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FIRM ENTRY DETERRENCE BEHAVIOUR IN THE CEMENT INDUSTRY IN CAMBODIA

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ABSTRACT

The study empirically analyzes whether the existing firm in the cement industry in Cambodia exhibits entry deterrence behaviour and also whether this threat is credible. Basic game theory and pure strategy Nash equilibrium were deployed in analyzing the behaviour of both firms. The framework in this study considered the payoff between two firms which act in different ways. The new firm is considered as 'entrant' and the other firm already established in Cambodia as 'incumbent'. The study modeled the cost function to consist of fixed setup cost, constant cost per unit of capacity and constant average variable cost in estimating the total cost of production. The price of cement was estimated using the inverse demand function. The total revenue is estimated as the product of the price and the total supply of cement on the market. The payoff is the revenue less the total cost of production of each firm. The unique Nash equilibrium of the game, is, "No new investment, No new investment" in both the short and long run by both firms. The study concludes that the threat of the incumbent in the cement market in Cambodia to deter the entrant is not credible.

Keywords: Firm deterrent behaviour, Foreign direct investment, Cement industry, Nash equilibrium, Game theory.

Contribution/ Originality

This study contributes to the existing literature on strategic entry deterrence behaviour in the cement industry using game theory analysis.

1. INTRODUCTION

There is only one cement production plant in Cambodia, which has been operating since 2007 with installed capacity of 1 million metric tons per year. Cement demand in Cambodia increased to

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3.3 million tons in 2012, and with the establishment of the ASEAN Economic Community (AEC) in 2015, it is expected to increase to 3.5 million tons and reach 4.5 million tons over the 2020. Since the year 2001, Thailand had continuously been exporting Portland cement to Cambodia with 20.5% accumulated growth between the years 2003 to 2012. The cement industry is capital intensive; its market characteristic is oligopoly both in Thailand and Cambodia. Thailand has over installed capacity of cement production with the availability of a huge raw material resource. Thailand has been a major exporter of cement to Cambodia since 1990. Cement demand in Thailand is also expected to increase when AEC is opened and as a result Thai's firms have reduced their export volume. If Thai's exporters consider investing new green filed cement plant project in Cambodia, it will take at least 2 years before their products will be ready for sale in the Cambodia market. Since Thai firms are major players in Cambodia cement market, they have options to choose to produce cement in Thai and then export to Cambodia or invest the new plant in Cambodia.

Production in the cement industry is considered as economies of scale (Norman, 1979) and such characteristic implies that cement production firms could have asymmetric cost depending on their size. Since cement is a capital intensive industry, a larger firm may have lower average cost. From the survey of cement industry in Thailand by The Federal of Thai Industries (FTI) there are 10 cement firms and the largest 3 of those firms have a market share of over 85 % in the domestic market, which could be said to be an oligopoly market. In Cambodia, there is one cement production firm and few cement importers which could also be said to be an oligopoly. With oligopoly behaviour, members have incentives to cheat and this creates a demand for strategies that members could pursue that might discourage cheating and increase profits on the average. Fujiwara (2009) conducted a study on asymmetric oligopoly by revisiting the classical topic of gain from trade in a differential game model of oligopoly. The study Fujiwara (2009) shows how the difference in the number of firms and costs of home and foreign firms, affects gainfulness of trade.

Under perfect competition, firms can make super-normal profits and as a result, attract new entrants into the market. The entry could take many forms some of which include; a takeover from outside the industry, the widening of a product range from a firm outside a specific market, transfer of brand names from one sector of the economy to another, increasing competition from overseas among others. Neo-classical economists have argued that perfect competition would produce the best possible outcomes for consumers. A scenario where an existing firm in a market embarks on an action that seem to prevent potential entrants from entering into competition in the market is referred to as strategic entry deterrence Salop (1979). Analyzed strategic entry deterrence in two classes of entry barrier; an innocent entry and strategic entry barriers and found that before the entrant makes his entry decision, the establish firm has already committed resources which is explained by the "move first advantage".

