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Exploring the Nexus of Intellectual Property Rights Infringement and Socio-Economic Factors: Evidence from a Global Perspective

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Abstract
This paper contributes to the ongoing discourse on the relationship between intellectual property rights infringement and socio-economic factors by employing a bivariate Granger causality test. By utilizing data from 100 countries over a 16-year period, the study explores the interplay between IPR infringement, income levels, sociopolitical factors, and legal factors. Through co-integration analysis employing an error correction model, the study sheds light on the causality issue among these variables. The findings reveal a bi-directional causality between corruption and piracy rates, suggesting a mutually reinforcing relationship between these factors. Additionally, the study demonstrates that the rule of law exerts a causal influence on piracy rates, indicating the importance of legal frameworks in shaping intellectual property infringement. However, the causal relationship does not appear to be reciprocal, suggesting that piracy rates do not significantly impact the rule of law. Interestingly, the study uncovers nuanced dynamics regarding the impact of piracy on economic growth. While piracy demonstrates a short-term stimulatory effect on growth, particularly in the context of certain socio-economic conditions, such as corruption, the long-term relationship reveals a dampening effect of growth on piracy rates. This suggests a complex interplay between piracy, economic development, and institutional factors over time. Overall, these findings provide valuable insights into the multifaceted relationship between IPR infringement and socio-economic factors, highlighting the importance of addressing corruption and strengthening legal frameworks to combat piracy effectively while also fostering sustainable economic growth.
Keywords: Intellectual Property Rights, Piracy Rates, Corruption, Rule of Law, Economic Growth
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1. INTRODUCTION

Economic costs, socio-political dynamics, legal frameworks, technological advancements, and cultural attitudes all play crucial roles in shaping piracy rates, underscoring the complex interplay of factors at play. Banerjee (2006) and Koboldt (1995) have focused on estimating the economic costs associated with piracy, highlighting the financial implications for industries affected by intellectual property infringement. These studies shed light on the tangible economic consequences of piracy, including lost revenues, reduced innovation incentives, and distortions in market dynamics. On the other hand, research by Shadle et al., (2005), Depken and Simmons (2004), and Van Kranenburg and Hogenbirk (2005) delves into the broader socio-political and legal dimensions of piracy, exploring how governance structures, institutional frameworks, and social norms influence piracy rates. These studies recognize the importance of addressing underlying social and political drivers of piracy, such as poverty, corruption, and ineffective law enforcement, in effectively combating piracy. Furthermore, cultural factors also emerge as significant determinants of piracy, as evidenced by the works of Bezmen and Depken (2006), Andrés and Fischer (2006a, 2006b), and Gopal and Sanders (1998). These studies highlight the role of cultural attitudes, norms, and perceptions towards intellectual property rights in shaping individuals' propensity to engage in piracy activities.

Technological advancements also have a profound impact on piracy rates, as demonstrated by Marron and Steel (2000), Husted (2000), and Robertson et al. (2008). The proliferation of digital technologies and the internet have facilitated the widespread distribution of pirated content, posing new challenges for copyright enforcement and intellectual property protection. While the existing literature provides valuable insights into the various determinants of piracy, the direction of causality remains a subject of debate. Some studies suggest that economic, political, and legal factors drive piracy rates, while others argue that piracy itself can influence economic and political dynamics. This complexity underscores the need for interdisciplinary research approaches that account for the interdependencies and feedback loops between different factors influencing piracy. By gaining a deeper understanding of these dynamics, policymakers and stakeholders can develop more effective strategies to address piracy and promote a culture of respect for intellectual property rights.

The observation regarding the predominance of cross-sectional studies in the piracy literature is indeed noteworthy. Cross-sectional studies offer valuable insights into the relationships between piracy and various socioeconomic factors at a specific point in time, allowing researchers to identify correlations and associations. However, they are limited in their ability to establish causal relationships or capture dynamic processes unfolding over time. Moreover, the issue of reverse causality presents a significant challenge in interpreting the findings of cross-sectional studies. For instance, while these studies may identify correlations between piracy rates and socioeconomic variables, they often fail to disentangle the

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direction of causality. It is plausible that piracy rates could influence socioeconomic factors, just as socioeconomic conditions could affect piracy rates. To address these limitations, there is a growing need for longitudinal studies that track changes in piracy rates and socioeconomic variables over time. By collecting data at multiple time points, longitudinal studies can better capture the temporal dynamics of piracy and its interactions with socioeconomic factors. Additionally, these studies can help elucidate the direction of causality by examining how changes in piracy rates precede or follow changes in socioeconomic conditions.

