CHAPTER 2

LITERATURE REVIEW AND RESEARCH METHODOLOGY

Exchange rates play a crucial role in economic activities since it does not only determine prices and returns internationally, but it is also an economic variable to stabilize external and internal balances. Consequently, exchange rates draw an attention from many researchers to deal with its implications on the real economy. The main issues are addressed in several aspects such as exchange rates and the firm's prices, those related to the firm's performances (the value of the firm), and those examined the relationship between exchange rate movements and the investment decision. In this section, we will discuss about literatures concerned, theoretical framework, and research methodology used in the study. We firstly begin with the presentation of literature discussing the implication of exchange rate on goods price, and on investment, respectively. The theoretical framework is developed in the second section. The last section demonstrates the research methodology of the study.

2.1 Literature review

2.1.1 Exchange rate and the price of goods

As exchange rates measure the price of one currency in terms of another, the change in exchange rates results in the change in price level. This change in price has influence on trade, consumption, and investment inevitably. Various prices such as export price, import price, producer price, and consumer price, are tested for the impact of exchange rates on prices. Two of the most distinguished literatures describing the relationship between exchange rates and prices are "Exchange rate Pass-Through" (ERPT), which referred to the response of local currency import prices to exchange rate changes, and "Pricing to market" (PTM), which referred to the price discrimination across export markets. (see, for examples, Donbusch (1987), Gagnon and Knetter (1995), Menon (1995), Goldberg and Knetter (1997), Adolfson (1999)).

ERPT is the percentage changes in local currency import prices resulting from a one percentage change in the exchange rates between the exporting and importing countries. The more the exchange rates can pass its effect through prices, the greater the prices are sensitive to exchange rate changes. ERPT is said to be complete if a one percentage change in exchange rates causes a one percentage change in import prices. If a one percentage change in exchange rates causes less or more than one percentage change in import prices, we would call an incomplete or partial pass through.

Krugman (1987) was first mentioned to pricing to market literature (PTM). If exporters have some market power and markets are segmented, an exchange rate change may induce price discrimination across each market destination. This means that exporters can set different prices, in the exporters' currency, in different destinations, and there is a destination specific markup adjustment that absorbs part of exchange rate changes. Consider a firm that sells output in i separate destination markets. Firm's profits are given by:

$$\Pi(p_{1,\ldots,}p_n) = \sum_{i=1}^{n} p_i q_i (E_i p_i) - C\left(\sum_{i=1}^{n} q_i (E_i p_i), w\right) \qquad (2.1)$$

where p is the price in the exporter's currency, q is the quantity demand (a function of the price in the buyer's currency, Ep), and $C(q, w)$ is the cost function where w denotes input prices. The first order condition of profit maximization implies that firm equates the marginal revenue in each market to the common marginal cost. Alternatively, the export price to each destination is the product of the common marginal cost and a destination-specific markup:

$$p_i = C_q (1 - 1/|\eta_i|)^{-1} \qquad (2.2)$$

C_q is the marginal cost while η_i is the price elasticity of demand in each market.

A degree of an incomplete pass-through is an inverted degree of pricing to market. For example, 60 percent pass-through to local currency price implies a 40 percent markup adjustment to offset exchange rate changes. In other word, PTM is the degree of markup adjustment designed to stabilize the price measured in the buyer's currency. Furthermore, PTM could depend on a combination of market power and nominal price rigidities. An appreciation of the exporter's currency will increase the foreign export price. In order to stabilize the price (in terms of foreign export price) and limit the deteriorated competitiveness, the exporters have to reduce their profit margin: the markup. One explanation of PTM is that because of the slow adjustment of demand, the current price will affect the customer's stock and firm's revenues; it is worth to have a stable short-run price and secure market shares.

The price discrimination documented by PTM studies implies the existence of market power. The higher degree of PTM the more firm can adjust markup price to stabilize export currency price (to maintain market share and competitiveness), and this implies the more market power that firms have.

The set of pass-through elasticity is a country-specific phenomenon, and depending on the pricing strategy of each producer. For Thailand, Chitpokasem (2007) examined the pass-through of exchange rates on consumer price. He found that the change in exchange rate for 1 percent leads to the change in consumer price for 0.18 percent. The rates of pass-through in developing countries are found to be small, that is between 0.10-0.40. In contrast, for developed countries, the pass-through rate is relatively high and nearly to one.

Chantasakda (2008) investigated the relationship of exchange rate in terms of THB/USD and export US dollar price. He found that exchange rate has limited impact on the adjustment in export price. The degree of pass-through differs across industries; export industries with larger share in total's world export are likely to have higher pass-through. The result also confirms the view that for a small country like Thailand, export price tends to be stable in foreign currency, implying that markup has to vary when exchange rate fluctuates.

Integration of ERPT and PTM has shed light on how exchange rates affect goods prices. This connects the dot of exchange rates and firm's decision to investment. Once there is a change in exchange rate, it will have the effect on price (it could be a pass-through on foreign export price or local currency import price). The adjustment on goods price leads to an increase or a decrease in a firm's profit through revenue and cost sides. The investment would be modified via the process of changes in profit since the greater is the expected profit, the investment would be more stimulated. However, the sensitiveness in price brings difficulty for producers to maintain the market share. Thus, firms with high markup price, interpreted as firms with high pricing power, will absorb much of the effect of exchange rates changes in their markups in order to stabilize buyer's currency price to secure their shares. By doing so, their sales, profits and investments will not be too sensitive to exchange rates. On the contrary, firms with low markup price have less power to adjust their markups in responsive to exchange rate changes. A high percent of exchange rate pass-through causes prices to be sensitive and fluctuated following exchange rates changes. Therefore, the effect of exchange rate changes on firm's investment is much more sensitive.

