixed impacts remain unmentioned in the model.

We conducted a regression analysis of the nation-pair fixed impacts on the overall distance together with a border and language sharing dummy. Geographically and culturally closer nation pairings, in my opinion, tend to share more technology overall. While contiguity has statistically significant and positive influence, distance has a negative effect and numerically significant, as **Table 3** (first column) demonstrates. Only around 18% of the variance in the country-pair fixed impacts can be explained by these factors. When combined, these findings imply that the model's economic variables have a strong ability to predict the fixed effects determined by gravity regression. In that regard, these variables are responsible for a significant portion of the difference in what the knowledge exporter ships overseas and what the knowledge importer gets. The next part delves further into the extent to which the data's explanations of foreign technology licensing by the model's foundations fit the data, and suggests a number of explanations for the variance that cannot be explained. **Table 3** displays the impact of geographical and cultural factors on fixed effects between pairs of countries, as shown in the gravity regression. The first column represents these impacts, while the second column takes into account fixed effects of both importers and exporters.

Table 3. Fixed Impacts Across Countries and Economic Fundamentals

	1	**2**
Log(Distances)	-.681***	-.832***
	(.03)	(.04)
Contiguity	.381*	.242
	(.15)	(.13)
Common languages	.731***	.333***
	(.10)	(.10)
K	4.161***	5.001***
	(.25)	(.44)
Exporter_FE	No	Yes
Importer_FE	No	Yes
N	3,61	3,61
R^2	.181	.482
*SE *p< .05, ** p < .01, *** p < .001*		

We conducted a regression analysis where i directly correlate royalty payments with the economic factors specified in Eq. (11). Using Eq. (12), we conducted a reversion analysis using PPML techniques. The analysis is conducted on a sample of 61 nations over the time period from 1995 to 2024.

$$RP_{ni,t} = exp\left[log\left(\frac{\varepsilon_{ni}}{\varepsilon_{ni}+g}\right) + log\left(\curlywedge_i T_{it}(Y_{it}^{\tau})^{\beta i}\right) + log\left(\prod_{nt}\right) + \varepsilon_{ni,t}\right] \tag{12}$$

where $\varepsilon_{ni,t}$ is an error term. All constants exhibit the anticipated signals and possess both statistical and economic significance. Country-pairs that have greater geographical distance or lack a common language have lower levels of technological transfers. Countries with higher degree of productivity and R&D tend to export more technology. Lastly, nations with higher GDP or those that are less geographically isolated often get a greater influx of foreign technology and hence incur higher royalty payments. Furthermore, the economic fundamentals derived from the model demonstrate a strong ability to forecast bilateral royalty costs. The connection among the actual data and the anticipated rate of this reversion is approximately 45%. Nevertheless, there are still some inexplicable variations. We investigate the following three aspects as possible causes for discrepancies between the data and the core principles of the model: The factors that influence the effectiveness of technology transfer to a recipient nation include: (i) the efficacy of IPR application, (ii) the composition of the production system, and (iii) tax framework in place.

IPRs are generally acknowledged to have a significant impact on promoting innovation, advancing technical development, and spurring economic expansion [37]. According to Henry and Stiglitz [38] and Encaoua, Guellec, and Martínez [39], IPR promote innovation by providing innovators with a temporary monopoly on their inventions. Throughout time, several IPR instruments have been created, each serving distinct goals and being applicable in various industries. Since the Industrial Revolution, the ability to restrict others from utilizing one's intellectual works has been enhanced to incentivize private investment in research and support long-term economic progress. According to Nersessian and Mancha [40], the primary objective has been to establish regulations governing the interaction between creators/innovators and customers, and to provide compensation to creators/innovators for their ideas.

However, some experts have raised doubts over the objective of IPR in enhancing innovation, and fostering economic development. The effects of IPR on stimulating economic development and innovation has garnered significant attention from economists. There has been a significant rise in the relevant theoretical literature, and several empirical studies have been carried out to evaluate the impact of IPR on economic development and innovation. Several studies, such as [41, 42, 43, 44, 45, 46], have shown that protecting IPR has a beneficial effect on both innovation and economic development. On the other hand, studies conducted by Neves et al. [47] and Woo, Jang, and Kim [48], among others, suggest that reducing IPR protection might promote invention and innovation, leading to growth. According to Verspagen [49], the connection between innovation, IPR protection, and economic development is uncertain and unclear, both in principle and in the research conducted.

