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Jirawat Panpiemras
Department of Economics, University of Colorado at Boulder
Boulder, Colorado

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Center for Economic Analysis
Department of Economics

University of Colorado at Boulder
Boulder, Colorado 80309

International Joint Ventures under Imperfect Protection of Intellectual Property Rights and Asymmetric Information

Jirawat Panpiemras *

Department of Economics, University of Colorado at Boulder

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Abstract: In this paper, I develop a quality ladder product cycle model with two quality levels to examine the effects of intellectual property rights (IPRs) protection on the extent of international joint ventures (JVs) and the rate of innovation under asymmetric information and imitation risk. The Northern share of a JV is endogenously determined. An optimal Northern share of a JV is an increasing function of Southern IPRs. With asymmetric information problem and imitation risk, an optimal JV contract involves giving a Southern partner a larger share of a JV when Southern IPRs are weaker, and giving a smaller share when Southern IPRs are stronger. The results are that stronger Southern IPRs increase the extent of JVs, the rate of innovation and the relative wage. In the case of low-quality technology transfer, licensing is a preferred mode of technology transfer. In the case of high-technology transfer, a JV is a preferred mode of technology if the cost of imitation under a JV contract is sufficiently higher than the cost of imitation under licensing contracts.

: F12, F23, O34, D82
Key Words: International Joint Ventures, Licensing, Innovation, Intellectual Property Rights

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* Department of Economics, Campus Box 256, University of Colorado, Boulder, CO, 88309-0256, USA; Jirawat@Panpiemras@colorado.edu

Introduction

As a result from the Uruguay Round of Multinational Trade Negotiation, the agreement on Trade-Related Aspects of Intellectual property right (TRIPs) requires all WTO members to adopt minimum standard set by WTO within designated time. An important argument relating IPRs is whether stronger intellectual property rights in developing countries encourage international technology transfer and innovation. International technology transfers through three important channels that are foreign direct investment, licensing and joint venture. There exists a large numbers of literatures regarding the relationship between IPRs and technology transfer such as FDI and licensing. However, what is missing from the literature is an examination of the relationship between intellectual property rights, joint ventures (JVs) and innovation, particularly in a dynamic setting. Although, American joint venture activity is declining continuously since 1980s, international joint venture is an important mode of technology transfer in some countries and deserves some analytical studies. In addition, economic growth of developing countries such as India and China where the local government prohibits 100% foreign-ownership (FDI) relies on technology transfer from JVs. In the paper, I use a product-cycle dynamic general equilibrium model to study the effects of intellectual property right on joint venture and innovation. In addition, the model incorporates asymmetric information in technology transfer from the North to the South.

The main difference among channels of technology transfer stated above is the ownership of the producing firm. In the cas(e local gJ1eli,uct)0.6(eus of ltil joint v7(. In 9(haJ17reign7.9791 producing firm. In the case of joint venture, a

consisting of an upfront fixed fee and proportional royalties, which is a proportion of the monopoly rent, to signal the true quality of technology transferred and discourage licensees from imitating their product. In this paper, we name contract specified in Yang and Maskus (2002) a LP contract. Similar to Gallini and Wright (1990), the licensor's optimal licensing contract involves giving up some monopoly rent to solve the problem of imitation and asymmetric information. Comparing a Northern share a JV to Licensors' rents allow us to build a condition under which JV is a more preferred mode of technology transfer.