2.1.2 Exchange rate and investment activities

The study about the impact of exchange rates and investment can be divided into two groups. The first group is considered the impact of exchange rate volatility on investment. The second group is studied on the level of exchange rate and investment.

Regarding the impact of exchange rate volatility on investment, it is vague to believe that exchange rate volatility suppresses the investment activity, or actually stimulates the investment level. Dixit and Pindyck (1994) developed the model about investment under uncertainty in which investment project have two important characteristics. First, investment expenditure is irreversible. Second, investment project can be delayed if the firm takes an opportunity to wait for new information to arrive about prices, costs, and other market conditions. Darby, Hallett, Ireland, and Piscitelli (1999) extended the Dixit and Pindyck model by examining the exchange rate uncertainty of investment. The results from their theoretical model suggested that it is not possible to say that suppressing exchange rate volatility will automatically increase investment. There are situations where that will happen and situations where it will not. The empirical results, however, suggest that exchange rate volatility can have an important negative impact on investment, but this is estimated to be smaller than the usual cost of capital or expected earnings effects. Furthermore, Serven (2003) using GARCH method measures of exchange rate uncertainty, found that real exchange rate uncertainty has a highly negative significant impact on investment using evidence from the developing countries. He also found that the investment effect of real exchange rate uncertainty was shaped by the degree of trade openness and financial development: high openness and weaker financial systems are associated with a more significantly negative uncertainty-investment link.

Theoretical work by Baum, Caglayan, and Barkoulas (2001) analyzed the impact of the permanent and transitory components of exchange rate uncertainty on firm's profit. They suggested that it is difficult to identify the effect of volatility of exchange rate on growth in profits. There is a clear result that a rise in volatility of the permanent component will boost profit volatility while a rise in temporary volatility will dampen it. Therefore, they have highlighted the potential importance of separating permanent from transitory volatility in assessing the real impact of uncertainty. Furthermore, Bryne and Davis (2003) investigated the impact on business investment at a macroeconomic level of permanent versus transitory components of exchange rate uncertainty using GARCH model and Pooled Mean Group approach to panel estimation. The key result is that for a poolable subsample of EU countries, it is the transitory and not the permanent component which adversely affects investment. This result can imply that to the extent that EMU favors lower transitory exchange rate volatility, it will also be beneficial to investment.

Moreover, Leelapornchai (2008) found weak relationship between exchange rate volatility and private investment in Thailand. After leaving fixed exchange rate regime, exchange rates had little contribution to private investment. The fluctuation in exchange rates brings about the negative impact on investment, but the coefficients only lie between 0.002-0.006.

Regarding the impact of level of exchange rate on investment, Agenor (2001) said that exchange rate have either positive or negative impact on the investment project. The negative effect occurs when a depreciation raises domestic prices which further lowers income and wealth of private sector. The fall in domestic demand could induce firms to revise their expected future demand and postpone investment plans. In addition, exchange rate depreciation could also increase the real cost of imported capital goods, the rising in capital cost leads firms to decrease their investment spending. However, the depreciation raises the price of traded goods relative to the price of home goods, thereby investment in tradable sector is likely to be stimulated.

Jongwanich and Kohpaiboon (2008), for example, found that a 1 percent depreciation of real exchange rate leads to an increase in Thailand’s private investment in the long run by 5 percent. In this case, the positive impact of the depreciation on tradable sector overcomes the negative impact that might appear in the nontradable sector. This reflects the nature of export-led growth economy in Thailand; that is, depreciation would bring benefit to export sector and stimulate investment. Although exchange rate has some implications on investment level, its effect is less important than other factors e.g. output growth, lagged investment, credit availability. In this study, output growth changes would have long run effect on investment at 26 percent.

Literature mentioned above mainly described the impact of exchange rates on the overall country’s investment. Aside from this, there are some literatures involving in the impact of exchange rate movements on investment that are specific to the manufacturing sector. However, the results from various empirical works are complicated; there are some studies that imply a negative impact, although zero or even positive results of exchange rate changes through the investment.

Mentioned to literature of exchange rate movements and its impact on manufacturing investment, the analysis can be divided into the industry-level, and the firm-level analysis. Most of these studies focused on the two main factors which are the external exposure and the price-cost markup to be the factor that causes the different response of investment through exchange rates.

The study of exchange rates and investment believes that exchange rates affect investment through its impact on the desired capital stock. This is because exchange rates changes influence the expected future profitability in a given industry (firm). The net balance of revenue and cost side jointly determined whether the depreciation would hurt or stimulate the desired capital stock and investment. The origin of studying the effects of exchange rates on manufacturing investment is from the contribution of Campa and Goldberg (1995). They showed that the implications of exchange rate movements for investment strongly depend on the form of external exposure of the producers, which is the more the exposure to imported inputs, the more domestic currency depreciation depressed domestic investment. On the contrary, the higher the export share of the industry, the more domestic currency depreciation stimulated investment. For instance, a 10 percent US dollar appreciation from the 1970s until 1983, implied a decrease in pooled sample of US manufacturing about 0.5 percent. However, due to an increase in average reliance on imported input, the overall investment would have declined by only 0.1 percent. Therefore the change in net exposure overtime leads to the variety effects on investment.

