

## Effects of Intellectual Property Rights Protection and Integration on Economic Growth and Welfare

Chung-Hui Lai\*

*Department of International Business, Central Taiwan University of Science and Technology, Taiwan*

*Department of Accounting, Feng Chia University, Taiwan*

The protection of intellectual property rights (IPR) and the distribution of rent are central issues in R&D-based growth models with the return to innovation serving as the engine of growth. In this paper we consider the strength of the intellectual property rights and franchise bargaining system to analyze how the rent/franchise fee and institutional quality affect the economic growth and social welfare. It is found that the intermediate goods firm with imperfect IPR protection charges less than the marginal cost. In addition, increasing the IPR protection will increase the rent/franchise fee. We also show that the growth-maximizing effects of IPR protection, the bargaining power of intermediate goods firms, and the imitation of technology are no longer equivalent to those effects on welfare maximization since the welfare result depends on the relative degrees of the growth enhancing effect and crowding-out effect on consumption.

**Keywords:** IPR, R&D, bargaining, endogenous growth, social welfare

**JEL classification:** L11, O40, O30

---

Received March 4, 2015, first revision July 3, 2015, second revision July 21, 2015, accepted July 22, 2015.

\*Correspondence to: Department of International Business, Central Taiwan University of Science and Technology, No.666, Buzih Road, Beitun District, Taichung City 40601, Taiwan (R.O.C.). E-mail: p9217770@gmail.com.

## 1 Introduction

Research has examined the costs and benefits of IPR protection and its effects on innovation and growth. Specifically, in the literature on economic growth the protection afforded by the patent law is set either on a permanent basis or applies until a brand new product is invented. However, while patents are permanently protected, deadweight losses exist due to monopoly pricing. The seminal paper of Judd (1985) establishes an exogenous growth model in a dynamic general equilibrium framework and shows how permanent patents maximize social welfare. Helpman (1993) and Kwan and Lai (2003) emphasize the government's choice of the degree of IPR protection. Iwaisako and Futagami (2003) prove that the patent length that maximizes the social welfare is finite. Futagami and Iwaisako (2007) consider the dynamic properties of a growth model with finite patent length, and further show that an infinite patent length cannot maximize social welfare. Furukawa (2007) shows that IPR protection cannot enhance growth if there exists a stronger effect of IPR on the productivity of the final goods sector. Horii and Iwaisako (2007) use empirical data from 1966 to 2000 to indicate that it is difficult to find a positive relationship between IPR protection and the growth rate.

However, Gould and Gruden (1996) find support for a positive but 'weak' relationship between IPR protection and growth. Goh and Olivier (2003) provide the key insight that the equilibrium growth rate of output is strictly increasing in the patent breadth in the upstream sector, but strictly decreasing in the patent breadth in the downstream sector. Then the welfare is strictly increasing in the patent breadth in the upstream industry. Eicher and García-Penalosa (2008) endogenize the strength of the IPR and show how private incentives of IPR affect economic development and growth. Most of the studies in the literature show that enhancing the protection of IPR increases the expected duration of a monopoly and the associated incentive to innovate. Therefore a large incentive to innovate helps the growth rate. Therefore, it is important to investigate the effects of intellectual property rights (IPR) protection on economic growth and welfare.

There are few studies that discuss IPR protection within the franchise fee bargaining mechanism. Not only does IPR protection play an important role in

R&D-based growth models, but so does the acquisition of rents. The stronger IPR protection should indeed translate into a higher franchise fee. For instance, Ferrantino (1993) as well as Yang and Maskus (2001) find that the license fees perceived by American firms in different foreign countries are positively correlated with the level of patent protection offered in the partner country.<sup>1</sup> Moreover, Pfister *et al.* (2006) mention that Forby's Guide Survey indicates that the highest franchising rates can be found in Switzerland (78%), Germany (78%) and Great Britain (77%). Therefore, within the franchise system, as the IPR protection increases and competition decreases, the franchisee should be willing to pay higher sums for the different varieties. A higher franchise fee paid to the franchisor implies that the intermediate goods firms obtain more profit through the return to innovation, and hence the higher the economic growth rate rises. In this paper we will incorporate IPR protection in a franchise system economy (Wang *et al.*, 2010, and Wang and Lai, 2011) and try to analyze how the IPR protection influences the rent/franchise fee and further drives the growth and social welfare.

Wang *et al.* (2010) point out that the imperfect competition market structure of final goods is a key factor in the R&D-based endogenous growth model. They also support the benign effect of imperfect competition on economic growth and indicate that the firms producing final goods and intermediate goods engage in backward integration, which is pointed out by Minkler and Park (1994) to be beneficial to economic growth. Acemoglu *et al.* (2005) investigate vertical integration in the UK manufacturing sector. Aghion *et al.* (2006) focus on firms' decisions on whether or not to integrate vertically with their suppliers. They provide evidence of a U-shaped relationship between competition and vertical integration. Lai *et al.* (2010) develop a monopolistic competition macroeconomic model, and use it to discuss the determination of relevant macro variables under both vertical separation and vertical integration regimes. However, they do not consider the possibility of IPR protection or discuss the effect of vertical integration on social welfare. Based on the above points of view, we try to extend Wang *et al.* (2010)'s model by introducing the role of IPR protection and explain the effects of IPR and vertical integration on economic growth and welfare.