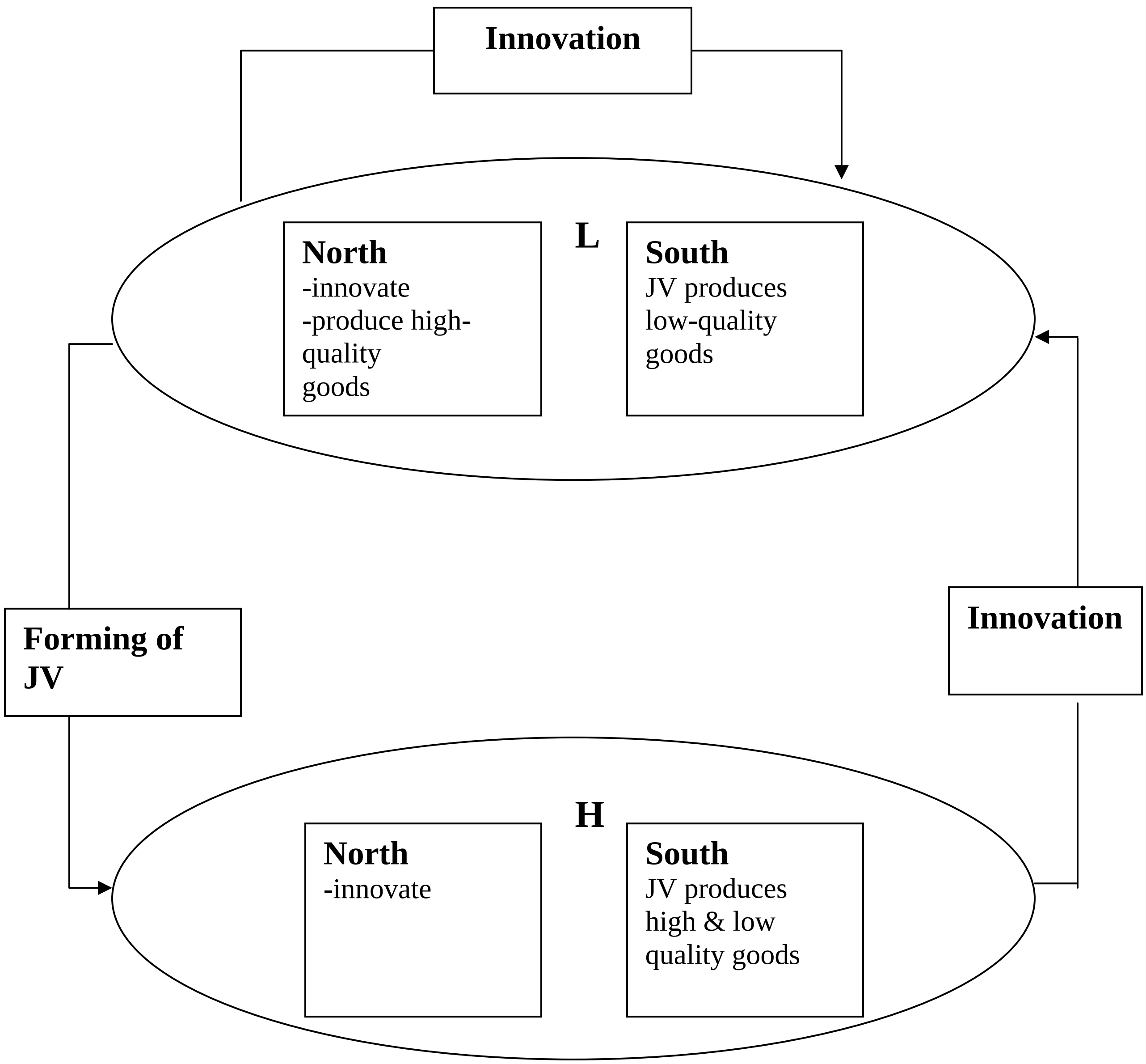
Market Structure

In this paper, I focus on the Southern country that a local government does not allow 100% foreign-ownership. Thus, a multinational firm is not able to transfer technology and production in form of FDI but able to transfer technology and production to a JV firm in the South. I further assume that in the absence of JVs, Southern partner does not have the technology to produce both quality levels of goods. In other words, Southern firms only have an access to technology that no longer yield profit from the production. Productions of either or both Northern goods (high and low-quality) could be produced in the South by JV firms located in the South only. Further assume that the direct imitation from imported goods is extremely expensive and is prohibited in the model. Thus, JV is the only channel of technology transfer from the North to the South. However, once JV is formed, Southern partner could imitate Northern partner's product at some cost at which is positively correlated with the level of Southern IPRs. This means the stronger Southern IPRs is, the higher the cost of imitation. Moreover, Southern firms rather than the Southern partner of a JV cannot imitate a JV's product due to the limit pricing and less imitating ability. A JV would set the price just equal to the imitator's marginal cost and prevent an imitating firm having positive profits.

