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What Happened to Asian Exports During the Crisis?

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After the large exchange rate depreciations following the 1997 East Asian crisis, export volumes from East Asian countries responded with a notable lag. Two main explanations for this lag have been proposed: that contraction in domestic credit affected supply of exports and that "competitive depreciation" by other countries neutralized the effects on demand for exports. This paper considers the plausibility of these two mechanisms using a new monthly database of exports of selected industries. The results indicate that "competitive depreciation" played an important role in the propagation of the East Asian crisis through the trade channel, even at a monthly frequency. [JEL F1, F14]

During the financial crisis in 1997–98, export revenues of many East Asian countries did not increase in spite of massive depreciation by the afflicted economies.[1] The depreciations led to sharp declines in dollar-denominated export prices with only modest increases in export volumes. The absence of a quick response of exports to depreciation played a key role in prolonging the East Asian crisis and is puzzling from an analytical point of view.

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[1]Henceforth "Asia" will refer to the following six economies in this sample: Hong Kong SAR, Indonesia, Malaysia, Singapore, South Korea, and Thailand. China, Philippines, and Taiwan Province of China could not be included in the sample because of lack of data.

Several plausible factors could underlie the sluggish response of East Asian exports to the huge depreciations following the currency crisis. First, demand for Asian exports may have been price inelastic in the short run. Second, the contraction of credit to the private sector may have limited the supply of exports. Third, demand may have slowed down in response to an exogenous shift in world demand. Finally, demand for exports in a single country could have slowed because of "competitive depreciations" by others. These different hypotheses lead to very different interpretations of the Asian crisis, its propagation mechanisms, and the policy recommendations for recovery. This paper considers these alternative hypotheses. To address this question, a new monthly data set on price and quantity of exports for selected commodity groups is constructed. Using these data, demand and supply for Asian exports are analyzed within a vector cointegration framework of estimation.

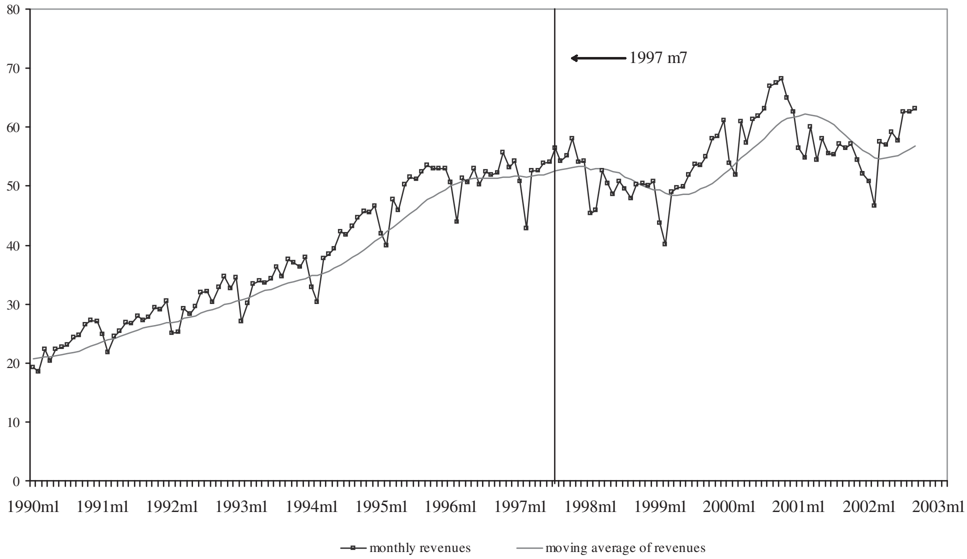
The empirical results indicate that the demand for East Asian exports is very sensitive to prices—both own and competitors'—and to world growth rate. The supply prices of exports are generally insensitive to own quantities but very sensitive to nominal exchange rate changes. Typically, a nominal depreciation decreases the U.S. dollar-denominated export price, thereby increasing the demand for the depreciating country's exports. However, depreciation of every export competitor's currency weakens the positive demand effect of the initial depreciation such that the overall effect is a fall in export prices with a very modest increase in export volumes. In this context, evidence of a correspondence between export supply price and contraction of credit to the private sector is somewhat mixed.

The importance of trade in the transmission of the East Asian crisis has been studied both empirically and theoretically. Empirically, Glick and Rose (1999); Caramazza, Ricci, and Salgado (2000); and Van Rijckeghem and Weder (1999) look at market shares in trade for evidence of a contagion effect through the trade channel. These authors conclude that the trade shares are important in explaining currency crises in general (see, for instance, Glick and Rose, 1999) and the crisis in East Asia in particular.[2] Abeysinghe (2001) uses a structural vector auto regression model during 1983–1998 at quarterly frequency to analyze the transmission of recessions across 12 Asian economies through their trade links. Thus, looking at trade shares constitutes an important first step in analyzing the role of trade in crises. However, for explicit comparisons of the alternative explanations behind export slowdown, it becomes necessary to estimate the underlying structural demand and supply equations, which is done in this paper. Moreover, this paper is among the few studies on the East Asian currency crisis that uses a unique database with countries' disaggregated trade data at a monthly frequency.[3] The use of high-frequency data permits the analysis of the relative speeds of adjustment of export volumes and prices in response to external shocks. Gerlach and Smets (1995) formalize the

[2]However, not all economists agree that trade has played an important role. For instance, Kaminsky and Reinhart (2000) argue that the trade links between East Asian countries are not strong enough to explain the spread of the crisis.

[3]Barth and Dinmore (1999) also study the movements of trade prices and aggregate volumes in East Asia during the crisis at monthly frequency. They find that although the export prices of the East Asian countries (Hong Kong SAR, Indonesia, Korea, Singapore, Taiwan Province of China, and Thailand) fell by 4.8 percent in 1997 and 9.1 percent in 1998, their aggregate export volumes went up by 8.8 percent in 1997 and only 0.7 percent in 1998.

Figure 1. Monthly East Asian Exports
(In billion U.S. dollars)



idea— in a theoretical model—that strong competition in the external sector can be responsible for the transmission of a currency crisis. This paper is an empirical validation of the same idea in the context of East Asia.

I. Overview of Aggregate East Asian Exports

The export performances of the six East Asian countries in this study were remarkable between 1981 and 1995. On average, export revenues grew by 12 percent a year, with continuous positive year-to-year growth rates, except in 1983 and 1985. Starting in 1995, however, export growth rates declined—exports became virtually stagnant in 1996 and 1997, declined in 1998, and recovered only after the second half of 1999 (Figure 1).[4]

The decrease in export revenues toward the end of the 1990s was primarily led by a decline in export prices.[5] Export prices peaked in 1995 and sagged continuously

[4]In order to control for the seasonality of export revenues, both the actual monthly export revenues and a moving annual average are reported. The decline in exports from the first half of 2001 reflects in part a slowdown in world economic activity starting in 2001.

[5]Several authors have explored the export slowdown at the end of 1995. Fernald, Edison, and Loungani (1999) show that the Chinese effective devaluation in 1994 did not change the trade shares in the rest of Asia and hence did not cause the Asian crisis. Corsetti, Pesenti, and Roubini (1998a and 1998b) suggest that the sharp appreciation of the U.S. dollar relative to the Japanese yen and European currencies since the second half of 1995 led to deteriorating cost-competitiveness in most Asian countries whose currencies were effectively pegged to the dollar. In addition, there was a price war in the electronic sector, which accounted for an important export share in several Asian countries. The weak economic growth in Japan and the over-investment in these countries were the cause of the price war in 1995. This industry is included in this study in recognition of its importance in the development of the crisis. Finally, Chinn (1998) finds that while some Asian currencies, like those of Malaysia, Philippines, and Thailand, were overvalued before the crises, some others, like the Korean won, were not.

thereafter, while export volumes continued to grow before the crisis and slowed gradually after September 1997 (Figures 2 and 3). Figure 3 presents the East Asian export data in a price-quantity space, which allows analysis of the actual price-quantity equilibrium points over time. Two distinct patterns are observed. In the period 1989 until June 1995 prices and volumes expanded continuously, with a

