CHAPTER 5

EMPIRICAL RESULTS

In this chapter empirical results are presented and discussed. First of all, the properties of time series variables are considered. Next, the time series model is estimated using cointegration technique to examine long-run relationships between variables. Estimates from cointegrating equations are interpreted. Finally, the short-run dynamics towards equilibrium are investigated from the error correction model (ECM).

5.1 Unit Root Test Results

The first priority of dealing with time series data is to test for its stationarity. According to the ADF test results, all the series have the absolute value of ADF-statistic less than that of Mackinnon critical value at the 1% significance level. Hence, the null hypothesis that the series has a unit root cannot be rejected at the 1% significance level for all the series examined in this study, indicating that they are nonstationary in their level.[1] A further test is conducted on the first differenced series and it is shown that all of them are stationary or $I(0)$. Therefore, it can be said that all these data series are integrated of order one, $I(1)$. Because all the series are integrated of the same order, the cointegration test can be conducted to explore long-run relationships among variables in each pass-through equation.

5.2 Cointegration Test Results

The multivariate Johansen cointegration test is based on an underlying VAR model. Determining appropriate lag length is necessary in the construction of a cointegrated VAR model. However, it is widely accepted that there is no clear-cut procedure in determining lag length. The lag lengths suggested by the LR test and the

[1] See detailed test results in Appendix B.

Akaike Information Criterion (AIC) are very small (0 and 1) in most cases. Since the data are monthly, to small lag length may not fully captures dynamics of the variables. This should be especially reasonable when export pricing behavior involves lags in business transactions such as the order-payment lag, the situation in which current price is determined by variables in previous periods which are longer than one month. Importantly, the other thing to be considered is the properties of the residuals; i.e. Gaussian residuals are preferred. This study takes into account three important properties of the residuals, namely the absence of autocorrelation, heteroskedasticity and non-normality in selection of the appropriate lag order. Since the VAR model is transformed into vector error correction model (VECM) form to discover long-run information about the relationship between variables, the lag length used in cointegration test is that of the VECM. The selected VECM lag order of each pass-through is presented in table 5.1.

Table 5.1

Selected VECM Lag Order

Industry	*Lag length*
Rubber products	5
Canned seafood	5
Iron & steels	5
Furniture and parts	3
Motor cars	6
Garments	2
Plastic	3
Chemicals	4

These selected lag orders are used to perform test for cointegration. Results from the multivariate serial correlation LM test indicate non-rejection of the null hypothesis of no serial correlation at selected lag order at the 5% significance level. The residual heteroskedasticity test results show that the null hypothesis of no heteroskedasticiy cannot be rejected at the 5% significance level. Thus, all the

VECMs with selected lag order contain neither autocorrelation nor heteroskedasticity at the 5% significance level; however, non-normality is still present.[2]

5.2.1 Cointegration Test Results (Symmetric Pass-Through)

The cointegrating relationship among the variables is tested using Johansen Maximum Likelihood method. The results of the test are presented in Appendix C. Under the trace test, there exists two cointegrating vectors in the pass-through models of rubber products, canned seafood and iron & steels industries but only one in the case of furniture and parts, motor cars, garments and plastic products industries at the 5% significance level. For chemical products, no cointegrating vectors is found at the 5% significance level. The coefficients of cointegrating vectors have been normalized on *pxd*, and are based on the largest eigenvalues. Based on equation (3.2.9) which assumes that export prices behave in an asymmetric fashion during the Baht depreciation and appreciation, the estimated coefficients are shown in table 5.2.1.

Table 5.2
Coefficients of Cointegrating Vectors (Symmetric Pass-Through)

	pxd	*c*	*erd*	*pc*
Rubber products (2)	1	0.81	-0.20	0.28
Canned seafood (2)	1	0.98	-0.65	0.27
Iron & steels (2)	1	1.35	-0.07	0.18
Furniture and parts (1)	1	-1.05	-0.12	1.05
Motor cars (1)	1	2.04	-0.40	0.31
Garments (1)	1	-0.21	-0.18	0.53
Plastic products (1)	1	0.75	-0.04	0.13
Chemical products (0)	n.a.	n.a.	n.a.	n.a.

Note: The number in parentheses shows the estimated number of cointegrating vectors.
Results above are from the cointegrating vectors with the largest eigenvalue.