There are two qualities of product sold in equilibrium at any point in time. The production of high-quality product requires one-quality high level of technology above the production of low-quality product. Following Yang and Maskus (2002), firm that had innovated the current state-of-the-art technology is the leader, and other firms that had invented a one-quality level below the state-of-the-art is the follower. As in Grossman and Helpman (1991), I assume that the leader will not conduct R&D to improve the quality of its own product. All improvements on the current state-of-the-art product are done by followers.

Similar toYang and Maskus (2002), there are two markets (low-quality JV and high-quality JV) co-existing in the equilibri whenever there is a successful innovation targeting the current high-quality in H market.

The market structure is presented in Figure 1.



Picture 1. Market Structure

Consumers

The consumption side is similar to Glass and Saggi (1998) and Yang and Maskus (2002).

There are two types of consumer, ,

$$( ) \int_{0}^{1} (,) \; (,) \qquad (4)$$

Free entry condition is

chooses the joint venture intensity by equalizing the capital gain, 1 1, to the cost

of joint venture, . The equilibrium condition of a joint venture is

A JV produces low-quality product and sets the price, to prevent entry. A low-quality JV has a marginal cost equal 1. Thus, a Northern firm has a cost saving incentive to transfer its technology and production to a JV. The demand for low-quality product is ——. An instantaneous profit for a JV is

Let be the fraction of an instantaneous profit of a high-quality JV allocated to the Northern partner. Let1 be the fraction of an instantane

In addition, a Northern leader also faces the risk that the current high-quality product might be transferred to a JV.

The value of a Northern leader in the L market is

$$ {}^{1} \quad \frac{{}^{1} \qquad\qquad {}^{1}}{(\qquad\qquad)} \qquad (18) $$

where is the market value of a low-quality JV hold by a Northern partner in L market, and ^{1} is the market value of a high-quality JV hold by a Northern partner in H market.

A low-quality JV in L market faces the risk of successful innovation and the risk that high-quality technology being transfer to a JV. If high-quality technology is transferred to a JV, a low-quality JV in L market becomes a low-quality JV in H market. Moreover, a low-quality JV in L market is out of the market whenever there is a successful innovation.

The value of a low quality JV in L market is

$$ \frac{\qquad\qquad {}^{2}}{(\qquad\qquad)} \qquad (19) $$

In H market, a Northern leader transfers production of high-quality product to a JV. A high-quality JV faces the risk of innovation by followers. A high-quality JV in H market becomes a low-quality JV in L market whenever there is a successful innovation.

The value of a high-quality JV in H market is

$$ {}^{1} \quad \frac{{}^{1}}{(\qquad)} \qquad (20) $$

A low-quality JV in H market faces only the risk of innovation. A low-quality JV is out of the market whenever there is a successful innovation. The value of a low-quality JV in H market is

$$^{2} \quad \frac{^{2}}{(\quad)} \qquad (21)$$

Since ^{2}, we can show that $^{2} \quad \frac{^{2}}{(\quad)}$ (22)

The Northern share of a high-quality JV in H market is

$$_{1} \quad \frac{_{1}}{(\quad)}. \qquad (23)$$

The Northern share of a low-quality JV in L market is

$$\frac{^{2}}{} \qquad (24)$$

The Northern share of a low-quality JV in H market is

$$^{2} \quad \frac{^{2}}{} \qquad (25)$$

Substituting (13), (24) and (25) into (23), we get the Northern share of a high-quality JV in H market

$$_{1} \quad \frac{_{1}}{} \quad _{1} \qquad (26)$$

The Northern share of a high-quality JV is equal to the fraction

$$^{1} \quad 1 \quad \frac{1}{\qquad} \quad (1 \quad) \quad ^{1} \qquad (27)$$

The Northern share of a low-quality JV in L market is

$$\frac{\quad}{\quad} \quad \frac{\quad}{\quad} \qquad (28)$$

The Southern share of a low-quality JV in L market is

$$\frac{\quad}{\quad} \quad (1 \quad) \frac{\quad}{\quad} \quad (1 \quad) \qquad (29)$$

The Northern and Southern shares of a JV in H and L market are the fraction multiplied by the value of a low-quality JV and $(1 \quad)$ multiplied by the value of a low-quality JV respectively.

