Exchange Rate Volatility and Trade among the Asia Pacific Countries

SaangJoon Baak

Graduate School of International Relations
International University of Japan
Yamato-machi, Minami Uonuma-gun
Niigata, 949-7277 Japan

Email: sbaak@iuj.ac.jp
Phone: 81-257-79-1510
Fax: 81-257-79-1187

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ABSTRACT

The purpose of this paper is to investigate the impact of exchange rate volatility on exports among 14 Asia Pacific countries, where various measures to raise the intra-region trade are being implemented. The empirical tests, using annual data for the period from 1980 to 2002, detect a significant negative impact of exchange rate volatility on the volume of exports. In addition, various tests using the data for sub-sample periods indicate that the negative impact had been weakened since 1989, when APEC had launched, and surged again from 1997, when the Asian financial crisis broke out. Also, the test results show that the GDP of the importing country, the depreciation of the exporting country's currency value, the use of the same language and the membership of APEC have positive impacts on exports, while the distance between trading countries have negative impacts.

JEL Classification: C2, F1, F3

Keywords: Exchange rate volatility, Export, Asia Pacific region, APEC, Gravity model

1. Introduction

Since its establishment in 1989, the Asia-Pacific Economic Cooperation (APEC, hereafter) has worked "to reduce tariffs and other trade barriers across the Asia-Pacific region,"[1] to boost trade in the region. However, the impact of exchange rate volatility on trade, which has been an important research agenda for many economies since the breakdown of the Bretton-Woods agreement in 1973, has been rarely discussed for the Asia-Pacific region.

Against this background, this present paper aims to investigate the impact of exchange rate volatility on exports in the Asia-Pacific region. In particular, this paper examines the annual export volumes of 14 Asia-Pacific countries (Australia, Canada, Chile, Indonesia, Japan, Republic of Korea, Malaysia, Mexico, New Zealand, Papua new Guinea, the Philippines, Singapore, Thailand, and the U.S.), for the period from 1980 to 2002.

In fact, numerous studies, theoretically and empirically, have attempted to find the nature of the relationship between exchange rate volatility and exports for the last few decades. However, as Arize, Osang and Slottje (2000), Aristotelous (2001), and Sercu and Uppal (2000, Ch. 6) state, extant papers have shown that both positive and negative relationships are theoretically possible and have reported the empirical findings of both positive and negative relationships. In addition, some have reported no significant relationship.

For example, De Grauwe (1988) and Secru and Uppal (2000, Ch. 6) present models showing an ambiguous relationship and Baccheta and Wincoop (2000) present a model showing no relationship. The empirical research of Baak et al. (2003), Arize, Osang and Slottje (2000), Chowdhurry (1993), Kim and Lee (1996) and Peree and Steinherr (1989) report a negative relationship, while Bahmani-Oskooee and Payestech (1993) and Hooper and Kohlhagen (1978) report an insignificant relationship. These research results imply that the impact of exchange rate volatility varies depending on regions and periods.

[1] See the official website of the Asia-Pacific Economic Cooperation (http://www.apecsec.org.sg).

This paper examines the impact of exchange rate volatility on trade volumes in the Asia-Pacific region for the period of 1980-2002 in the context of gravity models, which have been "widely applied to empirical work in international economics" (Dell'Ariccia (1999)) and have "a remarkably consistent history of success" in that area (Aristotelous (2001)).

Specifically, this present paper estimates a gravity model (gravity model, hereafter) in which the dependent variable is the product of the exports of two trading countries, as in the paper of Dell'Ariccia (1999). In addition, it also estimates a generalized gravity model as in the work of Aristotelous (2001)). Different from a typical gravity model, the generalized gravity model (unilateral exports model, hereafter) puts not the product of the exports of two trading countries but the exports from one country to another as the dependent variable. By doing this, the depreciation rate of the exporting country's currency value can be included as one of the explanatory variables affecting the volume of exports.

More specifically, the regression equation of this paper adopts, as the explanatory variables of the export volume, the GDP of the importing country, the depreciation rate of the exporting country's currency value (in the case of the unilateral exports model), the bilateral exchange rate volatility of two trading countries, their distance, a time trend and dummies for the share of the border line, the use of the same language, and the APEC membership. In addition, in the case of the unilateral exports model, considering that the export volume will also depend on various conditions of the exporting country, dummies for exporting countries are also included as an explanatory variable.

