International Technology Transfer and Market Size: The Case of an Emerging Economy

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Abstract Kyoto Protocol allows developing countries to obtain technology transfer from developed countries under the framework of Clean Development Mechanism (CDM). Although South Africa is an ideal country to implement CDM projects, it lags behind many other countries in the number of CDM projects. This result prohibits South Africa to obtain technology transfer. This paper studies what licensing mode facilitates technology transfer when the market size is considered. We find that two-part tariff licensing mode facilitates technology transfer when the total market size is large enough.

Keywords: International technology transfer, Market size, Two-part tariff

JEL Classification: D45, D43, L13

1. Introduction

Kyoto Protocol is one of ways to resist the global climate warming (United Nations, 1997). Following the Kyoto Protocol, Clean Development Mechanism (CDM) is one of method to reduce the gaseous emissions of carbon dioxide (CO2) – the so called greenhouse gases (GHG) and is also a way to assist developed countries to meet their targets set under the Kyoto Protocol. According to the spirit of CDM, developing countries (non-Annex I countries) which participate CDM are awarded technology transfer for the projects and developed countries (Annex I countries) which provide funding for the projects gained from the projects by getting the carbon credits. Since South Africa is classified as a non-Annex I country by Kyoto Protocol, it is eligible to obtain technology transfer by implementing CDM projects. Although South Africa is an ideal candidate to host CDM projects (Greene, 2005; Jung, 2006; Greene, 2006), the number of projects that are implemented by South Africa continues to lag behind other
non-Annex I countries like India, China, Brazil and even Honduras and Chile. The obvious evidence come form that a total of 996 CDM projects had been published by the United Nations in August 2006, only 12 projects were from South Africa (United Nations Environment Programme, 2006). This implies South Africa faces a tardy technology transfer from CDM projects. The contemporary press article “SA tardy in signing up for carbon credits” (Njobeni, 2006) confirms our viewpoint. Little et al. (2007) study what factors facilitate and what factors inhibit technology transfer within South Africa industry under the CDM framework. Our paper studies how various licensing methods influence technology transfer when considering the market size in international market.

According to Sauers and Argersinger (2006) and the Survey of Current Business (2007), the licensing revenue of United States firms from abroad has shown a significant increase from US$4.3 billion to US$57.4 billion from 1975 to 2005, with the increasing amount of in licensing revenue at US$0.4 billion and US$4.9 billion in 1984 and 2005, respectively. The licensing revenue hit US$62.4 billion and US$71.3 billion in 2006 and 2007, respectively. This shows that international technology licensing has become an important business action. According to Rostoker (1984), royalty licensing contracts are employed 39% of the time, fixed-fee licensing contracts for 13% of the time, and two-part licensing contracts for 46% of the time among 150 firms surveyed in the United States.

Many studies about international technology licensing focus on the relationship between the international trade environment and technology transfer (Either and Markusen, 1996; Horstmann and Markusen, 1987, 1996; Saggi, 1996; Song, 1996; Vishwasrao, 1994; Wright, 1993) as well as on the affect of trade policy on international technology licensing (Song, 1996; Brecher, 1982; Rodriguez, 1975; Wu et. al., 2002). These studies usually only discuss the effect of one of three kinds of licensing contract. However, only Mukherjee (2007) considers all three kinds of licensing contract and finds the optimal licensing contract under an open economy. He sets up a low cost licensor and a high cost licensee to play Cournot competition in a licensee's market. He concludes that if the licensee's marginal production cost and the licensor's per unit transport cost are sufficiently high, then the optimal licensing contract is an up-front fixed fee. On the contrary, if the licensee's marginal production cost is sufficiently high and the licensor's per unit transport cost is sufficiently low, then the optimal licensing contract is a royalty licensing contract. However, the two-part licensing contract is the optimal licensing contract for the licensor when it has an intermediate per unit transportation cost. By contrast, when the licensee's per unit production cost is not very high, the optimal licensing contract for the licensor is either a royalty licensing contract or a two-part tariff licensing contract. There are also many

This paper follows Mukherjee (2007) to discuss the optimal licensing strategy under an open economy. However, our model setting is significantly different from Mukherjee (2007). Since our study mainly discusses the optimal licensing strategy when the market size changes, we assume that both the home country firm and the foreign country firm can sell their own product in each other's market. We also extend our model to discuss the influence of a business cycle on the licensor's optimal licensing behavior.

