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Who benefits from strong patent protection? An oil-dependent country's perspective

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Abstract

In this paper, a complex interplay is demonstrated, indicating that the impact of intellectual property rights (IPR) and patent protection varies in certain trade contexts. We review the IPR and patent laws in Oman and subsequent amendments following the signing of free trade agreements and investigate how strong protection of patents and IPRs affects Oman's trade. A panel data set comprising the majority of Oman's trading partners from 2000 to 2021 was utilized to achieve this objective. Under the Oman Intellectual Property (IP) Laws, 5617 patent applications were used to calculate the patent index scores. This study contributes four significant findings. First, it analyzes how strong IP and patent protection affect Oman's exports and imports. Second, it assesses the variation in overall trade flows and manufacturing trade flows. Third, while most studies use the IPR index, this study offers a more specific perspective by examining the patent index, particularly concerning manufacturing trade, which is primarily associated with patent-protected technologies. Fourth, this study provides the first comprehensive analysis of a GCC country that is heavily dependent on oil. This study reveals that Oman's strong IPR and patent regimes significantly enhance overall exports. Strong patent protection promotes the import of high-tech goods, whereas robust IPR protection unexpectedly reduces manufacturing trade.

KEYWORDS
GCC, IPR, Oman, patent index, trade

1 | INTRODUCTION

The protection of intellectual property rights (IPR) is considered a key indicator of a country's economic growth, even though intellectual property is more difficult to protect than physical property. It is primarily protected through patents, trademarks, copyrights, and industrial designs. As part of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), countries must meet minimum IPR protection standards to participate in world trade.

In terms of trade, scholars show that strong IPR protection can either increase or decrease trade based on market expansion and market power effects. The impact depends on a country's ability to absorb technology and to innovate, its market size, human capital, and wage rate. In the case of Oman, as a small and developing oil-dependent country, a stronger IPR protection could encourage multinational enterprises (MNEs) to expand their operations and produce technologically differentiated products, resulting in a wider income distribution and a production shift to low-wage countries, thus stimulating economic growth. Nevertheless, it could also limit the ability of domestic businesses to learn and build upon advanced technologies from foreign firms, slowing international trade, thereby impacting overall economic growth.[1]

Based on Krugman's theory of economies of scale in trade, nations can benefit from specialization and increased production through economies of scale. Effective IPR protection can encourage firms to invest in innovation and technology, ultimately improving productivity and allowing them to take advantage of economies of scale and scope. This theory can significantly increase trade by promoting technology transfer and knowledge spillovers between countries.[2]

Chin and Grossman[3] investigated the North-South model and found a conflict of interest between the North (developed countries) and the South (developing countries) in terms of IPR protection, with the South benefiting from the ability to imitate technology while the North suffers. Protecting IPR belonging to Northern enterprises in the South contributes to the well-being of Northern firms and global efficiency. Still, it may not provide obvious incentives for Southern firms since it would make learning through imitation more costly for developing countries in their effort to facilitate technology transfer to other countries.[4] Conversely, Chen and Puttitanun suggested a positive impact of IPR on innovation in developing countries by identifying a U-shaped relationship with economic development in the long term.[5]

Since the inception of the World Trade Organization, and apart from multilateral trade agreements, there has been a trend toward the emergence of mega-regional free trade agreements (FTAs), which are large-scale agreements involving multiple countries.[6] Recently, the Gulf Cooperation Council (GCC) region, including Oman, has signed several regional FTAs with the European Free Trade Association (EFTA), the United States, and Japan, all of which include strengthening the GCC's IPR system. However, there is a challenge to balance IPR protection and innovation promotion.[7] In addition, it is presently unclear how IPR affects international trade flows and in what direction.

This study reviews the IPR and patent framework in Oman, considering the amendments following the trade agreements, and aims to investigate how robust protection of the IPR and the patents impacts Oman's trade with the world. We achieved this objective by using a panel data set comprising Oman's trading partners during the period from 2000 to 2021. The study makes four significant contributions. First, it analyzes how strong IPR and patent protection affects a developing country's exports and imports. Second, it assesses the variation in the impact on overall trade flows and manufacturing trade flows. Third, while previous studies use the IPR index, with patents, copyrights, trademarks, and perceptions of IP protection equally weighted, this study offers a more precise perspective by focusing on the patent index, particularly concerning manufacturing trade, which is predominantly associated with technologies protected by patents. Fourth, this is the first paper to focus on oil dependent GCC countries.

The following section discusses Oman's IPR and patent framework, followed by the theoretical background linking trade and IPR. The calculation of the patent index for Oman, the methodology, the results and discussion are presented in subsequent sections, and conclusions are drawn.

2 | THE IPR FRAMEWORK IN OMAN

Oman's IPR system is based on the Agreement on TRIPS. TRIPS is the Uruguay Round Agreement which was obligatory to sign by all the countries to be a member in the World Trade Organizations. As stated in its objectives in article 7, the protection and enforcement of the IP system should contribute to the promotion of technological innovation and technology transfer, but this will make learning by imitation more costly for developing countries in return to facilitate technology transfer for other countries.[8] As a member of the World Intellectual Property Organization (WIPO) since 1997, Oman has largely adopted the 26 treaties of the organization.

The initial Patent Law of 2000 (Law No. 82/2000) established the framework for patent laws and procedures in the absence of membership in the Patent Cooperation Treaty (PCT) and an effective patent office. Subsequently, the amended Industrial Property Law of 2008 (Law No. 68/2008) was enacted following Oman's accession to the PCT and the signing of FTA with the United States. This updated legislation includes patents, trademarks, and industrial designs, while also introducing notable changes such as the inclusion of provisions for utility models and plant protection, burden-of-proof reversals, border measures, and detailed clauses on compulsory licensing.

2.1 | The role of preferential trade agreements (PTA)

After introducing TRIPS agreement, many developed countries tend to sign bilateral and regional trade agreements with their trading partners to strengthen the local IP system beyond the minimum standard of protection in TRIPS which lead to TRIP plus agreements. However, high protection of intellectual property (IP) leads to monopolies, allowing rights-holders to maintain high prices and restrict public access.[9] Also, there are studies showing that the TRIPs agreements and other bilateral agreements affect negatively innovation in developing countries.[10]

Trade agreements promote global market opening with enforceable trading rules. These agreements prioritize protecting IPRs, which is important to the foreign enterprises who earn significant revenue from intangible assets. Developing countries struggle with TRIPS obligations and at the same time developed countries raise IPRs through FTAs. The US promotes higher IP standards than TRIPS requires. TRIPS-Plus provisions cover various areas of IP. These areas are being renegotiated bilaterally with every TRIPS-Plus provision.[11] The new provisions are in the following forms: (a) adding new areas of IPRs; (b) enforcing higher levels of IPR protection standards than TRIPS requires; and (c) removing TRIPS flexibility and limitations on compulsory licenses and parallel importing especially in the pharmaceutical inventions.