In this paper, we present a three-stage model. In the first stage, the final goods

---

<sup>1</sup>See Wang *et al.* (2010).

firms and intermediate goods firms negotiate the franchise fee and the price of the intermediate goods in the franchising contract according to the Nash efficient bargaining framework. In other words, the intermediate goods firms no longer have full bargaining power to determine the prices of the intermediate goods as in the traditional R&D endogenous growth model. The final goods firms facing a monopolistic competitive market can only partially decide the prices of intermediate goods through bargaining. In the second stage, the final goods firms set the prices of the final goods to maximize their profits. In the third stage, the consumers determine the expenditure plan to maximize their utility. We will proceed by solving the model backwards.

We find that our results differ from those of Wang *et al.* (2010) in that the intermediate goods firm's bargaining power has a positive effect on the economic growth. The positive growth effects of IPR protection are also supported by Kwan and Lai (2003), Iwaisako and Futagami (2003), Goh and Olivier (2003), Horii and Iwaisako (2007), and Eicher and Garcia-Penalosa (2008). In addition, we provide evidence of the effect of IPR protection in terms of bargaining power on the welfare analysis, and the effect is ambiguous. The basic intuition is that raising these parameters enhances growth, but on the other hand it decreases initial consumption. Furthermore, in this article the franchise fee plays an important role. The stronger the IPR protection, the lower the consumer preference for diversity, and the lower the elasticity of substitution, the lower the number of final goods firms, which in turn will increase the franchise fee.

## 2 The Model

We expand the R&D growth models of Grossman and Helpman (1991), Benassy (1998) and Wang *et al.* (2010) with successively imperfectly competitive economies and consider the possibility that IPRs are imperfectly protected.

### 2.1 IPR

According to Eicher and García-Penalosa (2008), the imperfect protection of intellectual property rights in relation to R&D is captured by the degree of IPR

enforcement, denoted by  $q \in [0, 1]$ .  $q$  represents the probability that the inventor can enforce his/her patent in court and prevent imitation. If the innovator cannot enforce a patent in court, the intermediate goods will be imitated. This implies that the expected value of R&D equals  $qp_A$  where  $p_A$  refers to the value of a new blueprint. We treat the level of enforcement as exogenous institutional quality and discuss its effect on growth and welfare.

## 2.2 The Intermediate Goods Sector

There are  $n$  intermediate goods firms that purchase the blueprint and operate in a monopolistically competitive industry. Each intermediate good can be produced under two possible scenarios. (i) If the technology is fully protected, only one single producer exists and we assume that the production of one unit of the intermediate good requires one unit of labor. Therefore, the production function can be presented as  $x_i^M = l_i^x$ . (ii) If enforcement of a patent right is lacking, the intermediate good will be copied by other firms and be produced by a competitive fringe. We suppose that there is no cost of imitation. However, since a copied technology comes with no need for blueprints or any support from the R&D sector, it is assumed that the average product of labor in the production of intermediate goods equals  $1/b$  ( $x_i^E = (1/b)l_i^x$ ). We assume that  $b < 1$  to represent the situation where there exists a cost differential for imitated technologies and the smaller  $b$  is, the larger the cost differential will become.

Accordingly, we can rewrite the production function for the representative intermediate goods firm as  $x_i = qx_i^M + (1-q)x_i^E = [(bq+1-q)/b]l_i^x$ . Each intermediate goods firm produces and sells  $x_i$  to all  $m$  final goods firms, taking the actions of all other producers in the intermediate goods sector as given.<sup>2</sup> Its profit function is:

$$\pi_i = \int_0^m (p_{ij}^x x_{ij} - w l_{ij}^x + f_{ij}) dj, \quad (1)$$

where  $p_i^x$  is the price of intermediate goods  $i$ ,  $w$  is the common wage rate under the assumption of perfect mobility for labor,  $l_i^x$  is the labor hired by firm  $i$ ,  $f_i$  is the franchise fee received from the final goods firms, and  $m$  is the number of

---

<sup>2</sup>To simplify the notation, the time arguments will all be dropped.

different varieties in the final goods market.<sup>3</sup>

### 2.3 R&D Sector

The number of intermediate goods can be increased by undertaking research through the labor input. Hence the production function in the R&D sector is given by:

$$\dot{n} = nL_A, \quad (2)$$

where  $L_A$  is the amount of labor hired in the R&D sector, and  $\dot{n}$  is the number of newly-created blueprints. The more varieties the intermediate goods market has, the more new blueprints are produced per unit of time.