Until the year 2006, cement in Cambodia was completely imported. During the years, 1993 to 2007, imported cement from Thailand was between 74% and 95% of total consumption and 74% and 99% of total imported cement. The first domestic cement factory was started late in 2007 which reduced the proportion of imported cement to between 74.5% and 82% of total consumption between the years 2008 and 2012. Imported price per ton of cement from Thailand are mostly

lower when compare to other sources. Especially since 2003 there has been a big gap of price difference (36%) between the price of imported cement from Thailand and other countries. Because Thailand is Cambodia's neighbouring country, there are a lot of reasons to explain why high proportion of imported cement is from Thailand. Thailand could have comparative advantage in supplying cement compared to other neighbouring countries such as Laos and Vietnam or other countries such as China, Indonesia and the Philippines.

Total cement production capacity in Thailand is in excess of supply when compare to domestic demand and so Thai's manufacturers can export cement to Cambodia market. More so the Cambodia market price is much higher than imported price from Thailand (for example, 2010 prices: Cambodia market price was 56.02 USD per ton and imported price was 41.25 USD per ton). This renders Thai cement more competitive on the Cambodia market due to the price difference. This serves as incentive for foreign firms to enter the cement industry in Cambodia. While horizontal FDI involves the location of production near a firm's large customer bases, vertical FDI is mainly driven by production cost differences between countries. In terms of horizontal FDI, trade and transport costs play a much more important role than production cost differences. Since the sale of cement in Cambodia earns higher profit amidst other benefits (export and transportation cost) firms are attracted to the cement industry in Cambodia. The only established cement production plant (firm) in Cambodia is expected to exhibit entry deterrence behaviour in order to avoid competition. Theory on strategic entry deterrence is well established in theoretical literature (Wilson, 1992) and this theory predicts that when an existing business in a particular market is under threat due to competition, the existing business may take actions that discourages potential entrants from entering into competition in that market. This study therefore tries to empirically analyze whether the existing firm in Cambodia will exhibit entry deterrence behaviour or not with respect to the new entrant in the cement industry in Cambodia and whether this threat is credible. In addition to providing empirical evidence of strategic entry deterrence, this study complements and extends the literature on strategic entry deterrence in the cement industry using game theory analysis.

2. LITERATURE

Gilbert and Vives (1986) posits that despite the non-cooperative behaviour among incumbent firms, no evidence of underinvestment is found in entry prevention. According to Gilbert and Vives (1986) the opposite result sometimes occurs where the incumbents prevent entry even though their profits would have been higher if entry were allowed. It is believed that preventing investment earns revenues and this confers direct benefits on any firm that invests to exclude rivals. A study by Waldman (1987) found that for certain types of entry deterring investments the introduction of uncertainty causes the oligopoly to underinvest in entry deterrence; however, for other types no underinvestment arises. In another study, Calzada and Valletti (2008) developed a model of logit demand that extends the traditional duopoly framework of network competition to a multi-firm industry. Calzada and Valletti (2008) posit that incumbents establish the reciprocal access charge inefficiently below cost when they compete in prices but they behave efficiently if they compete in utilities. They also posit that incumbents may accommodate all possible

entrants, only a group of them, or may completely deter entry but when entry deterrence is the preferred option, incumbents distort the access charge upwards. Dixit (1980) discussed the role of investment in entry deterrence, where the prospective entrant is assumed to believe that the established firm would maintain the same output after entry as its actual pre-entry output. Dixit (1980) explained that the role of an irreversible commitment of investment by firms in entry-deterrence is the alteration of the initial conditions of the post-entry game to the advantage of the established firm. Investment by the incumbent firm helps deter entry by changing the initial conditions.

3. FRAMEWORK AND METHODOLOGY

Basic game theory and pure strategy Nash equilibrium is deployed in analyzing the behaviour of both firms in this study. The framework in this study will consider payoff between two firms which act in different way. One of the firms, the new firm is considered as 'entrant' and the other firm which is already established in Cambodia is considered 'incumbent'. There is asymmetric cost of cement production in Thailand and Cambodia which is due to unequal factor price of inputs but the cost structure (proportion of variable and fix cost) are assumed to be the same in both countries. There is also the assumption that all cement plants have three identical input factors which consist of Thermal Energy, Electrical Energy and Raw material and these firms use the Cobb-Douglas production function technology. Using the observed panel data from a cement company, the Cobb Douglas production function was estimated using the OLS and the result show that the firm exhibits constant return to scale. The modeling of cost function in this study takes leads from Dixit (1980) who modeled cost function consisting of fixed set up cost, constant cost per unit of capacity and constant average variable cost of output. It is also assumed the two firms have the same cost function. Schwartz and Thompson (1986) use similar form of cost function and also assumed all firms have same cost function, to explain why successful, large-scale entry by firm with no informational advantage is extremely rare.