Considering Oman's ambitions to become an international trade hub and attract foreign investment, its PTAs are important in facilitating economic growth. Consequently, Oman has entered into 14 PTAs since 2000 which led to strengthen the IPR regime. These global alliances were anticipated to improve the export contribution to Oman's GDP and to broaden the production base of diverse sectors. A research by Hamed Al Wahaibi[12] indicates that Oman's nonoil export and re-export activities are expected to increase alongside its primary trading partners. Additionally, this study shows a significant influence of FTAs on trade expansion, and it varies depending on GDP and population growth of each trading partner. By 2040, the primary metrics are to achieve 10% FDI net inflow as a proportion of GDP and to rank among the top 20 nations on the Global Innovation Index. But there is no clear prediction on the nature and direction of the IPRs impact on the international trade flows and economic growth.

Most of the PTAs are with leading innovative countries in the Global Innovation Index 2022.[13] These countries are aiming to protect their products in other markets by strengthening the IPR regime in the IPR reforming countries. The vital two PTAs with Oman that leads to strengthen the IPR regime is the FTAs with the United States signed in 2006 and the Agreement with EFTA entered into force on the July 1, 2014 that include trade in goods and services, IPRs, and bilateral investment.[14]

There are further assessments required during the transposition of the PTAs into the domestic system. This requires to modifying the laws, effective enforcement mechanisms and adopting any additional mechanisms to

comply with the PTAs new provisions as explained in Table 1.[15] In Oman, for example, the new provisions provide a high level of protection for plants by allowing for patent filing and registration of new plant varieties through the International Convention for the Protection of New Varieties of Plants (UPOV). This provision requires understanding the plant patent system's protection under the Oman's IP Office which is under the supervision of the Ministry of Commerce, Industry, and Investment Promotion. Even though, Oman is a member in UPOV since 2009, of new plant varieties just commenced recently in 2021 by the Ministry of Agriculture, Fisheries, and Water Resources.

2.2 | Oman's score in the International Property Rights Index (IPRI)

The IPR index is a subindex of the IPRI to evaluate countries using four criteria: perceptions of IP, patents, copyrights, and trademark protections. In the IPR index, Oman's score is based on the data provided in the mentioned elements, except patent protection, which has missing data, affecting the overall score.[16] In this research, we calculated the patent index and adjusted the overall IPR score based on it.

Therefore, the use of the patent index is essential for four reasons: First, FTAs predominantly concentrate on fortifying patent clauses within legislation, notwithstanding modifications to trademark and other provisions. Second, FTAs with the US bolster the biotechnology and pharmaceutical sectors by protecting their IPRs, which are predominantly reliant on patent protection. Third, the incorporation of patent applications from nonresident entities in the patent index is indicative of international trade dynamics. Fourth, the patent index bears a direct correlation with technology-intensive products, thereby influencing manufacturing trade flows.

Since Oman was incorporated into the IPR index in 2010, there has been a consistent trend toward stability in the country's overall strength of IPR protection as shown in Figure 1. The IPR score witnessed an increase in 2010, it might be due to the issuance of the new industrial property law in 2008 after signing the FTA with the United States. Also, it has increased in 2017 after approving the Oman IP office as an international receiving office for patent applications under the PCT. The increase in the Perception of IPR protection in 2019 lead to the rise in the IPR score. In 2021, Oman's IPRI slightly dropped to reach 5.387 on a scale of (10) because of including the trademark protection element in the index, indicating a near-parity with GCC countries, and a lag behind industrialized nations as shown in Figure 2.

2.3 | Oman's score in the patent index

The Ginarte-Park index is now the preferred index for international business scholarship and policy-making organizations.[17] It is built based on six clusters: duration of protection, patent coverage, restrictions on patent scope, membership in international treaties, enforcement mechanisms, and patent applications of nonresidents. To delve deeper into Oman's patent index score, as depicted in Figure 3, it becomes evident that there has been a notable uptick following its accession to the FTA with the United States in 2006, coupled with the enactment of Industrial Property Law 67/2008. These legislative actions have facilitated heightened enforcement measures and the incorporation of plant patents, thereby contributing to the observed increase in the index.

As illustrated in Figure 4, all components of the patent index have experienced growth except for duration and restrictions. This increase in the index can be attributed to Oman's accession to IP treaties like the UPOV in 2009, expanding patent protection to encompass pharmaceuticals, biotechnology inventions, and plant patents. Additionally, the rise in enforcement can be attributed to the inclusion of measures such as preliminary injunctions, burden-of-proof reversals, border controls, and criminal sanctions.

TABLE 1 Summary of the FTA-US specific IP clauses.

IP type	Specific clauses (TRIPS+)
Patents	– Patentability of new uses or methods of using a known product – Patentability of new methods of medical treatment – Grace period (12 months) with restrictions – No pregrant opposition – Amendment, correction, or observations during examination process – Adjustment of patent terms due to unreasonable delays in patent issuance and marketing approval grants – Bolar exception (products can only be used for marketing approval in the territory of the party) – Patent linkage provisions in approving generic drug
Trademarks	– Term (10 years) – Nice classification – Certification marks – Nonvisually perceptible marks (sounds and scents) – GIs as trademarks and member in Lisbon Agreement – When trademarks are associated with mandatory common names, requirements on size, placement, or style shall not impair the distinctiveness – Nonrecordable licensing agreements – Rules on prosecution (including electronic filing)
Other areas	– Domain names on the Internet – Copyright and related rights – Test data – Enforcement

3 | THEORETICAL BACKGROUND

IPR protection and trade have an indterminate relationship.[18] Due to differences in market sizes, human capital and wage rates vary depending on the country's capacity for innovation and technology absorption.[19] A strong IPR protection can have two opposite effects on trade, which economists cannot predict. As a result of stronger IPR protection, trade could increase by preventing imitation through market expansion effects, attracting multinational companies (MNEs) to grow their business operations and develop differentiated products while transferring their technological facilities to IPR-reforming countries and reducing trade by raising prices through the market power effect.[20]

Although many studies discuss the topic of strong IPR protection, which includes patents, copyrights, and trademarks, there is little literature regarding the correlation between strong patent protection and trade. A number of empirical studies in Table 2 have shown that patent protection can positively affect trade in developed countries, while developing countries are unable to develop new technologies due to a lack of R&D expenditure. Compared with developing countries, Schneider[21] finds that a stronger patent system positively affects US patent filing as a developed country while negatively or insignificantly affecting developing countries. Deardorff[22] supports this argument using the world welfare model by showing that extending patent protection benefits the invention country due to the monopoly profit, stimulating inventions in the first country while increasing costs for other countries with small markets. Several studies using panel data confirm the increase in exports to countries with strong IPR.[23] IPR protection may, however, have an equivocal effect on ASEAN's exports because the increase in ASEAN's exports may be partially offset by the decrease in imports.[24]

Developed countries increasingly rely on regional and bilateral trade agreements to secure their IPR protection and reduce trade barriers.[25] Their primary motivation is to combat counterfeiting and IP piracy and protect their national firms operating in other trading countries.[26] Boughanmi[27] estimates MENA countries' bilateral trade with their primary trading countries using a gravity trade model. The study revealed that GCC trade with the European Union and the United States

is highly concentrated, and the newly signed trade agreements will enhance new trade opportunities. According to Al-Mawali,[28] IPR has an insignificant relationship with economic growth in the GCC but not with trade.

The current industrial property law in Oman (68/2008) was issued as a result of the FTA with the United States in 2006 which led to strengthening the IPR regime in increasing the enforcement, coverage of the patent protection and IP treaties. This is supported by Krikorian and Szymkowiak[29] that FTAs always leads to major changes in raising the IPR protection standards.