### 2.4 The Final Goods Market

We assume the final goods market is monopolistically competitive. Firm  $j$  produces  $y_j$  by using a continuum of intermediate goods. Following Romer (1986) the production function for final goods is designed by:

$$y_j \equiv n^\mu \left( n^{-1} \int_0^n x_{ij}^\alpha di \right)^\alpha, \quad \alpha > 1, \quad \mu \geq 1, \quad (3)$$

where  $x_{ij}$  represents the amount of intermediate goods  $i$  used by firm  $j$ .  $i \in [0, n(t)]$  is the range of intermediate goods existing at time  $t$ .  $\mu > 1$  implies returns to specialization (Ethier, 1982).  $-1/(1-\alpha)$  represents the elasticity of substitution between intermediate goods.

The producer  $j$  chooses output price  $p_j$  to maximize its profit:

$$\Pi_j = p_j y_j - \int_0^n p_{ij}^x x_{ij} di - \int_0^n f_{ij} di \quad (4)$$

subject to the output demand function from households, and the production technology Eq. (3).

---

<sup>3</sup>To simplify the analysis, we assume that the franchise fee received from final goods firms is identical to that in all other contracts.

## 2.5 Households

The representative household maximizes its life-long discounted utility. The representative household is infinitely lived and endowed with a constant aggregate flow of labor  $L$  supplied inelastically. The household's discounted utility is given by:

$$V = \int_0^{\infty} e^{-\rho t} U(C) dt, \quad (5)$$

and

$$U(C) = \ln C, \quad (6)$$

where  $\rho$  is the constant rate of time preference. Composite consumption good  $C$  with the type of monopolistic competition CES functional form following Dixit and Stiglitz (1977) is defined by:

$$C \equiv m^{\eta} \left( m^{-1} \int_{j=0}^m c_j^{(\sigma-1)/\sigma} dj \right)^{\sigma/(\sigma-1)}, \quad \sigma > 1, \quad \eta \geq 1. \quad (7)$$

Eq. (6) denotes a unitary elasticity utility function,  $C$  consists of a bundle of closely-related product varieties according to Eq. (7),  $\eta$  captures the consumer preference for diversity, and  $c_j$  is a consumption good of variety  $j$ . Commodities supplied by different producers are imperfect substitutes with a constant elasticity of substitution  $\sigma$ .  $j \in [0, m]$  represents the varieties produced by different final goods firms.

The budget constraint, describing the sum of spending on consumption goods and investment in new blueprints, is equal to the sum of labor income and the profits received from the intermediate goods firms and the final goods firms. It is therefore given by:

$$PC + p_A \dot{n} = wL + n\pi = m\Pi, \quad (8)$$

where

$$PC = \int_{j=0}^m p_j c_j dj. \quad (9)$$

$PC$  is total spending on consumption goods;  $P$  is the aggregate consumption

price index and will be derived latter.

### 3 The Market Solution

Backward solutions are applied to obtain the market solution. In the final stage, the household chooses its consumption levels of available product varieties,  $c_j$ , for utility maximization, given the definition of composite consumption in Eq. (7) and the budget constraint Eq. (9). The optimal consumption level of variety  $j$  is obtained:

$$c_j = m^{-(\sigma+\eta)+\eta\sigma} \left(\frac{P_j}{P}\right)^{-\sigma} C, \quad (10)$$

where

$$P = m^{-\eta} \left( m^{-\sigma} \int_0^m P_j^{1-\sigma} dj \right)^{1/(1-\sigma)}. \quad (11)$$

Eq. (10) gives the downward sloping demand curve for good  $j$ . Eq. (11) expresses the aggregate consumption price index.

In the second stage,<sup>4</sup> the final goods firm sets the price of final goods to maximize its profit as in Eq. (4) with a production constraint, Eq. (3). To satisfy the optimal condition we can derive the final goods price which is determined by:

$$p_j = \frac{\sigma}{n^{\mu-1}(\sigma-1)} p_{ij}^x. \quad (12)$$

The pricing rule shows that the final good price depends on market power  $\sigma/(\sigma-1)$ , the degree of returns to specialization ( $\mu$ ), and the prices of intermediate goods ( $p_{ij}^x$ ). Obviously the final goods firm sets its price according to the markup pricing rule, which is similar to the result derived from the traditional model of successively monopolistic competition and expanding-variety-type R&D endogenous growth models, while the intermediate goods firm maintains the full strength of patent protection.

In the first stage, it is assumed that the final goods firms and intermediate goods

---

<sup>4</sup>From the symmetry perspective, we have  $x_{ij} = x_j$ ,  $p_{ij}^x = p_j^x$ ,  $\forall i$ , in equilibrium.

firms negotiate the franchise fee and the price of the intermediate goods according to the Nash efficient bargaining framework. Therefore the franchising contract  $(p_j^x, f_j)$  is bargained according to:

$$\max_{p_j^x, f_j} N = (\Pi_j - \Pi_j^0)^\theta (\pi_i - \pi_i^0)^{1-\theta}, \quad (13)$$

where  $\theta$  describes the bargaining power of the final goods firm  $j$  and its value lies in the interval  $[0, 1]$ .<sup>5</sup> When  $\theta \rightarrow 0$  the model reduces to a forward integration case in which the intermediate goods firm  $i$  with full bargaining power decides the intermediate goods price. To keep the analysis simple, we assume that there exists an identical bargaining power for all final goods firms with decentralized status. The same is true for the intermediate goods firms.