The cement market is oligopolistic, and assuming there are two firms, the "incumbent" will decide whether to increase its production capacity by investing in new production plant and the "entrant" who has over production capacity will decide whether to utilize its full capacity (in the home country) to supply for both the domestic and foreign (export) market or invest in new plant in Cambodia. For the entrant firm, even if it has over production capacity, it will pay some re-investment cost when it decides to utilize its full capacity. Cost function is used to estimate the marginal cost using the production data of the entrant firm. Since cement production is engineering base, the cost factors used can be calculated from technical specification hence this study has an assumption that marginal cost function of the entrant can also be used for the incumbent, with the difference being only the factor price. Finally, cement product are assumed homogeneous in both countries and consumers have identical utility. Pure strategy and complete information game is applied in this study and all pay offs are determined using the profits in the short term and long term (15 years). Cement price and consumption in each year will be estimated by forecasting using an inverse demand function and all prices converted to 2005 base year.

3.1. Cost Function

Cost function consists of investment cost, variable cost and fixed cost as presented in equation (1)

$$TCi = Ii + \mathrm{V}Ci + Fi \quad , \quad = (1= \text{Entrant}, 2 = \text{Incumbent}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where investment cost (Ii) is different for each firm since it depends on the designed plant capacity and source of machines manufacture. The variable cost is determined by marginal cost multiplied by the quantity produced ($\mathrm{V}Ci = MCiqi$). The Fixed cost (F) is calculated as a proportion of total production cost using data from firms' income statement. To estimate the cost function, the investment cost, variable cost and the fixed cost are estimated separately using various methods as described below. Since cement is an energy intensive industry, three factors deployed in the production function include; Thermal Energy ($\mathrm{XT}i$), Electrical Energy (XE) and Raw Material (X). From the framework described above on the variable cost, labour cost is excluded but it is added to the fixed cost. Notations used in the model are described as follows in table 1.

Table-1. Meaning of notation used in the model

Notations used	Meaning of notation
qi	Quantity of cement , Thai (export) and Cambodia (produce)
Q	Total cement demand in Cambodia
P	Cement Price in Cambodia
XT,i	Thermal Energy (Gcal) used in cement production
XE,i	Electrical Energy (kWh) used in cement production
XR,i	Raw Material (ton) used in cement production
wT,i	Price of Thermal Energy
wE,i	Price of Electrical Energy
wR,i	Price of Raw Material
α	Proportion of Thermal Energy used in production function
β	Proportion of Electrical Energy used in production function
γ	Proportion of Raw Material used in production function
Ii	Investment cost for new cement production
Fi	Fixed cost of cement's firm

3.2. Investment Cost

Investment cost in new cement plant is obtained from public announcement by the cement firms at beginning of 2012. Incumbent announced to invest in a new plant in Cambodia with annual capacity of 1.0 million ton at an investment cost of 177 million USD. The entrant also announced to invest in a new plant in Cambodia with annual capacity of 1.2 million ton at an investment cost of 250 million USD. Since both incumbent and entrant are original Thai firms, an investment decision will be made from Thai's perspective so Thai Consumer Price Index (CPI) is used in cost conversion from nominal to real prices using the same year 2005 price. Using Thai's CPI in 2005 (121.9) and in 2012 (147.1), the incumbent investment cost is converted to 167.6 million USD (Y 2005 price) and entrant investment cost is converted to 236.7 million USD (Y 2005 price). The entrant has options of either choosing to produce using existing plant in Thailand and export to Cambodia by rejecting new plant investment project. In this case $I_i = 0$ or invest in Cambodia and augment its total supply from plant in Thailand.