Furthermore, the impact of exchange rates on investment is highlighted on industry's structure of price-cost markup, based on the explanation of pricing to market and pass-through framework. The high markup industries have more potential to adjust their markup in order to absorb the effect of exchange rate movements than in low markup industries. The effect of exchange rates on investment in high markup industries is less effective.

Campa and Goldberg (1999) extended their earlier work to a comparative study of manufacturing investment responses to exchange rates in four countries: US, Japan, UK, and Canada. This study has provided the strong investment model that is useful to other researches, including this study, afterwards. The finding appears to reinforce the existing one; that is, the impact of exchange rates on investment varies over time, positively in relation to sectoral reliance on export share, and negatively to the share of imported input. In addition, low markup industries are significantly more responsive to exchange rates. However, the country-specific induces the difference in magnitude of the effects. The investments in UK and Canada are less responsive than those in US and Japan.

Similar to Campa and Goldberg (1995, 1999) in spirit, but Nucci and Pozzolo (2001), Swift (2006), and Caglayan and Torres (2008) provided a bit different along the way of the empirical model and the estimation technique. Nucci and Pozzolo (2001)'s finding of firm-level data in Italian manufacturing are consistent with the traditional view as in Campa and Goldberg (1995, 1999) that a depreciation has a positive effect on investment through the export revenue channel, and a negative effect through the cost channel. To the extent of market power, the effect of exchange rates on investment is stronger for firm with low markup price. Moreover, they provided evidence that the impact of exchange rates on investment is distinct on a small firm, and on firm with high degree of import penetration in the domestic market. Swift (2006) also confirmed the same result of the traditional framework. He investigated the impact of exchange rate on Australian manufacturing at industry level, and found a 10 percent appreciation of Australian dollar caused an average 8 percent decrease in investment through export channel, and an average 3.8 percent increase through imported input channel.

For the case of Canadian manufacturing, Harchaoui, Tarkhani and Yuen (2005) found that the overall effect of exchange rates on total investment is statistically insignificant, consistent with the previous work investigating the impact of exchange rates on investment in Canada case of Campa and Golgberg (1999). Without controlling the exchange rate variability, there is no evidence that investment is affected by exchange rate movements. They, hence, take into account of exchange rate variability by testing the effect between high and low exchange rate variability environment. The key finding is when the exchange rate volatility is below the average, depreciations tend to have a positive impact on investment.

The literature mentioned above is the panel analysis. Apart from this, Blecker (2006) did time-series analysis, focusing on the overall impact of exchange rates on aggregate profits and investment in the US manufacturing sector as a whole, not the different effects among different branches of industries as in previous works. They claimed that Campa and Goldberg (1995,1999) omitted one of the most important elements of industry external exposure: the share of imports of finished goods (as opposed to imported inputs) in total domestic demand. The omission of import competition in domestic markets seems likely to produce underestimates of the negative impact of the dollar’s value on investment. Moreover, Campa and Goldberg’s method of interacting trade weights with exchange rate changes may have had the unintended effect of overemphasizing cross-sectional differences in the trade weights relative to time-series changes in the value of the dollar, particularly since the exchange rate was differenced but the weights were measured in levels. Blecker’s estimates show that the negative effects of the dollar are significant only when the exchange rate is measured in level, not differences.

What distinguishes Blecker’s work from others’ is that he estimated investment function that includes profit variable in the equation, and separately estimated profit function as they intended to capture the indirect effect of exchange rates on investment via profit. As exchange rates affect actual profits, then they can either tighten or loosen financial (liquidity) constraint on investment spending. He cited that previous studies of exchange rates and investment may have suffered from omitted variable bias since none of them included profits and exchange rates in the same model. Accordingly, he found robust evidence for strongly negative effects of the real value of the dollar on total investment in US manufacturing. Nevertheless, if markups and form of external exposure are factor determining the difference of firms' adjustment across industries, this work cannot clarify this point since there have no explanation about these determinants in the context.

However, in this study, we investigate the impact of exchange rates on manufacturing investment in Thailand by using the traditional framework of Campa and Goldberg (1995, 1999), but our study is based on the firm-level analysis, not the industry-level like the original one. Since there is no study using this framework to investigate the effect of exchange rates on firm's investment in Thailand, this study takes an opportunity as the first step to examine the relationship of exchange rates on investment at micro-level. However, we concentrate only on the impact of level of exchange rate changes, not the effect of exchange rate volatility. The change in level of exchange rate is easier perceived by investors, and investors would have a quick response to the level change in exchange rate. Moreover, the movement in exchange rates during the period of study is quite stable; it might not be worth studying the impact of exchange rate variability on investment during that period.

2.2 Theoretical model

We consider a model of investment with adjustment costs that replicated from Campa and Goldberg (1999). For concreteness, the adjustment costs are assumed to be internal. A firm produces output for the domestic (x) and foreign (x^*) market with two types of inputs[1]: quasi-fixed capital (K) and variable input (L, L^*).

[1] Variable input is referred to a factor that has no adjustment costs while quasi-fixed factor means a factor which has an increasing marginal adjustment costs.