Resource Constraints

Let denote the extent of high-quality JV market (the proportion of products produced in H market). Let $(1 \quad)$ denote the extent of low-quality JV market (the proportion of products produced in L market). and denote Northern labor supply and Southern labor supply respectively. In the labor market equilibrium, the demand for labor must equal to the supply of labor in each country.

In the North, labors are allocated to innovation and the production of high-quality product in L market. Northern labor market clearing condition is

$$(1 \quad) \qquad (30)$$

The first term is Northern labor demand for innovation in both markets. The second term is Northern labor demand for production in L market.

In the South, labors are allocated to adaptation, production of low-quality product in both markets, and production of high-quality product in H market.

The Southern labor market clearing condition is

$$(1 \quad) \qquad (31)$$

The first term is Southern labor demand for adaptation of new high technology. The second term is Southern labor demand for the production of low-quality product in both markets. The last term is Southern labor used in the production of high-quality product in H market.

Contractual Design under Asymmetric Information and Imitation Risk

The coexistence of high-quality and low-quality product in the model allows for the asymmetric information in joint venturing. Under asymmetric information, Northern partners have private information about the quality level of their technology. Southern partners cannot observe the quality of technology without direct inspection. In the model, Northern partners face two problems (asymmetric information and imitation risk). Due to an imitation risk, a high-quality Northern firm cannot inform a potential Southern partner of the quality of technology without revealing its technology. As a result, a low-quality Northern firm has an incentive to pretend to be a high-quality Northern firm. A high-quality Northern partner faces imitation risk after technology is transfers to a JV. A high-quality Northern partner has to design a joint venture contract that not only informs a southern partner of the true quality of technology but also the share of value of a JV that prevents imitation.

Following Gallini and Wright (1990), I focus on separating equilibrium contracts in a signaling game. The game has three stages. In the first state, a Northern partner offers a take-it-or-leave-it joint venturing contract to a Southern partner. A Southern partner cannot observe the type of technology at the time being. A Southern partner accepts or rejects the offer. In the second stage, if a Southern partner accepts the contract, a Northern partner transfers its technology, and a Southern partner observes the type of technology by inspection. In the third stage, a Southern partner decides whether to imitate or not. If a Southern partner imitates, it earns monopoly profits. If a Southern partner does not imitate, it gets the share of the value of a JV specified in the contract.

The low-quality Northern partner faces the imitation problem. It has to decide a contract that discourages imitation. The low-quality Northern partner maximizes its share of a JV, . Since there are two kinds of technology, let and denote the marginal cost of imitating low-quality and high-quality product with respectively.

( ) is the imitation cost by the Southern partner, where is the degree of Southern IPRs protection and '( ) 0 . Let ( ) = , where n = L and H. Moreover, the marginal cost of imitating high-quality product is higher than the marginal cost of imitating low-quality product. That is .

The low-quality Northern partner's maximization problem is to choose the fraction of the value of a JV (0 1) to maximize the Northern share of value of a low-quality JV.

( ) (32)

s.t. (feasibility)

(1) (no imitation)

0 1

The feasibility constraint is that the Northern share of a JV is less than or equal to the value of the producing firm in L market (a JV). The no imitation constraint is that the southern share of market value with no imitation is greater than or equal to net gain from imitation. The restriction on the fraction of the value of a JV allocated to the Northern partner, 0 1, guarantees that the feasibility constraint is hold with inequality. That is the feasibility constraint is not binding. The Lagrangian equation for the low-quality Northern partner's problem is

( ) ( ) (33)

The Kuhn-Tucker Conditions are:

(1) 0 C.S. 0 (34)

0 C.S. 0 (35)

C.S. 0 (36)

C.S. denotes the complementary-slackness condition.