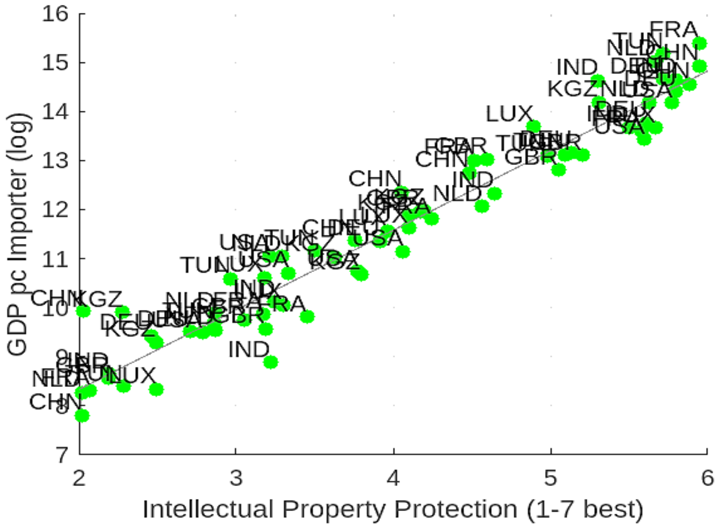

Fig 3. Correlation Between GDP Per Capita and IPR Protection

Ito et al. [50] discovered compelling evidence of a significant technological spillover occurring inside production networks or Global Value Chains (GVCs). Their hypothesis posited that the influx of novel ideas into a nation is directly influenced by the degree of interconnectedness between that country and others where knowledge is being produced. Their econometric model conducted a regression analysis on patents registered through the Patent Cooperation Treaty (PCT), which were categorized by industries and residents of a particular country. The analysis included several variables: domestic spending on R&D, the average of foreign R&D spending weighted by importance, national control variables, and fixed effects for both country and industry. The unique aspect is that the bilateral weights are determined by many measurements of networked trade relationships across vertical supply chains. The weights were derived from the World Input-Output Database, which establishes connections between nations based on the exchange of intermediate inputs and products.

A significant number of developing nations have expressed dissatisfaction with the insufficient level of technology transfer they obtain via market channels, which falls short of the ideal quantity. Inadequate IPR protection may result in suboptimal technology transfer from foreign sources. In order for an inventor to be motivated to authorization a knowledge in a global marketplace, she needs have assurance that the company certifying the knowledge would not replicate it or disclose it to other rivals. The technology importer's investment environment plays a crucial role in attracting foreign intellectual property (IP) via licensing. To effectively assess the significance of IPR protection, we use information from the historical dataset of the GCI that has been released by WEF (World Economic Forum). This set of data ranks nations based on many factors to measure their competitiveness. We specifically concentrate on the index of IPR protection, which is rated on a scale of 1 to 7, as a metric for evaluating the effectiveness of IPR enforcement.

Fig 3 illustrates the relationship between index and the logarithm of GDP per capita for a group of 61 nations. The data is averaged over the years 1995-2024. The data shows a strong positive association between the two variables, indicating that industrialized nations have more effective enforcement of IPR compared to developing countries [51]. Furthermore, nations that excel in technology-intensive industries have a higher likelihood of attracting technology transfer, since they possess superior capabilities in adopting and implementing cutting-edge innovations from inventive countries. Therefore, we calculate a metric that quantifies the level of technology used in the manufacturing process. For every nation i, we gather information on value addition at industrial levels, VA_i^j and calculate the nation's shares in j. **Fig 4** demonstrates that nations that specialize in highly creative industries tend to get a greater amount of technology transfer, on average. **Fig 3** and **Fig 4** illustrates the correlation between IPR protection, productivity, and the legal system. The following graphs illustrate the association among GDP per capita and: the production structure and IPR protection.