Let a firm choose investment (I) to maximize the expected present value of the stream of future profit (V). Capital is subject to a traditional capital accumulation of installing new capital.

$$V_t(K_t, e_t) = \max_{\{I_\tau\}_{\tau=1}^{\infty}} E\left\{\sum_{\tau=0}^{\infty} \beta^{\tau} \left(\Pi(K_{t+\tau}, e_t) - C\left(I_{t+\tau}\right) - I_{t+\tau}\right)\right\} \quad (2.3)$$

Subject to

$$K_t = (1-\delta)K_{t-1} + I_t \quad (2.4)$$

where Π is the profit function gross of investment costs, that is the total revenue from the domestic and foreign markets net of the total variable cost. $C(I)$ is the capital adjustment cost, and I_t is the investment expenditure at time t. The discount factor is $\beta = (1+r)^{-1}$, with r being the firm's nominal required rate of return, which is assumed to be constant over time. E_t is the expectation operator conditional on all the information available at time t. The exchange rate, e_t, is defined as the domestic currency per unit of foreign exchange. The capital stock K_t is governed by the standard accumulation where δ is the depreciation rate of capital.

The timing of the model is as follow: The firm observes the exchange rate at the beginning of the period. After observing the exchange rate, the firm chooses its variable inputs and output level for the period and observes the period's profits. Given profits in this period and expected future profits, the firm chooses its investment level. The new capital resulting from this investment becomes productive at the beginning of the next period, i.e., under the assumption of a one period time to build lag.

Maximizing the value of the firm in Eq. (2.3) subject to the constraint of Eq. (2.4) yields the optimal investment path.

$$\sum_{\tau=0}^{\infty} \left(\beta(1-\delta)\right)^{\tau} E_t\left(\frac{\partial \Pi_{t+\tau}}{\partial K_{t+\tau}}\right) = 1 + \frac{\partial C(I_t)}{\partial I_t} \quad (2.5)$$

The expected per-period marginal benefits of investing an additional unit of capital are $E_t(\frac{\partial \Pi}{\partial K})$. According to the optimal condition (2.5), the firm will invest up to the point where the present value of expected future marginal benefits of investment is equal to the marginal cost of investment.

Suppose that the cost of adjustment function has the following quadratic form:

$$C(I_t) = \frac{\gamma}{2}\left(I_t - \mu\right)^2 \tag{2.6}$$

where γ and μ are parameters. The first-order condition Eq. (2.5) becomes

$$\sum_{\tau=0}^{\infty}\left(\beta(1-\delta)\right)^{\tau} E_t\left(\frac{\partial \Pi_{t+\tau}}{\partial K_{t+\tau}}\right) = \gamma I_t - \gamma\mu + 1$$

$$I_t = \mu' + \frac{1}{\gamma}\sum_{\tau=0}^{\infty}\left(\beta(1-\delta)\right)^{\tau} E_t\left(\frac{\partial \Pi_{t+\tau}}{\partial K_{t+\tau}}\right) \tag{2.7}$$

where $\mu' = \mu - \frac{1}{\gamma}$. Rewriting the equation, eq. (2.7) states a firm's investment is an increasing function of its expected marginal profitability of capital, $E_t\left(\frac{\partial \Pi_{t+\tau}}{\partial K_{t+\tau}}\right)$.

We now need to clarify this marginal profitability. Producers maximize their profits by observing the exchange rate (e_t) and make their choice of output sales in the foreign and domestic markets, and of domestic and foreign variable input used. Exchange rates can alter the relative unit labor costs and influence the prices of goods sold in domestic and foreign markets. We maximize profit gross of investment costs subject to the production function. K_t is a quasi-fixed factor of production, L_t and L_t^* are the quantities of domestic and foreign variable inputs. x_t and x_t^* are the quantities output by the firm to the domestic and foreign markets, w and w^* are the unit costs of the domestic and foreign inputs. $p(e)$ and $p^*(e)$ are the final price of goods sold in domestic and foreign markets respectively. The production function, $F(K, L, L^*)$, is the homogeneous of degree one implying a constant returns-to-scale production function. Note that price of goods sold in domestic and international market, and price of imported variable inputs are the function of exchange rates.

$$\prod(K_t, e_t) = \max\ p(x_{t,} e_t)x_t + e_t p^*(x_t^*, e_t)x_t^* - wL_t - e_t w^*(e_t)L_t^* \qquad (2.8)$$

subject to $\qquad X = x_t + x_t^* = F(K_t, L_t, L_t^*)$

Solving this maximization problem and differentiating the profit function with respect to capital yields an expression for the marginal profitability of capital (see appendix A):

$$\frac{\partial \prod_t}{\partial K_t} = \frac{2}{K_t}\left[\frac{p_t x_t}{MKUP_t} + \frac{e_t p_t^* x_t^*}{MKUP_t^*} - w_t L_t - e_t w_t^* L_t^*\right] \qquad (2.9)$$

where $\quad MKUP_t = \dfrac{1}{1-\dfrac{1}{|\eta_t|}} = p_t / MC_t$ and $MKUP_t^* = \dfrac{1}{1-\dfrac{1}{|\eta_t^*|}} = e_t p_t^* / MC_t$

We have known so far that investment today relies on the future marginal profitability of capital. In addition, we assume that exchange rates are the only one source of uncertainty and its changes are permanent changes. The expected future marginal profitability is all alike today's marginal profitability, $E_t\left(\dfrac{\partial \prod_{t+\tau}}{\partial K_{t+\tau}}\right) = \dfrac{\partial \prod_t}{\partial K_t}$.