4 | METHODOLOGY AND DATA

4.1 | Patent index calculation

Many studies have employed indices, such as the Ginarte-Park index or the Rapp-Rozek index, to measure patent protection. These measures are acceptable for controlling the impact of patent protection, but not for studying it.[30] The International Patent Index developed by Park and Ginarte[31] and updated by Park[32] are designed to capture the strength of the national IP laws. Although it is based on book law, the updated version includes the count of nonresident patent applications to capture the effect of the IPR protection on the global market. Unfortunately, all GCC countries, except Saudi Arabia are not listed in this index. Therefore, this research follows the same methodology of Park and Ginarte and Park[33] to capture the strength of the patent protection in Oman which will be shown in the methodology section.

The score of the patent index for Oman is calculated based on the methodology of Park and Ginarte and updated by Park as shown in Table 3. This required analyzing the Patent Law 82/2000 and the Industrial Property Law 67/2008, and the membership of Oman in the WIPO administered treaties that include the TRIPs, Paris Convention for patent filing, PCT for the international patent filing route, The Unition for the Protection of Plant Varieties (UPOV) and the Budapest Treaty for the protection of new microorganism.

Moreover, a total of 5617 patent applications collected from the Omani IP office in the Ministry of Commerce, Industry, and Investment Promotion since the start of receiving patent applications in 2002 untill 2021 that include local and foreign applications by residents and nonresidents. The data has been verified for accuracy using the Patent Scope database administered by the WIPO to search for foreign applications. This data is used to calculate the newly added 6th element in the updated index formula introduced by Park in 2007,[36] which is the number of nonresident filings normalized by the maximum filed.

The strength of patent protection is affected by several components such as the coverage of plant protection as a patent and as a new plant variety, the enforcement in terms of having preliminary injunctions, burden of proof, border measures, and criminal sanctions. Table 4 shows the results of the patent index score on a scale of 10, following Ginarte and Park[37] from 2002 to 2006 and following the update Park[38] for the remaining years.

The patent index on a scale of (10) resulted from the calculation is used for recalculating the IPR index of Oman because the published index is lacking the patent index score. The new scores of the IPR index will give more precise results after including the scores of the patent index. Both IPR and Patent index data are fed into the regression model for the period of 20 years as will be discussed in the following section.

4.2 | The gravity model

This study compiled a panel data set spanning 22 years (2000–2021). When analyzing trade relationships, panel data are preferred because they capture the evolution of relationships over time and allow observation of individual effects between trading partners. A total of 196 countries export to Oman, and 136 countries import from the country are included in the datasets. For 2007–2021, the IPR were taken from the IPRI of the Property Rights Alliance. However, collecting index data has been challenging due to the lack of Oman scores in the patent index.

TABLE 2 Summary of the empirical studies on the effect of IPR on trade.

Reference	Country	Method	Result
Maskus and Penubarti[a]	Korea	Helpman Krugman bilateral gross imports equations	+
Rafiquzzaman[b]	Canada	First-difference gravity model	+
Doanh and Heo[c]	ASEAN countries	Gravity model	+ –
Awokuse and Yin[d]	China	Hausman–Taylor IV Gravity models	+
Branstetter et al.[e]	US	Fixed effect	+
Maskus et al.[f]	United States	a probit model	+
Delgado et al.[g]	158 WTO members	OLS method, difference-in-difference analysis	+
Briggs and Park[h]	91 countries	Gravity fixed effects	+
Boring[i]	US	OLS, PPML	+
Biancini and Bombardab[j]	US	OLS, Fixed effect	+
Doanh et al.[k]	Korea	Gravity model	+ –

[a]Keith E Maskus and Mohan Penubarti, 'How Trade-Related Are Intellectual Property Rights?' (1995) 39 JIE 227.

[b]Mohammed Rafiquzzaman, 'The Impact of Patent Rights on International Trade: Evidence from Canada' (2002) 35 CJE 307.

[c]Nguyen Khanh Doanh and Yoon Heo, 'Impacts of Intellectual Property Rights on Trade Flows in ASEAN Countries.' (2007) 14 JIAS 1.

[d]Titus O Awokuse and Hong Yin, 'Does Stronger Intellectual Property Rights Protection Induce More Bilateral Trade? Evidence from China's Imports' (2010) 38 WD 1094 accessed 9 November 2021.

[e]Lee Branstetter and others, 'Does Intellectual Property Rights Reform Spur Industrial Development?' (2011) 83 JIE 27.

[f]Keith E Maskus, Lei Yang and Hong Kong, 'The Impacts of Post-TRIPS Patent Reforms on the Structure of Exports' (2013).

[g]Mercedes Delgado, Margaret Kyle and Anita M McGahan, 'Intellectual Property Protection and the Geography of Trade' (2013) 61 The Journal of Industrial Economics 733.

[h]K Briggs and WG Park, 'There Will Be Exports and Licensing: The Effects of Patent Rights and Innovation on Firm Sales' (2014) 23 JITED 1112

[i]Anne Boring, 'The Impact of Patent Protection on US Pharmaceutical Exports to Developing Countries' (2015) 47 AE 1314.

[j]Sara Biancini and Pamela Bombarda, 'Intellectual Property Rights, Multinational Firms and Technology Transfers' (2021) 185 JEBO 191.

[k]Nguyen Khanh Doanh, Nguyen Thi Gam and Yoon Heo, 'The Impact of Intellectual Property Rights Protection on Trade: The Role of a "Third Country" in Market Power and Market Expansion Effects' (2022) 46 ES 100942.

Consequently, the Park and Ginarte[39] methodology was applied to determine patent index scores from 2002 to 2006, while the updated methodology by Park[40] was used for the subsequent period. UN Comtrade provided trade information, while the World Bank, CEPII, and WTO Regional Trade Agreements Information System provided information on economic size, distance, and trade agreements (Table 5).

To assess the multicollinearity among the independent variables in our trade flow model, a variance inflation factor (VIF) test was conducted. The results of the VIF test are summarized in Table 6.

The VIF analysis indicates that while there is some multicollinearity present in the model, particularly with the variables related to IPR and patent protection, it is not at a level that typically warrants significant concern. The highest VIF values ranges between 3.05 and 6.5 are for the patent and IPR protection variables, which may be expected given their conceptual similarity. Nonetheless, the centered VIF values are generally below the critical threshold of 10, suggesting that multicollinearity, while present, is unlikely to severely distort the regression estimates.[41]

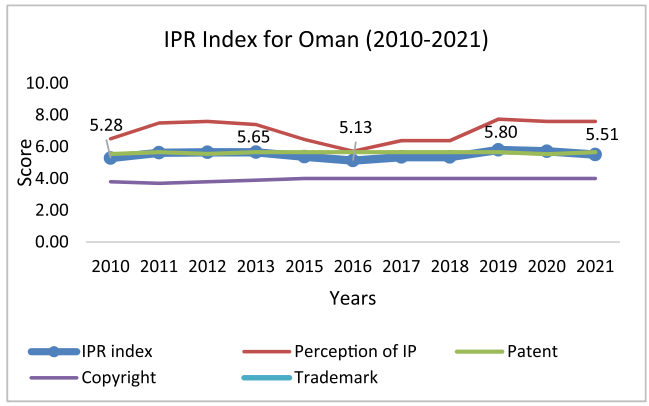

FIGURE 1 Oman's IPR index scores, 2010–2021. IP, intellectual property; IPR, intellectual property rights. *Source*: IPRI, Authors. [Color figure can be viewed at wileyonlinelibrary.com]