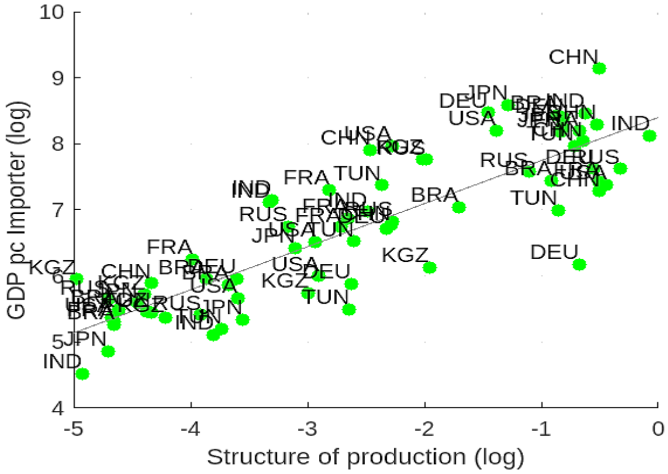

Fig 4. Correlation Between GDP Per Capita and Production

We enhance the baseline model by including adjustments for the quality of IPR held by the importer and the structure of their production. All of these extra variables have coefficients that are statistically significant, and their signs align with what was anticipated. Countries that have strong IPR protection and specialize in highly inventive areas tend to attract a greater influx of technology [52]. All the remaining economic parameters maintain their value and numerical importance, with the exception of those pertaining to the importer: The significance of remoteness diminishes.

V.CONCLUSION

Our research show that economic factors such as R&D expenditure, GDP per capita, and regional location significantly influence international technology transfer processes. The findings prove that the nations with elevated R&D investment and productivity rates belong to the group of crucial technology exporters, while the large and less geographically isolated economies could be considered as those possessing greater potential to import technologies. The analysis using the Poisson Pseudo Maximum Likelihood (PPML) regression also brought out the fact that all the constants were statistically substantial, thereby pointing to the fact that economic fundamentals play a vital role in facilitating royalty payment and technology transfer. The extended model, including IPR protection and technology intensity, advanced these perceptions by expressing that strong IPR protection and focus on technology-sensitive industries strengthen a country's capability to attract foreign technology. In addition, the breakdown of the R^2 values for developed and developing countries showed that exporter factors such as R&D and GDP have a greater influence on developed nations while importer factors including remoteness and GDP have a significant impact on developing countries. The study revealed considerable technology transfer gaps in countries with poor IPR protection and large geographical distances from technology sources, underlining the importance of improved IPR protection and decreased distances to enhance world technology exchange.

CRediT Author Statement

The author reviewed the results and approved the final version of the manuscript.

Data Availability

The datasets generated during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interests

The authors declare that they have no conflicts of interest regarding the publication of this paper.