Furthermore, the issue of bidirectional causality between piracy and socioeconomic factors underscores the importance of adopting a dynamic systems perspective. Rather than treating piracy and socioeconomic variables as independent and static entities, researchers should recognize their interdependence and the feedback loops that exist between them. This approach can provide a more nuanced understanding of the complex relationships between piracy and socioeconomic factors, revealing how changes in one domain can influence the other and vice versa. While cross-sectional studies have contributed valuable insights to the piracy literature, there is a clear need for more rigorous and comprehensive research designs that address the limitations associated with reverse causality and temporal dynamics. By adopting longitudinal approaches and considering bidirectional causality, researchers can enhance our understanding of the multifaceted nature of piracy and its interactions with socioeconomic factors. The approach outlined in this study represents a commendable effort to address the gaps in the existing literature on intellectual property rights (IPR) infringement. By employing co-integration analysis and an error correction model, this study aims to provide a more robust understanding of the relationship between IPR infringement and various economic, sociopolitical, and legal factors. Using software piracy rate as a proxy for IPR infringement and GDP per capita, corruption, and rule of law as proxies for economic, sociopolitical, and legal factors respectively, this study seeks to explore both the long-term equilibrium relationship and short-term dynamics among these variables. Co-integration analysis allows for the examination of whether these variables move together over time, indicating a stable relationship among them. Furthermore, the inclusion of sociopolitical and legal factors such as corruption and rule of law adds depth to your analysis by acknowledging the broader institutional context within which IPR infringement occurs. By assessing the causal relationships between these factors, this study sheds light on the complex interplay between economic, sociopolitical, and legal dynamics in shaping IPR infringement outcomes. The longitudinal nature of analysis, spanning 15 years and encompassing data from 100 countries, provides a comprehensive view of the relationships under investigation. This allows for a more robust assessment of causality issues and helps to mitigate potential biases arising from cross-sectional variations. This study represents a significant contribution to the literature on IPR infringement, offering valuable insights into the multifaceted determinants of this phenomenon. By employing rigorous analytical techniques and considering a broad range of factors, this research has the potential to inform policy discussions and interventions aimed at addressing IPR infringement in a more holistic manner.

2. LITERATURE REVIEW

Study's Otto (2015) approach to narrowing down the factors contributing to piracy to three general indicators—GDP per capita and corruption—reflects a thoughtful consideration of the broader economic, socio-political, and legal landscape within which piracy occurs. By selecting these indicators, this study aims to capture key dimensions of economic health and transparency that may influence piracy rates. GDP per capita serves as a widely used measure of economic well-being, providing insight into the overall prosperity and purchasing power of individuals within a country. Its selection as an indicator reflects its broad applicability and relevance to understanding the economic context in which piracy operates. By examining the relationship between GDP per capita and piracy rates, your study seeks to explore how variations in economic wealth may affect the propensity for piracy. Corruption, on the other hand, serves as a proxy for socio-political factors related to governance, transparency, and rule of law. Corruption can undermine legal frameworks and enforcement mechanisms designed to protect intellectual property rights, creating an environment conducive to piracy. By including corruption as an indicator, your study acknowledges the importance of institutional quality and governance structures in shaping piracy outcomes. The choice to include the Rule of Law as an indicator adds depth to the study by examining the integrity and effectiveness of a nation's legal system in addressing piracy. The Rule of Law encompasses principles such as legal transparency, accountability, and adherence to established legal norms, all of which are relevant to the enforcement of intellectual property rights. Exploring the causal relationships between GDP per capita, corruption, Rule of Law, and piracy rates provides a nuanced understanding of the multifaceted dynamics underlying piracy behavior. By considering economic, socio-political, and legal factors simultaneously, the study offers a comprehensive analysis of the drivers of piracy across different national contexts.

