An Empirical Analysis on the Effect of IP Protection on Economic Growth in Shenzhen

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Abstract. This research paper examines the relationship between intellectual property (IP) protection and economic growth, with a specific focus on Shenzhen from 2014 to 2020. The study investigates the effect of IP protection measures, the combined effect of IP protection and investment, and the combined effect of IP protection and workforce on the total output. Previous literature has highlighted the positive influence of IP protection on economic growth in developed regions, but its impact in transitioning economies, like Shenzhen, remains less explored. Using a linear regression model, this research aims to provide insights into the interplay between IP protection, fixed investment, workforce size, and trade openness in the context of Shenzhen's economic development during the period under study. This will further clarify the connection of IPR to economic growth in a transitioning economy.

Keywords: the endogenous theory, economic growth, IP protection, innovation, technological advancements, regression analysis.

1. Introduction

Since the 16th century, economic growth has been a topic of complexity. Classic economist Adam Smith recognized the significance of capital accumulation and population growth in economic activities. Though without quantitative evidence, Smith, based on observations and experience, stated that increase in labor supply and tangible machinery could potentially expand the market and induce specialization, and ultimately enhance productivity [1].

Smith's views on economics growth have profound influence on subsequent economic thoughts. The Keynesian model of economic growth was independently developed by Roy F. Harrod in 1936 and Evsey Domar in 1946 respectively in advocacy of government interventions in economic activities. This model explains growth rate in terms of capital savings and labors [2]. In 1956, Based on extensions and modifications of the Harrod-Domar Model, neoclassical scholars Robert M. Solow and Trevor Swan attempted to illustrate long-run economic growth with a special production function, which considers saving rates and population growth as endogenous factors [3]. This is known as the Solow-Swan Model. It states that long-run growth is impossible when exogenous factors remain unchanged due to diminishing returns of population and capital [3].

However, one significant flaw of the neoclassical model is assuming that technological improvements act outside of an economy [4]. This criticism paved the way for endogenous growth theory, which was proposed in the 1980s. One prominent advantage of this model is assuming technological improvements as an endogenous factor affecting economic performance. According to Paul Romer, three characteristics of innovation including increasing returns to scale, positive externalities and centrality of knowledge make self-driven economic growth possible in the long term [5]. He emphasized on the significance of policies that incentivize R&D, education and accumulation of human capital [5].

Intellectual property (IP) protection is a general policy implemented in most countries. Under the framework of the Endogenous Theory, intellectual property rights (IPRs), through incentivizing innovation, are recognized as catalysts for economic growth [6]. A number of previous literatures have explored the implications of different strength of IP protection under certain circumstances. Robust IP protection regimes in developed countries is said to be a substantial contributor to their economic growth [7]. In these countries and regions, IPRs influence economic performance indirectly

by creating positive impact on the accumulation of production factors like physical properties and R&D [8]. However, the conclusion is questioned when applied to less developed regions. In these areas, patented innovations can potentially constrain collaborative research and contribute to monopoly power [9]. In a lot of middle-income countries, the influence IP protection on economic growth is generally negative or insignificantly positive.

Shenzhen, as a special economic zone in China, has been one of the cities most benefited from the "Reform and Opening Up". During early period of economic development, Shenzhen's rapid urbanization is driven by investment in fixed assets and population growth. The past few years has witnessed Shenzhen's transition from a middle-income city to a high-income one. In the recent decade, the city is trying to convert to a tech-driven economy: according to the data from the Shenzhen Municipality Bureau of Statistics, since 2013, fixed investment has leveled off and the size of workforce has also reached a plateau. Given this unique economic stage, using the data of this period can further clarify the economic implications of IP protection in upper-middle-income and high-income regions. This investigation is primarily concerned with the effect of IP protection on economic growth, so the data of Shenzhen from 2014 to 2020 is applied to run a regression as a case study. This study examines the individual economic impact of IP protection on economic growth, the combined effect of IP protection and investment, and the combined effect of IP protection and workforce.

2. Methodology and Data Description

2.1. Methodology

A linear regression model is set up to incorporate total output of Shenzhen and factors that can directly or indirectly affect economic growth. These factors include IP protection, workforce size, investment in fixed assets, and trade openness.