Finally, this paper performs not only simple OLS estimations, but also both fixed-effects and random-effects estimations.

The empirical tests using annual data for the period from 1980 to 2002 detect a significant negative impact of exchange rate volatility on the volume of exports in the Asia-Pacific region. In addition, the test results indicate that the GDP of the importing country, the depreciation of the exporting country's currency value, the use of the same language and the membership of APEC have positive impacts on exports, while the distance between trading countries have negative impacts.

Of special interest is that the negative impact of exchange rate volatility turns out to be insignificant in the tests with the sample set covering the sub-sample period from 1989 to 1996 (post-APEC and pre-Asian financial crisis), while it turns out to be significant in other sub-periods, implying that the impact of exchange rate volatility is time-dependent and that it is significantly negative at least in the present time. This phenomenon is noticed regardless which estimation model is adopted.

The following section presents the models employed in this research, the definitions of the variables, and the data used in the analysis. The empirical test results are presented in section 3. The last section presents conclusions.

2. The models and the data

2.1. The models

As mentioned previously, two different regression equations are estimated in this paper in the context of a simple OLS model, a fixed effects model and a random effects model. The first regression equation (the gravity model) puts the product of the exports of two trading countries as the dependent variable, while the second regression equation (the unilateral exports model) puts the exports from one country to another as the dependent variable.

2.1.1. The gravity model

The gravity model estimated in this paper is the following:

$$EXP_{ijt} * EXP_{jit} = \beta_0 + \beta_1 GDP_{it} * GDP_{jt} + \beta_3 VOL_{ijt} + \beta_4 DIST_{ijt} + \beta_5 BORD_{ijt} + \beta_6 LANG_{ijt} + \beta_7 APEC_{ijt} + \beta_8 TREND + \varepsilon_{ijt}$$

The subscripts, *i* and *j,* stand for countries involved in trade, and the subscript, *t*, stands for time. EXP_{ijt} is the real exports from country *i* to country *j* at

time *t*, while EXP_{jit} is the real exports from country *j* to country *i*. GDP_{it} is the real GDP of a country *i*; VOL_{ijt} is the exchange rate volatility that is defined as the annual standard deviation of the log value of the monthly bilateral real exchange rates (between the country-pairs involved); and $DIST_{ijt}$ is the geographical distance between the two countries measured in miles as the direct-line distance between the capital cities of the two countries. All these variables take on log values.

In addition, $BORD_{ijt}$ is the dummy for the share of a border line. If the two trading partner countries share a border line, the value of this variable is one, and it is zero, otherwise. $LANG_{ijt}$ is the dummy for the use of the same language. $APEC_{ijt}$ is the dummy for the APEC membership. If both countries (*i* and *j*) are members, the value of this variable is one, and it is zero, otherwise. Finally *TREND* stands for the time trend dummy.

Table 1-1, Table 1-2, and Table 1-3 show, respectively, the countries sharing a border, the countries using the same language, and the date the countries joined the APEC.

2.1.2. The unilateral exports model

The unilateral exports model is quite similar to the gravity model presented in the previous section. It differs from the previous model just in four points. First, it puts not the product of the exports of two trading countries but the exports from one country to another as the dependent variable. Second, as a result, one of the explanatory variables is not the product of the GDPs of the two trading countries, but the GDP of the importing country. Third, the depreciation rate of the currency value of the exporting country against the currency value of the importing country is included as one of the explanatory variables. Lastly, because small countries are

expected to export less than big countries if other things are equal, the dummies for exporting countries are included.[2]

Accordingly, the unilateral exports model has the following specification:

$$EXP_{ijt} = \beta_0 + \beta_1 GDP_{jt} + \beta_2 DEXR_{ijt} + \beta_3 VOL_{ijt} + \beta_4 DIST_{ijt} + \beta_5 BORD_{ijt} + \beta_6 LANG_{ijt} + \beta_7 APEC_{ijt} + \beta_8 TREND + \delta_2 D_2 + \cdots + \delta_{14} D_{14} + \varepsilon_{ijt}$$

The subscripts *i*, *j* and *t* stand, respectively, for an exporting country, an importing country and time. EXP_{ijt} is the real exports from country *i* to country *j* at time *t*; GDP_{jt} is the real GDP of an importing country *j*; $DEXR_{ijt}$ is the depreciation rate of the exporting country's currency value; and D_i ($i = 2, 3, \ldots, 14$) is the dummy for an exporting country. Other specifications are the same as in section 2.1.1.