The negative relationship between national income per capita and piracy rates, as highlighted in previous research by Ginarte and Park (1997), Husted (2000), Shin et al., 2004 Gopal et al., (2004), Banerjee et al., (2005), and Andrés (2006b), underscores the importance of economic factors in shaping piracy behavior. Higher levels of economic prosperity may reduce the incentive for individuals to engage in piracy, as they have greater purchasing power to access legitimate products and services. The study aims to build upon these existing findings by investigating how corruption and the Rule of Law interact with economic factors to influence piracy rates. By examining these relationships within a coherent analytical framework, the research contributes valuable insights to the ongoing discourse on piracy and intellectual property rights enforcement. The negative relationship between national income per capita and piracy rates, as highlighted by Shin et al. (2004), underscores the significant impact of economic factors on piracy behavior. This relationship was found to be particularly pronounced in countries with a per capita GDP below $6,000, indicating that lower levels of economic prosperity may exacerbate the prevalence of piracy. As individuals and businesses face greater financial constraints in such contexts, the allure of pirated goods and services as more affordable alternatives may be heightened.

Thus, understanding the nuances of economic disparities and their implications for piracy rates is essential for devising effective policy measures to combat intellectual property infringement. The findings underscore the nuanced relationship between economic factors and piracy rates, highlighting the complex interplay between affordability, consumer behavior, and legal enforcement mechanisms. Moreover, they suggest that addressing the underlying economic challenges facing individuals and businesses in lower-income countries may be crucial for curbing piracy effectively. By focusing on strategies that promote economic development, enhance access to legitimate goods and services, and strengthen legal frameworks, policymakers can work towards creating an environment conducive to reducing piracy rates and fostering innovation and creativity. Over the last few years, there have been a handful of studies stating the possible existence of a non-linear relationship between income level and piracy (El Harbi et al., 2012; Andrés, 2006a, 2006b). These studies found an inverted U-shaped relationship between per capita income and piracy, supporting the hypothesis that piracy first increases with the level of income per capita, reaches a maximum, and then decreases at higher levels of income. The identification of a potential inverted U-shaped relationship between per capita income and piracy offers valuable insights into the dynamics of piracy behavior across different income levels. This suggests that as countries experience initial economic growth and improvements in living standards, piracy may initially rise as individuals gain access to technology and digital content but may subsequently decline as legal enforcement mechanisms and consumer preferences evolve. Understanding this nonlinear relationship can inform policymakers and industry stakeholders in developing targeted interventions and strategies that address piracy effectively while also promoting economic growth and development.

In addition to real GDP per capita, the significance of other economic factors has been identified in the case of R&D, economic freedom, income inequality, high technology exports, and inflation (Ginarte and Park, 1997; Marron and Steel, 2000; Husted, 2000; Andrés, 2006a; Imran et al., 2021). These studies highlight the multifaceted nature of the relationship between economic factors and piracy rates. For instance, research and development investment reflects a country's commitment to innovation and technological advancement, which can influence the availability of legal alternatives to pirated goods. Economic freedom measures the extent to which individuals and businesses can engage in voluntary transactions without government intervention, impacting the ease of access to legitimate products and services. Income inequality may exacerbate piracy by limiting access to affordable legal options for lower-income individuals, while high technology exports may stimulate demand for pirated software as users seek to complement their technological capabilities. Furthermore, inflationary pressures may affect the affordability of legal goods and services, potentially driving consumers towards pirated alternatives. Understanding the nuanced relationships between these economic factors and piracy behavior is essential for devising targeted interventions to mitigate piracy and promote lawful consumption. Policymakers, industry stakeholders, and researchers must collaborate to develop comprehensive strategies that address the underlying economic drivers of piracy while fostering an environment conducive to innovation, economic growth, and social welfare.

Socio-political factors constitute a diverse set of variables that can influence piracy rates. Studies have explored a range of indicators such as education levels, openness to trade and globalization, democratic governance, and levels of corruption. While the evidence regarding the relationship between software piracy rates and these socio-political indices is mixed, corruption consistently emerges as a significant factor across various studies (Marron & Steel, 2000; Depken & Simmons, 2004; Ginarte & Park, 1997; Yang & Maskus, 2007). Corruption, as a socio-political variable, encompasses a broad range of behaviors and practices, including bribery, nepotism, and favoritism, among others. In the context of piracy, corruption can undermine enforcement efforts, weaken intellectual property rights protection, and foster an environment conducive to illicit activities. High levels of corruption may lead to regulatory capture, where government agencies tasked with combating piracy are compromised or ineffective due to improper influence or incentives. Moreover, corruption can erode trust in public institutions and undermine the rule of law, reducing the perceived risks and consequences associated with engaging in piracy. Individuals and businesses may feel emboldened to flout intellectual property laws if they perceive that enforcement efforts are lax or susceptible to manipulation. Given the significant role of corruption in shaping piracy behavior, addressing corruption through targeted anti-corruption measures and institutional reforms is crucial for combating piracy effectively. Strengthening governance structures, enhancing transparency and accountability, and promoting ethical behavior among public officials are essential steps toward creating a more conducive environment for intellectual property rights enforcement and lawful commerce.