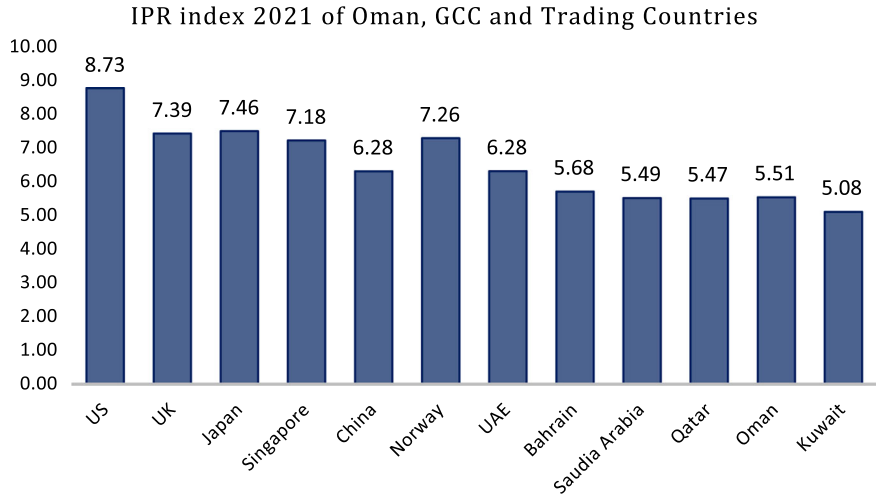

FIGURE 2 IPR index 2021 for Oman, GCC and trading countries. *Source*: IPRI. [Color figure can be viewed at wileyonlinelibrary.com]

4.2.1 | Model specification

The study employs an export and import augmented gravity model to investigate the effect of strong IPR and Patent protection on Oman's trade. The gravity model has undergone both theoretical and empirical scrutiny, and it has been classified as a new quantitative trade model, given its structural flexibility and strong predictive power.[42]

The study uses both export and import models. It should be noted that in both models, the overall trade flow (T_{ijt}) and manufacturing trade flow (M_{ijt}) are used interchangeably as the dependent variables, while the explanatory variables remain the same (Equations 1 and 2).

$$\ln T_{ijt} = \beta_0 + \beta_1 \ln GDP_{ijt} + \beta_2 \ln GDP_{it} + \beta_3 \ln dist_{ijt} + \beta_4\, fta\_wto_{ijt} + \beta_5 IPR_{it} + \beta_6 IPR_{jt} + \beta_7 Patent_{it} + \beta_8 Patent_{jt} + \delta_i + \delta_j + \mu_{ijt}, \quad (1)$$

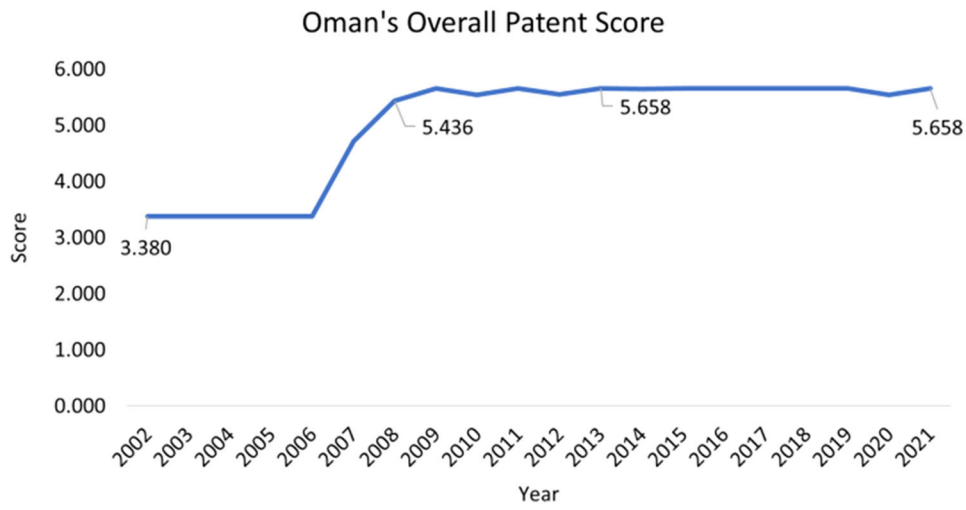

FIGURE 3 Trend of the Patent Index Score of Oman during (2002–2021). IPR, intellectual property rights. [Color figure can be viewed at wileyonlinelibrary.com]

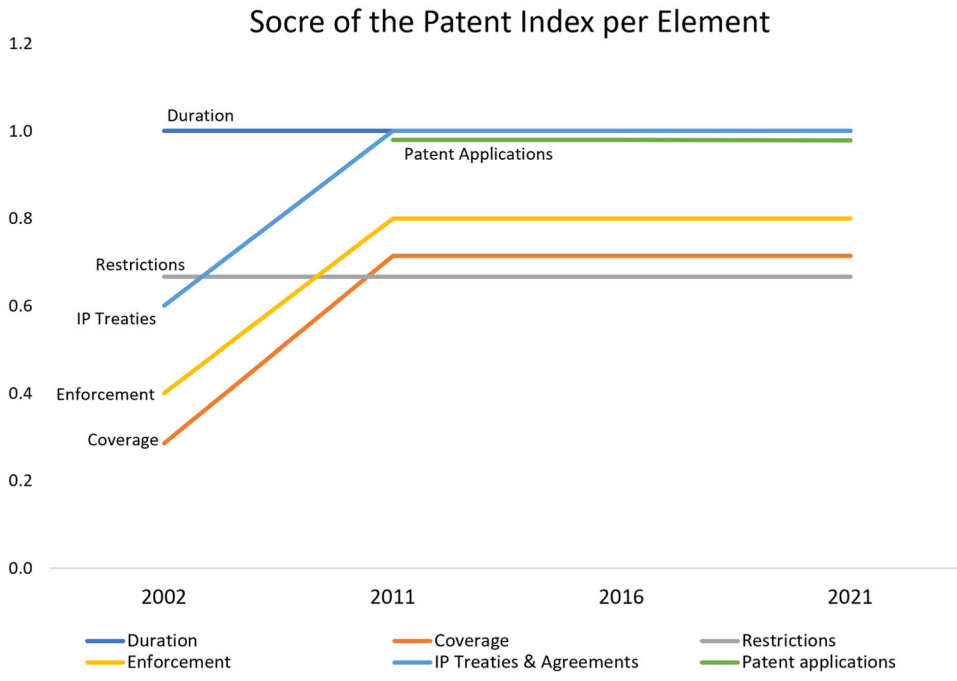

FIGURE 4 Score of the Patent Index per Element (2002–2021). IP, intellectual property. [Color figure can be viewed at wileyonlinelibrary.com]

$$\ln M_{ijt} = \beta_0 + \beta_1 \ln GDP_{ijt} + \beta_2 \ln GDP_{it} + \beta_3 \ln dist_{ijt} + \beta_4 fta\_wto_{ijt} + \beta_5 IPR_{it} + \beta_6 IPR_{jt} + \beta_7 Patent_{it} + \beta_8 Patent_{jt} + \delta_i + \delta_j + \mu_{ijt}, \quad (2)$$

T_{ijt} represents the overall exports (imports) of Oman from its trading partners at time t, while M_{ijt} represents Oman's manufacturing exports (imports) from its trading partners at time t. GDP_{ijt} captures the economic size (GDP)

TABLE 3 A calculated score for Oman's Patent Index in 2021.