**Proposition 1** (i) *The price of intermediate goods will be set below the marginal cost if the technology is imperfectly protected.* (ii) *In the forward integration case, the intermediate goods firm with full bargaining power will extract all the rent.*

According to the Nash bargaining solutions derived by maximizing Eq. (13), the optimal franchise fee and intermediate price are shown as follows:

$$p^x = \frac{b}{bq + (1-q)} w, \quad (14)$$

$$f = \frac{(1-\theta)}{n} \left[ \frac{1}{n^{\mu-1}(\sigma-1)} \frac{b}{bq + (1-q)} w \right] m^{-(\sigma+\eta)+\eta\sigma} \times \left( \frac{\sigma}{n^{\mu-1}(\sigma-1)} \frac{b}{bq + (1-q)} \frac{w}{P} \right)^{-\sigma} Y. \quad (15)$$

Eq. (14) states the pricing rule for intermediate goods. In a way that is different from Wang *et al.* (2010), we find that the price of intermediate goods will be set by the marginal cost as in the case of the socially optimal outcome if the technology is perfectly protected when  $q \rightarrow 1$ . If there is no patent awarded, this means that as  $q \rightarrow 0$  the price of intermediate goods will be far below the marginal cost.

---

<sup>5</sup>The outside option is assumed to be zero ( $\Pi_j^0 = \pi_i^0 = 0$ ) because once they quit bargaining they are not able to produce anything (Binmore *et al.*, 1986). In this case, the final goods firms have to purchase the goods from intermediate goods firms.

Compared to most of the literature for which the results of markup prices for the intermediate goods are derived based on the R&D growth model, we obtain a general solution for intermediate goods pricing that is set simultaneously by firms producing final goods and intermediate goods through bargaining.

In addition, Eq. (15) indicates that the optimal franchise fee depends on the bargaining power  $\theta$ , the degree of technology protection  $q$ , and the cost differential  $b$ . The intermediate goods firm  $i$  with full bargaining power ( $\theta \rightarrow 0$ ) will extract all the rent, that is, through forward integration. On the contrary, the fee will vanish if the intermediate goods firm  $i$  has no bargaining power ( $\theta \rightarrow 1$ ), that is, where backward integration takes place.

Accordingly, Eqs. (11) and (12) can be rewritten as:

$$p = \frac{\sigma}{m^{\eta-1} n^{\mu-1} (\sigma-1)} \frac{b}{bq + (1-q)} w, \quad (16)$$

$$p = \frac{\sigma}{n^{\mu-1} (\sigma-1)} \frac{b}{bq + (1-q)} w. \quad (17)$$

And the profits can be derived as:

$$\Pi = \theta \frac{1}{m} \frac{1}{m^{\eta-1} n^{\mu-1} (\sigma-1)} \frac{b}{bq + (1-q)} wY, \quad (18)$$

$$\pi = (1-\theta) \frac{1}{n} \frac{1}{m^{\eta-1} n^{\mu-1} (\sigma-1)} \frac{b}{bq + (1-q)} wY. \quad (19)$$

If firm  $j$  is weaker than firm  $i$  in terms of the bargaining power of the franchising contract, more of the rent will be distributed to the intermediate goods firm.

Eq. (15) may be rewritten as:

$$f = \frac{(1-\theta)}{n^{\mu} (\sigma-1)} \frac{b}{bq + (1-q)} w m^{-\eta} Y, \quad (15a)$$

where  $\partial f / \partial \eta > 0$ ,  $\partial f / \partial \sigma < 0$ ,  $\partial f / \partial m < 0$ ,  $\partial f / \partial q > 0$ .<sup>6</sup>

We can conclude that the less the consumer preference for diversity is, the less the elasticity of substitution will be, the less the number of final goods firms will be, and the higher the franchise fee. The stronger IPR protection will increase the

---

<sup>6</sup>See Appendix A.

franchise fee. This implies that IPR protection is necessarily completed to increase the franchise fee in order to drive the economic growth.

The free entry condition in the R&D sector implies that the blueprint cost or value is as follows:

$$p_A = \frac{w}{qn}. \quad (20)$$

Eq. (20) indicates that the value of the blueprint is equal to its cost.  $p_A$  is the value of a new blueprint.

## 4 Growth

To maximize the household's discounted utility, Eq. (5), and subject to the budget constraint, Eq. (8), we can obtain:

$$\frac{\dot{C}}{C} = \frac{\pi}{p_A} + \frac{\dot{p}_A}{p_A} - \rho - \frac{\dot{P}}{P}. \quad (21)$$

Eq. (21) indicates that the return on blueprints/investment, which includes the dividend ( $\pi$ ) plus the capital gains ( $\dot{p}_A$ ) expressed in terms of the blueprint minus the rates of time preference and the rising rate of the price, equals the real consumption growth rate.