The literature consistently indicates a positive relationship between corruption and software piracy (Ronkainen et al., 2008 Ronkainen and Guerrero-Cusumano, 2001; Papadopoulos, 2003; Bagchi et al., 2006; Banerjee et al., 2005; Goel and Nelson, 2009; Robertson et al., 2008; Andrès and Goel, 2011). This positive association underscores the detrimental impact of corruption on intellectual property rights enforcement and the prevalence of piracy in corrupt environments. Corruption can facilitate piracy by undermining legal and regulatory frameworks, impeding enforcement efforts, and fostering an atmosphere of impunity for intellectual property violations. Furthermore, corrupt practices such as bribery, extortion, and collusion may enable the illicit distribution and reproduction of copyrighted software, allowing individuals and businesses to evade legal consequences and exploit pirated materials for financial gain. The findings of these studies highlight the importance of addressing corruption as a critical factor in efforts to combat software piracy. By tackling corruption through comprehensive anti-corruption measures, promoting transparency and accountability in governance, and strengthening institutional integrity, policymakers can enhance the effectiveness of intellectual property rights protection and create a more conducive environment for innovation, creativity, and lawful economic activity.

The findings of several studies consistently highlight the significant role of intellectual property rights (IPRs) protection in influencing software piracy rates (Yang & Maskus, 2007; Van Kranenburg and Hogenbirk, 2005; Andrés, 2006b; Papadopoulos, 2003). These studies suggest that stronger IPRs protection measures have a substantial negative impact on

software piracy, indicating that enhancing legal frameworks and enforcement mechanisms for intellectual property rights can effectively deter piracy activities. By implementing robust IPRs protection measures, policymakers can create a more supportive environment for innovation, incentivize investment in research and development, and safeguard the rights of creators and innovators. Furthermore, strengthening IPRs protection can contribute to fostering a culture of respect for intellectual property rights, promoting lawful business practices, and facilitating the growth of legitimate markets for software products. The evidence underscores the importance of prioritizing IPRs protection as a key component of strategies to combat software piracy and promote a conducive environment for innovation and economic development.

Holm (2003) and Andrés (2006a) provide valuable insights into the relationship between the rule of law and software piracy. Their research not only underscores the importance of legal frameworks but also sheds light on the broader implications for intellectual property rights (IPR) protection. By utilizing the rule of law as a proxy for IPR protection, their studies offer a comprehensive perspective on the role of formal institutions in combating piracy. They demonstrate that countries with stronger legal systems and greater adherence to the rule of law are better equipped to address intellectual property infringements. Moreover, their findings highlight the need for effective enforcement mechanisms to deter piracy and ensure compliance with copyright laws. Strengthening legal institutions and enhancing enforcement capacities emerge as critical strategies in reducing software piracy rates. Holm and Andrés (2006b), research contributes to our understanding of the complex interplay between legal frameworks, institutional quality, and piracy. Their findings have significant implications for policymakers, emphasizing the importance of prioritizing legal reforms and bolstering enforcement efforts to safeguard intellectual property rights and promote innovation in the digital economy. The relationship between legal frameworks and software piracy, while conceptually straightforward, presents significant challenges in practice. Authorities tasked with combating piracy often face complex dilemmas that require careful consideration of various factors.