Index clusters	Components	Oman status	Score
Duration	20 years TRIPS international standards	20 years	1
Coverage	Software	No	0.625
	Plant and animals	Yes	
	Food, chemicals	Yes	
	Pharmaceuticals	Yes	
	Business methods	No	
	Biotechnology	Yes	
	Surgical products	No	
Restrictions	Working requirements	No	0.667
	Compulsory licensing	Yes	
	Revocation	Yes	
Enforcement	Preliminary injunctions	Yes	0.8
	Contributory infringement pleadings	No	
	Burden-of-proof reversals	Yes	
	Border measures	Yes	
	Criminal sanctions	Yes	
IP treaties and agreements	The TRIPS agreement	Yes	1
	The Patent Cooperation Treaty (PCT)	Yes	
	The Paris Convention	Yes	
	The Union for the Protection of Plant Varieties	Yes	
	Budapest Treaty	Yes	
Patent applications	Number of nonresident filings normalized by the maximum filed.		1
Total			5.092
Patent Index Score on Scale of (10)			5.658

Source: Author's calculations based on Park & Ginarte[34] and Park[35] methodology.

of both importers and exporters. A higher value of GDP suggests a larger economy with more resources and capacity to demand goods and services, which may increase trade flow. Distance between trading partners is reflected by $dist_{ijt}$, a greater distance might imply higher transport costs and result in decreased trade flow. fta_wto_{ijt} indicates if the trading countries are involved in a trade agreement and serves as a proxy for TRIPS agreements of the WTO.[43]

IPR and *Patent* are two variables of interest that represent the IPR index and patent index respectively of the trading partners. Both variables measure the strength of the country's IPR and patent protection. The changes in the IPR and patent protection indexes are not on a yearly basis but rather according to changes in the laws due to entering into WTO and bilateral trade agreements with other countries. A higher value of the patent index suggests stronger patent protection, which may encourage foreign firms to invest in Oman and export their products, leading to increased trade flow and manufacturing trade flow. The IPR index is a

composite of the strength of protection in patent, copyright, trademark, and perception of IP protection of a country. Therefore, the patent index is more closely associated with trade in technology-related goods and manufacturing trade flow than the IPR index. The strength of patent protection can be more accurately interpreted through manufacturing trade flow as patents are linked to technological products that must be protected before being exported to other countries. δ_i and δ_j capture the importer and exporter fixed effect, which controls for multilateral resistance[44] while μ_{ijt} is the error term.

4.2.2 | Estimation method

An accurate specification of gravity models depends upon addressing several critical issues such as heterogeneity, zero trade flows, the multilateral resistance term, and heteroskedasticity.[45] The gravity model has undergone both theoretical and empirical scrutiny and it has been classified as new quantitative trade models, given the structural flexibility and strong predictive power.[46] This study utilizes panel data that includes a variety of cross-sectional

TABLE 4 The score of the patent Index for Oman during 2002–2021.

	Patent index elements						
Year	Duration	Coverage	Restrictions	Enforcement	IP treaties and agreements	Patent applications	Score scale of 10
2002	1.0	0.286	0.667	0.400	0.600	NA	3.380
2003	1.0	0.286	0.667	0.400	0.600	NA	3.380
2004	1.0	0.286	0.667	0.400	0.600	NA	3.380
2005	1.0	0.286	0.667	0.400	0.600	NA	3.380
2006	1.0	0.286	0.667	0.400	0.600	NA	3.380
2007	1.0	0.286	0.667	0.400	0.800	1.000	4.713
2008	1.0	0.571	0.667	0.800	0.800	1.000	5.436
2009	1.0	0.714	0.667	0.800	1.000	1.000	5.658
2010	1.0	0.714	0.667	0.800	1.000	0.896	5.542
2011	1.0	0.714	0.667	0.800	1.000	1.000	5.658
2012	1.0	0.714	0.667	0.800	1.000	0.905	5.553
2013	1.0	0.714	0.667	0.800	1.000	1.000	5.658
2014	1.0	0.714	0.667	0.800	1.000	0.993	5.650
2015	1.0	0.714	0.667	0.800	1.000	1.000	5.658
2016	1.0	0.714	0.667	0.800	1.000	1.000	5.658
2017	1.0	0.714	0.667	0.800	1.000	1.000	5.658
2018	1.0	0.714	0.667	0.800	1.000	1.000	5.658
2019	1.0	0.714	0.667	0.800	1.000	1.000	5.658
2020	1.0	0.714	0.667	0.800	1.000	0.892	5.537
2021	1.0	0.714	0.667	0.800	1.000	1.000	5.658

Source: Authors.

representations of countries. OLS estimators can, therefore, cause bias due to observable heterogeneity across countries. Using log-linearization techniques can produce inconsistent estimations with heteroskedasticity or zero trade flow.[47] A simplified solution for zero trade is to estimate the gravity model in multiplicative form using the Poisson Pseudo-maximum Likelihood (PPML) estimator. The absence of multilateral terms in gravity models could result in the omission of critical factors that influence trade patterns among countries, resulting in skewed analyses (committing a 'Gold medal mistake').[48] There have been several approaches proposed to resolve the multilateral resistance problem. However, the fixed-effects method is preferred due to its ease of calculation and ability to deal with country-specific characteristics.[49] As a result, a model specification that incorporates fixed-effects and PPML estimation regression model specification is more appropriate because it facilitates estimation with zero trade flow in the presence of heteroskedastic disturbances and addresses multilateral resistance issues. Further, the coefficients obtained from PPML appear to be easy to interpret, just like OLS.[50] This study utilizes PPML estimator and explores fixed and non-fixed effect PPML estimation models.

TABLE 5 List of variables.

Variable	Description	Measurement scale	Source
Dependent			
Trade flow (T_{ijt})	The total value of goods and services exported and imported by Oman	Thousands of US dollars at current prices	UN Comtrade database
Manufacturing trade flow (M_{ijt})	The total value of manufactured goods traded between Oman and other countries in each period		Bilateral Commodity Trade Database (BACI)
Independent			
Economic size (GDP_{ijt})	Gross domestic product	Thousands of US$	World Bank's Development Indicators
distance ($dist_{ijt}$)	Distance between Oman and trading countries		CEPII's GeoDist
IPR index (IPR_{ijt})	Measure the strength of IPR protection, including patent, copyright, and trademark protection, and perception of IP	0–10	Ginarte and Park and IPRI[a]
Patent index ($Patent_{ijt}$)	Measure the strength of patent protection	0–10	Ginarte and Park, Park, IPRI[b] for trading countries and Author's calculation for Oman score following same methodology
Trade agreements (fta_wto_{ijt})	Free or bilateral trade agreements between Oman and trading countries	1 if the country pair is engaged in a regional trade agreement	WTO's Regional Trade Agreements Info. System

[a]Juan C Ginarte and Walter G Park, 'Determinants of Patent Rights: A Cross-National Study' (1997) 26 RP 283; 'The 2022 IPRI' <https://www.internationalpropertyrightsindex.org/full-report> accessed 19 September 2022.