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References

[1]. T. Homer-Dixon, “The ingenuity gap: Can poor countries adapt to resource scarcity?,” Population and Development Review, vol. 21, no. 3, p. 587, Sep. 1995, doi: 10.2307/2137751.
[2]. R. Frieden, “Lessons from broadband development in Canada, Japan, Korea and the United States,” Telecommunications Policy, vol. 29, no. 8, pp. 595–613, Sep. 2005, doi: 10.1016/j.telpol.2005.06.002.
[3]. J. G. Williamson, “Regional Inequality and the Process of National Development: A description of the patterns,” Economic Development and Cultural Change, vol. 13, no. 4, Part 2, pp. 1–84, Jul. 1965, doi: 10.1086/450136.
[4]. J. F. Reinganum, “On the Diffusion of New Technology: A Game Theoretic Approach,” The Review of Economic Studies, vol. 48, no. 3, p. 395, Jul. 1981, doi: 10.2307/2297153.
[5]. C. P. Braga, “Reforming intellectual property rights regimes: challenges for developing countries,” Journal of International Economic Law, vol. 1, no. 4, pp. 537–554, Dec. 1998, doi: 10.1093/jiel/1.4.537.
[6]. D. Archibugi and A. Filippetti, “The Globalisation of Intellectual Property Rights: Four learned lessons and Four theses,” Global Policy, vol. 1, no. 2, pp. 137–149, May 2010, doi: 10.1111/j.1758-5899.2010.00019.x.
[7]. L. Yang and K. E. Maskus, “Intellectual property rights, technology transfer and exports in developing countries,” Journal of Development Economics, vol. 90, no. 2, pp. 231–236, Nov. 2009, doi: 10.1016/j.jdeveco.2008.11.003.
[8]. J. Hsu and Y.-E. Tiao, “Patent rights protection and foreign direct investment in Asian countries,” Economic Modelling, vol. 44, pp. 1–6, Jan. 2015, doi: 10.1016/j.econmod.2014.08.018.
[9]. A. Dechezleprêtre, M. Glachant, and Y. Ménière, “What Drives the International Transfer of Climate Change Mitigation Technologies? Empirical Evidence from Patent Data,” Environmental and Resource Economics, vol. 54, no. 2, pp. 161–178, Aug. 2012, doi: 10.1007/s10640-012-9592-0.
[10]. L. Erdal and İ. Göçer, “The Effects of Foreign Direct Investment on R&D and Innovations: Panel Data Analysis for Developing Asian Countries,” Procedia - Social and Behavioral Sciences, vol. 195, pp. 749–758, Jul. 2015, doi: 10.1016/j.sbspro.2015.06.469.
[11]. D. Kyrkilis and S. Koboti, “Intellectual property rights as determinant of foreign direct investment entry mode: the case of Greece,” Procedia Economics and Finance, vol. 19, pp. 3–16, Jan. 2015, doi: 10.1016/s2212-5671(15)00003-9.
[12]. G. Valacchi, N. Doytch, and N. Yonzan, “Impact of outward foreign direct investments on patent activity of Greenfield multinationals,” Technological Forecasting and Social Change, vol. 173, p. 121168, Dec. 2021, doi: 10.1016/j.techfore.2021.121168.
[13]. S. Deqiang, C. Zhijun, M. Hajduk-Stelmachowicz, A. R. Larik, and M. Z. Rafique, “The role of the global value chain in improving trade and the sustainable competitive advantage: evidence from China’s manufacturing industry,” Frontiers in Environmental Science, vol. 9, Nov. 2021, doi: 10.3389/fenvs.2021.779295.
[14]. M. Callon and V. Rabeharisoa, “Research ‘in the wild’ and the shaping of new social identities,” Technology in Society, vol. 25, no. 2, pp. 193–204, Apr. 2003, doi: 10.1016/s0160-791x(03)00021-6.
[15]. E. Gómez-Herrera, “Comparing alternative methods to estimate gravity models of bilateral trade,” Empirical Economics, vol. 44, no. 3, pp. 1087–1111, Mar. 2012, doi: 10.1007/s00181-012-0576-2.
[16]. D. S. Jacks, C. M. Meissner, and D. Novy, “Trade costs in the first wave of globalization,” Explorations in Economic History, vol. 47, no. 2, pp. 127–141, Apr. 2010, doi: 10.1016/j.eeh.2009.07.001.
[17]. J. Harrigan, “Specialization and the volume of trade: do the data obey the laws?,” SSRN Electronic Journal, Jan. 2001, doi: 10.2139/ssrn.921392.
[18]. A.-M. Audet, “Medical Practice Guidelines: current activities and future directions,” Annals of Internal Medicine, vol. 113, no. 9, p. 709, Nov. 1990, doi: 10.7326/0003-4819-113-9-709.
[19]. J. R. Burch, E. M. Clarke, K. L. McMillan, D. L. Dill, and L. J. Hwang, “Symbolic model checking: 1020 States and beyond,” Information and Computation, vol. 98, no. 2, pp. 142–170, Jun. 1992, doi: 10.1016/0890-5401(92)90017-a.
