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IMPACT OF INTELLECTUAL PROPERTY RIGHTS ON MACROECONOMIC GROWTH : A PANEL DATA STUDY IN KOREA

Abstract:

Based on the assumption that intellectual property rights are a driver of economic development, this paper aims to estimate the production elasticity of intellectual property stocks in Korea. The unbalanced panel data during 2005-2012 is constructed with 29 manufacturing and service industries and applied to a Cobb-Douglas production function. Empirical results confirm that the stock of patents, the stock of trademarks, and the stock of design rights significantly contribute to Korean economic growth in the 2000s, respectively. Whereas the production elasticity of intellectual property stocks differs in the characteristics of patents, trademarks and design rights, the results show that increases in trademark stocks are the most influential factor in economic growth.

Keywords:

Production Elasticity, Intellectual Property Stock, Cobb-Douglas Production Function, Panel Data

JEL Classification: O00, O30

Introduction

In economics literature, the innovation and creative activities have long been acknowledged to be an important factor of the economic growth. In particular, patent stocks have been received great attention in economic growth models as a proxy of innovation outputs for a long time (Nordhaus, 1969; Grossman and Helpman, 1991; Aghion and Howitt, 1992; O'Donoghue and Zweimueller, 2004). In contrast, trademarks and design rights have little been dealt as indicators of innovation in depth (Feeny and Rogers, 2003; Schmoch, 2003; Mondonca et al., 2004; Marxt and Hacklin, 2004; Griffith et al., 2005; Millot, 2009; Greenhalgh et al., 2011). Basically, patents have direct effects on technological changes while it is possible for other types of intellectual property rights including trademarks and design rights to influence industries in various ways of diversifying production structures or marketing innovation.

Thus, this paper aims to analyze whether each type of intellectual property stocks such as patents, trademarks and design rights plays an important role on economic growth. A modified Cobb-Douglass production function is applied to Korean panel data of manufacturing and service industries.

Literature Review

Based on the neoclassical growth model, a Cobb-Douglass production function has been expanded to capture the role of technological changes and intellectual property stocks.

$$\mathrm{Y_t = A_t \times L_t^{\alpha} \times K_t^{1-\alpha}} \tag{1}$$

Here, Y stands for outputs (sales or added values). A is a measure of technology stocks while L and K are labor inputs and capital accumulation, respectively. α is the input contribution of labor on total outputs while 1-α is that of capital. Hence, a linear equation model is derived in natural logarithms as below:

$$\mathrm{ln(Y_t) = ln(A_t) + \alpha ln(L_t) + (1-\alpha) ln(K_t)} \tag{2}$$

The endogenous growth theory regards the total factor productivity as the accumulation of capital (Romer, 1990). The assumption is that technological changes ($\dot{A}_t$) can be affected by skilled labor (SL), R&D investment (R&D), and technology stocks (A^{θ}). This theory can be denoted by the following equation. On the other hands, Griliches (1979) investigates the effect of R&D on productivity as a part of capital investment.

$$\dot{A}_t = \alpha_k \mathrm{R\&}D_t^{\beta} \times \alpha_l \mathrm{SL}_t^{\gamma} \times A_t^{\theta} \tag{3}$$

In the meantime, patents have been highlighted as an essential determinant of the economic performances in the endogenous growth model (Nordhaus, 1969; Grossman and

Helpman, 1991; Aghion and Howitt, 1992; O'Donoghue and Zweimueller, 2004). Jungmittag et al. (1999) tries to capture the impact of technological progress by supposing that A is a function of various forces on technological change, which can be proxied by patent stocks. Blind and Jungmittag (2008) investigates the effects of patent stocks and standard patents on technological change and productivity. Thus, technology stocks can be divided by R&D investment and stocks of intellectual property rights.

Methodologies

This paper estimates the effects of stock changes in patents, trademarks and design rights on industry sales by modifying the Cobb-Douglass production function of Blind and Jungmittag (2008). Thus, the following general equation model is constructed in natural logs (denoted by lower case):

$$\mathrm{y_{it}} = \beta_0 + \beta_1 \mathrm{l_{it}} + \beta_2 \mathrm{k_{it}} + \beta_3 \mathrm{r}\&d_{\mathrm{it}} + \beta_4 \mathrm{dummy08} + \beta_5 \mathrm{ipstock_{it}} + \varepsilon_{\mathrm{it}} \tag{4}$$

where y = sales of industry i at year t, l = wages of industry i at year t, k = expenditures on intermediate goods of industry i at year t, r&d = research and development expenditure of industry i at year t, dummy08 = binary variable to control shocks of financial crisis of year 2008, ipstock = total effective stock of patents, trademarks and design rights of industry i at the end of year t, and ε = error term, i = industry (29 industries), and t = year (2005-2012).