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TABLE 6 Multicollinearity test.

Independent variables	Coefficient variance	Uncentered VIF	Centered VIF
$dist_{ijt}$	76.28956	5.027276	1.269619
Fta_wto_{ijt}	9.52E+09	1.975353	1.474665
GDP_{it}	7450973	5.381569	1.328822
GDP_{jt}	7324496	5.595119	3.241678
IPR_{it}	2.52E+09	73.42143	5.614293
IPR_{jt}	2.84E+09	82.89403	6.467569
$Patent_{it}$	1.38E+09	59.97180	3.052306
$Patent_{jt}$	1.46E+09	63.37566	3.434126
C	7.40E+10	60.59390	NA

5 | EMPIRICAL RESULTS AND DISCUSSION

Tables 7 and 8 show the regression results for the export and import models using PPML with fixed effects (PPMLFE) and PPML without fixed effects (PPML). Coefficient signs follow consistent directional patterns across specifications, but significance levels vary. Compared to specifications without fixed effects, the estimates from specifications with fixed effects appear higher, indicating unobserved heterogeneity may affect parameter estimation.[51]

Oman's (exporter) GDP coefficient is negative and statistically significant for overall trade, but positive and not significant for manufacture exports. As oil revenues rise, Oman may rely more on importing goods from trading partners. However, the GDP coefficient of the trading countries is positive and statistically significant for manufacturing trade flow, indicating they import more of Oman's manufactured exports.

The coefficients for Oman's IPR and patent are both positive and significant in the overall trade. However, both are insignificant for manufacturing sector export. This indicates that a robust IPR and patent regime in Oman significantly contributes to increased overall exports but not manufacturing exports. This might suggest that industries in Oman rely more on existing technologies or can be influenced by other factors such as skilled labor availability and access to finance and consumer preferences as indicated by Zaibet et al.,[52] Omani firms have not widely adopted technology sourcing or new organizational development.

The enhanced global protection of patents has proven beneficial for technology-emulating countries to boost their export capacity.[53] As a developing nation, ensuring stronger patent protection in Oman is expected to encourage knowledge-based industries and expands export opportunities which can contribute to economic diversification. But, Oman's manufacturing exports face barriers to enter markets where IPRs are well-protected which contradict Sharma and Masks and Yang[54] that developed countries invest in developing countries through inward flows of patent applications and reducing the licensing cost imposed on licensors, which in turn impact R&D activities of developed countries. Moreover, according to Javorcik,[55] weak IPR regimes divert foreign investment from the manufacturing to the service sectors, whereas Oman has a strong IPR regime that should have the opposite effect. Possibly, foreign companies don't have manufacturing facilities in Oman yet. However, in the long run, multinational firms might contribute to enhancing the innovative capabilities of local firms, as suggested by Chen and Puttitanun.[56]

The PPML results shows that strong IPR of trading partners decrease overall trade exports of Oman while strong patent protection decreases manufacturing trade exports from Oman and does not significantly affect

TABLE 7 Export estimates.

	Overall trade flow		Manufacturing trade flow	
	(1)	(2)	(3)	(4)
Dependent variable	PPMLFE	PPML	PPMLFE	PPML
ln_gdp_i	−0.220	−0.200	0.016	0.059
	(0.056)**	(0.095)*	(0.052)	(0.074)
ln_gdp_j	0.055	0.132	0.080	0.125
	(0.045)	(0.007)**	(0.029)**	(0.005)**
ln_dist	–	−0.141	–	−0.127
	–	(0.017)**	–	(0.013)**
fta_wto	−0.051	0.175	−0.010	0.163
	(0.040)	(0.022)**	(0.027)	(0.015)**
IPR_i	0.114	0.117	−0.013	−0.029
	(0.021)**	(0.040)**	(0.015)	(0.028)
Patent_ i	0.320	0.160	0.069	−0.024
	(0.141)*	(0.268)	(0.115)	(0.205)
IPR_j	0.033	−0.026	0.064	−0.006
	(0.031)	(0.012)*	(0.033)+	(0.009)
Patent_j	0.023	−0.001	0.022	−0.020
	(0.026)	(0.016)	(0.016)	(0.010)*
constant	2.624	3.212	−0.416	0.246
	(0.923)**	(1.499)*	(0.776)	(1.101)
Fixed effects (Importer and exporter)	Yes	No	Yes	*No*
No of Obs.	700	702	910	916
ll	−1452.484	−1635.639	−1899.631	−2080.982
AIC	2920.968	3289.279	3815.263	4179.964
BIC	2957.377	3330.264	3853.770	4223.344

Note: Standard robust errors in parentheses.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

overall trade exports. This could be explained that the strong IPR regime in trading countries create barriers to entry of the Omani overall products protected by different types of IPRs like trademarks, copyright, and patents which lead to decrease in the overall trade export. On the other hand, the manufactured exported products mainly relied on patent protection which makes it difficult for Omani goods to comply to the high standards of patent regime countries. There is a plausible explanation for these findings: Oman's manufacturing sector is still developing,[57] and manufacturing products require a great deal of research and development, making imitation tricky.[58]

Moreover, the WTO membership or the presence of a FTA is statistically having a significant effect on trade flow. A recent study by Casteleiro[59] illustrated that the European Union's PTA approach is adaptable to the needs

TABLE 8 Import estimates.

	Overall trade flow		Manufacturing trade flow	
	(1)	(2)	(3)	(4)
Dependent variable	PPMLFE	PPML	PPMLFE	PPML
ln_gdp_i	−0.005	0.133	0.083	0.136
	(0.037)	(0.007)***	(0.034)**	(0.007)***
ln_gdp_j	0.081	0.009	−0.016	−0.092
	(0.034)**	(0.078)	(0.036)	(0.079)
ln_dist	–	−0.161	0.000	−0.195
	–	(0.016)***	–	(0.016)***
fta_wto	–	0.188	0.000	0.196
	–	(0.028)***	–	(0.023)***
IPR_i	0.033	0.028	0.024	0.046
	(0.021)	(0.009)**	(0.019)	(0.009)***
Patent_i	0.008	0.031	0.004	0.023
	(0.013)	(0.011)***	(0.015)	(0.010)*
IPR_j Oman	−0.023	−0.015	−0.036	0.002
	(0.014)*	(0.033)	(0.013)***	(0.031)
Patent_j Oman	−0.000	−0.116	0.236	0.143
	(0.097)	(0.216)	(0.091)***	(0.219)
_cons	0.814	1.136	−0.165	1.804
	(0.752)	(1.270)	(0.662)	(1.291)
N	484	488	527	531
ll	−1001.576	−1108.529	−1083.091	−1191.293
AIC	2017.153	2235.059	2180.181	2400.587
BIC	2046.427	2272.772	2210.052	2439.060

Note: Standard robust errors in parentheses.