Four exhaustive cases are considered.

Case 1: 0 1, 0, 0

Case 2: 0 1, 0, 0

Case 3: 0 1, 0, 0

Case 4: 0 1, 0, 0

Case 1, 2, and 4 can be rule

From (35), we have 0 1 (38)

From (36),we have ——

technology with out revealing its type of technology. The Northern firm has to distinguish its quality of technology from a low-quality JV. On the other hand, the

^{2} ^{2} 0 C.S. 0 (46)

Eight exhaustive cases are considered.

Case 1: 0 $1,$ $0,$ $0,$ 0

Case 2: 0 $1,$ $0,$ $0,$ 0

Case 3: 0 $1,$ $0,$ $0,$ 0

Case 4: 0 $1,$ $0,$ $0,$ 0

Case 5: 0 $1,$ $0,$ $0,$ 0

Case 6: 0 $1,$ $0,$ $0,$ 0

Case 7: 0 $1,$ $0,$ $0,$ 0

Case 8: 0 $1,$ $0,$ $0,$ 0

Case 1, 2, 3, 5, 6, 7, and 8 can be ruled out by the restriction on and the allocated to the Northern partners is an in

The first term in (51) represents the net flows of product out of L market L, and the second term represents the net flows of product into L market.

Since innovation targets both markets, the rate of innovation (( )) is the intensity of innovation ( ).)

$$(1 \quad)(\qquad\qquad\qquad\qquad) \tag{55}$$

,where $\qquad \frac{\qquad}{\qquad} \quad 1$

Taking total derivative of (55), we obtain the relation ship between the rate of innovation, and the extent of high-quality joint venture market, .

$$\frac{}{} \quad \frac{(\qquad (\qquad 2 \;) \;)}{(1 \quad)(\qquad)} \quad 0 \tag{56}$$

$$\frac{{}^{2}}{{}^{2}} \quad \frac{{}^{2} \qquad (\qquad 2 \; (\qquad) \qquad (1 \quad 2 \quad 2 \; {}^{2}) \qquad (\quad (\qquad) \quad 2 \quad (\; 1 \qquad))}{(\; 1 \quad) \qquad (1 \quad (\; 1 \quad) \;)^{2}} \tag{57}$$

$$\frac{{}^{2}}{{}^{2}} \qquad 0$$

Thus, there is a positive relationship between the extent of high-quality joint venture market and the rate of innovation. This is because an increase in the extent of high-quality joint venture market frees up Northern labor in a production of high-quality product sector. As a result, more Northern labor are used in R&D sector.

Using (50), (6) and (5), we can solve for the equilibrium wage rate as follow.

$$\frac{\qquad}{\qquad} \tag{58}$$

Substituting equations (6), (39) and (51) into (18), we have

$$_{1} \quad \frac{{}^{1} \qquad \overline{(1 \quad)}}{\qquad} \tag{59}$$

Substituting (59) and (8) into (6), we have the following joint venture equilibrium condition as a function of three endogenous variable (, and) and exogenous variables.

curve. The RC curve has a positive slope, and the VC curve has a negative slope. The intersection of RC and VC determines the steady-state equilibrium rate of innovation and the extent of high-quality JV market. The curve RC and VC are shown in picture 2.

Intellectual Property Rights, Innovation and Technology Transfer

In this section, we study how a strengthening of Southern intellectual property right affects the rate of innovation and the extent of high-quality JV market. In the model, the change in Southern intellectual property right affects only VC curve. We determine the shift of VC curve by solving a system of two linear equations, shown in Appendix B, for —— and ——. As shown in Appendix B, —— 0 and —— 0. Therefore, a stronger Southern intellectual property right shifts VC curve to the right (from VC1 to VC 2) but leaves RC curve intact. The shift of VC is shown in picture 2.