One such dilemma revolves around the balance between enforcing intellectual property rights (IPRs) and ensuring access to technology and information. While stringent enforcement measures may be effective in reducing piracy, they could also hinder access to essential software and digital resources, particularly in developing economies where affordability is a concern. Moreover, the effectiveness of enforcement efforts may be limited by institutional capacity, resource constraints, and competing priorities. In many jurisdictions, law enforcement agencies grapple with limited resources and expertise, making it difficult to effectively combat piracy amidst other pressing issues. Additionally, the rapid evolution of technology and the borderless nature of the digital environment pose significant challenges to enforcement efforts. Pirated software can easily be distributed across multiple jurisdictions, making it challenging for authorities to track and prosecute offenders effectively. Furthermore, there are ethical considerations surrounding the enforcement of intellectual property laws, particularly in contexts where access to technology is essential for socio-economic development. Striking a balance between protecting intellectual property rights and promoting innovation while ensuring equitable access to technology remains a complex and multifaceted challenge for policymakers and law enforcement agencies worldwide.

The dilemma faced by authorities in balancing the enforcement of intellectual property rights (IPRs) with broader societal welfare concerns is indeed multifaceted and challenging. On one hand, there is pressure to implement and maintain systems for IPRs protection, often driven by international organizations and developed countries seeking to uphold global standards of intellectual property rights enforcement. However, the cost of such enforcement measures can be prohibitively expensive, particularly for developing countries with limited resources. Moreover, strict enforcement of IPRs can result in the exclusion of marginalized and economically disadvantaged populations from accessing essential software products and digital resources. This exclusion not only hinders individual access to technology but also impedes broader societal development and knowledge sharing. At the same time, developing countries must navigate the increasing pressure and sanction threats from multilateral organizations, such as the World Trade Organization (WTO), to comply with international intellectual property standards. Failure to meet these standards can have significant economic and diplomatic ramifications, further complicating the decision-making process for authorities. As a result, authorities in these countries are faced with the formidable task of finding a delicate balance between fulfilling international obligations related to IPRs enforcement and safeguarding the welfare and development needs of their citizens. This may entail exploring alternative approaches to IPRs protection that prioritize equitable access to technology while still addressing concerns related to intellectual property rights infringement. Ultimately, achieving this balance requires thoughtful policy formulation and stakeholder engagement to ensure that the interests of all parties are adequately addressed.

3. ECONOMIC MODEL

Trochim's (2000) emphasis on the importance of establishing temporal precedence in causal relationships is indeed crucial when examining phenomena such as piracy and its socioeconomic determinants. By incorporating a time-lagged analysis into the study framework, researchers can better discern the directionality of causality between the predictor variables (GDP, corruption perception index, and rule of law) and the piracy rate. The proposed model for the study, as outlined, includes GDP, corruption perception index, and rule of law as predictors of the piracy rate (Pr). This model aims to elucidate how changes in these socioeconomic factors may precede variations in piracy rates over time. By examining the relationship between GDP, corruption perception index, and rule of law at earlier time points (e.g., t-1) and subsequent piracy rates at later time points (e.g., t), researchers can assess whether fluctuations in these predictors precede changes in piracy rates, thereby providing evidence for causal inference. Overall, integrating a time-lagged analysis into the study design enhances the robustness of causal claims regarding the influence of socioeconomic factors on piracy rates, aligning with best practices in causal inference outlined by (Trochim, 2000).

4. RESULTS

Table 1 presents descriptive statistics for four variables: Pr, GDP, Cor, and RL. The variable "Pr" represents a certain parameter or metric, with 1320 observations. The mean value of 59.53 suggests the average value across all observations, and the standard deviation of 21.37 indicates the dispersion or variability around this mean. The minimum value of 0 and maximum value of 99 represent the lowest and highest recorded values, respectively, for this parameter. "GDP," representing Gross Domestic Product, is described with 1483 observations. The mean GDP value of 15803.53 reflects the average GDP across all observations, while the standard deviation of 14273.73 indicates the variability in GDP values. The minimum GDP value of 202.53 and the maximum of 88558.83 illustrate the range of economic activity observed in the dataset. The variable "Cor" likely represents correlation coefficients, with 1279 observations. The mean value of 4.91 suggests the average correlation observed across all pairs of variables, while the standard deviation of 2.40 shows the variability in correlation coefficients. The minimum correlation value of 0.4 indicates weak positive correlation, while the maximum value of 10 suggests strong positive correlation. Finally, "RL," possibly representing "Relative Loss," is described with 1200 observations. The mean value of 0.26 indicates the average relative loss across all observations, and the standard deviation of 1.01 shows the variability in relative loss values. The minimum RL value of -1.94 suggests losses below a baseline, while the maximum value of 2.01 indicates losses exceeding the baseline.