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

and objectives of its treaty partner and are formed on the basis of trade and sustainable development agreements, creating a middle ground for regulatory convergence.

We focus more here on the variable of interest, IPR, and patent, in discussing the import model. The results show a different dimension from the export model, which primarily exhibits market expansion effects. IPR and patent protection appear to have a divergent effect on Oman's manufacturing imports based on the import model. Oman's imports of both overall and manufacturing trade flow specifications are negatively correlated with strong IPR protection. Thus, strong IPR protection reduces Oman's imports through market power[60] and there is a much greater impact of market power on the manufacturing import of Oman (0.036 vs. 0.023) relative to the overall import of Oman. This result aligns with Al-Mawali and Gani[61] that IPR protection correlates negatively with pharmaceutical imports between Asia and the rest of the world. These

findings can be reasonably explained: Oman's manufacturing sector is still developing,[62] and manufacturing products requires a great deal of research and development, making imitation tricky.[63]

It is, however, apparent that strong patent protection in Oman increases the imports in the manufacturing trade flow, showing a positive correlation between patent protection and imports which align with Lesser[64] showing that strengthening IPR protection increases imports by attracting MNEs that have the necessary technologies. As a result, patent-protected products are more accessible to the Omani market compared to manufactured products protected by copyrights and trademarks. Thus, strong patent protection increases manufacturing imports through market expansion effect.[65]

In this sense, the Omani market offers strong patent protection to companies importing technology-intensive goods. Increasing competition from new emerging markets has seriously threatened companies in highly industrialized countries,[66] resulting in stronger patent protections. Moreover, the inventing country exports more to countries with strong patent protection in the presence of third countries competing with the importing countries, stimulating market expansion.[67] According to Javorcik,[68] weak IPR regimes divert foreign investment from the manufacturing to the service sectors, whereas Oman has a strong IPR regime that should have the opposite effect. Possibly, foreign companies don't have manufacturing facilities in Oman yet.

From the exporting countries' perspective, it is significant in the PPML results and positively signed, shows that a robust IPR and patent system would increase their exports to Oman. As a result, an increase in trading countries' IPR and patent protection correlates with an increase in import trade between trading countries and Oman. Similarly, Maskus and Penubarti[69] found that patent laws greatly impacted small and large developing countries' manufacturing imports from OECD countries.

Table 9 summarizes the findings, revealing a positive correlation between strong patent protection and the importation of manufactured goods. This correlation is logical as manufactured products often rely on patented technologies. This contrasts with the effect of strong IPR protection, which tends to decrease manufacturing trade. This outcome provides valuable insights for decision-makers before engaging in trade agreements that impact the manufacturing sector, emphasizing the importance of aligning such agreements with adjustments to the patent regime.

6 | CONCLUSIONS

The study examines strong IPR and patent protection in the context of a developing nation. Based on a panel data set spanning 22 years, including 196 exporting and 136 importing countries, we have found that both strong IPR and patent protection positively impact Oman's trade. Our results have significant policy implications, especially when IPR issues are increasingly becoming essential to trade matters. We found that strong IPR and patent protection increases overall exports but do not significantly affect manufacturing exports. Thus, while the overall benefits measured in export volume are positive, sectors such as manufacturing might be negatively impacted by stronger IPR protection.

When designing trade policies, policymakers should consider the potential negative externalities faced by manufacturers due to stronger IPR regimes. This entails crafting measures that mitigate any adverse effects on domestic enterprises while capitalizing on the benefits of enhanced IP protection. One approach could be implementing measures to support innovation and entrepreneurship, particularly in sectors that may be disproportionately affected by stronger IPR protection. These can include providing financial incentives, fostering collaboration between research institutions and industries, and streamlining the patent application process.

Similarly, our study highlights that stronger IPR protection has the potential to decrease both overall and manufacturing imports, while stronger patent protection may increase manufacturing imports. Nevertheless, the

TABLE 9 Results summary.

	Export		Import	
Dependent variable	Overall trade	M. trade	Overall trade	M. trade
IPR_Oman	+		−	−
Patent_Oman	+			+
IPR_trading partners	−		+	+
Patent_trading partners		−	+	+

influence of these protections might differ across various trade sectors. Hence, it is advisable to delve deeper into each sector at a disaggregated level of trade to pinpoint the precise effects on individual sectors. When considering trading partners, it appears that more robust patent protection within those nations may Oman's exports but positively affect imports. We advocate a balanced approach to IPR protection that fosters innovation while safeguarding access to essential goods and technologies. Policymakers should aim to strike a harmonious equilibrium between incentivizing creativity and promoting competition while designing IPR policies. It is also essential to maintain a degree of policy flexibility to adapt to evolving trade dynamics and technological advancements. Policymakers should regularly review and update existing regulations to ensure they remain relevant and effective in addressing emerging challenges.

Considering these findings, policymakers must achieve a harmonious equilibrium between the benefits and drawbacks of strong IPR and patent protection, specifically in cross-sectoral commerce, to foster economic growth while bolstering domestic enterprises. Further investigation is required to determine the effects on specific sectors. Further sector-specific research can help to understand the differential effects of IPR and patent protection across various trade sectors. This will enable policymakers to tailor interventions that account for the specific needs and challenges faced by individual industries with different IPR spectra.

Finally, we also recommend that actions should not be taken only from one side. The opinions of trade partners should also be considered in the decision-making and policy design process. Engaging in international cooperation and dialogue to address the complexities of IPR protection in cross-border trade can help alleviate some of the issues with stronger IPR protection. Collaboration with trading partners can facilitate the development of mutually beneficial agreements that balance the interests of different stakeholders.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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APPENDIX A

See Tables A1 and A2, and Figures A1 and A2.

TABLE A1 WIPO Lex main IPR treaties signed and ratified by Oman.

No.	Treaty	In force
1	Berne Convention	July 14, 1999
2	Brussels Convention	March 18, 2008
3	Budapest Treaty	October 16, 2007
4	Hague Agreement	March 4, 2009
5	Madrid Protocol	October 16, 2007
6	Nairobi Treaty	March 26, 1986
7	Paris Convention	July 14, 1999
8	Patent Cooperation Treaty	October 26, 2001
9	Patent Law Treaty	October 16, 2007
10	Trademark Law Treaty	October 16, 2007
11	UPOV Convention	November 22, 2009
12	WIPO Convention	February 19, 1997
13	WIPO Copyright Treaty	September 20, 2005
14	WIPO Performances and Phonograms Treaty	September 20, 2005

TABLE A2 Selected PTAs with Oman.