Proposition 1.

The intuition behind Proposition 1 is as follow. A stronger Southern IPR increases the Northern share of a JV and thus encourages Northern firms to transfer more technology and production through JVs. In addition, since productions of high-quality product are transferred to the South, more resources are available for innovation activities in the North. Therefore, a stronger Southern IPR increases the rate of innovation.

Intellectual Property Rights, Aggregate Expenditure and Relative Wage

Using the steady-state equilibrium relative wage (58), we can show that —— 0

We find the effect of the Southern IPR on the aggregate expenditure by totally differentiating (54).

—— —— —— —— —— 0

Since, —— and —— 0 as shown in Appendix B.

Proposition 2.

The intuition behind Proposition 2 is the follow. When Southern IPR is stronger, there are two opposite effects on the relative wage. On one hand, a stronger Southern IPR increases the rate of innovation. This effect would raise the demand for Northern labor (used in innovative activities) and the Northern relative wage increases. On the other hand, a stronger IPR increases the Northern share of market value of a JV and thus, more Northern production is transferred to a JV. This would raise the Southern demand for labor (used in adaptive activities and the production of new good) resulting in a decrease in the relative wage. In this model, the first effect dominates the second effect.

Modes of Technology Transfer under Asymmetric Information and Imitation Risk

In this section, I derive conditions under which JV is a more preferred channel of transfer to Licensing under asymmetric information and imitation risk. Two types of licensing contract are studied; a contract with an upfront fixed fee and output royalties as in Gallini and Wright (2001) and a contract with an upfront fixed fee and the royalty fee proportional to the licensee's monopoly rent as in Yang and Maskus (2002). The optimal licensor's rent from the former contract is shown in appendix C, and the optimal licensor's rents from the later contract are shown in appendix D. We simply assume that a Northern multinational prefers a JV as a mode of technology transfer if the Northern share of a JV is greater than the licensor's rent. A Northern Multinational prefers licensing over a JV as a mode of technology transfer if the licensor's rent is greater than the Northern share of a JV. Table 1 presents the Northern value of a JV, the licensor's rent under a licensing contract with output royalties and (LO) the licensor's rent under a licensing contract with proportional royalty fee (LP).

Table 1

Contract / Technology Transfer	JV Contract	Licensing Contract (Fixed fee & Output Royalties, LO)	Licensing Contract (Fixed fee & Proportional Royalty fee, LP)
Low-Quality Technology Transfer	2	2	2

High-Quality Technology Transfer	1		where 0 1

In the case of low-quality transfer, both licensing contracts allow a licensor to extracts full monopoly rent by charging an up-front fixed fee equal to monopoly rent. A licensor under (LO) and (LP) get monopoly rent and respectively. Note that in the model, [2]. However, in a JV contract, a Northern partner has to share

Proposition 4.

1 1

(1)

Proposition 4 says that regardless of the strength of Southern IPRs, a LO contract is the most preferred for a Northern multinational. Moreover, a JV is more preferred than a LP contract when the Southern IPR is sufficiently strong..

Proposition 5.