[20]. Y. Barlas, “Formal aspects of model validity and validation in system dynamics,” System Dynamics Review, vol. 12, no. 3, pp. 183–210, Jan. 1996, doi: 10.1002/(sici)1099-1727(199623)12:3.
[21]. L. Capoani, “Review of the gravity model: origins and critical analysis of its theoretical development,” SN Business & Economics, vol. 3, no. 5, Apr. 2023, doi: 10.1007/s43546-023-00461-0.
[22]. O. Y. R. Goyeneche, M. Ramirez, J. Schot, and F. Arroyave, “Mobilizing the transformative power of research for achieving the Sustainable Development Goals,” Research Policy, vol. 51, no. 10, p. 104589, Dec. 2022, doi: 10.1016/j.respol.2022.104589.
[23]. A. Panagariya, “Preferential Trade Liberalization: the Traditional Theory and New Developments,” Journal of Economic Literature, vol. 38, no. 2, pp. 287–331, Jun. 2000, doi: 10.1257/jel.38.2.287.
[24]. H. Long, Y. Zhang, L. Ma, and S. Tu, “Land use Transitions: progress, challenges and Prospects,” Land, vol. 10, no. 9, p. 903, Aug. 2021, doi: 10.3390/land10090903.
[25]. Richar. T. Carson, Y. Jeon, and D. R. McCUBBIN, “The relationship between air pollution emissions and income: US Data,” Environment and Development Economics, vol. 2, no. 4, pp. 433–450, Nov. 1997, doi: 10.1017/s1355770x97000235.
[26]. D. Karemera, V. I. Oguledo, and B. Davis, “A gravity model analysis of international migration to North America,” Applied Economics, vol. 32, no. 13, pp. 1745–1755, Oct. 2000, doi: 10.1080/000368400421093.
[27]. R. Ramos and J. Suriñach, “A gravity model of migration between the ENC and the EU,” Tijdschrift Voor Economische En Sociale Geografie, vol. 108, no. 1, pp. 21–35, Jul. 2016, doi: 10.1111/tesg.12195.
[28]. P. Aghion, P. A. David, and D. Foray, “Science, technology and innovation for economic growth: Linking policy research and practice in ‘STIG Systems,’” Research Policy, vol. 38, no. 4, pp. 681–693, May 2009, doi: 10.1016/j.respol.2009.01.016.
[29]. K. Aiginger and M. Falk, “Explaining Differences in Economic Growth among OECD Countries,” Empirica, vol. 32, no. 1, pp. 19–43, Mar. 2005, doi: 10.1007/s10663-005-1977-7.
[30]. W. Hao, F. Rasul, Z. Bhatti, M. S. Hassan, I. Ahmed, and N. Asghar, “A technological innovation and economic progress enhancement: an assessment of sustainable economic and environmental management,” Environmental Science and Pollution Research, vol. 28, no. 22, pp. 28585–28597, Feb. 2021, doi: 10.1007/s11356-021-12559-9.
[31]. J. Huang, X. X. Lu, and J. M. Sellers, “A global comparative analysis of urban form: Applying spatial metrics and remote sensing,” Landscape and Urban Planning, vol. 82, no. 4, pp. 184–197, Oct. 2007, doi: 10.1016/j.landurbplan.2007.02.010.
[32]. G. Shmueli, “To explain or to predict?,” Statistical Science, vol. 25, no. 3, Aug. 2010, doi: 10.1214/10-sts330.
[33]. I. Martínez-Zarzoso and S. Chelala, “Trade agreements and international technology transfer,” Review of World Economics, vol. 157, no. 3, pp. 631–665, Jun. 2021, doi: 10.1007/s10290-021-00420-7.
[34]. Z. Deng, R.-J. “Bryan” Jean, and R. R. Sinkovics, “Rapid expansion of international new ventures across institutional distance,” Journal of International Business Studies, vol. 49, no. 8, pp. 1010–1032, Oct. 2018, doi: 10.1057/s41267-017-0108-6.
[35]. E. Fujii, “What does trade openness measure?,” Oxford Bulletin of Economics and Statistics, vol. 81, no. 4, pp. 868–888, Nov. 2018, doi: 10.1111/obes.12275.
[36]. J. Fagerberg, M. Srholec, and M. Knell, “The Competitiveness of Nations: Why some countries prosper while others fall behind,” World Development, vol. 35, no. 10, pp. 1595–1620, Oct. 2007, doi: 10.1016/j.worlddev.2007.01.004.
[37]. L. G. Zucker, M. R. Darby, and J. S. Armstrong, “Commercializing knowledge: university science, knowledge capture, and firm performance in biotechnology,” Management Science, vol. 48, no. 1, pp. 138–153, Jan. 2002, doi: 10.1287/mnsc.48.1.138.14274.
[38]. C. Henry and J. E. Stiglitz, “Intellectual property, dissemination of innovation and sustainable development,” Global Policy, vol. 1, no. 3, pp. 237–251, Oct. 2010, doi: 10.1111/j.1758-5899.2010.00048.x.