Substituted equation (2.9) into investment function (2.7), we have equation (2.10)

$$I_t = \mu' + \frac{A}{K_t}\left[\frac{p_t x_t}{MKUP_t} + \frac{e_t p_t^* x_t^*}{MKUP_t^*} - w_t L_t - e_t w_t^* L_t^*\right] \qquad (2.10)$$

where $\qquad A = \dfrac{2}{\gamma\beta\left(r+\delta\right)}$

To see the effect of exchange rates on investment, we differentiate the investment function with respect to the exchange rate. We get this following equation (see appendix B).

$$\frac{\partial I_t}{\partial e_t} = \frac{A'}{AMKUP} \cdot \frac{1}{e_t} \left\{ (1 - X_t) \left(\varepsilon_{p,e} - \varepsilon_{MKUP,e} \right) + X_t \left(\varepsilon_{p^*,e} + 1 - \varepsilon_{MKUP^*,e} \right) - \alpha_t \left(1 + \varepsilon_{w*,e} \right) \right\}$$

(2.11)

where $A' = \frac{A \cdot TR_t}{K_t}$, $\varepsilon_{p,e}$ and $\varepsilon_{p^*,e}$ are exchange rate pass-through elasticities in domestic and foreign market, $\varepsilon_{mkup,e}$ and $\varepsilon_{mkup^*,e}$ are the markup elasticities with respect to exchange rate changes, whereas $\varepsilon_{w^*,e}$ are the elasticity of imported variable input cost with respect to the exchange rate movements. X_t represents the share of foreign sales to total revenues, therefore $(1 - X_t)$ is the share of domestic sales. α_t is the share of imported input to total costs. Besides, we assume that $MKUP_t = MKUP_t^* = AMKUP_t$ since we cannot observe dominant markups for sales in domestic and foreign markets.

Equation (2.11) provides the link of the effect of exchange rates on investment. For each firm, the investment response to exchange rates relies on these following three main channels.

Firstly, exchange rates can affect investment behavior through the profitability in domestic sales. Exchange rate depreciation increases the price of goods sold domestically. If the domestic demand is elastic, the increase in domestic prices, in response to increased prices on competing imported goods, lowers the real income and wealth of the consumers, therefore lowering their demands. For producers, this causes a reduction in quantity sold that reflects a fall in domestic revenue. A fall in domestic income and purchasing power of an investor could induce him to revise expected future profit, and is likely to postpone the investment project. However, the size of the effect relies on the share of domestic sales $(1 - X)$. The more is the share of domestic market oriented, the worse is the investment suppressed by a depreciation through domestic sales. In addition, the interaction between the (positive) domestic price elasticity with respect to exchange rates $(\varepsilon_{p,e})$, and the (positive) markup elasticity with respect to exchange rate $(\varepsilon_{MKUP,e})$ interplay to determine the effect of exchange rate movements on investment. A higher percentage of pass-through to domestic price means that domestic price is extremely reflected, this induces the greater sensitiveness to purchasing power, domestic sales, expected profits, and long-term investment. In contrast, a high percentage of the markup elasticity implying the markup will be more reactive with exchange rates. The effect of exchange rates on investment is absorbed in markup. Investment in firms with high percentage of pass-though and low value markup elasticity, usually seen in a low markup firm, would have less impact of exchange rates.

Secondly, exchange rates can affect investment behavior through the profitability in export sales. Depreciation could lower the prices of export goods (in terms of foreign export price) which yields an increase in volume and revenue of export only if foreign demand is elastic. If export is expanded, investment accordingly tends to be stimulated. However, this effect relies on the share of export sales, the interaction between the export price elasticity with respect to exchange rate variation $(\varepsilon_{p*,e})$ which is between minus one to zero, and the (positive) foreign markup elasticity with respect to exchange rate $(\varepsilon_{MKUP*,e})$. The greater is the share of export, the more will be the export revenues gain from a depreciation. Besides, the higher degree of ERPT $(\varepsilon_{p*,e})$ magnifies the effect of exchange rates on investment. Markup in low markup firms will be less reactive with exchange rates, it can be seen that low value of $\varepsilon_{MKUP^*,e}$ magnifies the effect of exchange rates on investment.

Thirdly, the marginal profitability of capital and investment are also affected by changes in total production costs with respect to exchange rates. Currency depreciation directly raises the imported input costs which lower marginal profitability and investment, if the imported demand is elastic. Besides, the impact of exchange rate variation depends on the share of imported input (α), and the (non-negative) exchange rate pass-through on foreign input price $\varepsilon_{w*,e}$. The latter parameter depends on different pricing policy of foreign suppliers. For instance, if foreign input suppliers apply a local-currency price stability, then $\varepsilon_{w*,e} = 0$, domestic currency depreciation has no influence on imported input cost. Under any other pricing strategy, such as $\varepsilon_{w^*,e} > 0$, there would certainly be an effect of a depreciation on imported input prices.

Notice that the term A multiplies the right-hand side of Eq. (2.11) scales the effect of exchange rate on investment, it is indicating that the interest rate (r), discount factor (β), capital stock adjustment cost (γ), and capital stock depreciation (δ) have an influence to determine the effect of investment on exchange rate. The overall response is smaller for industries with high costs of capital adjustment, high rates of capital stock depreciation, and high user costs of capital.

However, there are channels which exchange rates affect investment, but not captured in the model, for example, channel of price of imported investment (Harchaoui, Tarkhani, and Yeun, 2005). As long as part of investment is imported and the pass-through on the imported capital is greater than zero, a depreciation leads to an increase in the price of investment is likely to cause investment to contract as firm substitute the variable input for capital. Since our model could not capture all possible channels of exchange rate affecting on investment, there are some missing variables in the estimated model which may distort the result.