Workforce and investment had been significant factor contributing to Shenzhen's economic growth in early stages. Including the two parameters can help examine their current role in a tech-driven economy and their interplay with IP protection. Trade openness captures the city's another prominent economic engine, international trade. IP protection indicates the city's level of innovation.

Workforce size and investments can potentially influence IP protection. Therefore, to observe the interplay of these two factors with IP protection, interaction terms are added to observe the combined effects of these parameters. The regression formula is shown equation (1):

$$Y = \beta_0 + \beta_1 IPP + \beta_2(WF \times IPP) + \beta_3(I \times IPP) + \beta_4 TRO + \epsilon \quad (1)$$

Y stands for total output of Shenzhen in each year from 2014-2020.

IPP represents the extent of IP protection in Shenzhen in each year from 2014-2020.

WF×*IPP* is the interaction term between workforce and IP Protection.

I×*IPP* is the interaction term between fixed investment and IP Protection.

$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$ are the coefficients to be estimated. They reflect in the effect of variables in each term on total output, *Y*.

All the data collected is processed with a rescaling formula to fit the regression model. The formula is stated equation (2):

$$Rescaled\ Value = \frac{Actual\ Value - Baseline\ Value}{Max\ Absolute\ Difference\ from\ the\ Baseline} \quad (2)$$

After rescaling, all the values are above 0 with no unit. The data of Shenzhen in 2013 acts as the baseline and the data in 2020 is always 100.00 after rescaling.

To examine the long-run correlation between IP protection and economic growth, data in Shenzhen from 2014 to 2020 is used. There is appreciable amount of data available for an effective regression analysis in this time period, and these seven years mark the economic transition of Shenzhen.

2.2. Data Description

This investigation used rescaled data of Shenzhen from 2014 to 2020. The rescaled data for regression is listed below (Table 1):

Table 1. The data used for regression

Year	Y	WF	I	IPP	TRO
2014	12.46	21.70	28.40	-32.17	34.63
2015	25.57	41.82	101.01	-58.15	19.07
2016	43.53	61.55	198.50	-82.57	-39.30
2017	64.24	80.85	332.14	-90.16	-100.00
2018	80.10	99.70	92.94	-89.29	-84.82
2019	93.88	97.29	61.06	-99.46	-5.06
2020	100.00	100.00	100.00	100.00	100.00

The unprocessed GDP values come from the National Statistics Bureau. The original values of sizes of workforce and investments in fixed assets are cited from Shenzhen Municipality Bureau of Statistics. The raw IPP index can be reviewed on the official website of the Intellectual Property Development & Research Center of China National Intellectual Property Administration.

There is no notable official or authoritative measure of Shenzhen's trade openness, so the raw trade openness index is calculated with the following self-made formula before rescaling:

$$Trade\ Openness = \frac{Exports + Imports}{GDP} \tag{3}$$

Export and import values are also collected from Shenzhen Municipality Bureau of Statistics. This formula effectively describes the occupation of total international trade value in the regional total output, thereby indicating the significance of international trade in local economy.

3. Results and Interpretation

3.1. Results

The above rescaled data is submitted into the regression model and the results are presented below (Table 2):

Table 2. Results of the regression analysis

Variable	Coefficient	t-Statistic	p-Value
Intercept	-93.998	-6.312	0.024
IPP	1.618	4.746	0.042
WF×IPP	-1.872	-10.034	0.0098
I×IPP	-0.0166	-5.379	0.033
TRO	-0.000546	-1.384	0.301

The p-Values of IPP, WF×IPP and I×IPP are less than 0.05. The coefficients of these parameters are therefore statistically significant. With a p-Value considerably above 0.05, the result of TRO is not statistically significant and will not be further discussed.

3.2. Interpretations

The coefficient of IPP is positive, suggesting that increase in IP protection value is associated with increase in total output. This indicates a stronger IP protection system can lead to higher economic growth. This finding aligns with previous literatures which studies IP rights in high-income regions.