Figure 2. East Asian (Log) Export Prices and (Log) Volumes

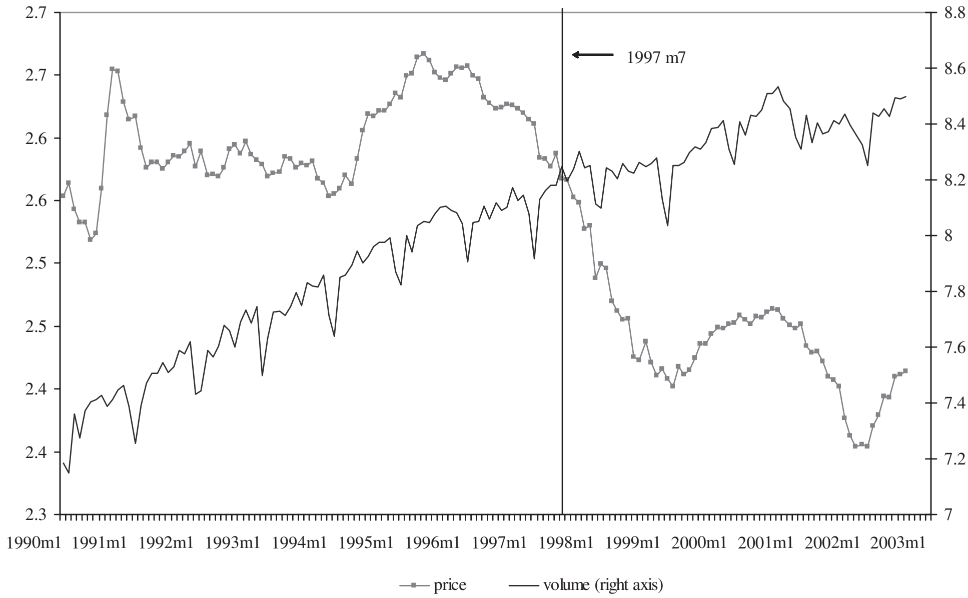


Figure 3. East Asian Export Price Versus Export Volume

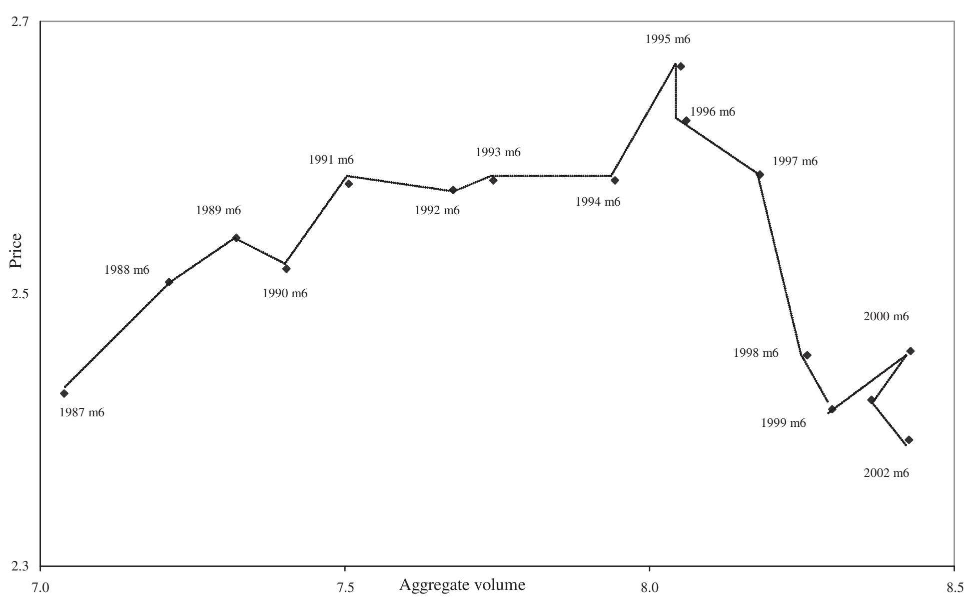
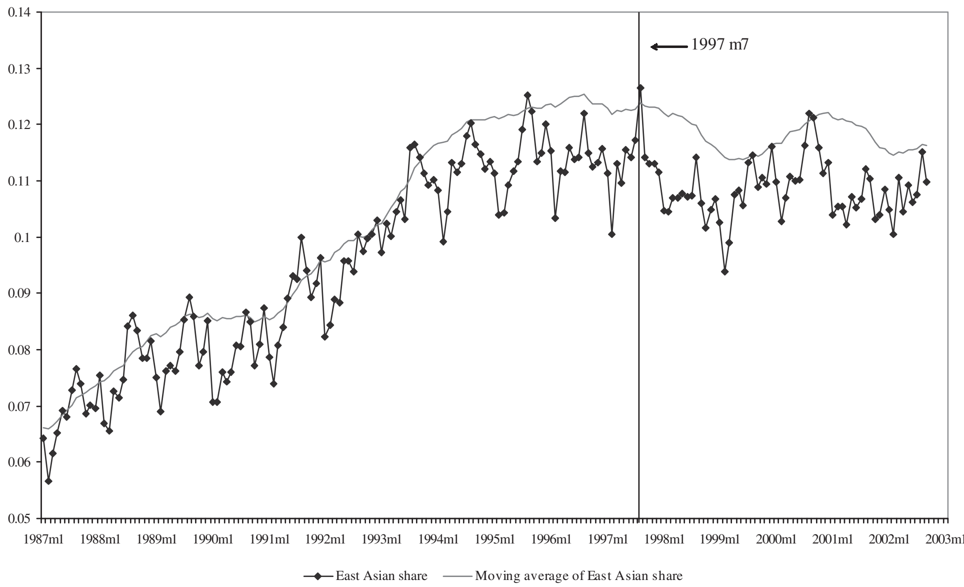


Figure 4. East Asian Share in World Imports



sharp spike in price during the first semester of 1995. Thereafter, export prices fell almost continuously with little response in volumes, especially after June 1997. The last period is the most striking and is the focus of this analysis.

Figure 4 shows that the share of East Asian exports in total world imports increased almost without interruption between 1987 and 1995, but started declining in 1996. This supports the view that the export decline was specific to East Asia and cannot be explained by worldwide demand slowdown, and hence emphasizes the need to focus on this region.[6]

II. The Model and Estimation Methodology and Regression Results

Data and Model

The analysis focuses on disaggregated Asian manufacturing exports.[7] Three broad export groups are considered (chemicals, manufactures, and machinery) corresponding to Standard International Trade Classification (SITC) codes 5, 6, and 7, the sum of which represents over 70 percent of exports for Korea, Malaysia, and Singapore, and 60 percent for Thailand. In addition to these three broad categories, three other specific industries (vehicles, clothing, and semiconductors), corresponding to SITC codes 78, 84, and 776, respectively, are also considered.[8] These subindustries have

[6]Moreover, as shown in Table 1 in the next section, the share of world import demand for the products that were exported by these countries in total world import demand did not decline during this period, implying that the Asian export decline did not result from a switch of world demand toward other commodities.

[7]Muscatelli, Stevenson, and Montagna (1994) provide evidence of the increasing importance of manufacturing exports (relative to traditional or primary exports) in Southeast Asia in the 1990s.

[8]For Korea and Thailand, data on road vehicles (SITC 78) could not be retrieved. Instead we included data on passenger cars (SITC 7812).

Table 1. Share of Specific Commodity Sections Out of Total Exports
(In percent)

		Chemicals	Manufactures	Machinery	Vehicles	Clothing	Semi-conductors
Hong	1995	4.0	11.1	29.4	0.0	31.9	7.5
Kong	1998	3.5	9.5	24.4	0.0	39.3	9.5
SAR	2000	3.4	8.7	24.5	0.0	42.2	10.7
Indonesia	1995	3.4	23.0	8.4	0.8	7.4	0.3
	1998	4.3	18.0	9.5	0.6	5.4	0.4
	2000	5.1	19.9	17.3	0.8	7.6	1.2
Korea	1995	7.2	22.0	52.5	8.1	4.0	15.5
	1998	7.7	21.6	49.2	8.9	3.5	14.7
	2000	8.0	17.6	58.2	9.0	2.9	14.3
Malaysia	1995	3.0	8.8	55.1	0.6	3.1	17.9
	1998	3.5	8.3	59.2	0.7	3.1	19.0
	2000	3.8	6.9	62.5	0.4	2.3	19.1
Singapore	1995	6.0	6.3	65.6	1.0	1.2	15.6
	1998	6.5	4.5	66.4	0.8	1.3	17.7
	2000	7.0	3.8	67.4	0.7	1.3	25.0
Thailand	1995	4.4	11.7	33.6	1.3	8.9	5.2
	1998	4.5	11.7	40.8	2.4	6.6	5.9
	2000	5.9	11.7	43.7	3.6	5.5	8.5
Memorandum item: World demand for specific commodities in total world demand							
	1995	10.0	16.1	37.8	2.6	8.7	3.4
	1998	9.9	15.0	40.3	2.6	9.1	3.6
	2000	9.5	13.7	40.8	3.2	8.6	3.5

played important roles in Asian trade.[9] Clothing, being labor-intensive, has traditionally been a very important export product for developing countries at the initial stages of industrialization, making this sector an interesting case for studying the effects of depreciation. The semiconductor industry is relatively new but it is already very important in most of East Asia. It is characterized by large initial investment, reliance on large volumes to cover the initial outlays, and a very high rate of technological innovation, making it highly cyclical and sensitive to price competition.[10] The road vehicle industry is also very important for the development strategy of Korea and Indonesia. The original sources for all the data are described in detail in the appendix.

Table 1 reports the share of particular commodity exports as a percentage of total exports. Manufactures and machinery items constitute a significant proportion

[9]For similar reasons Fernald, Edison, and Loungani (1999) focused on semiconductors and clothing in their study of Chinese exports.