2.2 The variables

Real exports

The real export from country *i* to country *j* (EXP_{ijt}) in the unilateral exports model and the product of real exports (EXP_{ijt} * EXP_{jit}) in the gravity model are defined respectively as follows:

$$EXP_{ijt} = \ln\left(\frac{EX_{ijt}}{USGDPD_t} \times 100\right)$$

[2] The economic size of an exporting country can be measured by its GDP. However, because export is one component of GDP, to include the GDP of the exporting country in the exports equation can generate the endogeneity problem.

$$EXP_{ijt} * EXP_{jit} = \ln\left[\left(\frac{EX_{ijt}}{USGDPD_t}\times 100\right) * \left(\frac{EX_{jit}}{USGDPD_t}\times 100\right)\right]$$

where EX_{ijt} is the annual nominal exports of country *i* to country *j;* EX_{jit} is the annual nominal exports of country *j* to country *i;* and $USGDPD_t$ denotes the U.S. GDP deflator.[3]

Real GDP

The real GDP of a country *j* (GDP_{jt}) in the unilateral exports model and the product of GDPs ($GDP_{it} * GDP_{jt}$) in the gravity model are defined respectively as follows:

$$GDP_{jt} = \ln\left(\frac{GDPN_{jt}}{USGDPD_t}\times 100\right)$$

$$GDP_{it} * GDP_{jt} = \ln\left[\left(\frac{GDPN_{it}}{USGDPD_t}\times 100\right) * \left(\frac{GDPN_{jt}}{USGDPD_t}\times 100\right)\right]$$

where $GDPN_{jt}$ is the nominal GDP of country *j* measured by purchasing power parity and $GDPN_{it}$ is the nominal GDP of country *i* measured by purchasing power parity.

Depreciation rate of real bilateral exchange rate ($DEXR_{ijt}$ **)**

The depreciation of the exporting country's currency value is computed as follows:

[3] Eichengreen and Irwin (1996) also use the U.S. GDP deflator to compute real exports. Exports price indices are available for total exports of a country but not available for bilateral exports.

$$DEXR_{ijt} = \ln\left(EXR_{ijt}\right) - \ln(EXR_{ijt-1})$$

$$EXR_{ijt} = E_{ijt} \times \frac{CPI_{jt}}{CPI_{it}}$$

where EXR_{ijt} symbolizes the real exchange rate; E_{ijt} is the nominal exchange rate; and CPI_{it} and CPI_{jt} denote the consumer price index of an exporting country *i* and an importing country *j*, respectively.

Real exchange rate volatility (VOL_{ijt})

This present study applies the standard deviation of exchange rates as the measure of exchange rate volatility. According to Sercu and Uppal (2000), the standard deviation is one of the major measures of exchange rate volatility. [4] Specifically, the annual real exchange rate volatility VOL_{ijt} is defined as the annual standard deviation of the natural logarithm of monthly real exchange rates:

$$VOL_{ijt} = \ln\left(\sqrt{\frac{1}{11}\sum_{k=1}^{12}\left(LEXR_{ijk} - \overline{LEXR_{ij}}\right)^2}\right)$$

where $LEXR_{ijk}$ is the natural logarithm of real monthly bilateral exchange rate EXR_{ijk}, $\overline{LEXR}_{ij}$ the annual average of $LEXR_{ijk}$, and *k* represents the month. The volatility measured in this way will be the same regardless of whether *i* is the exporting country or *j* is the exporting country. That is, $VOL_{ijt} = VOL_{jit}$.

2.3. Data sources

Annual trade data were compiled from IMF's *DOTS* (Direction of Trade Statistics). Nominal GDP (measured by international dollar) data were taken from

[4] See Akhtar and Hilton (1984), Cote (1994) and Baum et al. (2002).