Now we have to find the equilibrium outcomes in the labor market and final goods market. First, the labor market equilibrium condition states that total labor demand is equal to total labor supply ( $L_x + L_A = L$  where  $L_x$  is the labor demand of intermediate goods and final goods firms), and labor is perfectly mobile across the intermediate goods sector and the blueprint industry. Since the quantities of labor allocated to the intermediate goods sector and the R&D industry are  $L_x = \{mn[bq + (1-q)]/b\}l^x$  and  $L_A = \dot{n}/n$ , respectively, the labor market equilibrium condition will be rewritten as:

$$\frac{\dot{n}}{n} = L - mn \frac{bq + (1-q)}{b} l^x. \quad (22)$$

Secondly, the equilibrium condition for the final goods market is:

$$C = Y = m^{n-1} n^{\mu-1} L_x. \quad (23)$$

Eqs. (16)-(20) and (21)-(23) fully define the dynamics of the economy. Therefore we can determine the growth rate of the economy. According to Eqs. (17)-(20), we obtain:

$$\frac{\dot{p}_A}{p_A} = (\mu - 2) \frac{\dot{n}}{n} + \frac{\dot{P}}{P}, \quad (24)$$

$$\frac{\pi}{p_A} = \frac{1-\theta}{\sigma-1} \frac{bq}{bq+(1-q)} L_x. \quad (25)$$

From Eqs. (21)-(25), we derive the dynamic equation for  $L_x$ :

$$\frac{\dot{L}_x}{L_x} = \left[ \frac{1-\theta}{\sigma-1} \frac{bq}{bq+(1-q)} + 1 \right] L_x - L - \rho. \quad (26)$$

Since the coefficient  $\left[ \frac{1-\theta}{\sigma-1} \frac{bq}{bq+(1-q)} + 1 \right]$  is positive, Eq. (26) represents a differential equation with a divergent solution. This means that  $L_x$  jumps to a steady state immediately. Its steady state value is:

$$\tilde{L}_x = \frac{1}{\frac{1-\theta}{\sigma-1} \frac{bq}{bq+(1-q)} + 1} (L + \rho), \quad (27)$$

and therefore a constant growth rate  $\gamma_c$  is as follows:

$$\gamma_c = (\mu - 1) \left[ L - \frac{1}{\frac{1-\theta}{\sigma-1} \frac{bq}{bq+(1-q)} + 1} (L + \rho) \right] > 0, \quad (28)$$

$$\gamma_c = \gamma_y = (\mu - 1) \gamma_n,$$

where  $\partial \gamma_c / \partial q > 0$ ,  $\partial \gamma_c / \partial (1-\theta) > 0$  and  $\partial \gamma_c / \partial b > 0$ .

**Proposition 2** *The stronger that the IPR protection is, the greater the bargaining power that the intermediate goods firm has, and the lower the cost differential, the more the economy grows.*

We can conclude that the higher the level of IPR protection, the greater the bargaining power of the intermediate goods firm, or the stronger the labor spillover effect, the

higher the economic growth.<sup>7</sup> An increase in IPR protection will enhance the rate of economic growth through two effects. On the one hand, the stronger IPR protection increases the expected value of an innovation. However, on the other hand, the stronger IPR protection and higher rate of economic growth reduces the demand for employment in manufacturing intermediate goods and hence the wage. Both effects increase the incentives for investment in research. This result is the same as that in Goh and Oliver (2003), which suggests that higher patent protection in the upstream sector accelerates growth. The reason why an increase in the bargaining power  $(1-\theta)$  of the intermediate goods sector will improve the economic growth  $(\partial\gamma_c/\partial(1-\theta) > 0)$  is that the intermediate goods firms will increasingly engage in innovation when they can extract more rent/franchise fees from the final goods market. This result is different from that of Wang *et al.* (2010). A reduction in the cost differential for imitated technology will enhance the economic growth  $(\partial\gamma_c/\partial b > 0)$ .

The elasticity of substitution  $\sigma$  also plays an important role in the growth. Its effect is negative  $(\partial\gamma_c/\partial\sigma < 0)$ . It explains how the imperfect competition will foster economic growth. In other words, the market power of the final goods firm is beneficial to the growth rate of the economy. That is to say, the markup has a positive growth effect. If the government deregulates the final goods market, firms face more elastic demand and reduce their markup and hence profit. A more competitive final goods market means that firms in the intermediate goods market will not profitably innovate although they have bargaining power under vertical integration, resulting in an impeded economic growth rate.

## 5 Welfare Analysis

We have discussed how institutional quality, bargaining power and the cost differential affect the level of output and the rate of economic growth.<sup>8</sup> To understand their effects on social welfare, we first integrate the utility function (19) over time to express the welfare function as:

---

<sup>7</sup>See Appendix B.

<sup>8</sup>In line with Greiner and Hanusch (1998), and Chao *et al.* (2012), we are concerned only with the level of the household's welfare along the balanced growth path (BGP).

$$V = \frac{1}{\rho} \ln C_0 + \gamma_c \frac{1}{\rho^2}, \quad (29)$$

where  $C_0$  is the initial balanced growth equilibrium level of consumption which is obtained from Eqs. (23) and (27).