Table 1: Descriptive statistics

Variable	N	Mean	Stand. Dev.	Min	Max
Pr	1320	59.53	21,37	0	99
GDP	1483	15803.53	14273.73	202,53	88558.83
Cor	1279	4.91	2.40	0.4	10
RL	1200	0.26	1.01	-1.94	2.01

Table 2 provides insights from the Fisher Test for Unit Roots, which is crucial for assessing the stationarity of the variables under consideration. Stationarity is fundamental in time series analysis as it ensures that statistical properties of a series, such as mean and variance, remain constant over time. Analyzing the non-differenced variables, it's observed that Pr exhibits a p-value of 0.09, indicating a marginal significance level that falls just short of conventional thresholds for statistical significance. This suggests a tentative indication towards non-stationarity in Pr, although further investigation may be warranted to draw conclusive insights. In contrast, the p-value for GDP stands at 1.00, suggesting strong evidence in favor of a unit root and hence non-stationarity in GDP. Similarly, Cor and Rule of Law exhibit p-values of 0.10 and 0.11, respectively, hinting at potential non-stationarity in these variables, albeit not statistically significant at conventional levels. Moving to the Error Correction Terms (EC), the results indicate a more decisive stance against the presence of a unit root. EC-Pr presents a significant p-value of 0.0138, reinforcing the notion of non-stationarity in Pr when considering error correction. Meanwhile, both EC-GDP and EC-Cor display p-values of 0.0000, signaling robust evidence against unit roots in these variables. This implies that the integration order of GDP and Cor changes when incorporating error correction, underscoring the importance of addressing potential non-stationarity in these variables for accurate modeling. Similarly, the p-value of 0.0000 for EC-RL underscores the compelling evidence against a unit root in the Rule of Law variable when considering error correction. This finding is crucial as it suggests that RL exhibits stationarity after accounting for any deviations from equilibrium in the system. Overall, these results highlight the importance of error correction and its role in refining the assessment of stationarity in time series data, particularly concerning economic variables such as GDP, Corruption (Cor), and Rule of Law (RL).

Table 2: Fisher Test for Unit Roots

H_0: unit root	p-value
Variable tested	
Non-differenced Variables	
Pr	0.09
GDP	1.00
Cor	0.10
Rule of Law	0.11
Error Correction Terms	
EC-Pr	0.0138
EC-GDP	0.0000
EC-Cor	0.0000
EC-RL	0.0000

Table 3 presents the results of the cointegrating equation analysis, with the dependent variable being the piracy rate and several independent variables included. The coefficients and corresponding p-values offer insights into the relationships between the piracy rate and the explanatory variables. Firstly, the coefficient for GDP is -6.361 with a p-value of 0.000, indicating a statistically significant negative relationship between GDP and piracy rate. This suggests that as GDP increases, the piracy rate tends to decrease, highlighting the potential economic factors influencing piracy activities. Secondly, the coefficient for Cor is 4.141 with a p-value of 0.026, suggesting a statistically significant positive relationship

between Corruption (Cor) and piracy rate. This implies that higher levels of corruption may be associated with higher piracy rates, possibly due to weaker law enforcement or governance structures. Lastly, the coefficient for RL is -6.384 with a p-value of 0.000, indicating a statistically significant negative relationship between the Rule of Law (RL) and piracy rate. This suggests that stronger rule of law measures are associated with lower piracy rates, likely due to better enforcement mechanisms and deterrent effects. Overall, these results provide valuable insights into the determinants of piracy rates, highlighting the importance of economic, governance, and legal factors in shaping piracy activities.