[10]For a description of the highly competitive nature of the semiconductor industry, see Macher, Mowery, and Hodges (1999). This industry includes several products—for example, integrated circuits and memory devices. Memory devices are highly standardized and competition is mainly through price and timely delivery. The external market for memory devices has had three characteristic phases—the United States dominated this market prior to 1985, Japan dominated it between 1985 and 1990, and since 1990, the Newly Industrialized Economies have been increasing their market shares.

of total exports for all the sample countries. Among machinery items, semiconductors account for a large proportion of exports for Korea, Malaysia, and Singapore. However, these shares did not change much between the precrisis (1995) and postcrisis (1998) periods. Table 1 also confirms that the total world demand for the specific commodities exported by the Asian countries did not decline during 1995 and 1998, implying that the export decline was specific to Asia and not a result of a switch in composition of world import demand.

The aggregate data hide important heterogeneity in the composition and destination of exports. Tables 2 through 4 report the percentage of commodity-specific exports that each Asian country exports to its five Asian competitors (Table 2), to the United States (Table 3), and to Japan (Table 4). Table 2 shows that these countries engaged in substantial intra-Asian trade. After the crisis, the share of Asian trade declined for almost all commodity groups. The share of many of these commodities to the United States (Table 3) and Japan (Table 4) also declined after the crisis, implying that the depreciations did not lead to a significant increase in foreign demand for the Asian exports.

The sample data set is not readily available in any existing database at a monthly frequency. The database has been constructed from the original national sources. Unfortunately, for many commodity groups in the sample, only data on export revenues are available—that is, the data are not disaggregated into export prices and volumes for each commodity analyzed in the paper. Therefore, aggregate price data

Table 2. Asian Exports to Each Other: Percentage of Specific Exports to Asian Partners

(In percentage of total exports of specific commodities)

		Chemicals	Manufactures	Machinery	Vehicles	Clothing	Semi-conductors
Hong	1995	10.4	10.1	18.4	7.7	0.9	32.1
Kong	1998	7.3	8.1	12.3	1.6	0.3	20.8
SAR	2000	12.1	7.6	14.3	14.1	0.4	22.2
Indonesia	1995	32.1	25.8	42.1	55.3	4.3	62.7
	1998	31.6	22.0	42.6	31.0	2.5	54.6
	2000	30.9	23.0	41.5	29.0	3.4	44.0
Korea	1995	25.9	27.4	17.9	5.4	1.6	30.0
	1998	16.6	19.2	14.9	1.1	2.5	30.7
	2000	18.3	19.2	13.4	3.0	1.1	29.2
Malaysia	1995	46.0	38.7	34.3	27.2	7.4	34.4
	1998	36.7	36.7	28.6	14.9	4.9	31.4
	2000	41.1	34.9	32.4	27.3	4.8	43.6
Singapore	1995	46.2	53.2	33.7	36.2	8.0	41.9
	1998	37.1	43.8	27.8	23.2	5.0	38.3
	2000	34.7	48.3	33.7	37.9	5.5	40.3
Thailand	1995	53.3	25.9	34.4	15.2	9.4	40.5
	1998	34.7	19.8	23.4	5.9	1.9	27.2
	2000	38.3	19.2	24.6	7.8	2.0	29.4

Table 3. Asian Exports of Specific Commodities to the United States
(In percentage of total exports of specific commodities)

		Chemicals	Manufactures	Machinery	Vehicles	Clothing	Semi-conductors
Hong	1995	0.9	9.6	19.2	4.3	48.1	29.1
Kong	1998	1.0	12.4	17.6	1.3	47.1	26.8
SAR	2000	1.4	15.0	18.7	8.0	45.5	28.7
Indonesia	1995	3.4	7.4	24.4	11.2	32.5	23.5
	1998	5.4	11.4	15.2	10.4	45.3	14.8
	2000	6.2	10.0	14.7	8.0	42.6	7.1
Korea	1995	4.8	8.4	25.7	22.1	36.8	34.1
	1998	6.9	12.9	21.6	18.9	44.4	27.0
	2000	6.6	13.0	27.2	37.3	48.6	22.3
Malaysia	1995	9.3	6.8	29.3	3.2	48.7	33.5
	1998	10.3	8.1	28.5	7.7	54.2	30.9
	2000	10.0	8.8	25.7	5.3	53.3	19.7
Singapore	1995	7.6	2.3	24.1	3.9	53.4	20.3
	1998	6.5	3.6	25.5	5.1	54.0	20.8
	2000	5.9	4.8	21.6	3.0	56.8	18.6
Thailand	1995	2.3	13.6	20.6	6.3	24.9	21.8
	1998	2.7	17.8	24.3	4.0	50.1	23.1
	2000	3.5	18.6	20.4	2.7	54.0	21.0

Table 4. Asian Exports of Specific Commodities to Japan
(In percentage of total exports of specific commodities)

		Chemicals	Manufactures	Machinery	Vehicles	Clothing	Semi-conductors
Hong	1995	2.8	2.4	4.6	0.3	3.2	5.1
Kong	1998	2.0	0.9	5.8	0.3	1.0	7.0
SAR	2000	1.6	1.6	5.0	1.1	0.7	4.5
Indonesia	1995	8.9	22.7	7.6	6.0	10.0	7.1
	1998	7.3	13.0	16.2	8.7	4.5	14.0
	2000	8.9	17.9	15.7	14.5	3.9	29.7
Korea	1995	10.2	12.9	8.5	1.5	37.0	15.3
	1998	7.9	8.7	5.7	1.0	20.6	8.7
	2000	8.3	9.4	8.3	1.2	21.4	11.4
Malaysia	1995	10.8	14.7	9.4	3.8	5.0	7.9
	1998	9.7	11.5	8.7	3.2	4.4	6.8
	2000	11.1	15.0	10.9	4.0	5.6	8.3
Singapore	1995	5.3	3.5	7.6	3.2	4.3	8.6
	1998	5.0	4.6	6.4	5.1	3.2	6.3
	2000	5.2	3.5	6.6	4.7	2.3	6.3
Thailand	1995	8.9	11.3	15.3	6.0	9.9	16.5
	1998	10.2	9.3	12.6	7.1	8.0	18.0
	2000	10.4	12.7	14.3	6.3	7.2	14.4

for the relevant industries are used to deflate revenues and obtain export volumes. Country- and industry-specific competitors' price indices are constructed as weighted sums. Weights are constructed as the market shares of each Asian competitor in the total Asian market by particular industry. The construction of the data set is described in the appendix.

We estimate a standard reduced-form long-run equation of demand for exports, specified as follows (in logarithmic form):[11]

$$X_{ijt} = \alpha_{ij}^{c} + \alpha_{ij}^{op} P_{ijt} + \alpha_{ij}^{cp} P_{ijt}^{c} + \alpha_{ij}^{y} Y_{t}^{w} + v_{ijt}^{d}, \tag{1}$$

where α_{ij}^{c} = constant term in the demand equation; X_{ijt} = volume of the ith commodity exported by the jth country at time t; P_{ijt} = export price of the ith commodity (in dollars) exported by the jth country at time t; P_{ijt}^{c} = competitors' export price for commodity i as faced by country j at time t; Y_{t}^{w} = world real import demand at time t; and v_{ijt}^{d} = residual term in the demand regression.

Based on standard economic theory, an increase in own price should decrease the demand for own exports, while an increase in competitors' price or world demand should increase it $\left(\text{i.e., } \alpha_{ij}^{op} < 0 \text{ and } \alpha_{ij}^{cp}, \alpha_{ij}^{y} > 0\right)$.

The reduced-form long-run (inverted) supply equation is given by

$$P_{ijt} = \beta_{ij}^{c} + \beta_{ij}^{v} X_{ijt} + \beta_{ij}^{e} E_{jt} + \beta_{ij}^{dc} DC_{jt} + \beta_{ij}^{w} I_{jt} + v_{ijt}^{s}, \tag{2}$$

where β_{ij}^{c} = constant term in the supply equation; E_{jt} = nominal exchange rate in country j at time t; DC_{jt} = credit to the private sector in country j at time t; I_{jt} = domestic input price in country j at time t; and v_{ijt}^{s} = residual in the supply regression.

The export supply curve is expected to have a nonnegative slope $\left(\beta_{ij}^{v} \geq 0\right)$. A nominal depreciation should reduce the export supply price expressed in dollars $\left(\beta_{ij}^{e} < 0\right)$, although the extent of price decline depends on the pass-through elasticity.[12] An increase in private sector credit is expected to facilitate export supply, thereby reducing its price $\left(\beta_{ij}^{dc} < 0\right)$.[13] Finally, an increase in domestic input price is expected to manifest in an increase in the export price $\left(\beta_{ij}^{w} > 0\right)$.

Time Series Properties and Single Equation Approach

As a first step the stationarity of the data series is evaluated. The Augmented Dickey-Fuller (1979) and Phillips-Perron (1988) tests are both used to check for the

[11]See Goldstein and Khan (1985) for a discussion on specifications of trade equations. Note that although in principle own and competitors' prices should enter the demand equation as a ratio (standard assumption of price homogeneity), we enter them separately because P_{ijt}^{c} is only a close but not precise proxy for competitors' price.