2.3 Research methodology

2.3.1 Model specification

In order to investigate how investment behavior responds to exchange rate changes as the first objective, the following model is firstly constructed based on the aforementioned theoretical framework. Equation (2.12) is set in order to disclose the effect through channel of exchange rate exposure.

$$I_t^i = (\beta_1 + \beta_2 x_{t-1} + \beta_3 \alpha_{t-1})\Delta e_t + \beta_4 \Delta S_{t-1}^i + \beta_5 r_{t-1}^i + \varepsilon_t^i \qquad (2.12)$$

where I_t^i is the investment at time t. x and α are export share and imported input share, respectively. Δe is exchange rate changes in term of THB/USD. ΔS is growth rate in sale, and r is the interest rate.

Exchange rates are permitted to influence investment with constant elasticity (through β_1) or can vary over time with industry external exposure: export and imported input channels through β_2 and β_3. We also add two more control variables that should take part in the estimated model to determine the investment level; these are growth rate of sale, and interest rate. Accelerationists believe that the desired capital stock (K^*) is proportional to output $(K_t^* = kY_t)$, investment demand for the simplest accelerator model can be shown to be proportional to the change in output: $I_t = kY_t - kY_{t-1} = k\Delta Y_t$. We will use growth rate of sale as a proxy of the change in output. Moreover, investment is determined by the interest rate. A decrease in interest rate lowers the cost of capital which raises the amount of profit from owning capital, therefore investment is stimulated.

Investment project is commonly under the assumption "the one-period time-to-build", the investment decision that appears at time t was made at time $t-1$ using the best forecast of expected future variables available at time $t-1$. Time lags occur when firm adjust its capital stock, we would call the decision-making lag and the delivery lag. If there is a change in demand, firm will wait and see whether that change is permanent. The decision-making lag appears at this process. The delivery lag, however, may be administrative lag of ordering the capital, or lag that firm takes time to raise finance to buy the capital. Therefore, the explanatory variables express the information at time t-1. The lagged values for the export and the imported input share have been used to avoid the possible correlation with the exchange rate (Nucci and Pozzolo (2001), Swift (2006)).

According to the theoretical framework aforementioned, we expect that the coefficient of exchange rate changes through β_1 shows a negative value since currency depreciation lower real income through the effect on domestic prices, the decline in domestic income could lead firms to revise their future demand and then delay the investment projects. The coefficient associated with $x_{t-1}\Delta e_t$ is positive; that is depreciation could raise export revenues, which increases with the share of export, hence investment is expanded. The coefficient associated with $\alpha_{t-1}\Delta e_t$ is expected to be negative. Depreciation increase the firm's cost which lowers firm's profitability and investment with the share of imported input in the production. Moreover, the coefficient of growth rate in sale should be positively related to a firm's investment. The greater is the growth in total sale, the more is investment expanded. Interest rates should have negative impact on firm's investment. An increase in interest rates restrains investment level.

Equation (2.12) shows the evidence of how exchange rates affect firms' investment through each firms' exposure channel. We also would like to empirically investigate the role of price-cost markup in determining the relationship between exchange rates and firms' investment. The whole sample is split into two groups: high markup and low markup firms. The threshold used to split the sample is the mean markup in total sample. We expect that the coefficients interacted with exchange rate changes of high markup firms will have less value than in the low markup firms.

The next step is to be comprised of the impact of exposure channel and price-cost markup in the same model. We will estimate this following equation.

$$I_t^i = \left(\frac{\beta_1}{AMKUP_{t-1}^i} + \frac{\beta_2 X_{t-1}^i}{AMKUP_{t-1}^i} + \frac{\beta_3 \alpha_{t-1}^i}{AMKUP_{t-1}^i}\right)\Delta e_t + \beta_4 S_{t-1}^i + \beta_5 r_{t-1}^i + \varepsilon_t^i \qquad (2.13)$$

where $AMKUP$ is an average markup of each firm, the lagged value of markup is used to avoid the bias induced by the correlation between markup and exchange rates (Nucci and Pozzolo, 2001).

Equation (2.13) is more closely related to the theoretical framework aforementioned, as in equation (2.11) where the components are pre-multiplied by a decreasing function of the markup. According to equation (2.11), we expanded all terms in the blankets, and then separately combining those that contain (1/AMKUP), (X/AMKUP), and (alpha/AMKUP). The elasticity terms are absorbed into the beta coefficients.

The coefficient interacting with the change in exchange rates, export share or imported input share, and markup reflects the transmission of exchange rates and the degree of market power. The coefficient β_1 is expected to be negatively related to investment; that is the effect of exchange rate depreciation on firm’s investment is negative and reduced by the degree of price-cost markup of the firm. The coefficient β_2 should have positive value. Exchange rates depreciation raises the firm’s revenue through export channel, and hence its investment. The effect varies from firms to firms. That is increasing with the export exposure, but decreasing with the degree of markup price. The estimated coefficient of β_3 is negative, suggesting that depreciation depresses investment through imported input channel. The larger reduction in investment is caused by the strong imported input share and the weak market power.

Focusing on equation (2.13), we will empirically investigate the relationship between exchange rates and firm’s investment across industry. Since each industry has specific characteristic, the effect of exchange rate on investment is expected to vary across industries. Moreover, at firm level, there are differences across type of firm. The classifications are emphasized on type of ownership, and size of firm.

Ownership is indicated by the share of capital held. Firm is classified as a foreign firm if it reports share of capital held by foreigners at least 30 percent of total capital, otherwise it is classified as a Thai firm. We expect that the effect of exchange rates on firm’s investment in foreign firms is greater than in Thai firms since foreign firms are likely to engaged more in international activities, for example, having higher export sales, holding high level of foreign assets. However, the effect of exchange rate on investment is influenced by pricing strategy of each producer. For instance, investment might not be affected much by exchange rates if the producer follows a strategy of buyer’s currency price stabilization on export sale.