Table 3: Cointegrating Equation Results, Dependent Variable: piracy rate

Independent variable	Coefficient-value	p-value
GDP	-6.361***	0.000
Cor	4.141**	0.026
RL	-6.384***	0.000

Table 4 displays the results of the Error Correction Model (ECM), focusing on Equation 2 with the dependent variable being Pr (year t). The coefficients and corresponding p-values provide insights into the relationships between the dependent and independent variables, particularly focusing on the lagged values. The Error Correction Term (ECT) coefficient is 0.0066 with a p-value of 0.000, indicating a statistically significant relationship. This suggests that there is a correction mechanism in place to adjust for deviations from long-run equilibrium in the Pr variable. Moving to the lagged variables, the coefficient for Pr per capita (year t-1) is -0.163 with a p-value of 0.000, indicating a statistically significant negative relationship. This implies that changes in Pr per capita in the previous year have a significant impact on Pr in the current year. For GDP (year t-1), Cor (year t-1), and RL (year t-1), the coefficients are -2.771, -2.375, and 4.354, respectively. However, their p-values are relatively high (0.611, 0.528, and 0.256, respectively), suggesting that these variables may not be statistically significant predictors of Pr in the current year. Overall, these ECM results provide valuable insights into the dynamics of the Pr variable and its relationship with lagged values of Pr per capita, GDP, Corruption (Cor), and Rule of Law (RL), highlighting the importance of considering both short-term dynamics and long-run equilibrium in analyzing Pr.

Table 4: Error Correction Model Results

From equation 2: dependent variable = Δ Pr (year t)		
Independent variable	Coefficients	p-value
Error Correction Term	1.118***	0.000
0.0066		
Δ Pr per capita (year t-1)	-0 .163***	0.000
Δ GDP (year t-1)	-2.771	0.611
Δ Cor (year t-1)	-2.375	0.528
Δ RL (year t-1)	4.354	0.256

Table 5: Tests for Alternative Direction of Causality

Equation	(3)	(4)	(5)
Dependent Variable Year = t	GDP	Cor	RL
Error Correction Term	-0.018***	-0.023***	0.003
	(0.001)	(0.006)	(0.737)
Δ GDP	0.213***	0.018	0.092*
Year = t-1	(0.000)	(0.762)	(0.086)
Δ Pr	0.0008***	0.0002	0.0004
Year = t-1	(0.002)	(0.652)	(0.219)
Δ Cor	-0.045*	0.158***	0.024
Year = t-1	(0.071)	(0.000)	(0.490)
Δ RL	-0.025	-0.143***	0.014
Year = t-1	(0.326)	(0.000)	(0.694)

Table 5 presents the results of tests for alternative directions of causality among the variables, with Equation (3) focusing on the dependent variable in the current year (Year = t). Each column corresponds to a different independent variable (GDP, Cor, RL), and the coefficients along with their associated p-values are provided. The Error Correction Term (ECT) is included in each equation, with its coefficient denoted as -0.018, -0.023, and 0.003 for GDP, Cor, and RL, respectively. The p-values associated with these coefficients indicate statistical significance, with *** denoting significance at the 1% level. For the lagged values of GDP, the coefficients for Year = t-1 are 0.213, 0.018, and 0.092 for GDP, Cor, and RL, respectively. While the coefficient for GDP is statistically significant (p-value < 0.001), indicating a significant impact of lagged GDP on the current year's dependent variable, the coefficients for Cor and RL are not statistically significant.

Similarly, for the lagged values of Pr (Piracy Rate), the coefficients for Year = t-1 are 0.0008, 0.0002, and 0.0004 for GDP, Cor, and RL, respectively. Among these, only the coefficient for GDP is statistically significant at the 1% level, indicating a significant influence of lagged Pr on the current year's GDP. Moving to the lagged values of Cor (Corruption), the coefficients for Year = t-1 are -0.045, 0.158, and 0.024 for GDP, Cor, and RL, respectively. Here, the coefficient for Cor is statistically significant at the 10% level, suggesting a significant impact of lagged Cor on the current year's dependent variable. Finally, for the lagged values of RL (Rule of Law), the coefficients for Year = t-1 are -0.025, -0.143, and 0.014 for GDP, Cor, and RL, respectively. Among these, only the coefficient for Cor is statistically significant at the 1% level, indicating a significant influence of lagged RL on the current year's dependent variable. Overall, these results shed light on the potential directions of causality among the variables GDP, Cor, RL, and the Piracy Rate (Pr), providing valuable insights into their interrelationships and dynamics over time.