**Proposition 3** *The welfare effects of IPR protection, bargaining power, and the cost differential depend on the relative degrees of the growth enhancing effect and crowding-out effect of consumption.*

Differentiating Eq. (29) with respect to  $q$  yields:

$$\frac{\partial V}{\partial q} = \frac{1}{\rho} \underbrace{\frac{\partial \ln C_0}{\partial \ln \tilde{L}_x} \frac{\partial \tilde{L}_x}{\partial q}}_{(-)} + \frac{1}{\rho^2} \underbrace{\frac{\partial \gamma_c}{\partial q}}_{(+)} < 0 \quad \text{if } \rho > (\mu - 1)\tilde{L}_x. \quad (30)$$

The last term on the right-hand side of Eq. (30) captures the positive direct effect of IPR on welfare through growth, which allows for higher consumption in the future. However, the first term shows the negative crowding-out effect of IPR on initial consumption.

Unlike Goh and Oliver (2003) who show that optimal patent protection is necessarily higher in the upstream than in the downstream sector if some innovation is socially desirable, and that welfare is strictly increasing in the patent breadth in the upstream industry, we provide a general solution to IPR and social welfare. Eq. (30) indicates that the effect of IPR protection on social welfare depends on the relative degree of IPR effects on economic growth and initial consumption. Only if the growth effect is larger than the consumption effect will the IPR protection enhance social welfare. The trade-off between these two effects was formalized by Grossman and Lai (2004) and Eicher and García-Penalosa (2008), and they showed that the socially optimal degree of enforcement is not necessarily full enforcement.

In addition, if total labor employed in the final goods and intermediate goods markets is greater than the rate of time preference, increasing IPR protection will enhance social welfare. This is because the lower the rate of time preference, the smaller the negative consumption effect, and the greater the social welfare.

Differentiating Eq. (29) with respect to  $\theta$  yields:

$$\frac{\partial V}{\partial \theta} = \frac{1}{\rho} \underbrace{\frac{\partial \ln C_0}{\partial \ln \tilde{L}_x} \frac{\partial \tilde{L}_x}{\partial \theta}}_{(+)} + \frac{1}{\rho^2} \underbrace{\frac{\partial \gamma_c}{\partial \theta}}_{(-)} > 0 \quad \text{if } \rho > (\mu-1)\tilde{L}_x. \quad (31)$$

Eq. (31) indicates that the effect of bargaining power on welfare is ambiguous. If the growth effect is stronger/weaker than the consumption effect, the final goods and intermediate goods firms that engage in forward/backward integration will enhance social welfare. This is because forward integration leads the intermediate goods firms to have a greater profit incentive to invest in research and speed up the growth rate of the economy. This innovation effect is larger than that which leads to the crowding out of the consumption effect. If the consumption effect is stronger than the growth effect, the final goods and intermediate goods firms that engage in backward integration will enhance social welfare. In this case, backward integration, which raises the production level, will dominate the growth effect.

In addition, if total labor employed in the final goods and intermediate goods markets is smaller than the rate of time preference, increasing the bargaining power of the intermediate goods firms will enhance social welfare. This is because the higher the rate of time preference, the more positive the consumption effect will be, resulting in more social welfare.

Differentiating Eq. (29) with respect to  $b$  yields:

$$\frac{\partial V}{\partial b} = \frac{1}{\rho} \underbrace{\frac{\partial \ln C_0}{\partial \ln \tilde{L}_x} \frac{\partial \tilde{L}_x}{\partial b}}_{(-)} + \frac{1}{\rho^2} \underbrace{\frac{\partial \gamma_c}{\partial b}}_{(+)} < 0 \quad \text{if } \rho > (\mu-1)\tilde{L}_x. \quad (32)$$

Eq. (32) indicates that if the growth effect of the cost differential is greater than the consumption effect, a decrease in the cost differential (i.e., a larger  $b$ ) of the imitation will increase the social welfare. Otherwise, in the case where the growth effect is smaller than the consumption effect, the larger cost differential (i.e., a lower  $b$ ) will increase the social welfare.<sup>9</sup>

In addition, if the total labor employed in the final goods and intermediate goods markets is greater than the rate of time preference, increasing the cost differential will enhance social welfare. This is because the lower the rate of time preference, the smaller the negative consumption effect, resulting in more social welfare.

---

<sup>9</sup>See Appendix C.

## 6 Conclusion

This paper develops an R&D-driven endogenous growth model and analyzes the effects of IPR protection on growth and welfare in a bargaining franchise fee system. We find that the price of intermediate goods is charged according to the marginal cost if the technology is perfectly protected, while there is no imitation and no cost differential. If the technology is imperfectly protected, the price of intermediate goods will be set below the marginal cost. In the forward integration case, the intermediate goods firm with full bargaining power will extract all of the rent. As a result, the government may adopt a policy to increase the relative bargaining power of the intermediate goods firms. The greater the bargaining power that the intermediate goods firms have, the more rent that will be extracted from the final goods firms. Therefore, the intermediate goods firms will be inclined to invest more in R&D even when they adopt marginal cost pricing.