3.3. Variable Cost Function

Profits of an incumbent firm increase with investment up to the limit where output is constant with marginal costs, if entry is prevented (Gilbert and Vives, 1986). To obtain the marginal cost, we optimize the variable cost function subject to three factors Cobb- Douglas production function with constant return to scale as follows;

Firm minimizing problem of Variable cost

Min $VC_i(w_{T,i}, w_{E.i}, w_{R.i}, X_{T.i}, X_{E,i}, X_{R,i}) = w_{T,i}X_{T,i} + w_{E,i}X_{E,i} + w_{R,i}X_{R,i}$

Subject to $\ln q_i = \alpha \ln X_{T,i} + \beta \ln X_{E,i} + \gamma \ln X_{R,i}$

By first order condition

$$X_{T,i}^{*} = [q_i \cdot (\frac{\alpha}{\beta} \cdot \frac{w_{E,i}}{w_{T,i}})^{\beta} \cdot (\frac{\alpha}{\gamma} \cdot \frac{w_{R,i}}{w_{T,i}})^{\gamma}]^{\frac{1}{(\alpha+\beta+\gamma)}} \quad \text{..... (2)}$$

$$X_{E,i}^{*} = [q_i \cdot (\frac{\beta}{\alpha} \cdot \frac{w_{T,i}}{w_{E,i}})^{\alpha} \cdot (\frac{\beta}{\gamma} \cdot \frac{w_{R,i}}{w_{E,i}})^{\gamma}]^{\frac{1}{(\alpha+\beta+\gamma)}} \quad \text{..... (3)}$$

$$X_{R,i}^{*} = [q_i \cdot (\frac{\gamma}{\alpha} \cdot \frac{w_{T,i}}{w_{R,i}})^{\alpha} \cdot (\frac{\gamma}{\beta} \cdot \frac{w_{E,i}}{w_{R,i}})^{\beta}]^{\frac{1}{(\alpha+\beta+\gamma)}} \quad \text{..... (4)}$$

Substitute $\boldsymbol{X_{T,i}^{*}}$ $\boldsymbol{X_{E,i}^{*}}$ and $\boldsymbol{X_{R,i}^{*}}$ from equation (2), (3), and (4) into the variable cost function we get the cost function in form of quantity produced and input factor price vector

Assuming constant return to scale of production function it is expected that, $\alpha + \beta + \gamma = 1$

Then variable cost function become

$$VC_i(q_i, w_{T,i}, w_{E,i}, w_{r,i}) = q_i \cdot \Big[{w_{T,i}}^{\alpha} \cdot \left(\frac{\alpha}{\beta} \cdot w_{E,i}\right)^{\beta} \cdot \left(\frac{\alpha}{\gamma} \cdot w_{R,i}\right)^{\gamma} + {w_{E,i}}^{\beta} \cdot \left(\frac{\beta}{\alpha} \cdot w_{T,i}\right)^{\alpha} \cdot \left(\frac{\beta}{\gamma} \cdot w_{R,i}\right)^{\gamma} + \left(\frac{\gamma}{\alpha} \cdot w_{T,i}\right)^{\alpha} \cdot \left(\frac{\gamma}{\beta} \cdot w_{E,i}\right)^{\beta} \Big] \quad \text{..... (5)}$$

Therefore marginal cost function $MC_i(w_{T,i}, w_{E,i}, w_{r,i}) = \frac{\partial VC_i(q_i, w_{T,i}, w_{E,i}, w_{R,i})}{\partial q_i} =$

$$= {w_{T,i}}^{\alpha} \cdot \left(\frac{\alpha}{\beta} \cdot w_{E,i}\right)^{\beta} \cdot \left(\frac{\alpha}{\gamma} \cdot w_{R,i}\right)^{\gamma} +$$

$$ {w_{E,i}}^{\beta} \cdot \left(\frac{\beta}{\alpha} \cdot w_{T,i}\right)^{\alpha} \cdot \left(\frac{\beta}{\gamma} \cdot w_{R,i}\right)^{\gamma} + {w_{R,i}}^{\gamma} \cdot \left(\frac{\gamma}{\alpha} \cdot w_{T,i}\right)^{\alpha} \cdot \left(\frac{\gamma}{\beta} \cdot w_{E,i}\right)^{\beta} \quad \text{..... (6)}$$

Therefore the variable cost function VCi = $MCiqi$).