As mentioned in Part I, differing from low-income and middle-income regions, high-income regions like Shenzhen usually feature a strong positive correlation between IP protection and economic growth. This may be the consequence of its transition from a labor-dense economy to a

tech-driven one [10]. In the time examined, the trajectory of urbanization and massive real estate investments has shown signs of leveling off [11]. The economic growth driven by population has stagnated as the trend proceeds [12]; thus, to create new competitive edge, the city is converting its economy to a more innovative and productive mode of development by attracting talents, promoting education and human capital accumulation, and establishing a robust IP protection regime [13]. Due to its openness and transparency on intellectual properties, Shenzhen has harbored some China's most renowned technology companies like Tencent and Huawei. It is also revealed that the Shenzhen ecosystem, due to its innovativeness and product approach, has attracted any western start-ups to set up in Shenzhen [14]. This transition is aligned with the development trajectories of most developed regions and previous literatures. On the other hand, a negative coefficient of the term WF×IPP indicates that increases in both workforce and intellectual property protection are likely to considerably slow down economic growth. An increase in investment individually would certainly contribute to total output even if taking account of depreciation, and innovation incentivized by strong intellectual property rights is also beneficial for the economy. The negative combined impact indicated that the two factor have offsetting effect on each other. This might be the result of labor displacement triggered by high rate of innovation and diminishing returns of labor.

The mismatch of skills is proved be a common phenomenon in transitioning from a middle-income economy to a high-income one. Innovations including technological advancements, improvements in business models, and product developments may alter the general landscape of a market. The specialized workforce in the past must foster new skills to meet new requirements. In Britain, for example, workers in industries with high shares of R&D personally had increased rates of job loss from 1986 to 1987 and from 1990 to 1991 due to the advent of computer technology [15]. Also, the adoption of agricultural mechanization in U.S. has dramatically reshaped the local economy and caused lower wages and less farm labor demand [16]. These findings can also be used to explain the situation in Shenzhen: as IP protection regime is enhanced, more R&D and innovations are carried out. This results in rapid changes in market structure and ways of production. The large workforce cannot immediately fit the new market landscape, resulting in unemployment and inefficiency.

Moreover, though Shenzhen has benefited from labor-dense industries, according to the law of diminishing returns, after a certain point the increase of labor will no longer result in a proportional increase in output. A study in Russia states that without increase in productivity, simply adding labor will result in unsustainable development [17]. Similar mechanisms can also explain the negative combined impact of labor and IP protection on economic growth in Shenzhen. It is noted that in several years after 2008, investment and labor still dominated the economy of Guangdong province even though the region's industrialization has completed. Production inefficiency has risen in Guangdong Province, including Shenzhen City, during this period [18]. Therefore, displacement of labor and diminishing returns of human capitals are considered as major causes of the offsetting effect between workforce and intellectual property protection.

Furthermore, the combined effect of IP protection and investment on economic performance is also negative, but to a much smaller extent than the that of IP protection and labor. One unit increased in IPP×I lead to a slight decrease in total output, indicated by the coefficient -0.0166. This might be the result of the interplay amongst various factors including environmental regulations, depreciation of inputs, and low-quality investment. However, since the correlation is very mild, it is of small significance to discuss these causes.

4. Conclusions and Policy Implications

4.1. Conclusions

Intellectual property rights are generally perceived as a source of growth in many developed countries. This perception is further verified by this study. The empirical result of this study shows strong positive correlation between IP protection and economic growth in up-middle-income and high-income regions. These places have completed industrial bases and well-established

infrastructural systems. Investment and population are no longer major drivers of development. In this regard, innovations bulk larger in their economy.

However, this study finds that increase in both workforce and IP protection at the same time have significant negative impact on economic growth. A robust IP protection triggers commercial innovations. The change in market landscapes resulting from increased innovative activities gives rise to displacement of labor, which is likely to offset the positive impact of strong IP protection. High-quality education and training programs should be established to bridge the gap between new market demands and workforce skills.

The study also provides a slightly negative impact of investment and IP protection. However, the correlation is very weak, with a coefficient of -0.0166, and may be subject to random factors. Therefore, whether increase in both investment and IP protection can facilitate economic growth remains in question. Further investigation in this field is necessary.

4.2. Policy Implications

Given the high correlation between IP protection and economic growth, it is convincing to build a robust and effectively managed IP protection regime. Meanwhile, a strong and versatile education system is also necessary to integrate displaced labor into a new market and mitigate the negative effect of mismatch of skills.