Our results differ from the findings in Mukherjee (2007), in that Mukherjee (2007) concludes that the licensor's optimal licensing contract is an up-front fixed fee if the licensee's marginal production cost and the licensor's per unit transportation cost are sufficiently high. However, we conclude that on the matter for what is the difference between the licensee's marginal production cost and the licensor's per unit transportation cost, it is impossible for the licensor to use an up-front fixed fee licensing contract, because the market size also affects the licensor's licensing contract. We also find that given the foreign firm has a large transportation cost when the market size is large, the licensor's optimal licensing strategy is a royalty licensing contract. Finally, we also conclude that when the business cycle is in an expansion (recession) stage, the optimal licensing contract is a two-part tariff (royalty rate).

The remaining structure of the paper is organized as follows. Section 2 shows the model set-up. Section 3 offers the model analysis. Section 4 discusses the relationship between the business cycle and the optimal licensing contract in an extension model. The conclusions are provided in section 5.

2. The Model

There are two firms in the model. One firm (Firm H) is in the home country and the other firm (Firm F) is in the foreign country. Both firms have homogeneous product and their products can be sold into each other's market. The two markets are segmented completely and the firms play Cournot competition. The two firms face the inverse demand function as follows:

\[ p = A - Q; \text{ and } p^* = A^* - Q^*, \]  

(1)
where $Q (Q^*)$, $p (p^*)$, and $A (A^*)$ are respectively the home (foreign) country market's demand, price, and the maximum willingness to pay in the home (foreign) country. We use the maximum willingness to pay to represent the market size (Gupta, 1999).

Although the demand functions in the home country and in the foreign country are linear and have the same slope, the intercepts of the two demand functions are different. The large intercept represents that the consumer is willing to pay a high price given the quantity, or that the consumer is willing to buy more quantities given the price. Because the two markets are completely segmented, the market with a large intercept has a high equilibrium price and quantity in free trade. Gupta (1999) uses the demand function with a large intercept term as the large market. In other words, we take the intercept term of the demand function to represent the market size.

Assume that the foreign market size ($A^*$) is larger than the home market size ($A$), Firm $F$ uses the new technology, and the unit production cost is normalized to 0. Firm $H$ uses the old technology, and the unit production cost is $c$, where $0 < c < A < A^*$. Because Firm $F$ transports a small number of goods to service the home country's small market, Firm $F$ has a high per unit transportation cost $t$, where $t > 0$. Since Firm $H$ transports a large number of goods to service the large foreign market, Firm $H$ has a low per unit transportation cost. For simplicity, Firm $H$'s per unit transport cost is normalized to 0. In other words, Firm $F$ (licensor) has a cost advantage in production cost and Firm $H$ (licensee) has a cost advantage in transportation cost in our model set-up.

This is a two-stage game. In the first stage, the licensor (Firm $F$) chooses the optimal licensing contract among a fixed-fee licensing contract ($K > 0$, $r = 0$), a royalty fee licensing contract ($K = 0$, $r > 0$), and a two-part tariff fee licensing contract ($K > 0$, $r > 0$). The licensee (Firm $H$) will accept the licensing contract if it is not worse off under accepting the licensing contract versus rejecting the licensing contract. In the second stage, the two firms engage in Cournot competition. We employ backward induction to solve the sub-game perfect Nash equilibrium in the game.

Firm $H$'s (Firm $F$'s) sales quantities in the home country market and foreign country market are $x^*(y^*)$, respectively. The two firms' profit functions are represented as follows:

$$\pi_H = (p - c)x + (p^* - c)x^*; \text{ and } \pi_F = (p - t)y + p^*y^*.$$ (2)
Under the pre-licensing case, both firms' equilibrium outputs and profits are:

\[ x_0 = \frac{A + t - 2c}{3}, \quad x_0^* = \frac{A^* - 2c}{3}, \quad y_0 = \frac{A - 2t + c}{3}, \quad \text{and} \quad y_0^* = \frac{A^* + c}{3}; \]
\[ \pi_{H0} = x_0^2 + x_0^{*2}, \quad \pi_{F0} = y_0^2 + y_0^{*2}. \]  

(3)

The subscript "0" represents the pre-licensing case. Assume that the two market's sizes are sufficiently large enough to induce \( x_0, x_0^*, y_0, \) and \( y_0^* \) to be larger than or equal to 0. In Equation (3) we find that it is advantageous to the licensee if the licensor's transport cost is high. Similarly, it is advantageous to the licensor if the licensee's per unit marginal production cost is high.