World Bank's *WDI* (World Development Indicator). The U.S. GDP deflator, price indices and exchange rates were collected from IMF's *IFS* (International Financial Statistics). The data for the distances between countries were obtained from the Meridian World Data.

3. The test results

3.1. Expected signs of the coefficients

If the economic size (GDP in this research) of one country increases, then the country is expected to import more from foreign countries. Accordingly, β_1 in both the gravity model and the unilateral exports model is expected to be positive. If the depreciation rate of the currency value of an exporting country rises, then the export volume of the country is expected to increase, implying the sign of β_2 will be positive in the unilateral exports model.

In the meantime, most empirical work treats exchange rate volatility as a risk discouraging international trade. Higher risk means higher cost for risk-averse traders, which therefore leads to less international trade. In other words, if changes in exchange rates become more unpredictable, this generates more uncertainty about the profits to be made, discouraging economic agents involved in international trade. Even if hedging in forward markets is possible, there are limitations and costs. Moreover, exchange rate risk for developing countries is generally not hedged because forward markets are not accessible to all traders.

However, as Sercu and Uppal (2000, Ch. 6) point out, "most empirical work fails to find a strong negative relation between exchange rate volatility and the volume of international trade." Asseery and Peel (1991) and Kroner and Lastrapes (1993) even report that the relationship may be positive. In addition, Frankel and Wei (1994) find that the impact of exchange rate volatility on trade is time-dependent. According to them, the cross section data from 63 countries reveals a significant negative impact of the volatility in 1980, but insignificant impact in 1985. In addition, the data for the same countries reveals both positive and

negative values for the coefficient of the volatility in 1990, depending on model specifications.

In fact, as mentioned previously, theoretical papers (De Grauwe (1988) and Sercu and Uppal (2000), for example) have also presented economic models showing both positive and negative impacts of exchange rate volatility on trade. Baccheta and Wincoop (2000) show a general equilibrium model in which exchange rate volatility does not affect international trade. In this sense, the exchange rate volatility coefficient (β_3) can be positive, negative or insignificant.

As the distance between the exporting and importing countries becomes larger, exports will fall.[5] As a result, β_4 is expected to be negative. Countries sharing a border line and using the same language may have more trade opportunities. In addition, because of various trade-boosting efforts among member countries, APEC membership may have a positive impact on exports among member countries. Accordingly, β_5 β_6 β_7 are expected to be positive.

3.1. The test results

The regression results of the gravity model are listed in Table 2-1 for the simple OLS pooled data model, in Table 2-2 for the fixed effects model and in Table 2-3 for the random effects model. Since to include some dummy variables in the fixed effects model and the random effects model generate a near singular matrix in the regression equation, as shown in tables 2-2 and 2-3, some dummy variables are excluded in their estimations.[6]

Considering the finding of Frankel and Wei (1994) that shows the impact of exchange rate volatility is time-dependent, this present research splits the whole sample period into three sub-periods and performs the estimations with the data

[5] One major reason is higher transportation costs.

[6] As a result, it is impossible to statistically compare the validity of the three models. Because the simple OLS model contains all the explanatory variables that are expected to affect trade in this paper, more focus will be given to the estimation results of the simple OLS model, hereafter. However, it should be noted that the three models have generated differences only quantitatively. They have produced the same results qualitatively. This will be discussed in more detail, later.

for the sub-periods along with the data for the whole period: the pre-APEC period from 1980 to 1988 (sub-period I, hereafter); the post-APEC and pre-Asian financial crisis period from 1989 to 1996 (sub-period II, hereafter); and the post-Asian financial crisis period from 1997 to 2002 (sub-period III, hereafter).

The regression results for the simple OLS model, reported in Table 2-1, show that the estimated coefficient values for GDP, distance, border, language, and APEC membership have expected signs and that they are significant and quite stable across different sub-periods.

In contrast, the coefficient for the border dummy is negative, contradicting our expectation. However, the negative sign of the border dummy does not necessarily mean that to share a border discourages trade. As shown in Tables 2-1 through 2-3, the coefficient for the distance is negative. Because the distance between two countries sharing a border will be relatively shorter, they are expected to trade more products. If this effect is non-linear rather than linear as is implicitly assumed in the regression equation, then the impact of border-sharing can show a negative sign.