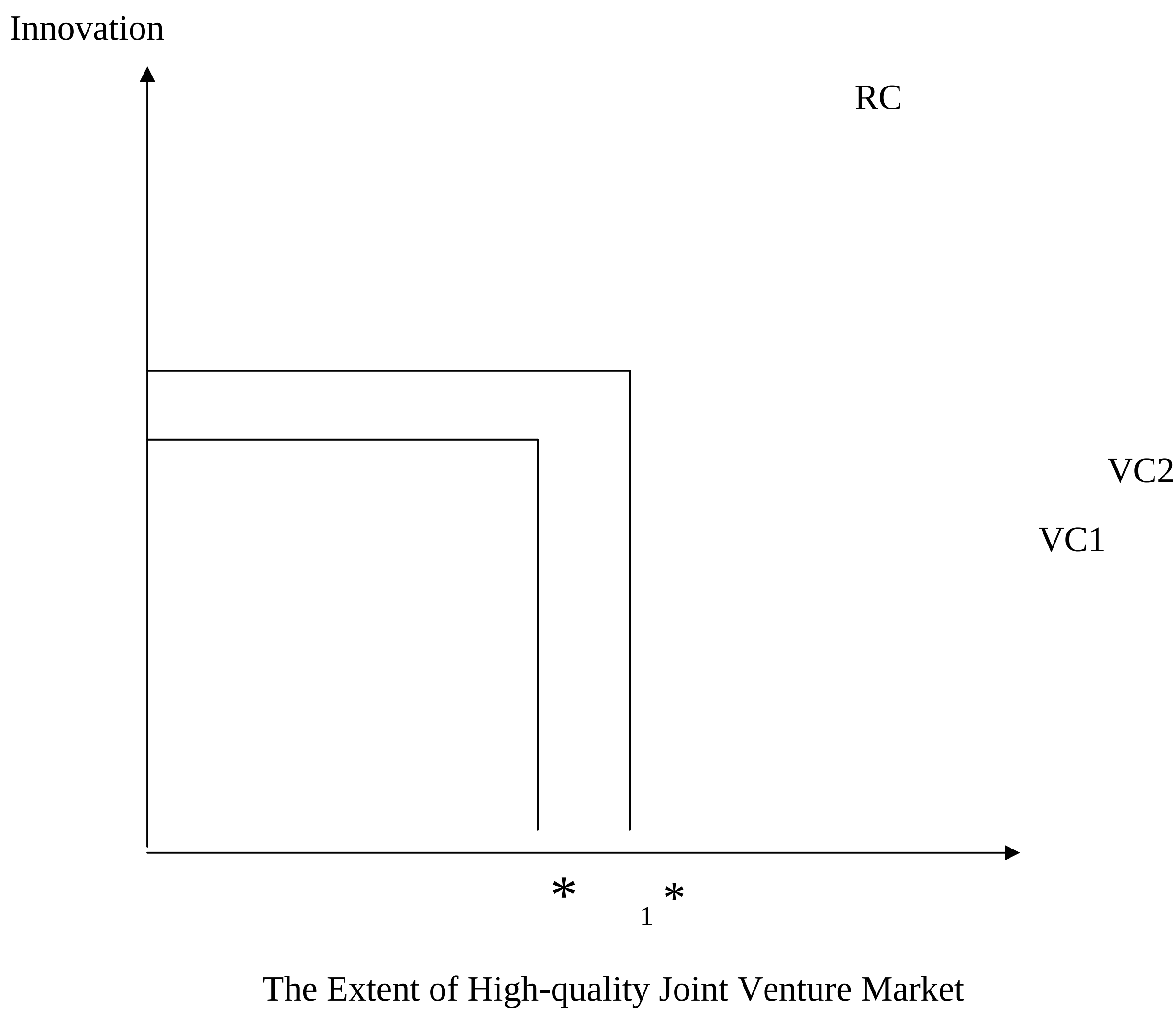
1 1

contract is the preferred mode of technology transfer. This might happen if a licensor can find the way keep the secret of it technology and transfers only how to use the technology to produce goods to the South. As a result, the cost of imitation under a licensing contract might be sufficiently high, and a licensing contract might be the preferred mode of technology transfer.

Conclusion

In this paper, I develop a quality ladder product cycle model with two quality levels to examine the effects of intellectual property rights (IPRs) protection on the extent of international joint ventures (JVs) and the rate of innovation under asymmetric information and imitation risk. The Northern share of a JV is endogenously determined. An optimal Northern share of a JV is an increasing function of Southern IPRs. With asymmetric information problem and imitation risk, an optimal JV contract involves giving a Southern partner a larger share of a JV when Southern IPRs are weak, and giving a smaller share when Southern IPRs are strong. The results are that stronger Southern IPRs increase the extent of JVs, the rate of innovation and the relative wage.