Assume that the licensor has a non-drastic cost-reducing innovation that lowers the licensee's marginal cost of production by an amount \( \varepsilon \). Thus, the marginal cost of Firm \( H \) is \( c - \varepsilon + r \) after accepting the licensing contract, where \( r \) is the per unit royalty fee and \( 0 \leq r \leq \varepsilon \). Under this scenario, the two firms' equilibrium outputs and profits are:

\[ x = \frac{A + t - 2(c - \varepsilon + r)}{3}, \quad x^* = \frac{A^* - 2(c - \varepsilon + r)}{3}, \]
\[ y = \frac{A - 2t + (c - \varepsilon + r)}{3}, \quad y^* = \frac{A^* + (c - \varepsilon + r)}{3}; \]
\[ \pi_H = x^2 + x^{*2}, \quad \pi_F = y^2 + y^{*2}. \]  

(4)

In Equation (4) we see that it is advantageous to the licensee if the innovation size is large and the licensee accepts the licensing contract. However, it may be disadvantageous to the licensor if the innovation size is large and the licensor licenses the new technology to its rival.

Now we go back to stage 1 and solve the optimal licensing contract. The optimization problem in this stage is:

\[ \max \limits_{r,K} \Pi_F = \pi_F + r(x + x^*) + K, \]  

(5-1)

subject to \( \pi_H - K \geq \pi_{H0} \)  

(5-2)

\[ x, x^*, y^2, y^{*2}, r, K \geq 0, \]  

(5-3)

where \( K \) is a fixed licensing fee. Equation (5-1) is the licensor's profit function which is composed of the profits from its own product selling and the licensing revenues from the licensee. Constraint (5-2) is the licensee's participation constraint. It implies that the licensee
prefers to accept the licensing contract rather than rejecting it. Constraint (5-3) represents that the licensor's and licensee's outputs must be non-negative and the licensor cannot accept negative payments from the licensees.

Firm $F$ chooses the optimal fixed fee as:

$$K \leq \pi_H - \pi_{H0}$$

$$= \frac{4(r-\varepsilon)}{9} [2(r-\varepsilon) + 4c - t - A - A^*]. \quad (6)$$

Here, $K$ allows constraint (5-2) to be binding. We substitute the above equation into Equation (5-1) and reduce it to:

$$\max_r \Pi_F = \pi_F + r(x + x^*) + (\pi_H - \pi_{H0})$$

$$= \{\left[\frac{A-2t+(c-\varepsilon+r)}{3}\right]^2 + \left[\frac{A^*+(c-\varepsilon+r)}{3}\right]^2\}$$

$$+ r\left(\frac{A+t-2(c-\varepsilon+r)}{3} + \frac{A^*-2(c-\varepsilon+r)}{3}\right)$$

$$+ \frac{4(r-\varepsilon)}{9} [2(r-\varepsilon) + 4c - t - A - A^*]. \quad (7)$$

By maximizing the above equation with respect to $r$, we obtain the optimal per unit royalty fee from the first-order condition as follows:

$$\hat{r} = \frac{A + A^* - 5t}{4} + 2(c - \varepsilon). \quad (8)$$

Since the second-order condition is less than 0, parameter $\hat{r}$ is an interior solution, i.e., $\hat{r} \in (0, \varepsilon)$ with $t \in (\tilde{t}, \overline{t})$, where $\tilde{t} = (A + A^* + 8c - 12\varepsilon)/5$ and $\overline{t} = (A + A^* + 8c - 8\varepsilon)/5$.

We substitute Equation (8) into Equation (6) and obtain the optimal fixed-fee as follows:

$$\hat{K} = \frac{1}{18} (A + 7t - 16c + 12\varepsilon + A^*)(-A + 5t - 8c + 12\varepsilon - A^*). \quad (9)$$

### 3. Model Analysis

There are two issues discussed in this subsection. First, we locate three licensing contracts in a figure and then discuss the optimal licensing regime based on a combination of $t$ and $c$. Second, we discuss the licensor's optimal licensing behavior when the market size changes.