Size of firms is measured by the number of worker. Firms with 500 employees or more are defined as large firms while firms with less than 500 employees are small firms. The effect of exchange rates on investment between firm’s sizes is ambiguous. On one hand, large firms tend to engage more international activities, and thereby more likely to be affected by exchange rate changes. On the other hand, large firms have more access to hedge against exchange rates, and having stronger financial position, so it is small firms that are likely to have more effect.

2.3.2 Data description

Our sample data are the panel data accounting for Thai firms in the manufacturing sector, which is covered by ISIC 15-37, for the period 2001-2005. The source of the data comes from the annual survey on Thailand's industries, by Ministry of Industry (MOI). This survey is useful since it reports some information that other survey, namely, The Industrial Census Survey of The National Statistical Office of Thailand (NSO) does not report. For example, the NSO does not report cost of imported input which is very important to this study.

The MOI survey contains about 4,000 responding firms each year. However, in order to obtain as much accurate and rationale result as possible, some filtration is operated.

First, in this study, we employ the balanced panel data in the sense that we focus only on the observations that report data in five consecutive years, observations less than five year are deleted from the sample set.

Second, we also eliminate firms that have zero or unreliable information. For instance, firms that report zero total sales, zero cost of raw material, zero inventories.

By doing so, we have 645 firms each year in the sample set. The selected sample set provides desirable information that is useful to our study.

The variables used in the estimated model are defined as of following.

- Investment at time t (I_t^i) is measured by the changes in net fixed assets in machinery and equipment at time t relative to the previous year's fixed asset in machinery and equipment.
- Export share (X_t^i) is defined as the total export sales over total sales.
- Imported input share (α_t^i) is the total cost of imported raw material over total production costs.

- Exchange rate (e_t) is measured in term of THB/USD, reference rate provided by the Bank of Thailand. A rise in exchange rate is a depreciation in baht currency.
- Sale growth (S_t^i) is measured by the change of total sales in year t relative to the total sale in previous year.
- Interest rate (r_t) is utilized by the rate of MLR provided by the Bank of Thailand.
- Markup price is actually the ratio of price over marginal cost, but we cannot observe marginal cost directly. We follow the construction of price-cost by Domowitz, Hubbard, and Petersen (1986, pp. 1-17)[2], that is

$$AMKUP = \frac{\text{value of sales} + \Delta\,\text{inventories}}{\text{Payroll} + \text{Cost of material}}$$

where value of sales is extracted from the total sales, Δ inventories is the inventories in the end year less inventories at the beginning of year. The inventories are composed of the inventories in raw material and energy, work-in-progress inventories, and finished goods inventories. Payroll is total compensation paid to total workers. And, the last component is the cost of materials. It consists of domestic and imported input raw material. Theoretically, the price-over-cost markups depend positively on the measure of concentration, and negatively on the elasticity of demand.

However, table 2.1 shows the statistical summary of variables in the studied model. Export share and imported input share lie between 0 and 1. The average of export share is 0.32 while the average imported input share is 0.18.

[2] Domowitz, Hubbard, and Petersen (1986) defined price-cost markup as price less marginal cost divided by price. They constructed PCM as:
PCM = (value of sales + changes in inventory – payroll – cost of material) / (value of sales + changes in inventory). However, price-cost markup in our study is defined as price over marginal cost, therefore markup in our study equals to 1-PCM. Value of sales plus changes in inventories is referred to the value of total output. Payroll and cost of material is referred to the variable cost. However, this construction of markup may underestimate due to the fact that firms report their inventories as the cost price unit.

Exchange rate approximately appreciates 2.15 during the period of study. Growth rate in sale is about 12 percent whereas the average interest rate is around 5.89 percent during 2001-2005.

Table 2.1

Statistical Summary of key variables

Variable	Mean	S.D.	Max	Min
Investment	0.12	0.92	-1.00	9.59
Export share	0.31	0.37	0	1
Imported input share	0.18	0.26	0	0.96
Markup	1.62	0.53	1.00	5.38
Exchange rate changes	-2.15	1.53	-3.43	-0.00
Sale rate	0.12	0.36	-0.82	7.08
Interest rate	5.89	0.20	5.63	6.10

Source: Author's calculation from the sample

Table 2.2 demonstrates correlations among independent variable in the model. There is no evidence of correlation between variables that are higher than 0.5. Therefore, it can be accepted that no multicollinearity problem exists in estimation.

Table 2.2

Correlations between independent variables

	Export share	Imported input share	Markup	Exchange rate changes	Sale rate	Interest rate
Export share	1.000					
Imported input share	0.291	1.000				
Markup	-0.049	-0.109	1.000			
Exchange rate changes	-0.009	-0.015	-0.008	1.000		
Sale rate	-0.036	0.018	0.085	-0.047	1.000	
Interest rate	0.008	0.004	0.005	0.093	-0.006	1.000

Source: Author's calculation from the sample

2.3.3 Econometric procedure

We analyze the responsiveness of investment to exchange rate changes by using firm-level pooled panel data. Not only panel data pools cross sections just to have larger sample sizes, the containing of both cross-sectional and time-series dimensions are useful to investigate the effect of time and individual idiosyncracies of each firm. The basic regression mode for panel data is of the form.

$$y_{it} = X_{it}^{'}\beta + z_i^{'}\alpha + \varepsilon_{it} \tag{2.14}$$

The individual effect is $z_i^{'}\alpha$ where z_i contains a constant term and individual specific variables.