Under an assumption of symmetric exchange rate pass-through, export price in terms of US dollar responds to exchange rate changes differently across export

[2] See detailed results of diagnostic tests for autocorrelation and heteroskedasticity in Appendix D.

industries. The pass-through coefficient is largest in canned seafood industry, where 1 change in exchange rate results in 0.65% change in export price in US dollar. Second is the motor car industry, where 1% change in exchange rate makes export price in US dollar change by 0.40%. Third is the rubber industry, where 1% change in exchange rate leads to 0.20% change in export price in US dollar. For the rest of industries, a 1% change in exchange rate results in 0.04% to 0.18% change in export price in US dollar. For all the industries examined, the coefficient sign of the exchange rate is negative in every case which is consistent with the theoretical model.

From table 5.2, it can be concluded that, generally, the Baht per US dollar exchange rate has limited impacts on the adjustment of export prices in US dollar terms of manufactures. Alternatively speaking, there is low degree of exchange rate pass-through to US dollar prices of manufactured exports. When the exchange rate changes, Thai exporters of manufactures tend to stabilize their export prices in US dollar terms by absorbing the exchange rate changes into their export prices in terms of Baht. This means that their markup varies with the exchange rate changes. The limited pricing power to change the dollar price of their exports when the exchange rate changes supports the hypothesis that the Thai exporters of manufactures are likely to be price takers in the world market.

Nevertheless, the degree of pass-through is relatively high in some export industries, canned seafood and motor cars. For canned seafood, the pass-through elasticity of 0.65 implies that exporters are able to adjust their prices in US dollar terms when the exchange rate fluctuates. This may be a reflection of the relatively high degree of pricing power of exporters in this industry compared to those in the other export industries. In other words, the result is likely to support the hypothesis that Thai exporters of canned seafood are inclined to be price setters rather than the price takers in the world market. The result may, to some extent, be attributable to the fact that Thailand is one of the largest suppliers of canned seafood in the world market. According to figure 5.1, Thailand's export of canned seafood accounts for around one-fifth of the world's total exports. For motor cars, the moderate pass-through of 0.40 indicates that exporters of motor cars have some influence on export pricing. The pricing power may be ascribable to the large share of foreign ownership in this industry[3]. Motor car industry in Thailand is overwhelmingly dominated by multinational enterprises (MNEs) which may be able to manipulate pass-through when the exchange rate changes.

For industries examined in this study, when considering the world export share of each export product, the degree of pass-through can be said to be positively related to the world export share as shown in the following figure.

Figure 5.1
Comparison of Export Industries with Different
Degrees of Pass-Through and World Export Share

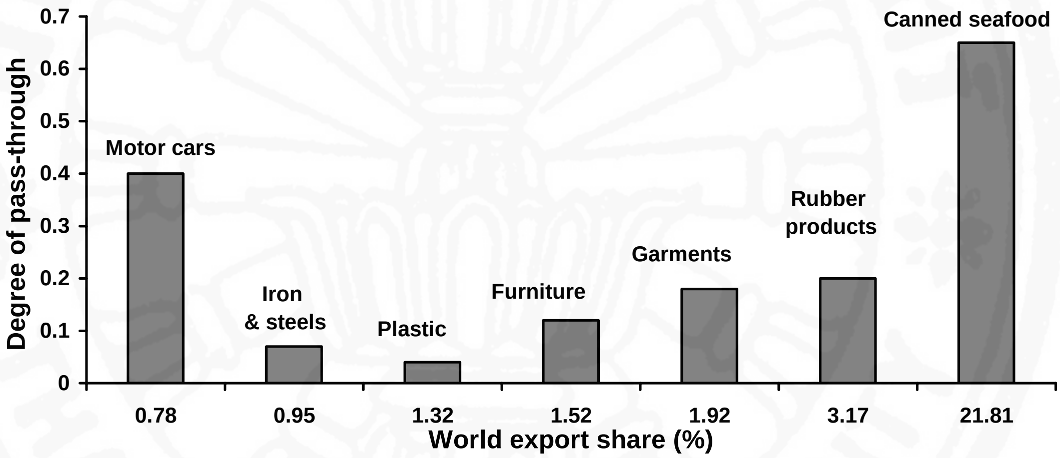

Figure 5.1 shows the positive relationship between the pass-through elasticity and world export share of each export industry. Strikingly, it is clear that the motor car industry, despite having the lowest world export share compared to other industries, has the second largest pass-through elasticity. It is important to note that the export market share used here is the total exports of motor cars from all over the world. Anyhow, in the class of developing countries, Thailand is one of the major players in motor car industry since it has been selected by MNEs to be a regional hub of motor car production. The same characteristic also applies to other developing countries such as Mexico, Argentina and Brazil (TDRI, 2008). The opportunity to influence world price is thus relatively higher compared to other export industries examined (except for canned seafood).