The above equation can be denoted by the following equation. This paper investigates the separate effects of intellectual property stocks (IPSTOCK) such as patent stocks (PSTOCK), trademark stocks (TSTOCK) and design stocks (DSTOCK). The estimated coefficient (β_5) of each intellectual property stock is interpreted as the production elasticity of total effective intellectual property stocks.

$$\begin{aligned}\ln(\mathrm{SALES})_{\mathrm{it}} = \beta_0 + \beta_1 \ln(\mathrm{WAGES_{it}}) + \beta_2 \ln(\mathrm{MEDINPUT_{it}}) + \beta_3 \ln(\mathrm{R\&D_{it}}) \\ + \beta_4 \mathrm{DUMMY08} + \beta_5 \ln(\mathrm{IPSTOCK_{it}}) + \varepsilon_{\mathrm{it}}\end{aligned} \tag{5}$$

In the neoclassical economic theory, elasticity is the most important concept to measure how an economic variable is responsible to a change in another. The production elasticity of IPSTOCK measures the percentage change in production induced by a percentage change in IP stocks. It is quantified by the ratio of the percentage change in patent stocks, trademark stocks or design stocks to the percentage change in production variable, which is measured by sales in this paper.

$$\beta_{IP} = \frac{\Delta\mathrm{SALES/SALES}}{\Delta\mathrm{IPSTOCK/IPSTOCK}} \tag{6}$$

To analyze production elasticities of patent, trademark, and design stocks, panel data is constructed for both manufacturing and service industries in Korea between 2005 and 2012.

Industry-level business and R&D data is collected and then combined with intellectual property databases. Table 1 shows the summary of variables and data sources.

Table 1: Summary of variables

<table>
<tr><th>Variables</th><th colspan="2">Description</th><th>Data Source</th></tr>
<tr><td>SALES</td><td>Sales (Y)</td><td rowspan="4">Converted into constant prices at 2010</td><td rowspan="3">The Mining and Manufacturing Survey, The Wholesale and Retail Trade Survey, The Service Industry Survey</td></tr>
<tr><td>WAGES</td><td>Wages (L)</td></tr>
<tr><td>MEDINPUT</td><td>Expenditures on intermediate goods (K)</td></tr>
<tr><td>R&D</td><td>R&D expenditures</td><td>Survey of R&D in Korea</td></tr>
<tr><td>DUMMY08</td><td colspan="2">Financial crisis of year 2008 (dummy variable)</td><td>-</td></tr>
<tr><td>PSTOCK</td><td rowspan="3">Total effective stocks of patents, trademarks, and design rights (as of December 31)</td><td rowspan="3">Combined with economic data at 2-digit KSIC</td><td rowspan="3">Databased from Korea Intellectual Property Office</td></tr>
<tr><td>TSTOCK</td></tr>
<tr><td>DSTOCK</td></tr>
</table>

First, industry-level data such as SALES, WAGES and MEDINPUT is downloaded through Korean Statistical Information Service provided by Statistics Korea (https://www.kosis.kr). Those economic data in 24 manufacturing industries and 10 service industries at two-digit Korea Standard Industrial Classification (KSIC) is collected from annual surveys such as ‘The Mining and Manufacturing Survey’, ‘The Wholesale and Retail Trade Survey’, and ‘The Service Industry Survey’.

Second, industry-wise R&D expenditures are collected from the ‘Survey of Research and Development in Korea’ through National Science and Technology Information Service (https://sts.ntis.go.kr) provided by Ministry of Science.

Third, stocks for patent, trademark, and design rights are defined as the number of valid rights as of December 31 at each year. Korea Intellectual Property Office supported the extraction of these three types of intellectual property stocks at each year, thus PSTOCK, TSTOCK, DSTOCK are collected at 24 patent classifications, 45 NICE classifications for trademark, and 75 design classifications, respectively. However, it is difficult to match classifications of intellectual property with KSIC because patent classifications are based on technological characteristics while trademarks and design rights are classified according to products and items. Therefore, to combine variables of intellectual property stocks with economic data at two-digit KSIC, these classifications are integrated and matched into total 29 KSIC industries by experts’ opinions and feedbacks.

Finally, the nominal values for SALES, WAGES, MEDINPUT and R&D variables are converted into constant prices at year 2010 by applying Producer Price Index (PPI) at the industry level. Those variables are transformed using natural logs after integrating into the 29 industries.

As a result, an unbalanced panel data set is constructed during 2005 and 2012 in 29 industries, some of which include missing values at specific years. The descriptive statistics for each variable are shown in Table 2.

Table 2: Descriptive statistics

Variables	Mean	Stad. Dev.	Min.	Max.
SALES	91,363,177	141,169,502	1,209,163	941,244,556
WAGES	9,685,187	13,150,521	55,318	71,626,441
MEDINPUT	71,886,521	130,474,675	1,139,356	883,949,817
R&D	1,074,859	2,550,540	765	18,278,126
DUMMY08	0.57	0.50	0.00	1.00
PSTOCK	23,950	40,821	0	203,289
TSTOCK	31,218	26,398	1,862	142,661
DSTOCK	11,116	9,474	165	37,747

Source: Combined data from Statistics Korea and Korea Intellectual Property Office at 2-digit KSIC level.

Results

The contribution of intellectual property stocks to economic growth is estimated by using a random effect regression model. Table 3 summarizes the estimation results of Models 1-3, which consider variables of patent stocks, trademark stocks and design stocks, respectively. The Hausman test result confirms that random effect models are more appropriate than fixed effect model to analyze the data set (Hausman, 1978).