Assuming Cobb – Douglas production function with constant return to scale;

$q_i = {X_{T,i}}^{\alpha} \cdot {X_{E,i}}^{\beta} \cdot {X_{R,i}}^{\gamma}$. The parameters; $\alpha, \beta \; and \; \gamma$ are estimated by transforming the function to log-linear form as follows; $\ln q_i = \alpha \ln X_{T,i} + \beta \ln X_{E,i} + \gamma \ln X_{R,i}$ and using OLS for the estimation. Using these parameters, the variable cost of production can then be estimated.

3.4. Fixed Cost

The fixed cost is calculated as a proportion of total production cost (variable cost + fixed cost) using data from firms' income statement. The data shows that the proportion of the entrant's total production cost in Thailand due to variable cost is 0.69 and that due to fixed cost is 0.31. In the case of the incumbent, proportion of the total production cost due to variable cost is 0.87 and that due to fixed cost is 0.13. The information shows that the incumbent and the entrant are asymmetric in terms of cost structure. This could be attributed to the differences in the factor prices as presented in table 2.

$$\text{The total production } (PC_i) = \frac{\tau_i PC_i}{1-\delta_i} = \frac{VC_i}{1-\delta_i}$$

Where τ and δ represent the proportion of the total production cost due to variable cost and fixed cost respectively and $\tau + \delta = 1$. After estimating the total production cost, the fixed cost can then be calculated ($Fixed\ cost_i = \delta_i PC_i$).

3.5. Input Factor Price

The input factor prices; $w_{T,TH}$, $w_{T,CA}$, $w_{E,TH}$, $w_{E,CA}$, $w_{R,TH}$, $w_{R,CA}$ are surveyed from a Thai's cement firm and data available from public sources (Den, 2004; Electricity Authority of Cambodia, 2012; Ruangrong, 2012; Electricity Generating Authority of Thailand (EGAT), 2012; 2013). The notation TH represent price in Thailand and CA represent price in Cambodia). Unit price of each factor (table 2) is calculated with its specific consumption used in cement production and then converted to price per ton of cement produced.

Table-2. Input factor prices

Year price	Thermal (USD / Gcal)		Electrical (USD / kWh)		Raw Mat (USD / ton)	
	$W_{T,TH}$	$W_{T,CA}$	$W_{E,TH}$	$W_{E,CA}$	$W_{R,TH}$	$W_{R,CA}$
Y2012 Price	16.25	18.66	8.05	11.83	0.98	2.29
Y2005 Price	15.39	17.70	7.63	11.20	0.93	2.18

Source: Data from public sources as cited in text

3.6. Estimation of Cement Price Using the Demand Function

Deploying the inverse demand function; $P(Q) = a + bQ$ with data from cement produced in Cambodia and trade data from United Nation Commodity Trade (UN comtrade), the parameters a, b are estimated using OLS. Average cement price is calculated using Y2005 price.

3.7. Estimation of the Marginal Cost (MC)

The OLS estimates of the transform log-linear model; $\ln q_i = \alpha \ln X_{T,i} + \beta \ln X_{E,i} + \gamma \ln X_{R,i}$ is shown below;

$$LQCEM = 0.7585914 \cdot LTHER + 0.2037212 \cdot LELEC + 0.0481847 \cdot LRMAT \quad \text{..... (7)}$$

(17.80)* (5.05)* (3.24)*

$R^2 = 0.9749$; F-statistic = 1385.53 (0.000); * significant at 95% level

The estimates of the inverse demand function $P(Q) = a + bQ$ in Cambodia cement market is also shown below;

Regression result $P = 75.57103 - 0.00000588 \cdot Q$ ..... (8)

(11.48)* (0.096)**

R^2 = 0.4561, F-statistic = 19.31 (0.000) * significant at 95% level, ** significant at 90% level

Deploying the factor prices in table 2 and the parameters estimates (α , β and γ) from the regressed equation into the marginal cost function in equation (6), the marginal cost (MC) with Thai factor prices is estimated to be 23.42 USD per ton cement and with Cambodia factor prices; 29.42 USD per ton cement (all are year 2005 price). It is worth noting that marginal cost equals average variable cost at the minimum of average variable cost. Converting to Thai Baht using year 2005 currency exchange rate (40.26), it is realized that MC with Thai factor price equal to 942.8 Baht per ton and this is close to actual variable cost reported in the Cement firm annual income statement. Therefore the marginal cost function in equation (6) could be said to be accurately estimated.