[3] Data compiled and calculated from the Office of Industrial Economics survey shows that the share of foreign ownership in motor vehicles industry is around 90%, Angklomkliew (2005).

The low pass-through coefficients might be due to the effects the exchange rate has on production cost. The calculation of long-run cointegrating relationship is based on a VAR model which allows every variable to be endogeneous. In the industry with some imported contents, cost of production may be affected by the exchange rate changes. When the cost is determined by the exchange rate (instead of being exogenous), export price in dollar might not be respond much to exchange rate changes. For example, when the Baht appreciates, exporters may not increase their dollar export price at a large amount because they gain from lower prices of imported inputs which make their costs lower. The exchange rate effects on production cost may offset the adjustment of dollar export prices. Therefore, the degree of pass-through may not be as high as in the model which assumes cost to be exogenous. (see Athukorala and Menon, 1994 and Hung, Kim and Ohno, 1993 for further discussions).

Regarding the unit cost of production (*c*), an important variable in export pricing behavior, it is evident that cost coefficient displays the expected positive sign in every pass-through equation, except in the case of furniture and parts and garments which it shows the negative sign[4]. The large magnitude of the coefficients of cost, ranging from 0.75 to 2.04, implies that Thai exporters of manufactures base their export price in dollar terms largely on domestic cost changes. Among all export industries, export price in dollar terms of motor cars is found most sensitive to cost changes, with 1% increase in domestic cost results in 2.04 % increase in export price in dollar terms.

For all export industries examined, the cost coefficients are larger than the exchange rate coefficients. These results supports the conjecture stated in Bache (2002) that exporters are more willing to absorb into their markups changes in exchange rates than change in costs, which are likely to be more permanent.

The coefficients of the proxy for foreign competitors' price (*pc*) display the expected positive sign in all industries which corresponds to what the model predicts.

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[4] This is rather unconvincing, particularly for furniture and parts industry which has the cost coefficient of -1.05. However, it is important to note that the true unit cost of production is unavailable. The producer price index (PPI) used as proxy for cost in these two industries may not well represent the true cost movement.

The influences of the competitors' price on export price in dollar are strong in furniture and parts and garment industries. The US dollar export price changes by 1.05% if the competitors' price changes by 1% in the case of furniture, while in garments industry 1% change in competitors' price results in 0.53% of an adjustment in US dollar export price. This reflects the high level of foreign competition in these two export industries. And China is one of the major competitors in these industries.

So far, the exchange rate pass-through coefficients are assumed to be symmetric between appreciations and depreciations of the Thai Baht against the US dollar. Next, the results from the model that allows long-run asymmetric adjustment of export price in USD between appreciations and depreciations are presented.

5.2.2 Cointegration Test Results (Asymmetric Pass-Through)

Adding the variable erd_t^D into equation (3.2.9) yields equation (3.3.1) which allows for asymmetric pass-through. A test for the asymmetry hypothesis is undertaken to ensure that erd_t^D should be included in the pass-through equation. This involves the test of the null hypothesis that the coefficient of erd_t^D is equal to zero ($\beta_2 = 0$) against the alternative hypothesis that $\beta_2 \neq 0$ to see whether the entry of β_2 is significant in the cointegration space. The test statistic is distributed chi-squared (χ^2). The test results are present in table 5.3.

Table 5.3 Test for asymmetry

	Chi-square test statistic	Probability
Rubber products	1.734498	0.187838
Canned seafood	2.254232	0.133250
Iron & steels	0.028622	0.865655
Furniture and parts	0.512116	0.474224
Motor cars	1.472329	0.224979
Garments	0.994555	0.318632
Plastic products	9.396208*	0.002174
Chemical products	1.590441	0.207263

Note: * and ** denotes significance at the 1% and 5% level, respectively.

The restriction that $\beta_2 = 0$ cannot be rejected in almost every pass-through equation except that of plastic product which can be rejected at the 1% significance level. Therefore, erd_t^D can be removed from the pass-through equation so that exchange rate pass-through of the appreciation episode equals to that of the depreciation episode. Say, export price in dollar responds symmetrically to appreciations and depreciations of the Thai Baht against the US dollar. Asymmetric adjustment is rejected. The only exception is the case of plastic products where the asymmetric adjustment cannot be rejected. The significance of erd_t^D at the 1% level indicates that this variable should be incorporated in the model. Table 5.4 shows the coefficients from the asymmetric pass-through equations.