5. CONCLUSIONS

The regression findings from the error correction model provide valuable insights into the complex relationship between piracy rates and GDP per capita. Specifically, the results suggest that while an initial increase in piracy rates may coincide with a short-term boost in GDP per capita, this relationship undergoes a reversal over the long term. This observation is indicative of a potential non-linear relationship between income level and piracy, wherein piracy rates may exhibit an initial rise with increasing income levels, reaching a peak before declining as income levels continue to rise. This phenomenon aligns with previous research indicating an inverted U-shaped relationship between income and piracy rates (El Harbi et al., 2012; Andrés, 2006a, 2006b), wherein piracy initially increases with income, peaks, and then decreases as income levels further rise. The short-run/long-run difference in the relationship between piracy rates and GDP per capita underscores the dynamic nature of this association. While short-term fluctuations in piracy rates may influence immediate economic outcomes, such as GDP per capita, the long-term trend reveals the underlying negative impact of piracy on economic growth. This highlights the importance of considering both short-term and long-term effects when assessing the economic consequences of piracy. These regression results contribute to our understanding of the nuanced relationship between piracy rates and economic indicators, shedding light on the potential non-linear dynamics at play in this complex relationship.

The findings of this study suggest that piracy may serve as a somewhat inevitable phenomenon during the early stages of development, potentially acting as a means for accessing essential resources or technologies. However, as countries progress and advance economically, piracy becomes less prevalent, indicating a shift away from reliance on pirated goods or software. Moreover, the observed positive relationship between piracy and corruption, as well as the negative relationship with the rule of law, underscores the importance of governance and legal frameworks in combating piracy. Countries with higher levels of corruption may struggle to enforce intellectual property rights and deter piracy effectively, while those with stronger rule of law mechanisms are better equipped to address piracy through legal channels. These implications have significant ramifications for both intellectual property rights holders and policymakers. Intellectual property rights holders may need to adopt tailored strategies for addressing piracy in different socio-political contexts, taking into account factors such as corruption levels and the strength of legal institutions.

Policymakers, on the other hand, should prioritize efforts to improve governance, transparency, and the rule of law as part of broader initiatives to combat piracy and promote economic development. The findings of this study highlight the complex interplay between piracy, economic development, governance, and legal frameworks, underscoring the need for multifaceted approaches to addressing piracy and its underlying drivers. The insights gleaned from this study suggest that original firms operating in economies characterized by high levels of piracy may adopt a long-term perspective, recognizing that while piracy may initially serve as a means for accessing goods or technologies, sustained economic growth is likely to diminish piracy over time. This understanding could inform their strategic decisions, leading them to adopt a more tolerant stance towards piracy in the short term, with a focus on leveraging economic growth to reduce piracy in the long term. Furthermore, original firms may view piracy as a strategic tool, particularly in environments where competition is fierce. By tolerating low levels of piracy during the early stages of economic development, firms may aim to deter competitors and cultivate a user base that could transition into paying customers as economic prosperity increases. This "addiction effect" could be leveraged to convert current pirates into future consumers, thereby capitalizing on the eventual decline of piracy as economic conditions improve. For policymakers, the findings underscore the complex relationship between piracy, economic growth, and intellectual property rights protection. Attempts to curb piracy through enforcement measures alone may prove counterproductive, particularly in economies where piracy serves as a driver of economic activity and access to essential goods. Instead, policymakers may need to adopt a nuanced approach, balancing the need to protect intellectual property rights with the imperative of fostering economic development.

Ultimately, the study suggests that a deeper understanding of the dynamics of piracy and its relationship to economic growth is essential for both original firms and policymakers alike. By recognizing the potential role of piracy in driving economic activity and the long-term effects of economic growth on piracy rates, stakeholders can develop more effective strategies for addressing piracy while promoting sustainable economic development. The implications of our findings extend to policy domains beyond intellectual property rights enforcement. By addressing underlying issues such as corruption and the rule of law, policymakers have an opportunity to not only combat piracy but also foster a more conducive environment for economic growth and development. Efforts to reduce corruption can enhance transparency and accountability within society, creating a more level playing field for businesses and reducing incentives for engaging in illicit activities such as piracy. Similarly, strengthening the rule of law can promote legal certainty and protect intellectual property rights, thereby deterring piracy and incentivizing innovation and investment. Policymakers should

prioritize initiatives aimed at improving governance, enhancing judicial independence, and bolstering legal frameworks to ensure effective enforcement of intellectual property rights. By addressing these fundamental issues, policymakers can contribute to creating an environment that is conducive to innovation, entrepreneurship, and sustainable economic growth while simultaneously reducing piracy and protecting intellectual property rights.

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