No.	Country/region	Decree No.	Agreement title
1	Hungary	11/2022	Ratifying the Agreement between the Government of the Sultanate of Oman and the Government of Hungary for the Reciprocal Promotion and Protection of Investments
2	Japan	18/2017	Ratifying the Agreement between the Sultanate of Oman and Japan for the Reciprocal Promotion and Protection of Investment
3	EFTA	43/2010	Ratifying the Free Trade Agreement between the EFTA States and the Member States of the Co-operation Council for the Arab States of the Gulf
4	Singapore	8/2009	Ratifying the Free Trade Agreement between the Cooperation Council for the Arab States of the Gulf and the Republic of Singapore
5	US	109/2006	Free Trade Agreement between the Government of the Sultanate of Oman and the Government of the United States of America
6	China	58/2005	Ratifying the Framework Agreement for Trade, Economic, Investment and Technical Cooperation between the Cooperation Council for the Arab States of the Gulf and the People's Republic of China
7	Turkey	31/2004	Ratifying the Trade Agreement and Economic, Technical, Scientific, and Cultural Cooperation between the Sultanate of Oman and the Republic of Turkey
8	Iran	110/2004	Ratifying the Trade Agreement between the Government of the Sultanate of Oman and the Government of the Islamic Republic of Iran

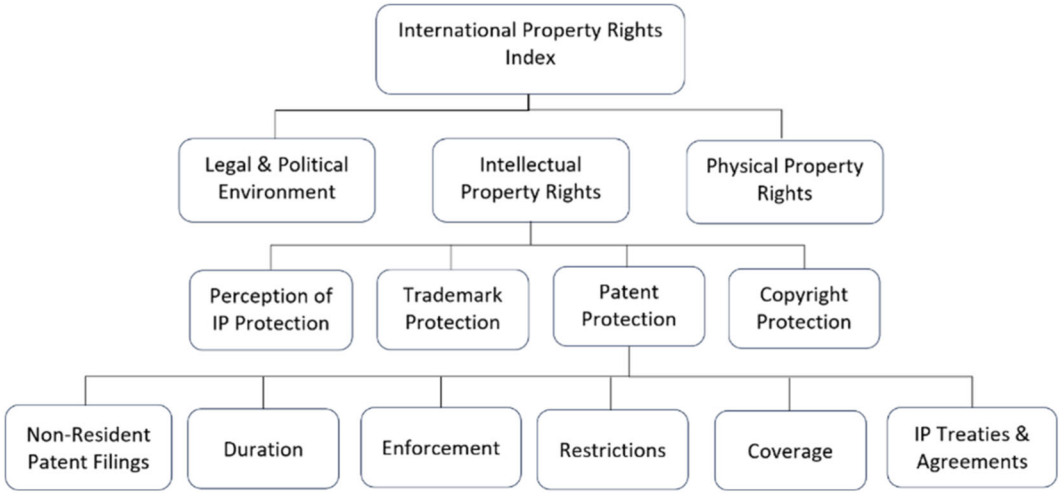

FIGURE A1 Structure of the International Property Rights Index.

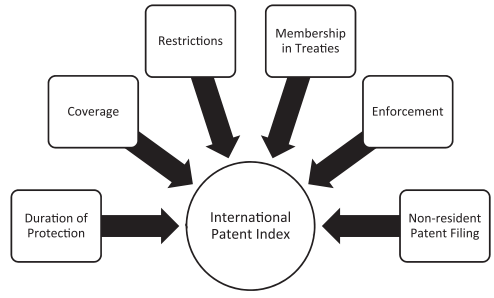

FIGURE A2 Six clusters of the International Patent Index (IPI).

AUTHOR BIOGRAPHIES

Shaikha Al Akhzami is a doctoral researcher in Natural Resource Economics at Sultan Qaboos University, holding an LLM in IP Law from the University of Turin in 2010. With over 20 years of experience in innovation, intellectual property, technology transfer, and research administration, she previously founded and directed the Innovation and Technology Transfer Center at Sultan Qaboos University, pioneering Oman's first Technology Transfer Office and establishing its IP policies and procedures. Sheikh Al Akhzami actively contributed to national innovation and IP strategies, serves as an IP expert in Omani court for infringement cases, sits on the board of the Omani IP society, and consults for UN-ESCWA. She volunteers as an IP Mentor for women inventors and entrepreneurs with WIPO and spearheaded the Oman-WIPO Summer School. Recently, she founded the W&A consultancy firm specializing in IPR, innovation, and serves as an independent consultant in innovation, intellectual property, and technology transfer.

Dr. Lokman Zaibet is specializing in agricultural economics and development. He started his education and research carrier in Tunisia, where he developed an early interest in agriculture and economic development. He then earned a Ph.D. in Agricultural Economics from the University of Missouri. Dr. Zaibet has held various academic and research positions in Tunisia, Oman, and Kenya. He has been involved in teaching undergraduate and postgraduate courses in agricultural economics, international trade, and related subjects. Dr. Zaibet's research interests include trade and food security, quality

standards and institutional analysis. He has published numerous research papers in international journals, contributing to the body of knowledge in these areas. He has authored and co-authored several research papers in international journals and has done consultancies to national and international organizations providing expert advice on agricultural policies and development strategies. Dr. Zaibet aims to continue his research on food security issues considering the complexity of the problem and using complex thinking approaches.

Dr. Abdallah Akintola earned his PhD in Natural Resource Economics from Sultan Qaboos University in Oman, complemented by certification as an Associate Accounting Technician from The Association of Accountancy Bodies in West Africa. Currently serving as visiting faculty in the Natural Resource Economics and Economics and Finance departments at Sultan Qaboos University, Dr. Akintola brings a wealth of expertise in international trade policy analysis, utilizing both partial and general equilibrium modeling approaches, to his teaching and research Dr. Akintola aims to further contribute to the advancement of economic knowledge and policy formulation in the context of sustainable development. His professional goals include expanding his research contributions in international trade policy, intellectual property rights and sustainability, and fostering a deeper understanding of economic dynamics in academia and policy circles alike.

Dr. Osman Gulseven is an international expert in Natural Resource Economics at the College of Agricultural and Marine Sciences and the WTO Chair in Oman. He has significantly impacted the field through extensive research and influential publications on sustainable resource management and international trade. Dr. Gulseven earned his Ph.D. in economics from North Carolina State University in 2008 and has since held key academic and advisory roles. At Sultan Qaboos University, he has been pivotal in connecting research with policy, particularly through his involvement in the WTO Chairs Program. Dr. Gulseven aims to further the integration of sustainable practices within economic policies through continued research and policy development. His future plans include enhancing educational programs and promoting international cooperation for sustainable economic growth.

Dr. Behnaz Saboori is an assistant professor at Sultan Qaboos University, recognized internationally for her expertise in Natural Resource Economics. For 4 consecutive years, she has been listed among the top 2% of scientists globally by Stanford University and Elsevier BV, highlighting her commitment to high-quality research. Dr. Saboori regularly publishes in prestigious journals and presents her findings at international and national conferences, significantly impacting her field and community. Dr. Saboori's research focuses on renewable energy, environmental degradation, sustainable economic growth, and energy security and diversification. Her career is marked by a commitment to advancing knowledge in these areas, with a proven track record of securing research funding and collaborating with scholars and institutions on innovative projects. Her work aims to advance the field of Natural Resource Economics and provide actionable insights for sustainable development policy and practice. Dr. Behnaz Saboori aims to advance research on sustainable economic practices, focusing on renewable energy, environmental degradation, economic diversification, and food security. She seeks to provide insights for sustainable growth and energy security, fostering interdisciplinary collaborations and securing funding for innovative projects. Dr. Saboori plans to integrate her research into her teaching, enhancing student engagement. Ultimately, she aspires to contribute to global sustainability discourse and mentor future scholars and professionals in addressing environmental, economic, and food security challenges.