Table 5.4
Coefficients of Cointegrating Vectors (Asymmetric Pass-Through)

	pxd	*c*	*erd*	erd^D	*pc*
Rubber products (2)	1	0.81	-0.20	-	0.28
Canned seafood (2)	1	0.98	-0.65	-	0.27
Iron & steels (2)	1	1.35	-0.07	-	0.18
Furniture and parts (1)	1	-1.05	-0.12	-	1.05
Motor cars (2)	1	2.04	-0.40	-	0.31
Garments (1)	1	-0.21	-0.18	-	0.53
Plastic products(1)	1	0.81	-0.35	0.18*	-0.18
Chemical products (0)	n.a.	n.a.	n.a.	n.a.	n.a.

Note: * and ** denotes significance at the 1% and 5% level, respectively.
Results are from the cointegrating vectors with the largest eigenvalue.

Long-run asymmetric pass-through is found only in the case of plastic products. A 1% of Baht appreciation causes export price in dollar increase by 0.35%, while a 1% of Baht depreciation causes export price in dollar decrease by 0.17%. The adjustment of export price in dollar during the Baht appreciation is greater than during the Baht depreciation. Equivalently, the degree of pass-through during appreciations is greater than during depreciations. This indicates that the exporters in plastic industry concern more about stabilizing profits during appreciation episodes than maintaining or increasing market share during depreciation episode.

5.3 Error Correction Model (ECM)

The long-run relationship among variables is found in almost every industry, except in the chemical industry. Now the short-run dynamics toward long-run equilibrium is investigated. The error correction model (ECM) is formed to find this short-run dynamics; that is, the speed of adjustment toward equilibrium. The ECM shows how the system converges to the long-run equilibrium implied by the cointegrating regression as estimated above.

The error-correction term (*ECT*) is derived by normalizing the cointegrating vector on *pxd* (pass-through equation). It captures the changes in *pxd* required to eliminate past departures of actual values of the variables from the equilibrium levels. According to the results as shown in table 5.5, the coefficient of the error-correction term (*ECT*) which is commonly recognized as the adjustment coefficient has emerged with the negative sign and significant for almost all pass-through equations. The negative and significant sign of the adjustment coefficient shows how much of the disequilibrium is being corrected, i.e. the extent to which any disequilibrium in the previous period effects any adjustment in pxd_t. This implies that there is some adjustment process which prevents the errors in the long-run relationship become larger.

It can be inferred from table 5.5 that for the symmetric pass-through model of canned seafood, iron & steels, furnitures, motor cars, garments and plastic products, a 38%, 13%, 48%, 12%, 21% and 28% of deviation from the long-run equilibrium relationship among variables in the pass-through equations are significantly corrected within one period (one month), respectively. For rubber industry, this short-run dynamics takes place but is not statistically significant.