[12]The empirical literature on whether nominal devaluation results in real devaluation is quite comprehensive. See Reinhart (1995) and the references therein.

[13]The sign of the coefficient on private sector credit also tests the possibility that a credit crunch could have slowed down export supply during the crisis. While some authors (e.g., Ghosh and Ghosh, 1999; and Ferri and Kang, 1999) have analyzed the impact of a credit crunch on the entire economy, we focus on its effect on specific exports.

presence of unit roots in the variables used in estimation.[14] For each of the six series in every country, the existence of unit roots cannot be rejected by at least one of the two tests, and sometimes by both, at the 1 percent level of significance. For the same variables, however, the existence of a unit root in the first difference is always rejected, indicating that the variable series are integrated of order one (I(1)).[15]

Next, the individual export demand and supply equations are tested for the existence of co-integration, using residual-based Augmented Dickey-Fuller tests given in Engle and Yoo (1987).[16] Given that the sample residuals exhibit AR(1), the long-run co-integration relationships are estimated using generalized least squares (GLS), with the Cochrane-Orcutt methodology. Time trends are also used in the regression, but not restricted to the co-integrated relationships. The results confirm the existence of co-integration for most commodities at the 5 percent level of significance. The demand curves generally confirm the standard negative relationship of export volume with own price and positive relationship with competitors' price and world demand (Table 5).[17] The individual export supply equations estimated indicate a flat supply curve in most cases, although the export price coefficients are sometimes negative (Table 6). While the export supply price has a positive and significant relationship with domestic input price and negative and significant relationship with the nominal exchange rate, the coefficient of private credit entering the supply equation is generally insignificantly different from zero.

The results for the individual long-run demand equations are summarized as follows: (i) own price elasticity is negative and significant but generally less than 1; (ii) competitors' price elasticity is positive and significant and generally greater than 1;[18] and (iii) world demand elasticity is usually greater than 1 and significant. The results for the long-run supply equations are these: (i) the supply price is relatively inelastic to quantity; (ii) the pass-through elasticity between nominal exchange rate and export supply price is negative and significant; (iii) there is a positive and significant relationship between domestic input price and export price; and (iv) the effect of private credit on export price is insignificant.

In addition, the individual long-run equations are used for the following robustness tests and sensitivity analyses: (i) the existence of price homogeneity in the demand equation; and (ii) a structural break test in both equations. The hypothesis of price homogeneity in the demand equations is generally rejected. The few cases

[14]The Bayesian Information Criterion is used to determine the optimal lag length.

[15]Notable exceptions are export volume of manufactures and clothing in Hong Kong SAR, chemicals and semiconductors in Indonesia, manufactures and clothing in Korea, vehicles and clothing in Malaysia, and chemicals and miscellaneous manufactures in Singapore. These series appeared to be trend-stationary.

[16]The details of this methodology, including the critical values for the significance of co-integration, are in Maddala and Kim (1999). Note however that the sample spans only 11 years, which may be too short to establish a "long-run" relationship. Hence, the power of these tests would generally be low.

[17]The exception is the case of Hong Kong SAR, which shows a negatively sloping demand curve.

[18]Compared with these results, Muscatelli, Stevenson, and Montagna (1994) found, for a sample of Asian countries, that the long-run elasticity of export demand with respect to own price relative to competitors' price is generally much greater than 1. Noting that estimation of the export commodities in this study is done at a more disaggregated level, own price and competitors' price are allowed to enter the demand equation independently, although price homogeneity is tested as a robustness check (see below).

Table 5. Co-integration Results for Single Equation Demand Estimation

Country	Industry	Co-integration at the 5 Percent Level of Significance	Coefficient[1] Own price	Competitors' price	World demand
Hong Kong SAR	Chemicals	YES	2.0	0.0	1.1
	Manufactures	YES	1.0	0.0	1.0
	Machinery	YES	1.9	0.7	0.9
	Semiconductors	YES	0.0	1.4	0.7
	Clothing	YES	1.3	0.0	0.0
Korea	Chemicals	YES	–1.2	1.6	0.6
	Manufactures	YES	0.0	1.0	1.0
	Machinery	NO	–0.4	1.1	1.7
	Passenger cars	NO	0.0	7.5	2.2
	Semiconductors	YES	–0.8	0.0	0.5
	Clothing	YES	–3.1	0.0	0.7
Singapore	Chemicals	NO	–1.0	0.7	1.0
	Manufactures	NO	0.5	0.8	1.3
	Machinery	YES	–0.6	0.0	1.3
Thailand	Chemicals	YES	0.0	0.0	1.3
	Manufactures	YES	–0.7	0.7	1.1
	Machinery	YES	–0.6	1.5	1.0
	Passenger cars	YES	0.0	0.0	2.1
	Semiconductors	YES	–0.6	1.9	0.6
	Clothing	NO	–0.6	1.2	0.5
Indonesia	Chemicals	YES	–0.9	0.6	1.0
	Manufactures	YES	–0.9	0.0	0.6
	Machinery	YES	–0.9	0.0	0.0
	Road vehicles	YES	–0.9	2.0	0.7
	Semiconductors	NO	0.0	0.0	0.0
	Clothing	YES	–0.7	0.0	0.0
Malaysia	Chemicals	YES	–0.6	1.2	0.6
	Manufactures	YES	–0.9	1.6	0.7
	Machinery	YES	–0.8	2.5	0.9
	Road vehicles	YES	–0.8	0.0	1.0
	Semiconductors	YES	–0.8	2.1	0.4
	Clothing	NO	–1.2	2.0	0.9

[1]Actual coefficient values are reported only if the variable is significantly different from zero at the 5 percent level of significance.

in which this hypothesis is not rejected are when price indices are defined imprecisely (due to lack of data on actual prices). With some exceptions (e.g., Indonesia), results do not reveal structural breaks.[19]

[19]The Chow predictive test (Greene, 1997, Chapter 7) is used to check for the possibility of a structural break in demand or supply in July 1997, when the financial crisis started, and in December 1997, when Korea devalued. Andrews' (1993) method of testing for a structural break (when the break point is unknown) is also used, restricting the breakpoint to between July 1997 and December 1997. The results indicate no structural break in demand or supply functions.

Table 6. Co-integration Results for Single Equation Supply Estimation

Country	Industry	Co-integration at the 5 Percent Level of Significance	Coefficient[1]			
			Export volume	Private credit	Nominal exchange rate	Input price
Hong Kong SAR	Chemicals	YES	0.0	0.0	0.0	1.1
	Manufactures	YES	0.0	0.0	0.0	1.1
	Machinery	YES	0.0	0.0	0.0	1.1
	Semiconductors	YES	0.0	–0.3	0.0	2.1
	Clothing	YES	0.0	0.0	0.0	1.0
Korea	Chemicals	YES	0.0	0.0	–0.3	0.9
	Manufactures	YES	0.0	0.0	–0.4	0.7
	Machinery	YES	0.0	0.0	–0.2	0.6
	Passenger cars	YES	0.0	0.0	–0.3	0.9
	Semiconductors	YES	0.0	0.0	–0.3	0.9
	Clothing	YES	0.0	0.0	–0.3	1.0
Singapore	Chemicals	YES	0.0	0.0	–0.8	0.2
	Manufactures	YES	0.0	0.0	–0.9	0.0
	Machinery	YES	0.0	0.0	–0.7	0.0
Thailand	Chemicals	YES	0.0	0.0	–0.4	1.2
	Manufactures	YES	0.0	0.0	–0.4	0.9
	Machinery	YES	–0.1	0.0	–0.3	0.0
	Passenger cars	YES	0.0	0.0	–0.3	0.0
	Semiconductors	YES	0.0	0.0	–0.3	0.0
	Clothing	YES	0.0	0.0	–0.4	0.8
Indonesia	Chemicals	YES	–0.1	0.0	0.0	–0.9
	Manufactures	YES	–0.2	–0.2	0.3	–0.9
	Machinery	YES	–0.1	0.0	0.3	–0.9
	Road vehicles	YES	–0.1	0.0	0.0	–0.8
	Semiconductors	YES	0.0	–0.8	0.0	–1.3
	Clothing	YES	–0.1	0.0	0.0	–1.0
Malaysia	Chemicals	YES	–0.1	–0.3	–0.6	1.3
	Manufactures	YES	–0.1	–0.3	–0.7	1.3
	Machinery	YES	–0.9	–0.3	–0.6	1.3
	Road vehicles	YES	0.0	–0.4	–0.6	1.3
	Semiconductors	YES	–0.1	–0.3	–0.6	1.3
	Clothing	YES	0.0	–0.4	–0.6	1.3

[1]Actual coefficient values are reported only if the variable is significantly different from zero at the 5 percent level of significance.