#### 3.1 Total Market Size and the Optimal Licensing Contract
Based on the licensee's participation constraint in Section 2, when the licensor provides a licensing contract \((\hat{r}, \hat{K})\), the licensee will accept this licensing contract. According to Equations (8) and (9), since parameter \(\hat{r}\) is an interior solution, it is impossible for the licensor, as an inside innovator, to use the fixed-fee licensing contract \((\hat{r} = 0\) and \(\hat{K} > 0\)). This result has been issued in Wang (1998, 2002). He concludes that when the patent holder is also a producer in the product market, it will not choose the fixed-fee licensing contract. However, our result is different from the findings in Fosfuri and Roca (2004). In their paper the licensor, as an insider innovator, adopts a two-part tariff licensing contract. The optimal royalty rate is a corner solution in their model. Hence, in this study the optimal licensing contract for the licensor will be either the royalty licensing contract or the two-part tariff licensing contract.

We know that \(t \in (t, \tilde{t})\) will induce \(\hat{r} \in (0, \varepsilon)\). Substituting \(t\) and \(\tilde{t}\) into Equation (9), we find that \(\hat{K}(t) = 0\) and \(\hat{K}(\tilde{t}) > 0\). Next, we use Table 1 to illustrate the condition that the parameter \(t\) makes \(\hat{K} \geq 0\). In Table 1 we see when the transportation cost of the foreign firm (patent holder) is low, and it prefers the royalty licensing contract. On the contrary, the patent holder adopts the two-part tariff licensing contract when its transportation cost is high. However, when the transportation cost of the patent holder is intermediate, its optimal licensing contract is either the royalty licensing contract or the two-part tariff licensing contract, depending on total market size \((A + A^*)\). In other words, when total market size is (not) large enough, the optimal licensing contract is the two-part tariff (royalty) licensing contract, because the patent holder can extract all benefits from the licensee by using two-part tariff licensing contract when the total market size is large enough. If the total market size is not large enough, then the patent holder can maintain a competition advantage by using the royalty licensing contract. Hence, we have the first proposition as follows.

**Proposition 1** When the total market size is large enough, the patent holder prefers to the two-part tariff licensing contract; on the contrary, the royalty licensing contract is adopted when the total market size is not large enough.

### 3.2 Innovation Size, Production Cost, Market Size, and the Optimal Licensing Contract

We have concluded that the patent holder adopts either the two-part tariff licensing contract or the royalty licensing contract. However, we are interested in how the innovation size affects the optimal licensing contract. By competitive static analysis, we obtain:
This implies that when the transportation cost is small, an increase in innovation size induces the optimal fixed-fee to decrease. Hence, the optimal licensing contract may be a royalty rate when the transportation cost is small and the innovation size is large. By contrast, if the unit transportation cost and the innovation size are large, then the optimal licensing is a two-part tariff licensing contract. Since a high transportation cost will weaken the patent holder's competitiveness, it has to adopt the two-part tariff licensing contract to abstract the profit from the licensee.

We next discuss how the unit production cost affects the optimal licensing contract. Similarly, we obtain the competitive static analysis result as follows:

\[
\frac{d\hat{r}}{dc} = 2 > 0, \text{ and } \quad \frac{d\hat{K}}{dc} = \frac{4}{9} (A + A^* - 17t + 32c - 4\varepsilon) > (\leq 0), \text{ if } t > (\leq 0) \frac{A + A^* + 32c - 4\varepsilon}{7}.
\]

The equations above show that when the unit transportation cost is large, an increase in the unit production cost induces \( \hat{K} \) to decrease. Moreover, \( \hat{r} \) and the unit production cost have a positive relationship. Hence, it implies that when the patent holder's unit transportation cost and the rival's unit production cost are large, the patent holder prefers the royalty licensing contract.

This result above is different from the findings by Mukherjee (2007). Mukherjee (2007) concludes that the optimal licensing contract is an up-front fixed fee, if the licensee's marginal production cost and the licensor's per unit transport cost are sufficiently high. The economic intuition of our result is since unit transportation cost and unit production cost are large, competition between the two firms is furious. At this time, the patent holder adopts the royalty licensing contract to increase the rival's marginal production cost so as to weaken the two firms' competitive degree and to increase its licensing revenue.