Also, this negative sign may come from the peculiar trade pattern of the APEC member countries sharing borders. As Table 1-2 shows, only three groups of countries share a border. Among them, Canada and Mexico share a border with the U.S., which is the biggest market for many APEC countries. If the gravity power of the U.S. is too big, then to share a border with the U.S. may not be a relative advantage. Also, the two countries, Indonesia and Malaysia, who share a border, have relatively small amount of trade between them, perhaps because they have similar export and import goods.

The impact of exchange rate volatility turns out to be negative and significant for the period from 1980 to 2002, regardless of incorporating fixed effects or random effects. However, the magnitude of the coefficient declines when fixed effects or random effects are incorporated in the regression.[7]

Of special interest is that the test results show the coefficient for the exchange rate volatility declines during 1989-1996 and rises back during 1997-

[7] Dell'Ariccia (1999) reports the same finding in his research on the European Union.

2002. In fixed effects models and random effects model, the coefficient for the volatility is not only relatively small but also insignificant. These figures strongly imply that the impact of exchange rate volatility is time-dependent. In addition, they imply exchange rate volatility matters in the Asia-Pacific region in the present time.

One point noticeable from the tables is that the coefficient for the APEC membership is significantly positive for the whole period regardless of the estimation method, but that it is insignificant for sub-period II in the fixed effects model and in the random effects model, while it is significant for the same period in the simple OLS model. It is not quite clear whether this difference comes from incorporating fixed effects of random effects in the estimation or from omitting some explanatory variables in the fixed effects and random effects models. Considering the possibility of misspecification caused from omitting significant explanatory variables and the high R^2 and adjusted R^2 of the simple OLS model, it is not believed that the impact of the APEC membership is insignificant. Except for this, the three models show no qualitative difference in the estimation results.

Tables 3-1 through 3-3 show the estimation results for the unilateral exports model. The estimates for the exporting country dummies, not reported in the tables, were significant in the simple OLS model. But, they were not included in the fixed effects model and the random effects model because they are not necessary in these models.

The coefficient for the depreciation rate, which could not be included in the gravity model, turns out to be positive as expected, except for the case of the fixed effects model in sub-period II. Also, it is significant in the whole period and in sub-period I, but insignificant in other times regardless of incorporating fixed effects or random effects. In fact, as in the case of the gravity model, the three models (the simple OLS model, the fixed effects model and the random effects model) generate only quantitative differences.

The estimates for other coefficients show the same pattern as in the gravity model. Especially, as in the gravity model, the impact of exchange rate volatility turns out to be negative, regardless of the time period or the estimation method. In

addition, it declines in sub-period II and rises back in sub-period III. The fact that it is insignificant only in sub-period II is also found in the unilateral exports model as it was in the gravity model.

3. Conclusions

To determine the impact of exchange rate volatility on trade volumes in the Asia-Pacific region, this paper has estimated a gravity model, in which the dependent variable is the product of the exports of two trading countries, and a generalized gravity model (unilateral exports model) in which the dependent variable is the exports from one country to another.

The empirical tests using annual data for the period from 1980 to 2002 detect a significant negative impact of exchange rate volatility on the volume of exports. In addition, various tests using the data for sub-sample periods indicate that the negative impact had been weakened since 1989 when APEC had launched and surged again from 1997 when the Asian financial crisis broke out. This phenomenon was found in the two models, regardless of incorporating fixed effects or random effects.

Also, the test results show, as expected, that the GDP of the importing country, the depreciation of the exporting country's currency value, the use of the same language and the membership of APEC have positive impacts on exports, and that the distance between trading countries have negative impacts. In contrast, contradictory to our expectations, it was revealed that to share a border did not boost trade in the Asia-Pacific region for the period examined.

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Table 1-1. Same language group

Group	Countries
1	Australia, Canada, New Zealand, Singapore, US
2	Indonesia, Malaysia
3	Chile, Mexico

Table 1-2. Countries sharing the border

Group	Countries
1	Canada and the U.S.
2	Indonesia and Malaysia
3	Mexico and the U.S.