The above results reveal a poor fit in some of the individual long-run relationships—the estimated demand and supply curves have perverse slopes in some cases (e.g., Hong Kong's export demand curves and Indonesia and Malaysia's export supply curves). This could be because the estimations suffer from relatively small sample sizes—as indicated above, the sample may be too short to capture long-run relationships. Mark and Sul (1999) have shown that there are sizable gains from pooling the data. Kao and Chiang (2000) have compared different estimation techniques for panel data in the presence of co-integration and have found that the dynamic generalized least squares (DGLS) outperforms both ordinary least squares (OLS) and fully modified OLS.[20] This supports the use of a panel estimation to analyze the above export demand and supply relationships, which is done in the next section.

Empirical Results: Panel Approach

Based on the confirmation of the existence of co-integration in a majority of the demand and supply equations, the long-run demand and supply are estimated in levels in a panel context, using the DGLS methodology of Stock and Watson (1989) as described in Campbell and Perron (1991). This methodology corrects for (i) serial correlation (as discussed above, the sample residuals exhibit AR(1)) using GLS; and (ii) endogeneity of the regressors by including lags and leads of changes in the explanatory variables. The long-run specification for the demand equation is

$$\begin{aligned} X_{ijt} &= \alpha_{ij}^{c} + \alpha_{ij}^{op} P_{ijt} + \alpha_{ij}^{cp} P_{ijt}^{c} + \alpha_{ij}^{y} Y_{t}^{w} + d_{ij}^{op}(L)\Delta P_{ijt} \\ &\quad + e_{ij}^{op}\left(L^{-1}\right)\Delta P_{ijt} + d_{ij}^{cp}(L)\Delta P_{ijt}^{c} + e_{ij}^{cp}\left(L^{-1}\right)\Delta P_{ijt}^{c} \\ &\quad + d_{ij}^{y}(L)\Delta Y_{t}^{w} + e_{ij}^{y}\left(L^{-1}\right)\Delta Y_{t}^{w} + \sum_{s=1}^{11} \lambda_{ijs} M_{s} + v_{ijt}^{d}, \end{aligned} \tag{3}$$

where M_s = monthly dummies that control for seasonal effects; $d_{ij}^{Z}(L) = \sum_{k} d_{ijk}^{Z} L^{Z}$ and $e_{ij}^{Z}\left(L^{-1}\right) = \sum_{k} e_{ijk}^{Z} L^{-k}$ for $Z = op, cp, y$, corresponding to the variables' own price, competitors' price, and world demand, respectively; and L is the lag operator while L^{-1} is the lead operator.[21]

The long-run specification for the supply equation is

$$\begin{aligned} P_{ijt} &= \beta_{ij}^{c} + \beta_{ij}^{v} X_{ijt} + \beta_{ij}^{e} E_{jt} + \beta_{ij}^{dc} DC_{jt} + \beta_{ij}^{w} I_{jt} + f_{ij}^{v}(L)\Delta X_{ijt} \\ &\quad + g_{ij}^{v}\left(L^{-1}\right)\Delta X_{ijt} + f_{ij}^{e}(L)\Delta E_{it} + g_{ij}^{e}\left(L^{-1}\right)\Delta E_{jt} + f_{ij}^{dc}(L)\Delta DC_{jt} \\ &\quad + g_{ij}^{dc}\left(L^{-1}\right)\Delta DC_{jt} + f_{ij}^{w}(L)\Delta I_{jt} + g_{ij}^{w}\left(L^{-1}\right)\Delta I_{jt} + \sum_{s=1}^{11} \mu_{ijs} M_{s} + v_{ijt}^{s}, \end{aligned} \tag{4}$$

[20]See Lane and Milesi-Ferretti (2000) for an application of panel dynamic ordinary least squares (DOLS).

[21]The integer k denotes the number of lags (or leads) and is chosen in the following manner: starting with a reasonable upper bound of k, on estimation, if the variable (with the highest possible lag) is significant, then k is chosen to be the upper bound. If the variable is not significant, the lag length is reduced further until the last included lag is significant in the estimation. A similar method is used to choose the optimum lead length.

where $f_{ij}^{Z}(L) = \sum_{k} f_{ijk}^{Z} L^{k}$ and $g_{ij}^{Z}\left(L^{-1}\right) = \sum_{k} g_{ijk}^{Z} L^{-k}$ for $Z = v, e, dc, w,$ corresponding to export volume, nominal exchange rate, private credit, and input price, respectively. Again, the optimum number of leads and lags is chosen as in the demand regression.

The specifications for short-run demand and supply are

$$\begin{aligned} \Delta X_{ijt} &= \gamma_{ij}^{c} + \gamma_{ij}^{d} ED_{ijt-1} + \gamma_{ij}^{s} ES_{ijt-1} + \gamma_{ij}^{op}(L)\Delta P_{ijt} + \gamma_{ij}^{cp}(L)\Delta P_{ijt}^{c} \\ &\quad + \gamma_{ij}^{y}(L)\Delta Y_{t}^{w} + \sum_{k}^{11} \eta_{ijk}^{d} M_{k} + \eta_{ijt}^{d}, \end{aligned} \tag{5}$$

$$\begin{aligned} \Delta P_{ijt} &= \delta_{ij}^{c} + \delta_{ij}^{d} ED_{ijt-1} + \delta_{ij}^{s} ES_{ijt-1} + \delta_{ij}^{v}(L)\Delta X_{ijt} + \delta_{ij}^{dc}(L)\Delta DC_{it} \\ &\quad + \delta_{ij}^{e}(L)\Delta E_{t} + \delta_{ij}^{w}(L)\Delta I_{ijt} + \sum_{k}^{11} \eta_{ijk}^{s} M_{k} + \eta_{ijt}^{s}. \end{aligned} \tag{6}$$

The terms ED_{ijt-1} and ES_{ijt-1} are the one-period-lagged error correction terms from the long-run demand and supply regressions, where

$$ED_{ijt} = X_{ijt} - \alpha_{ij}^{c} - \alpha_{ij}^{op} P_{ijt} - \alpha_{ij}^{cp} P_{ijt}^{c} - \alpha_{ij}^{y} Y_{t}^{w}, \tag{7}$$

$$ES_{ijt} = P_{ijt} - \beta_{ij}^{c} - \beta_{ij}^{v} X_{ijt} - \beta_{ij}^{dc} DC_{jt} - \beta_{ij}^{e} E_{jt} - \beta_{ij}^{w} I_{jt}. \tag{8}$$

Equations 3 to 6—corresponding to the long-run and short-run demand and supply equations—are estimated using GLS with the pooled data, after allowing for first-order autocorrelation in the error structure as well as heteroskedasticity across countries. The panel comprises exports from Hong Kong SAR, Indonesia, Korea, Singapore, and Thailand for the period March 1993 to July 2002.[22, 23] We drop Malaysia from the sample as it has very few observations overlapping with data for the other countries in this sample. Besides using monthly dummies to control for seasonality as before, country dummies are used to control for country-specific effects.

The panel estimation results are given in Table 7.[24] The results indicate a standard demand equation for Asian exports.[25] Price elasticity of demand for each export commodity is negative and significant at the 5 percent level of significance. Similarly, competitors' price elasticity is positive and significant except for clothing.

[22]To achieve a balanced panel, we use the rate of growth of the export price from Singapore to obtain an additional six months of data for Hong Kong in 2002. Our results do not change if we do not include the last six months of observations for which we do not have data.

[23]Using a Hausman test we could not reject a random effects model, that is, GLS is more efficient. Note that for road vehicles (SITC 78) the panel is imprecise, since the Korean and Thai data are for passenger cars (SITC 7812).

[24]The panel on road vehicles has three countries (Indonesia, Korea, and Thailand) as Hong Kong SAR has an insignificant export of vehicles, and Singaporean data beyond the one-digit level could not be retrieved. For all other one-digit commodity groups we have five countries.

[25]See also Faini, Clavijo, and Senhadji-Semlali (1992); Muscatelli, Stevenson, and Montagna (1994); and Reinhart (1995).

Table 7. Estimation Results (Panel Approach)[1]

Long-run demand: Dependent variable = X_{it}

Explanatory variables	Coefficients in the individual regressions					
	Chemicals	Manufactures	Machinery	Vehicles	Semiconductors	Clothing
P_{it}	–0.63	–0.75	–0.79	–0.74	–0.48	–1.16
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
P^c_{it}	0.56	1.18	1.408	0.69	1.68	0.04
	(0.26)	(0.00)	(0.00)	(0.05)	(0.00)	(0.90)
Y^w_t	1.71	0.50	1.55	1.68	1.81	–0.14
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.16)
Log likelihood	547.90	667.43	556.33	48.36	398.83	364.08
Countries	5	5	5	3	4	4
Number of observations	630	630	630	400	420	500

Short-run demand: Dependent variable = ΔX_{it}

Explanatory variables	Coefficients in the individual regressions					
	Chemicals	Manufactures	Machinery	Vehicles	Semiconductors	Clothing
ΔP_{it-1}	–0.26	0.01	0.20	0.12	–0.14	0.60
	(0.17)	(0.95)	(0.45)	(0.62)	(0.39)	(0.00)
ΔP^c_{it-1}	0.69	0.15	0.34	1.35	0.87	–0.47
	(0.01)	(0.64)	(0.43)	(0.14)	(0.03)	(0.40)
ΔY^w_{t-1}	–0.41	–0.15	–0.14	–0.70	0.34	0.02
	(0.01)	(0.22)	(0.35)	(0.05)	(0.04)	(0.91)
ECD_{t-1}	–0.08	–0.09	–0.06	–0.13	–0.11	–0.25
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)
Implied speed (months)	12.9	11.4	16.6	7.7	8.8	3.9
R^2	0.36	0.48	0.38	0.27	0.29	0.57

[1]Each long-run regression includes one lead and lag for the first difference of each continuous variable. The short-run equations include two lags for each continuous variable. All regressions include fixed effects for each country and monthly dummies, and controls for country-specific first-order autocorrelation in the error structure and contemporaneous correlation across countries in the long-run regressions. *R*-squares are not defined in the long-run regressions (see Greene, 1997). The speed of adjustment is calculated as the inverse of the opposite of the coefficient on the error-correction term. Each column in Table 7 reports the regression coefficient corresponding to the explanatory variable in a particular row, and the statistical significance of the variable is given by its p-value, reported in parentheses beneath the coefficient value.