First of all, the coefficients for ln(PSTOCK), ln(TSTOCK), and ln(DSTOCK) can be regarded as production elasticity of each intellectual property right. The production elasticities of patent stocks, trademark stocks, and design stocks are 0.022 ($p<0.01$), 0.033 ($p<0.1$), and 0.026 ($p<0.1$) and statistically significant, respectively. This result can be interpreted that 1% increase in patent stocks would lead to approximately 0.022% increase in total sales, for example.

Particularly, the result shows that the production elasticity of trademark stocks is the highest while that of patent stocks is lower than those of trademark stocks and design stocks, which is attributed to characteristics of the types of intellectual property rights. Since it takes a lot of time for a registered patent to be commercialized and the commercialization ratio of a patent is very low, the change in patent stocks doesn’t seem to directly influence on the change in industry sales. On the other hand, the registration of trademarks and design rights tends to be promptly connected with the applicants' revenues. In specific, patents are usually applied for defensive purposes against industry rivals while design rights such as fabric patterns or product appearances are commercialized in a short time after registration. Since a trademark can be permanently protected by a continuous renewal of the registration, firms construct brand identity by marketing strategies of utilizing their trademarks. Therefore, the change in trademark stocks seems to be the most effective in the change in sales.

Table 3: Results of random-effects regression

Random-effects regression DEPVAR : ln(SALES)	Model 1		Model 2		Model 3	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
ln(WAGES)	0.097 ***	0.027	0.091 ***	0.026	0.100 ***	0.025
ln(MEDINPUT)	0.805 ***	0.030	0.791 ***	0.028	0.816 ***	0.028
ln(R&D)					-0.001	0.004
ln($R\&D_{t-1}$)	0.006	0.004	0.005	0.004		
DUMMY08	-0.001	0.008	-0.004	0.008	-0.007	0.007
ln(PSTOCK)	**0.022** **	**0.012**				
ln(TSTOCK)			**0.033** *	**0.008**		
ln(DSTOCK)					**0.026** *	**0.013**
_cons	2.081 ***	0.323	2.251 ***	0.309	1.904 ***	0.304
Number of obs.	138		155		166	
R^2 within	0.963		0.958		0.968	
R^2 between	0.934		0.950		0.939	
R^2 overall	0.955		0.966		0.957	
sigma_u	0.327		0.303		0.296	
sigma_e	0.030		0.030		0.029	
rho	0.992		0.991		0.990	

Source: Own collected and adjusted data.

Second, the coefficients of proxy variables for labor and capital are also statistically significant at the 0.01 level. It seems reasonable that the expenditures on intermediate goods are the most influential variable on sales while wages are also significant in industrial growth. These results of these two variables support the basic assumption of Cobb-Douglass production function.

Third, the coefficient of R&D as a proxy of technology stocks is not statistically significant in all models. It is widely acknowledged that there are time-lags of five to ten years between patent registration and commercialization as well as between the application and registration of a patent. Nevertheless, this model only considers a year's time-lag between R&D and sales due to lack of a long-term panel data. When a lagged variable of R&D expenditure is included, Models 1 and 2 have increased results in R-squared value. Contrarily, there is no increased effect of lagged R&D on R-squared value in Model 3.

Finally, a dummy variable for controlling financial crisis in 2008 is not statistically significant at the 0.1 level. However, the coefficients are all negative in Models 1-3, which implicates that the financial crisis might have affected production negatively.

Conclusion

To summarize, this paper estimates the production elasticity of patent, trademark, and design stocks in Korea. The empirical analyses confirm that the coefficients of patent stocks, trademark stocks, and design stocks are all positive and statistically significant in a Cobb-Douglass production function. The main contribution is that this paper investigates the positive impacts of both trademark and design stocks as well as patent stocks on the economic growth. Whereas the effects of intellectual property stocks differs in the characteristics of patents, trademarks and design rights, the empirical results show that increases in trademark stocks are the most influential factor in economic growth in Korea in the 2000s.

However, the empirical analysis has a couple of limitations. First, this paper estimates the production elasticity of each type of intellectual property rights separately. That is, the complementarities among patents, trademarks and design rights are ignored in the analysis. This is an important point since a product is engaged in many intellectual property rights such as patents, trademarks and design rights. Thus, one percentage increase in patent rights can influence on the changes in trademarks or design rights. However, when all three types of intellectual property stock variables are included in the model, all their coefficients turn out not to be statistically significant.

Second, this paper also ignores industry differences in estimating the production elasticity of intellectual property stocks. For example, the production elasticity of biotechnology patents may be higher than that of patent stocks in other industries. This approach will give policy makers useful implications when they establish policies for promoting specific industries. However, the sample does not have enough observations to consider the industry effects although the production elasticity of each type of intellectual property stocks varies across industries.

Nevertheless, the empirical results show that intellectual property rights play an important role in Korean economic growth. The above limitations of this paper fortunately might give another opportunity for future research. Thus, future research needs to consider the complementarities among each type of intellectual property rights and enlarge the data ranges for analysis.

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