Table 1-3. APEC Membership

Year of Joining	APEC Members
1989	Australia, Canada, Indonesia, Japan, Korea, Malaysia, New Zealand, Philippines, Singapore, Thailand, US
1992	Chile
1993	Mexico, Papua New Guinea

Table 2-1. Regression Results for the gravity model (Simple OLS pooled data model)

Variable (Coefficient)	**Whole period** 1980~2002	**Sub-period I** Pre-APEC 1980~1988	**Sub period II** Post-APEC Pre-crisis 1989~1996	**Sub period III** Post-crisis 1997~2002
Constant (β_0)	12.673** (16.859)	12.665** (8.798)	12.494** (9.565)	16.600** (11.283)
GDP (β_1)	1.717** (57.446)	1.794** (32.106)	1.601** (33.225)	1.742** (37.817)
DEXR(β_2)				
VOL(β_3)	-0.601** (-7.657)	-0.783** (-5.127)	-0.510** (-3.618)	-1.009** (-6.887)
DIST(β_4)	-2.619** (-31.693)	-2.764** (-17.359)	-2.391** (-18.208)	-2.632** (-21.126)
BORD(β_5)	-3.362** (-8.641)	-4.652** (-6.377)	-2.516** (-4.047)	-2.388** (-3.995)
LANG(β_6)	2.188** (11.965)	2.703** (7.953)	1.898** (6.488)	1.536** (5.307)
APEC(β_7)	1.466** (6.461)		1.707** (6.126)	
TREND(β_8)	-0.078** (-4.572)	-0.121** (-2.732)	-0.114** (-2.171)	-0.262** (-4.456)
R^2	0.700	0.629	0.714	0.793
Adjusted R^2	0.699	0.626	0.711	0.790

Notes: 1) Numbers in parentheses are t-statistics; 2) One asterisk indicates statistical significance at the 10 percent significance level, and two asterisks indicate statistical significance at the 5 percent significance level.

Table 2-2. Regression Results for the gravity model (Fixed effect model)

Variable (Coefficient)	**Whole period** 1980~2002	**Sub-period I** Pre-APEC 1980~1988	**Sub period II** Post-APEC Pre-crisis 1989~1996	**Sub period III** Post-crisis 1997~2002
GDP (β_1)	2.213** (19.513)	2.225** (10.488)	2.571** (12.186)	2.370** (7.029)
VOL(β_3)	-0.082** (-2.476)	-0.099** (-2.128)	-0.012 (-0.279)	-0.074* (-1.790)
APEC(β_7)	0.384** (4.237)		0.016 (0.205)	
TREND(β_8)	-0.052** (-4.817)	-0.155** (-6.973)	-0.021 (-0.853)	-0.135** (-6.471)
R^2	0.958	0.978	0.988	0.991
Adjusted R^2	0.956	0.975	0.986	0.990

See the notes to Table 2-1.

Table 2-3. Regression Results for the gravity model (Random effects model)

Variable (Coefficient)	**Whole period** 1980~2002	**Sub-period I** Pre-APEC 1980~1988	**Sub period II** Post-APEC Pre-crisis 1989~1996	**Sub period III** Post-crisis 1997~2002
Constant (β_0)	11.337** (4.439)	12.133** (3.450)	11.079** (3.956)	15.433** (6.560)
GDP (β_1)	1.938** (23.772)	1.872** (14.726)	1.854** (17.196)	1.779** (17.915)
VOL(β_3)	-0.096** (-2.867)	-0.121** (-2.648)	-0.020 (-0.473)	-0.097** (-2.298)
DIST(β_4)	-2.523** (-8.414)	-2.505** (-5.963)	-2.425** (-7.510)	-2.553** (-9.659)
APEC(β_7)	0.425** (4.658)		0.014 (0.182)	
TREND(β_8)	-0.032** (-3.552)	-0.123** (-7.604)	0.048** (2.842)	-0.111** (-7.446)
R^2	0.958	0.978	0.986	0.989
Adjusted R^2	0.958	0.978	0.986	0.989

See the notes to Table 2-1.