Table 7. (*Continued.*)

Long-run supply: Dependent variable = P_{it}

Explanatory variables	Coefficients in the individual regressions					
	Chemicals	Manufactures	Machinery	Vehicles	Semiconductors	Clothing
X_{ijt}	0.01	0.02	–0.02	–0.03	0.01	–0.05
	(0.45)	(0.13)	(0.12)	(0.01)	(0.23)	(0.01)
DC_{jt}	–0.06	–0.12	–0.20	–0.33	–0.34	–0.10
	(0.04)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
E_{jt}	–0.23	–0.38	–0.25	–0.26	–0.51	–0.20
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
I_{jt}	0.44	0.53	0.39	0.18	0.99	0.21
	(0.00)	(0.00)	(0.00)	(0.12)	(0.00)	(0.00)
Log likelihood	1285.06	1430.44	1375.32	717.52	961.29	970.35
Countries	5	5	5	3	4	4
Number of observations	630	630	630	400	420	500

Short-run supply: Dependent variable = ΔP_{it}

Explanatory variables	Coefficients in the individual regressions					
	Chemicals	Manufactures	Machinery	Vehicles	Semiconductors	Clothing
ΔX_{it-1}	0.03	0.01	0.00	–0.01	0.02	–0.01
	(0.09)	(0.60)	(0.88)	(0.50)	(0.23)	(0.76)
ΔDC^{c}_{it-1}	0.04	0.07	0.03	0.03	0.07	0.03
	(0.67)	(0.46)	(0.72)	(0.75)	(0.61)	(0.77)
ΔE_{t-1}	0.07	0.05	0.08	0.12	0.32	0.13
	(0.59)	(0.65)	(0.47)	(0.32)	(0.00)	(0.31)
ΔI_{t-1}	–0.39	–0.41	–0.54	–0.67	–0.25	–0.69
	(0.11)	(0.08)	(0.02)	(0.03)	(0.42)	(0.03)
ECS_{t-1}	–0.05	–0.08	–0.04	–0.05	–0.04	–0.06
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Implied speed (months)	19.2	13.2	22.7	18.7	26.3	16.1
R^2	0.09	0.14	0.12	0.17	0.17	0.17

The absolute value of elasticity for competitors' price is large, supporting the argument that there is a considerable degree of intra-Asian competition. Exports for all commodity groups, except clothing, are sensitive to world demand. Clothing has a negative and insignificant sign, reflecting in part that Asian exporters have been moving away from this sector.

The supply equations do not perform as well as the demand equations. The coefficient on the price variable is insignificantly different from zero for all commodity groups except clothing and road vehicles, implying that export supply curves are basically horizontal in the long run.[26] Export prices are negatively and significantly sensitive to nominal depreciation. Note also that the pass-through elasticity is higher in manufactures and semiconductors than in the other industries—consistent with the argument that pass-through elasticities are higher in industries with relatively more market power (see Knetter, 1993). Export supply price is positively and significantly associated with increases in domestic input prices. Overall, these results with monthly data support similar findings in the literature (see Muscatelli, Stevenson, and Montagna, 1995; and Giorgianni and Milesi-Ferretti, 1997) based on lower frequency data.

The panel results support a significant influence of changes in private domestic credit on export supply.[27] However, under the single equation approach only 3 equations out of 30 have a negative sign for private credit and are significant (after excluding the results for Malaysia). Based on these results, and also noting that the speed of adjustment in the export supply function is on average 1.5 years, the evidence for a domestic credit crunch being responsible for the decline in East Asian exports is somewhat mixed. This result is consistent with the findings of Ghosh and Ghosh (1999) for East Asia and the observation of Krueger and Tornell (1999), who find that the Mexican tradable sector responded strongly to depreciation in the crisis of December 1994, a severe credit crunch notwithstanding.

The short-run equations show that price and quantities do not adjust immediately to shocks. However, the speed of adjustment, measured by the negative of the inverse of the error correction terms in the short-run equations, is relatively faster for the demand equations, ranging from 4 months to 17 months, compared to the supply equation, ranging from 14 months to 23 months.

Robustness

For a robustness check of the above results, the demand and supply equations are estimated (in unreported regressions) using the equation-by-equation estimation technique of Stock and Watson (1989) and instrumental variable regressions, and the results are similar but weaker than the results under the co-integration approach.

As a further robustness test, the U.S. import prices are used as alternative deflators for export revenues to obtain export volumes. This alternative method does not significantly change the results.

East Asia exports could be sensitive to individual economic activity in the United States, Japan, or other Asian countries such that both aggregate world demand and its

[26]No obvious explanation can be provided for the perverse relationship between price and volume in the export supply equations for road vehicles and clothing. However, for clothing, the gradual shift in exports away from this sector may have led to a structural break in the export supply function that could not be captured by the standard export supply equation estimated here. Besides, Asia's clothing exports were subject to quotas under the Multi Fiber Arrangement (MFA), which could have distorted the standard price-quantity relationship for the export supply equation.

[27]Noting that only a small share of private domestic credit is disbursed to each of the specific industries considered in this sample, the possibility of private credit being endogenous to a specific commodity export is expected to be low.

composition become important determinants of demand for Asian exports. In unreported regressions, alternative specifications with several scale variables corresponding to different geographical areas are used (for each industry). These results reveal that there is no significant difference between using some composition of world income and using aggregate world income.

Other alternative specifications are also used for the demand and supply equations. In particular, real interest rate is used as an alternative to domestic credit, and the results of the latter also are as inconclusive as the results using private domestic credit.

Interpretations

As noted in the introduction, four factors are considered as possible explanations for the lag of Asian exports following the huge depreciations. First, a credit crunch could choke off export supply. Second, world demand slowdown could affect East Asian exports. Third, the export demand could be inelastic in the short run. Fourth, export demand for a single country might have slowed down due to currency depreciation of its competitors. Table 8 summarizes the expected coefficient of the explanatory variables in the estimated demand and supply equations for each of the above explanations.

The results provide weak support for the credit crunch explanation for three reasons: First, there is mixed evidence on the significance of the relationship between domestic credit and export supply price. Second, the calculated speed of adjustment for the supply curve (between 1.5 and 2 years) indicates that any effect of a credit crunch would not be reflected within a year. Finally, an upward shift of the supply curve along the demand curve should *increase* the equilibrium price, not *decrease* it. An upward shift of the supply curve without any change in prices is possible only if the demand curve is horizontal and the estimated equations do not reveal horizontal demand curves for any commodities.

Regarding the second explanation, although the estimated results show large and positive income elasticity of demand for exports, Figure 4 shows that world import demand did not collapse at the end of the 1990s. Moreover, Table 1 indicates that world demand for commodities typically exported by Asia relative to total world demand also did not decline. Thus, noting that neither total demand nor the

Table 8. Implied Coefficients of Alternative Explanations for Slow Response of Exports to Depreciation

	X_i (Quantity in demand curve)			P_i (Price in supply curve)			
Explanation	P_i	P_i^c	Y^w	X_i	DC	E	I
Credit crunch					–		
Contraction of world demand			+				
J-curve effect	0 (short run)					–	
Competitive depreciation	–	+				–	

demand for those commodities exported mostly by Asia declined, we rule out the world demand contraction explanation.

The third explanation, implying a vertical demand curve in the short run (e.g., during the period 1997–mid-1999, which was characterized by sharply falling export prices without comparable increases in export volumes), is ruled out from the short-run estimation, which indicates a relatively quick adjustment along the export demand equation (within one year).

The fourth explanation—competitive depreciation—implies that exports of an individual country did not pick up because competitors were depreciating and cutting their export prices as well. In the supply equation, depreciation has to translate into lower export prices, while in the demand equation, export quantity has to be very sensitive to own and competitors' prices.[28] Our results support both these requirements.[29] Hence, a nominal depreciation in each country shifts down its export supply curve by some proportion, thereby reducing export prices. At the same time, nominal depreciation by its competitors shifts its demand curve to the left, such that quantity sold in exports does not increase by much despite a sharp decline in export price.