3.8. Trade and Investment Choice of Entrant Firm in Cambodia Cement Market

To analyze deterrent firm behaviour in trade and investment of cement in Cambodia, 15 years as a time frame for total payoff was set in the long run because investment in cement plant require some time before positive return on investment can be achieved. This study calculates the long run payoffs from the year 2015 to 2029 (15 years). This study also looked the deterrent firm behaviour in trade and investment of cement in the short run. The forecasted cement consumption in Cambodia will reach 3.5 million metric tons in year 2015 and then increase to its maximum (4.5 million) metric tons in year 2020 and assumed to be constant afterwards. Cement price in each year will be estimated using the inverse demand equation with all prices converted to year 2005 basis. The cost function $TC_i = I_i + MC_i q_i + F_i$, i = (1= Entrant, 2 = Incumbent), was used to estimate the total cost. The investment cost (I_i) of the incumbent is 167.6 million USD (Y 2005 price) and for the entrant is 236.7 million USD (Y 2005 price). Because of asymmetric factor prices between Thailand and Cambodia as shown in table 6, it depends on where firms choose to produce. The incumbent can use only $w_{T,CA}$, $w_{E,CA}$, $w_{R,CA}$ because it has only a choice to produce in Cambodia, while the entrant can use $w_{T,CA}$, $w_{E,CA}$, $w_{R,CA}$ if it invest new plant in Cambodia or use $w_{T,TH}$, $w_{E,TH}$, $w_{R,TH}$ if it decide to produce in Thailand and rescind decision to invest in Cambodia.

3.9. Game Theory and Payoff

Basic game theory is applied in this study. The incumbent has choice to invest in new plant to increase its capacity in order to protect its market or 'Stay' at current capacity. The entrant has choice to enter by investing in a new plant in Cambodia together with import from Thailand or refuse investment in Cambodia and import its product from Thailand. Since the incumbent capacity is currently 1.0 million metric ton per year and new investment will yield 1 metric ton per year, it will not be enough to meet the cement demand even if it produces at full capacity. Hence the incumbent will produce in full capacity in both choices to serve the market. The growing

demand of cement as forecasted in Cambodia requires strategic investment in the cement industry in Cambodia since strategic investment has been found to be crucial to market outcomes when demand is growing (Chicu, 2012). The entrant will consider either to produce in Cambodia or import cement from Thailand by considering the rest of the demand in the market. However, the entrant has one important constraint about maximum export volume which is not more than 1.0 million metric ton per year because it also needs to serve Thai market. The estimation of the payoffs of both the entrant and incumbent is shown in table 3 and table 4 respectively.

In the short run, only the variable cost is considered in the analysis. The maximum the entrant is permitted by law to export from Thailand is 1,000,000 and the current maximum production of the incumbent is also 1,000,000. Taken into consideration the maximum import from Thailand and maximum production in Cambodia, the total supply is 2,000,000 bags of cement. If the entrant invests in Cambodia and produces at its maximum capacity of 1,200,000 and the incumbent increases its production through new investment in Cambodia at its maximum capacity 1,000,000, then together with the importation from Thailand, there will be increase in supply of cement (4,200,000) on the market and the price of cement will be 50.88 USD per ton.

Table-3. The estimation of the payoffs of the entrant

	Entrant			
Investment behaviour	**New Investment**	**No new investment**	**New Investment**	**No new investment**
Produce in Cambodia	1200000		1200000	
Import from Thailand	1000000	1000000	1000000	1000000
Total entrant supply	2200000	1000000	2200000	1000000
Total quantity of supply by both the incumbent and entrant	4,200,000	3,000,000	3,200,000	2,000,000
Price	50.88	57.93	56.76	63.81
Marginal cost in Thailand	23.74	23.74	23.74	23.74
Marginal cost in Cambodia	29.42	29.42	29.42	29.42
Cost of cement produced in Thailand	23,740,000.00	23,740,000.00	23,740,000.00	23,740,000.00
Cost of cement produced in Cambodia	35,304,000.00	0.00	35,304,000.00	0.00
Total variable cost of the entrant	59,044,000.00	23,740,000.00	59,044,000.00	23,740,000.00
Investment Cost in Cambodia (USD)	236,700,000.00	0.00	236,700,000.00	0.00
Fixed cost of investment in Cambodia (USD)	5,275,310.34	0.00	5,275,310.34	0.00
Total cost of the entrant	301,019,310.34	23,740,000.00	301,019,310.34	23,740,000.00
Total revenue	111,925,066.00	57,931,030.00	124,861,066.00	63,811,030.00
Short run pay off	52,881,066.00	34,191,030.00	65,817,066.00	40,071,030.00
Long run Pay off	-189,094,244.34	34,191,030.00	-176,158,244.34	40,071,030.00