However, in panel data model, the assumption that residuals are assumed to be normally distributed and homogeneous could easily be individual-specific (groupwise) heteroskedasticity or autocorrelation over time which further distort estimation. A condition known for groupwise heteroskedaicity is that the error process may be homoskedastic within cross-sectional units, but its variance differs across units. We can diagnose this problem by using a modified Waldtest statistic under the null hypothesis that $\sigma_i^2 = \sigma^2$ for all $i = 1,..., N_g$, where N_g is the number of cross-sectional units. In addition, the presence of serial correlation in panel model biases the standard errors and causes the result to be less efficient. We identify the problem by using Wooldridge's test for autocorrelation to test the null hypothesis that there is no serial correlation in the model specification.

The violation of spherical disturbances assumption turns the classical regression model into the generalized linear model, as in equation (2.15)

$$\begin{aligned} y_{it} &= \mathrm{X}_{it}^{'}\beta + \varepsilon_{it} \\ E\left[\varepsilon \middle| \mathrm{X}\right] &= 0 \\ E\left[\varepsilon\varepsilon^{'} \middle| \mathrm{X}\right] &= \sigma^2\Omega = \Sigma \end{aligned} \tag{2.15}$$

Under the generalized linear model, the ordinary least square estimator is no longer efficient. The generalized least square estimator becomes the efficient estimator of β, the GLS estimator is shown in equation (2.16). The difference between OLS and GLS estimator is that GLS estimator uses a weighting matrix Ω^{-1}, instead of I as in OLS estimator. Moreover, the GLS estimator is the minimum variance linear unbiased estimator in the generalized regression model.

$$\hat{\beta}_{GLS} = (\mathrm{X}'\Omega^{-1}\mathrm{X})^{-1}\mathrm{X}'\Omega^{-1}y \tag{2.16}$$

In order to employ GLS estimator in equation (2.16), Ω must be known. We assume that Ω involves a small set of parameter θ such that $\Omega = \Omega(\theta)$. Suppose that $\hat{\theta}$ is a consistent estimator of θ. To make GLS estimation feasible, we will use $\hat{\Omega} = \Omega(\hat{\theta})$. If $p\lim\hat{\theta} = \theta$, then using $\hat{\Omega}$ is asymptotically equivalent to using the true value of Ω. Therefore, the feasible generalized least squares (FGLS) denoted in equation (2.17) has the same asymptotic properties as the GLS estimator.

$$\hat{\hat{\beta}}_{FGLS} = (\mathrm{X}'\hat{\Omega}^{-1}\mathrm{X})^{-1}\mathrm{X}'\hat{\Omega}^{-1}y \tag{2.17}$$

If there exists heteroskadacticity in a model, $Var\left[\varepsilon_i \left| \mathrm{X} \right.\right] = \sigma_i^2 = \sigma^2 \omega_i$. Then Ω^{-1} is a diagonal matrix whose ith diagonal element is $1/\omega_i$. The GLS estimator can be called the weighted least squares (WLS) estimator as in equation (2.18), where $w_i = 1/\omega_i$.

$$\hat{\beta} = \left[\sum_{i=1}^{n} w_i \mathrm{X}_i \mathrm{X}_i^{'} \right]^{-1} \left[\sum_{i=1}^{n} w_i \mathrm{X}_i y_i \right] \qquad (2.18)$$

However, the weights are often denoted $w_i = 1/\sigma_i^2$, therefore the GLS estimator for the heteroskedasticity model is

$$\hat{\beta} = \left[\sum_{i=1}^{n} \left(\frac{1}{\sigma_i^2} \right) \mathrm{X}_i \mathrm{X}_i^{'} \right]^{-1} \left[\sum_{i=1}^{n} \left(\frac{1}{\sigma_i^2} \right) \mathrm{X}_i y_i \right]. \qquad (2.19)$$

This estimator is first estimating $\hat{\sigma}_i^2$ by using some function of the OLS residuals. We would obtain $\hat{\hat{\beta}}_{FGLS}$ by using (2.19) and $\hat{\sigma}_i^2$. The statistics computed using OLS residuals will have the same asymptotic properties as those computed using the true disturbances.

Furthermore, in many cross-sectional dataset, the variance for each of the panels differs. The difference variances across cross-sectional units is said to be the groupwise heteroskedasticity. In this case, the n observations are grouped into G groups, each with n_g observations. The condition for groupwise heteroskedasticity regression is shown in equation (2.20).

$$\begin{aligned} y_{it} &= \mathrm{X}_{it}^{'}\beta + \varepsilon_{it}, \qquad i = 1,...,n \\ E\left[\varepsilon_{it}\right] &= 0 \\ Var\left[\varepsilon_{ig}\right] &= \sigma_{ig}^2 \end{aligned} \qquad (2.20)$$

Then, the GLS estimator is

$$\hat{\beta} = \left[\sum_{g=1}^{G} \left(\frac{1}{\sigma_g^2} \right) \mathrm{X}_g \mathrm{X}_g^{'} \right]^{-1} \left[\sum_{g=1}^{G} \left(\frac{1}{\sigma_g^2} \right) \mathrm{X}_g y_g \right] \tag{2.11}$$

As always, pooled OLS is a consistent estimator, we will use the group specific subvectors of the OLS residuals, $\hat{\sigma}_g^2 = \frac{e_g^{'} e_g}{n_g}$, to provide the needed estimator for the group specific disturbance variance. Then, the FGLS is a consequence of substitution of the group specific variance into equation (2.11).