It is somewhat puzzling that the sharp decline in East Asian export prices did not significantly increase overall Asian exports to the world (owing to the fact that the region as a whole had become more competitive relative to the rest of the world). This could be explained by the fact that while the elasticity of substitution between goods from individual East Asian countries is very high, the elasticity of substitution between East Asia as a whole and the rest of the world is less strong. This argument is confirmed by several studies that have looked specifically at the issue of different elasticities of substitution for goods from different countries. For instance, Faini, Clavijo, and Senhadji-Semlali (1992) find that the competition in exports between two less developed countries (LDC) is much stronger than the competition between a developed country (DC) and an LDC. Giorgianni and Milesi-Ferretti (1997) find that using two exchange rates—one vis-à-vis Korea and industrialized countries and another vis-à-vis Korea and nonindustrialized countries—can better explain demand for Korean exports than using one exchange rate. Finally, Spilimbergo and Vamvakidis (2003) show that the assumption of equal elasticity of substitution of export demands for LDCs and DCs is not supported by the data, and export equations work much better using two exchange rates.

III. Conclusion

This paper attempts to identify demand and supply curves for specific export groups at a monthly frequency, whereas most of the empirical trade literature has so far focused on lower time frequencies. The analysis of the developments up to and after a currency crisis could be done only with high-frequency data. However, working

[28]The results also show that export supply price is responsive to domestic input costs, which likely decreased relative to imported costs following the nominal depreciation.

[29]The only way to verify the depreciation explanation is by estimating demand and supply as is done here. Looking at changes in market shares cannot work because countries that engage in competitive devaluation could end up with the same market shares.

with recent monthly trade data poses several challenges. First, there is no readily available database. Second, there is a risk that trade equations, which may work well at low frequency, would not yield conventional results at high frequency. These challenges are dealt with by constructing an original database based on monthly prices and quantities for the industries in the sample. When the data are not available from the original sources, best alternative proxies are constructed to check the robustness of the results. The specification challenge is dealt with by using a vector co-integration framework in a panel context. The results are robust to different specifications and different ways of constructing the data set.

The main results are that demand for East Asian exports is very sensitive to prices—both their own and competitors'—and to world import demand. Export supply prices are very sensitive to depreciation and domestic input prices. These results indicate that competitive depreciation played a key role in exacerbating the real effects of the crisis by working through a trade channel and that these effects occur relatively quickly—between 4 months and 16 months. This paper calls for an interpretation of the Asian crisis that puts a stronger emphasis on the role of trade, the importance of competitive depreciation in prolonging the crisis, and the causes underlying the slowdown in export supply. An optimistic forecast is also presented about the future of East Asian exports—the results indicate that Asian exports should return to their precrisis growth rates as their economies strengthen and currencies stabilize, as was evidenced in the fast recovery of Asian exports during 1999–2000.

APPENDIX

The sample covers monthly data between January 1990 and July 2002, with a few exceptions when data could not be retrieved. A complete description of the variables and the data sources is given below.

Price and volume of exports: Export prices are used to deflate the export revenues and obtain volumes of exports. For commodities disaggregated at the one-digit level, such as chemicals, manufactured items, and machinery, commodity-specific export price indices for Korea, Singapore, and Thailand are available. At the two- and three-digit levels, the best available country- and commodity-specific export price index is used. For instance, the export price index of SITC 7 (machinery) is used to obtain volumes of SITC 78 (road vehicles) and SITC 776 (semiconductors) and so on. For Indonesia and Malaysia, commodity-specific export prices could be retrieved and the unit value of exports is used to deflate all export revenues. Hong Kong SAR has export price indices for clothing and semiconductors. For other commodities, the unit value of exports is used. The use of alternative proxies for price indices when individual price information is missing is not uncommon. For instance, Muscatelli, Stevenson, and Montagna (1994) have used import (and sometimes export) price indices of the United States to obtain volumes of developing country manufacturing exports. However, there is a problem with this deflator. Ideally we would like to have $X_{ij} = R_{ij}/P_{ij}$, where R_{ij} is the export revenue earned by the jth country in the ith good. However, when P_{ij} is not available, and a proxy like the U.S. import price index for i (denoted by $P_{i,USA}$) is used, a new variable, X^*_{ij}, is created such that, $X^*_{ij} = R_{ij}/P_{i,USA}$. $P_{i,USA}$ depends on the exports of commodity i from all exporters of i to the United States. Hence, an increase in the exports of i from all other countries (except j) leads to a decline in the import price faced by the United States ($P_{i,USA}$), which increases the value of X^*_{ij} even though X_{ij} does not increase. This is one caveat that needs to be kept in mind when using commodity-specific import price indices from the United States. However, in order to check the robustness of the results, the U.S. import price is used as an alternative proxy for Asian export price variables.

Competitors' export prices: For every commodity group geometric average weights are constructed (average of 1992–96) by taking the annual share of country *j*'s exports of commodity *i* (to the world) as a proportion of total Asian exports of that commodity. The weights are then used to obtain a geometric mean of export prices of the competitors. Thus, by construction,

$$\ln P_{ij}^{c} = \sum_{\substack{h=1 \\ h \neq j}}^{H} w_{ih} \ln P_{ih} \; ; \; w_{ih} = X_{ih} \Big/ \sum_{k=1}^{K} X_{ik}, \tag{9}$$

where *h* is all the other Asian competitors of good *i* for country *j.* The term *H* refers to the five other competitors. The variable X_{ih} is the total (annual) export of commodity *i* by country *h.* When country *h* does not have a commodity-specific export price, we simply use the overall export price, that is, the unit value of exports. The term *K* refers to the six countries in the sample. The weights are constructed with annual data obtained from the IMF's *Direction of Trade Statistics.*

The country-specific sources on the prices and quantities of exports are as follows:

Hong Kong SAR: Data on export revenue of chemicals, manufactures, and machinery are from Hong Kong SAR's Census and Statistic Department's *Monthly Digest of Statistics.* Data on exports of road vehicles, clothing, and semiconductors come from the same department's Trade Analysis Section (Hong Kong SAR's External Trade). Unit-value index numbers for domestic exports (from the same source) are used to deflate export revenues of chemicals, manufactures, machinery, and road vehicles. The specific export price index is used for clothing, while that of electronic components is used for semiconductors. These price data are retrieved from the Census and Statistics Department. The price data are available from 1988:10–2002:01.

Indonesia: Export data are obtained from the Bank of Indonesia's Economics and Statistics Department. The following data points for export revenue are missing in the sample of estimation for chemicals, manufactures, and machinery: 94:01–02; for road vehicles, clothing, and semiconductors: 1994:01–02; 1995:01–02; 1995:12; 1996:01–02; 1996:04–05. The unit value of the export index (in dollars) is used to obtain volumes of exports of these commodities. The source for the latter is the *International Financial Statistics* Database (IFS), series 74DZF. This series is available from 1980:01–1998:12 and is interpolated to obtain the missing values for the data points 1981:07–08 and 1987:01–02.

Malaysia: Export revenue data come from Malaysia's *Monthly External Trade Statistics,* Department of Statistics, covering 1994:01–2002:07. Values for 2000:12 and 2001:12 are missing for all the series. The unit value of the export index is used to deflate export revenues and obtain volumes. The source for the latter is *IFS* (series 74DZF). The series is interpolated to obtain the missing data points between 1992:04 and 1993:06, and 1996:07 and 1998:02. After interpolation the series is complete only until 1999:03. In order to construct the graphs, we use the rate of growth of the export price from Indonesia. Given the data limitation we do not use Malaysia in the panel regressions.

South Korea: Export revenue data come from the Bank of Korea's *Monthly Bulletin* and cover the period 1990:01–2002:10.

Singapore: Data on revenue and prices come from the *Monthly Digest of Statistics,* Singapore Department of Economics. Data on revenue and export prices cover the period 1989:01 to 2002:02 (missing between 1998:02 and 1998:06). The missing points are interpolated to complete the series.

Thailand: *Monthly Bulletin,* Bank of Thailand, is the source for exports of chemicals, manufactures, and machinery (available from 1989:01–2002:12). The following proxies were used (from the same source) for the two- and three-digit export commodities—line 18a (integrated circuits and parts) as a proxy for SITC 776 (semiconductors); line 2 (textile products) as a proxy for SITC 84 (clothing); and line 51a (passenger cars and parts) as a proxy for SITC 7812 (cars). Commodity-specific export prices are available during the same period. An aggregate export price index for Thailand is obtained from the *IFS* (series 74DZF).

United States import price index: The data for this index used to deflate export revenues for the alternative definition of volume come from the Bureau of Labor Statistics. For chemicals, manufactures, machinery, and clothing we retrieved quarterly series between 1990:03 and 1992:08, and monthly thereafter until 2003:01. For semiconductors, the data are quarterly from 1989:09 to 1993:12, and monthly thereafter (until 2003:01). The quarterly series for vehicles starts in 1989:09 and ends in 1993:12 and is monthly thereafter until 2003:01. All quarterly data are interpolated.