Source: Data analyzed

If the entrant invests but the incumbent does not increase investment, the total market supply will be 3,200,000 and the unit price will be 56.76 USD.

Table-4. The estimation of the payoffs of the incumbent

	Incumbent			
Investment behaviour	**New Investment**	**No new investment**	**New Investment**	**No new investment**
Produce in Cambodia	1000000	1000000	1000000	1000000
Produce in Cambodia (New investment)	1000000	1000000		
Total incumbent supply	2000000	2000000	1000000	1000000
Total quantity of supply by both the incumbent and entrant	4,200,000	3,000,000	3,200,000	2,000,000
Price	50.88	57.93	56.76	63.81
Marginal cost in Cambodia	29.42	29.42	29.42	29.42
Cost of cement produced in Cambodia (old investment)	29,420,000.00	29,420,000.00	29,420,000.00	29,420,000.00
Cost of cement produced in Cambodia (New investment)	29,420,000.00	29,420,000.00	0.00	0.00
Total variable cost of the entrant	58,840,000.00	58,840,000.00	29,420,000.00	29,420,000.00
Investment Cost in Cambodia (USD)	167,600,000.00	167,600,000.00	0.00	0.00
Fixed cost of investment in Cambodia (USD)	4,396,091.95	4,396,091.95	0.00	0.00
Total cost	230,836,091.95	230,836,091.95	29,420,000.00	29,420,000.00
Total revenue	101,750,060.00	115,862,060.00	56,755,030.00	63,811,030.00
Short run pay off	42,910,060.00	57,022,060.00	27,335,030.00	34,391,030.00
Long run pay off	-129,086,031.95	-114,974,031.95	27,335,030.00	34,391,030.00

Source: Data analyzed

Now if the entrant does not invest in Cambodia but the incumbent does increase investment, the total market supply will be 3,000,000 with unit price of 57.93 USD. Finally if both firms do not invest, the total supply will be 2,000,000 and the unit price will be 63.81.

Total variable cost of the entrant using the marginal cost in Thailand (23.74 USD) and in Cambodia (29.42 USD) is 59,044,000 USD if entrant invest and 23,740,000 USD if entrant does not invest. Similarly the total variable cost of the incumbent is 58,840,000 USD if there is new investment and 29,420,000 USD if there is no new investment.

The total revenue is the product of the price and the total supply of each firm on the market. The payoff is the revenue less the total cost of variable cost of each firm and it is presented in payoff matrix in table 5.

Payoff of each strategy, $\pi_i = Revenue_i - VC_i$

i = (1= Entrant, 2 = Incumbent)

The pure strategy Nash equilibrium for each player *i* is $\pi_i(\sigma_i^*, \sigma_{-i}^*) \geq \pi_i(\sigma_i, \sigma_{-i}^*)$

Using the elimination of dominated strategy method, it is easy to get the unique Nash equilibrium of the game, that is, "(No new investment, No new investment)" which is also Pareto optimal solution.

Table-5. Payoff matrix in the short run

Payoff (million USD)		**Incumbent (2)**			
		New investment		**No new investment**	
Entrant (1)	New investment	52,881,066	42,910,060	65,817,066	27,335,030
	No new investment	34,191,030	57,022,060	40.071.030	34,391,030

In the long run, the total capacity of the incumbent plus the capacity of the entrant together with import from Thailand cannot cover all market demand from year 2019 onwards. This indicate that there is still small volume (0.1 – 0.3 million metric ton) for other players other than these two firms to cater for in the market. In such a case the rest of the volume is too small when compare with total demand, but then the rest of the volume become larger if one or both the incumbent and the entrant choose to stay at current position by rejecting new investment project. The payoff of the action of each firm in the long run is the profit obtained by subtracting the total cost (TC_i) from the Revenue for the period (15 years). In estimating the total cost the fixed and investment costs of the new investment is considered in addition to the variable cost of their current production and the new investment. Payoff matrix in million USD along 15 years is shown in table 6. Such payoff metric will further be used to find the best strategy firms shall choose. Using the elimination of dominated strategy method, it is easy to get the unique Nash equilibrium point of the game, that is, "No new investment, No new investment" which is also Pareto optimal solution just as the unique Nash equilibrium in the short run.