Finally, we examine how the home country market size and the foreign country market size affect the optimal licensing contract. The competitive static analysis results are as follows:

\[
\frac{d\hat{r}}{dA} = \frac{d\hat{r}}{dA^*} = \frac{1}{4} > 0, \text{ and } \quad \frac{d\hat{K}}{dA} = \frac{d\hat{K}}{dA^*} = -\frac{1}{9} (A + A^* + t - 4\varepsilon) > (\leq 0), \text{ if } t > (\leq 0) -A - A^* + 4c.
\]
The two equations show the influences of the home country market size and the foreign country market size on the optimal royalty rate and the optimal fixed-fee are the same. Because the licensor sells its product in the home and foreign countries, these two markets are thus equally important to the licensor.

We also find that when the licensor's unit transportation cost is large, an increase in the market size decreases the optimal fixed-fee. The optimal royalty rate and the market size have a positive relationship no matter what the unit transportation cost is. This result implies that when the unit transportation cost and the market size are large, the royalty licensing contract may be a best choice. In contrast, if the unit transportation cost is small and the market size is large, then the licensor will choose the two-part tariff licensing contract. The economic intuition is that a large unit transportation cost is a disadvantage for the licensor. Hence, when the market size increases, the licensor uses the royalty rate to increase the rival's marginal production cost so as to decrease the two firms' competitive degree.

If we consider the unit transportation cost size, then we conclude the relationship between the market size and the optimal licensing contract as follows:

**Proposition 2** Given a large unit transportation cost, when the market size is large enough (no matter for the home country market size or foreign country market size), the optimal licensing contract is a royalty rate.

### 4. Business Cycle and Optimal Licensing Contract

This subsection extends our model to study the relationship between the optimal licensing contract and the business cycle. The linear demand function is employed to catch the situation of the global business cycle as follows:

\[ p = A - Q + \theta; \quad \text{and} \quad p^* = A^* - Q^* + \theta, \]

where \( \theta \in (\theta, \overline{\theta}) \) and \( \theta < 0 < \overline{\theta} \). When \( \theta = \overline{\theta} (\theta) \), it represents business expansion (recession). Equation (13-1) can be rearranged as follows:

\[ p = A_B - Q; \quad \text{and} \quad p^* = A_B^* - Q^*, \]

where \( A_B = A + \theta \) and \( A_B^* = A^* + \theta \). Substituting \( A_B \) and \( A_B^* \) into \( A \) and \( A^* \) respectively in Table 1 and we have Table 2.
When the global business cycle is in an expansion stage, i.e., $\theta = \bar{\theta} > 0$, it is easy for the inequalities in the third column in Table 2 to be correct. Hence, if the business cycle reaches a peak, i.e., a large $\theta$, then the optimal licensing contract for the licensor is a two-part tariff licensing contract. It implies that a prosperous business induces the licensee's selling profit to increase. Hence, the licensor uses the fixed-fee licensing contract to extract the licensee's excess profit. The licensor also wants to increase its profit by weakening the two firms' competition, and hence the licensor uses the royalty licensing contract to increase the rival's marginal production cost. Thus, the two-part licensing contract is the best licensing method when the business cycle reaches a prosperous stage.

When the global business cycle is in a recession stage, i.e., $\theta = \bar{\theta} < 0$, it is hard to let the equal sign of the inequalities in the third column in Table 2 to be correct. At this time, the optimal fixed-fee is equal to 0. In other words, the optimal licensing contract for the licensor is the royalty licensing contract when the business cycle comes to a trough. This result tells us that if the licensee has much excess profit, then the licensor can use the fixed-fee licensing contract to extract the licensee's own excess profit. However, when the licensee does not have much excess profit, the licensor can increase profit by using the royalty rate to increase the rival's marginal production cost and weaken the two firms' competitive degree. In this section we have the next proportion as follows.

**Proposition 3** When the business cycle is in an expansion stage, the optimal licensing contract for the licensor is a two-part tariff contract; however, when the business cycle is in a recession stage, the royalty licensing contract is the best choice for the licensor.

**5. Concluding Remarks**

Kyoto Protocol allows developing countries to obtain technology transfer from developed countries under the framework of Clean Development Mechanism. Although South Africa is an ideal country to implement CDM projects, it lags behind many other countries in the number of CDM projects. According to the statistic data from United Nations in August 2006, South Africa only implements 12 CDM projects in a total of 996 CDM projects (United Nations Environment Programme, 2006). The contemporary press with an article title “SA tardy in signing up for carbon credits” by Njobeni (2006) also points out this lack. Since South Africa implements limited CDM projects, this result prohibits South Africa to obtain technology transfer. The purpose of this paper is to study what licensing mode facilitates technology
transfer when the market size is considered.