Table 3-1. Regression Results for the unilateral exports model (Simple OLS pooled data model)

Variable (Coefficient)	**Whole period** 1981~2002	**Sub-period I** Pre-APEC 1981~1988	**Sub period II** Post-APEC Pre-crisis 1989~1996	**Sub period III** Post-crisis 1997~2002
Constant (β_0)	-7.711 (-0.679)	62.480* (1.940)	-29.542 (-0.909)	189.194** (4.967)
GDP (β_1)	0.890** (70.981)	0.899** (37.762)	0.851** (45.318)	0.936** (47.728)
DEXR(β_2)	0.609** (3.952)	1.541** (5.137)	0.233 (0.743)	0.113 (0.579)
VOL(β_3)	-0.216** (-8.388)	-0.328** (-6.436)	-0.168** (-3.614)	-0.368** (-7.281)
DIST(β_4)	-1.257** (-45.031)	-1.380** (-25.628)	-1.149** (-27.618)	-1.206** (-28.208)
BORD(β_5)	-1.065** (-8.150)	-1.716** (-6.851)	-0.702** (-3.610)	-0.650** (-3.254)
LANG(β_6)	0.502** (7.843)	0.572** (4.678)	0.436** (4.574)	0.442** (4.443)
APEC(β_7)	0.513** (7.000)		0.458** (5.102)	
TREND(β_8)	0.011* (1.888)	-0.024 (-1.485)	0.021 (1.310)	-0.088** (-4.615)
R^2	0.782	0.743	0.808	0.842
Adjusted R^2	0.780	0.739	0.805	0.839

Notes: 1) Numbers in parentheses are t-statistics; 2) One asterisk indicates statistical significance at the 10 percent significance level, and two asterisks indicate statistical significance at the 5 percent significance level.

Table 3-2. Regression Results for the unilateral exports model (Fixed effect model)

Variable (Coefficient)	**Whole period** 1981~2002	**Sub-period I** Pre-APEC 1981~1988	**Sub period II** Post-APEC Pre-crisis 1989~1996	**Sub period III** Post-crisis 1997~2002
GDP (β_1)	1.027** (13.284)	1.757** (8.528)	1.108** (7.758)	2.188** (8.993)
DEXR(β_2)	0.273** (3.154)	0.275** (2.090)	-0.011 (-0.100)	0.039 (0.609)
VOL(β_3)	-0.063** (-4.120)	-0.071** (-2.936)	-0.013 (-0.659)	-0.037* (-1.956)
APEC(β_7)	0.230** (5.479)		-0.006 (-0.163)	
TREND(β_8)	0.023** (5.157)	-0.063** (-4.884)	0.062** (6.461)	-0.064** (-7.459)
R^2	0.935	0.960	0.978	0.986
Adjusted R^2	0.932	0.954	0.975	0.983

See the notes to Table 3-1.

Table 3-3. Regression Results for the unilateral exports model (Random effects model)

Variable (Coefficient)	**Whole period** 1981~2002	**Sub-period I** Pre-APEC 1981~1988	**Sub period II** Post-APEC Pre-crisis 1989~1996	**Sub period III** Post-crisis 1997~2002
Constant (β_0)	-44.480** (-5.745)	49.445** (2.967)	-133.596** (-9.275)	83.552** (6.183)
GDP (β_1)	0.902** (16.522)	0.951** (10.329)	0.851** (12.249)	0.975** (12.951)
DEXR(β_2)	0.271** (3.105)	0.235* (1.779)	0.012 (0.104)	0.045 (0.677)
VOL(β_3)	-0.067** (-4.382)	-0.089** (-3.721)	-0.019 (-0.917)	-0.050** (-2.571)
DIST(β_4)	-1.077** (-7.384)	-1.067** (-5.265)	-1.050** (-6.948)	-1.164** (-7.898)
APEC(β_7)	0.244** (5.786)		0.009 (0.236)	
TREND(β_8)	0.0272** (6.959)	-0.020** (-2.417)	0.072** (9.894)	-0.037** (-5.390)
R^2	0.931	0.953	0.974	0.982
Adjusted R^2	0.931	0.953	0.974	0.982

See the notes to Table 3-1.