Scale variable: As discussed before, we first construct a trade-weighted world demand for each export commodity for the scale variable. However the use of this variable does not alter the performance of the estimated equations. This is because export data are highly trended, and therefore as long as we use a scale variable that is suitably trended, they perform well in the demand equation. Therefore we use world import demand for the estimation retrieved from the *IFS* database (series 71D). The world unit value of imports (series 75D) is used to deflate revenues and obtain volume of imports. The series for real world import is available from 1980:01–2002:09.

Domestic credit: The data source is *IFS* (domestic credit, based on claims on the private sector, series, 32DZF). This series (in domestic currency) covers the period 1980:01–2002:12 for all countries. For Hong Kong SAR, the series is annual between 1990 and 1993, quarterly between 1994:01 and 1995:12, and then monthly. Real domestic credit to the private sector is obtained by deflating with the country-specific consumer price index (CPI) data, which were also obtained from the *IFS* (series 64ZF), covering 1980:01–2002:12. For Hong Kong SAR, CPI data are available from 1990:01. Hong Kong SAR's real domestic credit has to be interpolated for the co-integration tests. However, all estimations are carried out without interpolating this variable.

Input price: In the absence of wage prices at monthly frequency, the wholesale price index is used to proxy for input price. The series is retrieved from the *IFS* (line 63).

Nominal exchange rate: This monthly series comes from the *IFS* (period average market rate, series RFZF) and covers the period 1980:01–2003:01.

REFERENCES

Abeysinghe, Tilak, 2001, "Thai Meltdown and Transmission of Recession within ASEAN 4 and NIE 4," in *International Financial Contagion,* edited by S. Claessens and K. Forbes (Boston: Kluwer Academic Publishers), pp. 225–240.

Andrews, Donald W. K., 1993, "Tests for Parameter Instability and Structural Change with Unknown Change Point," *Econometrica,* Vol. 61, No. 4.

Bank of Indonesia, Economics and Statistics Department, *Monthly Bulletin* (Jakarta).

Bank of Korea, *Monthly Bulletin* (Seoul).

Bank of Thailand, *Monthly Bulletin* (Bangkok).

Barth, Marvin, and Trevor Dinmore, 1999, "Trade Prices and Volumes in East Asia Through the Crisis," International Finance Discussion Paper No. 643 (Washington: Board of Governors of the Federal Reserve System).

Campbell, John Y., and Pierre Perron, 1991, "Pitfalls and Opportunities: What Macroeconomists Should Know about Unit Roots," NBER Technical Working Paper No. 100 (Cambridge, Massachusetts: National Bureau of Economic Research).

Caramazza, Francesco, Luca Ricci, and Ranil Salgado, 2000, "Trade and Financial Contagion in Currency Crisis," IMF Working Paper No. 00/55 (Washington: International Monetary Fund).

Chinn, Menzie D., 1998, "Before the Fall: Were East Asian Currencies Overvalued?" NBER Working Paper No. 6491 (Cambridge, Massachusetts: National Bureau of Economic Research).

Corsetti, Giancarlo, Paolo Pesenti, and Nouriel Roubini, 1998a, "What Caused the Asian Currency and Financial Crisis? Part I: A Macroeconomic Overview," NBER Working Paper No. 6833 (Cambridge, Massachusetts: National Bureau of Economic Research).

———, 1998b, "What Caused the Asian Currency and Financial Crisis? Part II: The Policy Debate," NBER Working Paper No. 6834 (Cambridge, Massachusetts: National Bureau of Economic Research).

Dickey, A., and W. A. Fuller, 1979, "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," *Journal of the American Statistical Association,* Vol. 74, No. 366, pp. 427–31.

Engle, R. F., and B. S. Yoo, 1987, "Forecasting and Testing in Cointegrated Systems," *Journal of Econometrics,* Vol. 35, pp. 143–59.

Faini, Riccardo, Fernando Clavijo, and Abdel Senhadji-Semlali, 1992, "The Fallacy of Composition Argument: Is It Relevant for LDCs' Manufactures Exports?" *European Economic Review,* Vol. 36, No. 4, pp. 865–882.

Fernald John G., H. J. Edison, and Prakash Loungani, 1999, "Was China the First Domino? Assessing Links between China and Other Asian Economies," *Journal of International Money and Finance,* Vol. 18 (August), pp. 515–35.

Ferri, Giovanni, and Tae Soo Kang, 1999, "The Credit Channel at Work: Lessons from the Financial Crisis in Korea," World Bank Policy Research Working Paper 2190 (Washington: World Bank).

Gerlach, Stephen, and Frank Smets, 1995, "Contagious Speculative Attacks," *European Journal of Political Economy,* Vol. 11, pp. 45–63.

Ghosh, Swati R., and Atish R. Ghosh, 1999, "East Asia in the Aftermath: Was There a Crunch?" IMF Working Paper 99/38 (Washington: International Monetary Fund).

Giorgianni, Lorenzo, and Gian Maria Milesi-Ferretti, 1997, "Determinants of Korean Trade Flows and Their Geographical Destination," CEPR Discussion Paper No. 1703 (London: Centre for Economic Policy Research).

Glick, Reuven, and Andrew K. Rose, 1999, "Contagion and Trade: Why Are Currency Crises Regional?" *Journal of International Money and Finance,* Vol. 18, pp. 603–617.

Goldstein, Morris, and Mohsin S. Khan, 1985, "Income and Price Effects in Foreign Trade," Chapter 20 in *Handbook of International Economics,* Vol. 2, edited by Ronald Jones and Peter Kenen (New York; Amsterdam: Elsevier).

Greene, William, 1997, *Econometric Analysis* (Upper Saddle River, New Jersey: Prentice Hall).

Hong Kong SAR, Census and Statistics Department, *Monthly Digest of Statistics* (Hong Kong).

International Monetary Fund, *Direction of Trade Statistics* (Washington, various issues).

International Monetary Fund, *International Financial Statistics* (Washington, various issues).

Kaminsky, Graciela L., and Carmen Reinhart, 2000, "On Crises, Contagion and Confusion," *Journal of International Economics,* Vol. 51 (June), pp. 145–68.

Kao, Chihwa, and Min-Hsien Chiang, 2000, "On the Estimation and Inference of a Cointegrated Regression in Panel Data" (unpublished; Syracuse, New York: University of Syracuse).

Knetter, Michael, 1993, "International Comparisons of Pricing-to-Market Behavior," *American Economic Review,* Vol. 83 (June), pp. 473–86.

Krueger, Anne, and Aaron Tornell, 1999, "The Role of Bank Restructuring in Recovering from Crisis: Mexico 1995–98," NBER Working Paper No. 7042 (Cambridge, Massachusetts: National Bureau of Economic Research).

Lane, Philip, and Gian Maria Milesi-Ferretti, 2000, "The Transfer Problem Revisited: Net Foreign Assets and Real Exchange Rates," IMF Working Paper 00/123 (Washington: International Monetary Fund).

Macher, T. Jeffrey, David C. Mowery, and David A. Hodges, 1999, "Semiconductors," in *U.S. Industry in 2000: Studies in Competitive Performance,* edited by David C. Mowery (Washington: National Academy Press).

Maddala, G. S., and In-Moo Kim, 1999, "Unit Roots, Cointegration, and Structural Change" (Cambridge, England: Cambridge University Press).

Malaysia Department of Statistics' *Monthly External Trade Statistics.*

Mark, Nelson C., and Donggyu Sul, 1999, "A Computationally Simple Cointegration Vector Estimator for Panel Data" (unpublished; Columbus: Ohio State University).

Muscatelli, Vito Antonio, Andrew Stevenson, and Catia Montagna, 1994, "Intra-NIE Competition in Exports of Manufactures," *Journal of International Economics,* Vol. 37, pp. 29–47.

———, 1995, "Modeling Aggregate Manufactured Exports of Some Asian Newly Industrialized Economies," *Review of Economics and Statistics,* Vol. 77, pp. 147–55.

Phillips, Peter, and P. Perron, 1988, "Testing for a Unit Root in Time Series Regression," Biometrika, Vol. 75, 335–46.

Reinhart, Carmen M., 1995, "Devaluation, relative Prices, and International Trade," *Staff Papers,* International Monetary Fund, Vol. 42, No. 2, pp. 290–312.

Singapore, Department of Economics' *Monthly Digest of Statistics.*

Spilimbergo, Antonio and Athanasios Vamvakidis, 2003, "Real Effective Exchange Rate and the Constant Elasticity of Substitution Assumption," *Journal of International Economics,* Vol. 60, No. 2, pp 337–54.

Stock, James H., and Mark W. Watson, 1989, "New Indexes of Coincident and Leading Indicators," *NBER Macroeconomics Annual* (Cambridge, Massachusetts: National Bureau of Economic Research), pp. 351–94.

United States, *Bureau of Labor Statistics* (Washington).

Van Rijckeghem, Caroline, and Beatrice Weder, 1999, "Sources of Contagion: Finance or Trade?" IMF Working Paper 99/146 (Washington: International Monetary Fund).