Table 5.5

Estimates of Error Correction Models (ECM), Dependent Variable: Δpxd

Variable	Rubber products	Canned seafood	Iron & steel	Furniture
constant	0.004 (0.002)	0.005 (0.003)	0.00 (0.002)	-0.057 (0.01)*
ECT	-0.10 (0.10)	-0.38 (0.07)*	-0.13 (0.04)*	-0.48 (0.08)*
$\Delta pxd(-1)$	0.02 (0.17)	0.03 (0.11)	-0.02 (0.13)	0.10 (0.11)
$\Delta pxd(-2)$	0.24 (0.17)	-0.26 (0.11)**	-0.07 (0.13)	-0.19 (0.09)**
$\Delta pxd(-3)$	0.06 (0.16)	-0.06 (0.12)	-0.19 (0.13)	-0.04 (0.10)
$\Delta pxd(-4)$	0.15 (0.15)	-0.15 (0.11)	0.002 (0.13)	
$\Delta pxd(-5)$	0.06 (0.15)	0.14 (0.11)	-0.08 (0.12)	
$\Delta pxd(-6)$				
$\Delta c(-1)$	0.07 (0.08)	-0.30 (0.22)	0.20 (0.10)	0.36 (0.32)
$\Delta c(-2)$	-0.09 (0.10)	-0.20 (0.21)	0.15 (0.12)	0.37 (0.31)
$\Delta c(-3)$	-0.04 (0.08)	-0.10 (0.22)	-0.04 (0.12)	0.40 (0.32)
$\Delta c(-4)$	0.02 (0.09)	0.03 (0.21)	0.06 (0.12)	
$\Delta c(-5)$	-0.15 (0.10)	-0.50 (0.21)**	0.04 (0.12)	
$\Delta c(-6)$				
$\Delta erd(-1)$	-0.26 (0.16)	0.06 (0.22)	0.22 (0.17)	0.08 (0.20)
$\Delta erd(-2)$	-0.16 (0.16)	0.24 (0.22)	-0.08 (0.18)	-0.13 (0.23)
$\Delta erd(-3)$	0.35 (0.16)**	0.35 (0.23)	0.13 (0.17)	0.45 (0.22)**
$\Delta erd(-4)$	-0.05 (0.16)	0.19 (0.23)	0.11 (0.17)	
$\Delta erd(-5)$	-0.06 (0.16)	0.58 (0.23)**	-0.09 (0.16	
$\Delta erd(-6)$				
$\Delta pc(-1)$	-0.16 (0.10)	-0.15 (0.13)	-0.01 (0.10)	-0.28 (0.16)
$\Delta pc(-2)$	-0.30 (0.11)*	-0.11 (0.13)	0.09 (0.10)	-0.16 (0.16)
$\Delta pc(-3)$	0.06 (0.11)	0.05 (0.13)	-0.05 (0.10)	-0.04 (0.14)
$\Delta pc(-4)$	0.02 (0.12)	-0.12 (0.12)	-0.08 (0.10)	
$\Delta pc(-5)$	-0.13 (0.11)	-0.02 (0.12)	0.07 (0.10)	
$\Delta pc(-6)$				
R^2	0.33	0.51	0.56	0.50
Adj. R^2	0.06	0.32	0.40	0.39

Notes: * and ** Denotes significance at the 1% and 5% level, respectively.
Figures in parentheses ( ) refer to estimated standard errors.

(*continued*)

Variable	Motor cars	Garments	Plastic products
constant	-0.0002 (0.002)	0.0009 (0.0009)	0.002 (0.001)
ECT	-0.12 (0.03)*	-0.21 (0.04)*	-0.28 (0.12)**
Δ *pxd(-1)*	-0.14 (0.15)	0.09 (0.10)	-0.020 (0.15)
Δ *pxd(-2)*	-0.26 (0.14)	-0.07 (0.10)	0.27 (0.14)
Δ *pxd(-3)*	-0.05 (0.15)		0.19 (0.13)
Δ *pxd(-4)*	-0.12 (0.15)		
Δ *pxd(-5)*	-0.09 (0.14)		
Δ *pxd(-6)*	-0.12 (0.14)		
Δ *c(-1)*	0.13 (0.34)	0.06 (0.07)	0.40 (0.09)*
Δ *c(-2)*	0.09 (0.33)	-0.04 (0.07)	-0.14 (0.12)
Δ *c(-3)*	-0.02 (0.32)		-0.13 (0.10)
Δ *c(-4)*	0.38 (0.31)		
Δ *c(-5)*	-0.36 (0.31)		
Δ *c(-6)*	0.270 (0.33)		
Δ *erd(-1)*	-0.220 (0.09)**	-0.02 (0.07)	-0.02 (0.08)
Δ *erd(-2)*	0.12 (0.10)	0.14 (0.07)**	-0.07 (0.08)
Δ *erd(-3)*	-0.06 (0.10)		0.12 (0.08)
Δ *erd(-4)*	0.06 (0.09)		
Δ *erd(-5)*	0.06 (0.09)		
Δ *erd(-6)*	0.01 (0.10)		
Δ *pc(-1)*	0.02 (0.07)	-0.12 (0.08)	-0.08 (0.04)
Δ *pc(-2)*	-0.10 (0.07)	0.07 (0.07)	0.02 (0.05)
Δ *pc(-3)*	-0.10 (0.07)		-0.005 (0.04)
Δ *pc(-4)*	0.06 (0.07)		
Δ *pc(-5)*	-0.09 (0.07)		
Δ *pc(-6)*	-0.10 (0.07)		
R^2	0.50	0.34	0.54
Adj. R^2	0.25	0.26	0.45

Notes: * and ** Denotes significance at the 1% and 5% level, respectively.
Figures in parentheses ( ) refer to estimated standard errors.