Payoff of each strategy, $\pi_i = \sum_{y=2015}^{2019}(Revenue_y - TC_y)$.

i = (1= Entrant, 2 = Incumbent)

The pure strategy Nash equilibrium for each player *i* is $\pi_i(\sigma_i^*, \sigma_{-i}^*) \geq \pi_i(\sigma_i, \sigma_{-i}^*)$

The unique Nash equilibrium point of the game shows that the entrant chooses not to invest in Cambodia but to stay at current situation by only importing cement from Thailand and reject new

Table-6. Payoff matrix in the long run

Payoff (million USD)		Incumbent (2)	
		New investment	No new investment
Entrant (1)	New investment	$(-1.89 \times 10^{08}, -1.91 \times 10^{08})$	$(-1.76 \times 10^{08}, 2.73 \times 10^{07})$
	No new investment	$(3.42 \times 10^{07}, -1.77 \times 10^{08})$	$(4.01 \times 10^{07}, 3.44 \times 10^{07})$

investment project and the incumbent also chooses not to invest in any new project but to stay at current production level.

3.10. Entry Deterrence in the Cement Market in Cambodia

An incumbent firm would like to prevent any entry into the market by the entrant and so would act strategically to accomplish this. The incumbent firm can threaten the entrant by increasing its current production in the short run leading to reduction of price on the market which would deter the entrant from entering. Chicu (2012) posits that the primary cause of the cement industry's excess capacity is the incentive to deter. In the case of the cement market in Cambodia, since the unique Nash equilibrium point of the game, is, "No new investment, No new investment" which is also Pareto optimal solution, the threat of the incumbent to deter the entrant is not credible. The findings is consistent with the evidence by Johnson and Parkman (1983) which suggest that entry has not been significantly deterred in the cement industry since preemptive plant proliferation do not contribute to higher rates of returns. The Nash equilibrium point of the game suggest that both firms stand to gain both in the short and long run if none of the firms engage in any new investment by agreeing to play the game according to Nash rules.

4. CONCLUSION

The study empirically analyzes whether the existing firm in the cement industry in Cambodia exhibits entry deterrence behaviour. The study also seeks to find out whether the threat of exhibiting any entry deterrence behavior is credible. Basic game theory and pure strategy Nash equilibrium were deployed in analyzing the behaviour of both firms. The finding shows that the unique Nash equilibrium of both the incumbent and entrant firms is not to establish new investment. Therefore the threat by the incumbent to deter the entrant is not credible and so the incumbent firm is better off not embarking on new investment. Since vertical foreign direct investment is mainly driven by the differences in production cost between countries, the entrant is also not motivated to invest in Cambodia due to high production cost. Further to this, Salop (1979) posits that before the entrant makes his entry decision, the incumbent has already committed resources which is explained as "move first advantage". Therefore the entrant firm is better off producing in Thailand and exporting to Cambodia than to establish a new investment in Cambodia.

Though the exact strategies of both firms are not known, (business confidential) any entry deterrence behaviour by the incumbent may not be credible with respect to the finding of the study. However, economies of scale (building extra capacity) may result in lowering the cost of

production of the incumbent, due to size, output, or scale of operation. This will generally decrease cost per unit of output and increase scale and therefore decrease the cost of fighting the entrant. The incumbent may take advantage of its economies of scale which it is likely to enjoy from any new investment to increase its capacity and this may affect the payoff. Uncertainty in demand and risk of investment as well as other factors that may influence cost such as the future logistic cost of the entrant importing cement from Thailand, volatility of input factor prices and possible change in proportion of fixed costs were not taken into consideration in this paper but believe could have an effect on the strategy of the firms. These are the limitations of this study.

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