National legislations and local policies should be updated to strengthen intellectual property rights. According to the Shenzhen Municipality Bureau of Statistic, number of patents in Shenzhen is increasing at a constant rate for years. However, it is important for policymakers to put more emphasis on the quality of innovation. Moreover, social institutions like universities should be developed to encourage creation of intellectual properties.

Proper education and propaganda need to be addressed in order to raise the overall awareness of copyrights and patents. College syllabus should include intellectual rights, and more linkage between universities and enterprises should be established to facilitate the transformation from patents to commercialized inventions and products.

Another concern is the labor displacement caused by high rate of innovation. This could be solved by government directly initiating training programs, which would offer a low-cost opportunity for displaced workforce to adapt to the new market environment. Government should also create incentives for private companies to invest in the accumulation of human capital. For example, establishing strong connection between firms and research institutions can substantially increase the size of effective workforce.

References

[1] Rosenburg N. Adam Smith, consumer tastes and economic growth. Journal of Political Economy, 76 (3): May-Jun., 1968.

[2] Evsey D. Domar. Capital expansion, rate of growth, and employment. Econometrica, 14 (2): 137 - 147., 1946.

[3] Robert M. Solow. A contribution to economic growth. The Quarterly Journal of Economics, 70 (1): 65 – 94., 1956.

[4] Tallman E.W. & WANG Ping. Human capital investment and economic growth: new routes in theory address old questions. Economic Review–Federal Reserve Bank of Atlanta, 77 (5): 1.,1992.

[5] Romer P.M. Increasing returns and long-run growth. Journal of Political Economy, 94 (5): 1002 - 1037., 1987.

[6] Gould D.M. & Gruben W.C. The role of intellectual property rights in economic growth. Journal of Development Economics, 48 (2): 323 - 350., 1996.

[7] Kim Y. K., Lee K., Park W.G. & Choo K., Appropriate intellectual property protection and economic growth in countries at different levels of development. Research Policy, 41 (2): 358 - 375., 2012.

[8] Park, W.G. & Ginarte, J.C. Intellectual property rights and economic growth. Contemporary Economic Policy, 15: 51 - 61., 1997.

[9] Janjua, P. Z. & Samad, G. Intellectual property rights and economic growth: the case of middle-income developing countries. The Pakistan Development Review, 46 (4 Part II): 711 – 722., 2007.

[10] Jimenez-Moro, E., Piperopoulos, P., Kafouros, M., & Ming, A. A. K. Innovation dynamics and club convergence in innovation activity in China: A temporal perspective. Papers in Regional Science, 102 (4), 791 – 816., 2023.

[11] CHENG Jiafan, CHEN Mingxing, & TANG Shujuan. Shenzhen – A typical benchmark of Chinese rapid urbanization miracle. Cities, 140: 104421., 2023.

[12] Leaf M. Learning from Shenzhen. Cities, 13 (3): 195 - 197., 1996.

[13] Ka-Ho M., Anthony W. & KANG Yuyang. Government innovation policy and higher education: the case of Shenzhen, China. Journal of Higher Education Policy and Management, 42 (2): 194 - 212, 2020.

[14] Hossain M. The Shenzhen ecosystem: What does it mean for the western world. Technology in Society, 68:101919., 2022.

[15] Addison J.T., Fox D.A., & Ruhm C.J. Technology, trade sensitivity, and labor displacement. Southern Economic Journal, 66 (3): 682 - 699., 2000.

[16] Schmitz A., Moss C.B. Mechanized agriculture: machine adoption, farm size, and labor displacement. AgBioForum, 18 (3): 278 - 296, 2015.

[17] Fedulova I., Voronkova O., Zhuravlev P., Gerasimova E., Glyzina M., & Alekhina N. Labor productivity and its role in the sustainable development of economy: on the example of a region. Entrepreneurship and Sustainability Issues, 7 (2), 2019.

[18] ZHANG Sheng, XU Meng, YANG Yifu, & SONG Zeyu. Technological innovation, production efficiency, and sustainable development: a case study from Shenzhen in China. Sustainability, 13 (19): 10827, 2021.