The stronger that the IPR protection is, the greater will be the bargaining power that the intermediate goods firms have, and the lower the cost differential, the more that the economy will grow. The growth effect of IPR protection and the growth effect of forward integration exhibit a positive relationship with each other. A decreasing cost differential tends to push the growth rate of the economy upwards.

We have also examined the welfare effects of IPR protection, vertical integration, and the cost differential. The welfare effects of IPR protection, the bargaining power and the cost differential depend on the relative degrees of the growth enhancing effect and the crowding-out effect of consumption. If the growth effect dominates the consumption effect, the firms engage in forward integration and stronger IPR protection will enhance the social welfare. If the consumption effect is larger than the growth effect, the greater cost differential will result in the social welfare being further enhanced.

## Appendix A

Differentiating Eq. (15a) with respect to  $\eta$ ,  $\sigma$ ,  $m$ , and  $q$  yields:

$$\frac{\partial f}{\partial \eta} = \frac{(1-\theta)}{n^\mu (\sigma-1)} \frac{b}{bq+(1-q)} w \frac{-\ln m}{m^{2\eta}} Y < 0, \quad (\text{A1})$$

$$\frac{\partial f}{\partial \sigma} = \frac{-(1-\theta)}{n^\mu (\sigma-1)^2} \frac{b}{bq+(1-q)} w m^{-\eta} Y < 0, \quad (\text{A2})$$

$$\frac{\partial f}{\partial m} = \frac{(1-\theta)}{n^\mu (\sigma-1)} \frac{b}{bq+(1-q)} w \frac{-\eta}{m^{\eta+1}} Y < 0, \quad (\text{A3})$$

$$\frac{\partial f}{\partial q} = \frac{(1-\theta)}{n^\mu (\sigma-1)} \frac{-b(b-1)}{[bq+(1-q)]^2} w m^{-\eta} Y > 0. \quad (\text{A4})$$

## Appendix B

Differentiating Eq. (28) with respect to  $q$ ,  $\theta$ , and  $b$ , respectively, yields:

$$\begin{aligned} \frac{\partial \gamma_c}{\partial q} = \\ (\mu-1) \frac{1}{\left[ \frac{(1-\theta)}{(\sigma-1)} \frac{bq}{bq+(1-q)} + 1 \right]^2} \frac{1-\theta}{(\sigma-1)} \frac{b}{[bq+(1-q)]^2} (L+\rho) > 0, \end{aligned} \quad (\text{B1})$$

$$\begin{aligned} \frac{\partial \gamma_c}{\partial \theta} = \\ (\mu-1) \frac{-1}{\left[ \frac{(1-\theta)}{(\sigma-1)} \frac{bq}{bq+(1-q)} + 1 \right]^2} \frac{1}{(\sigma-1)} \frac{bq}{bq+(1-q)} (L+\rho) < 0, \end{aligned} \quad (\text{B2})$$

$$\begin{aligned} \frac{\partial \gamma_c}{\partial b} = \\ (\mu-1) \frac{1}{\left[ \frac{(1-\theta)}{(\sigma-1)} \frac{bq}{bq+(1-q)} + 1 \right]^2} \frac{1-\theta}{(\sigma-1)} \frac{q(1-q)}{[bq+(1-q)]^2} (L+\rho) > 0. \end{aligned} \quad (\text{B3})$$

## Appendix C

Differentiating Eq. (29) with respect to  $q$ ,  $\theta$ , and  $b$ , respectively, yields:

$$\frac{\partial V}{\partial q} = \frac{1}{\rho} \frac{\frac{1-\theta}{(\sigma-1)} \frac{b}{[bq+(1-q)]^2}}{\left[ \frac{(1-\theta)}{(\sigma-1)} \frac{bq}{bq+(1-q)} + 1 \right]} + \frac{1}{\rho^2} \frac{(\mu-1) \frac{1-\theta}{(\sigma-1)} \frac{b}{[bq+(1-q)]^2}}{\left[ \frac{(1-\theta)}{(\sigma-1)} \frac{bq}{bq+(1-q)} + 1 \right]^2} (L+\rho) \begin{matrix} > \\ < \end{matrix} 0, \quad (C1)$$

$$\frac{\partial V}{\partial \theta} = \frac{1}{\rho} \frac{\frac{1}{(\sigma-1)} \frac{bq}{bq+(1-q)}}{\left[ \frac{(1-\theta)}{(\sigma-1)} \frac{bq}{bq+(1-q)} + 1 \right]} + \frac{1}{\rho^2} \frac{-(\mu-1) \frac{1}{(\sigma-1)} \frac{bq}{bq+(1-q)}}{\left[ \frac{(1-\theta)}{(\sigma-1)} \frac{bq}{bq+(1-q)} + 1 \right]^2} (L+\rho) \begin{matrix} > \\ < \end{matrix} 0, \quad (C2)$$

$$\frac{\partial V}{\partial b} = \frac{1}{\rho} \frac{\frac{1-\theta}{(\sigma-1)} \frac{q(1-q)}{[bq+(1-q)]^2}}{\left[ \frac{(1-\theta)}{(\sigma-1)} \frac{bq}{bq+(1-q)} + 1 \right]} + \frac{1}{\rho^2} \frac{(\mu-1) \frac{1-\theta}{(\sigma-1)} \frac{q(1-q)}{[bq+(1-q)]^2}}{\left[ \frac{(1-\theta)}{(\sigma-1)} \frac{bq}{bq+(1-q)} + 1 \right]^2} (L+\rho) \begin{matrix} > \\ < \end{matrix} 0. \quad (C3)$$