International technology licensing has become a very important business for many firms. Based on the survey of Sauers and Argersinger (2006), the international technology licensing revenue of United States firms has significantly increased from 1975 to 2005. In the real world, the licensor is always a firm in a developed country with a large market size, and the licensee is always a firm in a developing country with a small market size. Thus, the aim of this paper is to study the relationship between market size and the licensor's optimal licensing contract under an open economy. We also extend our model to discuss the relationship between the optimal licensing contract and the business cycle.

The main conclusions of this paper are as follows: (i) When total demand market size is large enough, the licensor's optimal licensing contract is a two-part tariff licensing contract. On the contrary, if total market size is small, then the licensor's optimal licensing contract will shrink to the royalty licensing contract. (ii) Given a licensor with a large transportation cost, if the market size is large enough, then the licensor prefers the royalty licensing contract. Hence, the licensor's transportation cost affects the licensor's optimal licensing strategy. (iii) Finally, we extend our model to discuss the relationship between the optimal licensing contract and the business cycle. We conclude that the licensor prefers to adopt the two-part tariff (royalty) licensing contract when the business cycle is in an expansion (a recession) stage.

This paper has provided some viewpoints on a firm's licensing behavior in an open economy. For a simplified analysis, we do not discuss the government's international trade policy. A testable direction in the future is to add the home government's international trade policy for the home firm to obtain a technology transfer.

Endnotes

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References


### Table 1. The Optimal Licensing Contract

<table>
<thead>
<tr>
<th>$t \in (t, \tilde{t})$</th>
<th>Fixed-fee</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t = \frac{A + A^* + 8c - 12\varepsilon}{5}$</td>
<td>$\hat{K}(t) = 0$</td>
<td>no</td>
</tr>
<tr>
<td>$t = \frac{A + A^* + 8c - 11\varepsilon}{5}$</td>
<td>$\hat{K} \geq 0$</td>
<td>$A + A^* \geq 2c + \frac{17}{12} \varepsilon$</td>
</tr>
<tr>
<td>$t = \frac{A + A^* + 8c - 10\varepsilon}{5}$</td>
<td>$\hat{K} \geq 0$</td>
<td>$A + A^* \geq 2c + \frac{5}{6} \varepsilon$</td>
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<tr>
<td>$t = \frac{A + A^* + 8c - 9\varepsilon}{5}$</td>
<td>$\hat{K} \geq 0$</td>
<td>$A + A^* \geq 2c + \frac{1}{4} \varepsilon$</td>
</tr>
<tr>
<td>$\tilde{t} = \frac{A + A^* + 8c - 8\varepsilon}{5}$</td>
<td>$\hat{K}(t) &gt; 0$</td>
<td>no</td>
</tr>
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</table>

### Table 2. The Optimal Licensing Contract under the Consideration of a Business Cycle

<table>
<thead>
<tr>
<th>$t \in (t, \tilde{t})$</th>
<th>Fixed-fee</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t = \frac{A_B + A_B^* + 8c - 12\varepsilon}{5}$</td>
<td>$\hat{K}(t) = 0$</td>
<td>no</td>
</tr>
<tr>
<td>$t = \frac{A_B + A_B^* + 8c - 11\varepsilon}{5}$</td>
<td>$\hat{K} \geq 0$</td>
<td>$A_B + A_B^* \geq 2c + \frac{17}{12} \varepsilon$</td>
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<td>$t = \frac{A_B + A_B^* + 8c - 10\varepsilon}{5}$</td>
<td>$\hat{K} \geq 0$</td>
<td>$A_B + A_B^* \geq 2c + \frac{5}{6} \varepsilon$</td>
</tr>
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<td>$t = \frac{A_B + A_B^* + 8c - 9\varepsilon}{5}$</td>
<td>$\hat{K} \geq 0$</td>
<td>$A_B + A_B^* \geq 2c + \frac{1}{4} \varepsilon$</td>
</tr>
<tr>
<td>$\tilde{t} = \frac{A_B + A_B^* + 8c - 8\varepsilon}{5}$</td>
<td>$\hat{K}(t) &gt; 0$</td>
<td>no</td>
</tr>
</tbody>
</table>