[39]. D. Encaoua, D. Guellec, and C. Martínez, “Patent systems for encouraging innovation: Lessons from economic analysis,” Research Policy, vol. 35, no. 9, pp. 1423–1440, Nov. 2006, doi: 10.1016/j.respol.2006.07.004.
[40]. D. Nersessian and R. Mancha, “From Automation to autonomy: legal and ethical responsibility Gaps in artificial intelligence innovation,” Michigan Technology Law Review, no. 27.1, p. 55, Jan. 2021, doi: 10.36645/mtlr.27.1.from.
[41]. D. M. Gould and W. C. Gruben, “The role of intellectual property rights in economic growth,” Journal of Development Economics, vol. 48, no. 2, pp. 323–350, Mar. 1996, doi: 10.1016/0304-3878(95)00039-9.
[42]. W. S. Comanor and F. M. Scherer, “Patent statistics as a measure of technical change,” Journal of Political Economy, vol. 77, no. 3, pp. 392–398, May 1969, doi: 10.1086/259522.
[43]. G. Dosi, L. Marengo, and C. Pasquali, “Knowledge, competition and innovation: Is strong IPR protection really needed for more and better innovations?,” Michigan Telecommunications and Technology Law Review, vol. 13, no. 2, pp. 471–485, Jan. 2007, [Online]. Available: https://iris.luiss.it/handle/11385/86012
[44]. G. M. Grossman and E. Helpman, “Endogenous innovation in the theory of growth,” The Journal of Economic Perspectives, vol. 8, no. 1, pp. 23–44, Feb. 1994, doi: 10.1257/jep.8.1.23.
[45]. L. H. Fang, J. Lerner, and C. Wu, “Intellectual Property Rights Protection, Ownership, and Innovation: Evidence from China,” Review of Financial Studies, vol. 30, no. 7, pp. 2446–2477, Apr. 2017, doi: 10.1093/rfs/hhx023.
[46]. Y. Chen and T. Puttitanun, “Intellectual property rights and innovation in developing countries,” Journal of Development Economics, vol. 78, no. 2, pp. 474–493, Dec. 2005, doi: 10.1016/j.jdeveco.2004.11.005.
[47]. P. C. Neves, O. Afonso, D. Silva, and E. Sochirca, “The link between intellectual property rights, innovation, and growth: A meta-analysis,” Economic Modelling, vol. 97, pp. 196–209, Apr. 2021, doi: 10.1016/j.econmod.2021.01.019.
[48]. S. Woo, P. Jang, and Y. Kim, “Effects of intellectual property rights and patented knowledge in innovation and industry value added: A multinational empirical analysis of different industries,” Technovation, vol. 43–44, pp. 49–63, Sep. 2015, doi: 10.1016/j.technovation.2015.03.003.
[49]. B. Verspagen, “University Research, Intellectual Property Rights And European Innovation Systems,” Journal of Economic Surveys, vol. 20, no. 4, pp. 607–632, Aug. 2006, doi: 10.1111/j.1467-6419.2006.00261.x.
[50]. K. Ito, K. Ikeuchi, C. Criscuolo, J. Timmis, and A. Bergeaud, “Global value chains and domestic innovation,” Research Policy, vol. 52, no. 3, p. 104699, Apr. 2023, doi: 10.1016/j.respol.2022.104699.
[51]. S. Lall, “Indicators of the relative importance of IPRs in developing countries,” Research Policy, vol. 32, no. 9, pp. 1657–1680, Oct. 2003, doi: 10.1016/s0048-7333(03)00046-5.
[52]. C. Forero-Pineda, “The impact of stronger intellectual property rights on science and technology in developing countries,” Research Policy, vol. 35, no. 6, pp. 808–824, Jul. 2006, doi: 10.1016/j.respol.2006.04.003.

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