Comparing our result to the one in Glass and Saggi (2002), although FDI and joint venture are basically foreign direct investment, the impacts of Southern IPRs on these two channels of technology transfer are opposite. In Glass and Saggi (2002), stronger IPRs require more southern resources used in imitation at a given successful rate resulting in fewer resources available for FDI. A decrease in FDI implies that more productions remain in the North resulting in less Northern labor available for innovation. Therefore, the rate of innovation decreases. In our model, imitation is discouraged by the



Picture 2: Steady-State Equilibrium of the Rate of Innovation and the Extent of Joint Venture Market

Appendix A

Condition for Separation

In the L market, if a Northern leader chooses pooling, it would charge (where the superscript indicates pooling) because it wants to capture the whole market.

It sells — units of products and earns instantaneous

profits (1 —) = (1). The top firm's expected value is ——.

If the top firm chooses separation (here labeled with superscript), it would

charge . It sells —— units of products, and earns instantaneous profits

= (1). Its expected firm value is $\frac{1 \quad 2}{\quad}$.

Separation occurs in the L market if > . Thus > is a sufficient condition that separation will happen. The condition > is satisfied

if $\frac{1}{1}$.

Similarly, in the H market, under pooling the high-quality JV would charge

and get instantaneous profits (1 $\frac{1}{\quad}$) = (1). The firm has

expected value

——. Under separation, it would charge and get instantaneous

profits

= (1). Its expected firm value is = $\frac{2}{\quad}$. Separation is assured

by > , therefore, separation occurs if $\frac{1}{1}$.

If separation occurs in the H market, it will also occur in the L market, because if

$\frac{1}{1}$, then $\frac{1}{1}$ holds automatically. Therefore, separation occurs in both the H and L markets if is greater than $\frac{1}{1}$. In other words, separation occurs if high-valuation consumers have a sufficiently high income share. In addition if, $\frac{1}{1}$, then from 20 and 21, we can show that

Appendix C

Contractual Design of Licensing with an Upfront Fixed Fee and Output Based Royalties (LO contract)

This result follows Gallini and Wright (1990). In the first period, a Northern Licensor offers a LO contract. A Southern licensee accepts or rejects contract. In the second period, if a Southern licensee accepts a LO contract, then a Southern licensee pays upfront fixed fee. Then, the technology is transferred, and a Southern licensee observes the type of technology transferred. In the third period, a southern licensee makes a decision to imitate a Northern product. If a Southern licensee doesn't imitate, then it pays output-based royalties.

Let be the profit maximizing output chosen by the licensee producing with type of innovation, { , }.

technology transferred. In the third period, a southern licensee makes a decision to imitate a Northern product. If a Southern licensee doesn't imitate, then it pays fixed royalties proportional to the Licensee's monopoly rent. In a separating equilibrium, the low-quality licensor offers the contract with an upfront fixed fee equal to the licensee's monopoly rent ( ) . Similar to this paper, the licensor maximizes rent subject to feasibility, no imitation, and separation constraint. is an upfront fixed fee specified in LP contract. the royalty rate.

^{1} (2.0)

s.t. ^{1} ^{1} (feasibility)

^{1} ^{1} ^{1} (no imitation)

^{1} (separation)

The Lagrangian function for the high-quality licensor's rent maximization problem is as follows:

^{1} (^{1} ^{1}) (^{1}) (^{1})

The Kuhn-Tucker conditions are:

1 0 C.S. 0 (2.1)

^{1}(1) 0 C.S. 0 (2.2)

^{1} ^{1} 0 C.S. 0 (2.3)

^{1} 0 C.S. 0 (2.4)

0 C.S. 0 (2.5)

,where C.S. denotes the complementary-slackness condition.

Three exhaustive cases are considered

Case 1: 0 and 0 ; Case 2: 0 and 0 ; Case 3: 0 and 0 .

There are no solutions for Case 1 and Case 3 given that ^{1} and 0 . Only Case 3 is left. There are eight different sub-cases for Case 3:

					0,	0,	0
(d)	0,	0,	0	(h)	0,	0,	0

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