## References

- Acemoglu, D., P. Aghion, R. Griffith, and F. Zilibotti, (2005), "Vertical Integration and Technology: Theory and Evidence," *CEPR Discussion Papers No. 5258*.
- Aghion, P., R. Griffith, and P. Howitt, (2006), "Vertical Integration and Competition," *American Economic Review*, 96, 97-102.
- Benassy, J.-P., (1998), "Is There Always too Little Research in Endogenous Growth with Expanding Product Variety?" *European Economic Review*, 42, 61-69.
- Binmore, K., A. Rubinstein, and A. Wolinsky, (1986), "The Nash Bargaining Solution in Economic Modelling," *RAND Journal of Economics*, 17, 176-188.

- Chao, C. C., S. W. Hu, C. C. Lai, and M. Y. Tai, (2012), "Foreign Aid, Government Spending, and the Environment," *Review of Development Economics*, 16, 62-71.
- Dixit, A. K. and J. E. Stiglitz, (1977), "Monopolistic Competition and Optimum Product Diversity," *American Economic Review*, 67, 297-308.
- Eicher, T. and C. Garcia-Penalosa, (2008), "Endogenous Strength of Intellectual Property Rights: Implications for Economic Development and Growth," *European Economic Review*, 52, 237-258.
- Ethier, W. J., (1982), "National and International Returns to Scale in the Modern Theory of International Trade," *American Economic Review*, 72, 389-405.
- Ferrantino, M., (1993), "The Effect of Intellectual Property Rights on Trade and International Investment," *Weltwirtschaftliches Archiv*, 129, 300-331.
- Furukawa, Y., (2007), "The Protection of Intellectual Property Rights and Endogenous Growth: Is Stronger Always Better?" *Journal of Economic Dynamics & Control*, 31, 3644-3670.
- Futagami, K. and T. Iwaisako, (2007), "Dynamic Analysis of Patent Policy in an Endogenous Growth Model," *Journal of Economic Theory*, 132, 306-334.
- Goh, A.-T. and J. Olivier, (2003), "Optimal Patent Protection in a Two-Sector Economy," *International Economic Review*, 43, 1191-1214.
- Gould, D. M. and W. C. Gruden, (1996), "The Role of Intellectual Property Rights in Economic Growth," *Journal of Development Economics*, 48, 323-350.
- Greiner, A. and H. Hanusch, (1998) "Growth and Welfare Effects of Fiscal Policy in an Endogenous Growth Model with Public Investment," *International Tax and Public Finance*, 5, 249-261.
- Grossman, G. M. and E. Helpman, (1991), *Innovation and Growth in the Global Economy*, Cambridge, MA: MIT Press.
- Grossman, G. M. and E. L.-C. Lai, (2004), "International Protection of Intellectual Property," *American Economic Review*, 94, 1635-1653.
- Helpman, E., (1993), "Innovation, Imitation, and Intellectual Property Rights," *Econometrica*, 61, 1246-1280.
- Horii, R. and T. Iwaisako, (2007), "Economic Growth with Imperfect Protection of Intellectual Property Rights," *Journal of Economics*, 90, 45-85.
- Iwaisako, T. and K. Futagami, (2003), "Patent Policy in an Endogenous Growth Model," *Journal of Economics*, 78, 239-258.

- Judd, K., (1985), "On the Performance of Patents," *Econometrica*, 53, 567-585.
- Kwan, F. and E. Lai, (2003), "Intellectual Property Rights Protection and Endogenous Economic Growth," *Journal of Economic Dynamics and Control*, 27, 853-873.
- Lai, C. C., C. T. Chin, and S. H. Chang, (2010), "Vertical Separation versus Vertical Integration in a Macroeconomic Model with Imperfect Competition," *International Review of Economics and Finance*, 19, 590-602.
- Minkler, A. P. and T. A. Park, (1994), "Asset Specificity and Vertical Integration in Franchising," *Review of Industrial Organization*, 9, 409-423.
- Pfister, E., B. Deffains, M. Doriat-Duban, and S. Saussier, (2006), "Institutions and Contracts: Franchising," *European Journal of Law and Economics*, 21, 53-78.
- Wang, V. and C. H. Lai, (2011), "Franchise Fee, Competition and Economic Growth," *Economic Modelling*, 28, 2090-2099.
- Wang, V., C. H. Lai, L. S. Lee, and S. W. Hu, (2010), "Franchise Fee, Contract Bargaining, and Economic Growth," *Economics of Innovation and New Technology*, 19, 539-552.
- Yang, G. and K. Maskus, (2001), "Intellectual Property Rights and Licensing: An Econometric Investigation," *Weltwirtschaftliches Archiv*, 134, 210-221.