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***The Ratio of International Reserves to Short-Term
External Debt as an Indicator of External
Vulnerability: Some Lessons from the Experience of
Mexico and other Emerging Economies***

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I. Introduction

- ❖ This presentation has four objectives:
 1. To provide evidence on the usefulness of the IR/STED indicator in predicting economic crises.
 2. To deepen the analysis of the limitations faced when using this ratio, taking into account both the ideal characteristics its components should display and the data available to calculate these components.
 3. To contribute to the discussion on the values of this ratio that can provide reasonable coverage in the event of economic shocks.
 4. On the basis of more timely and detailed data for Mexico, to analyze the adjustments that could be introduced to increase the usefulness of the ratio as a tool for crisis prevention.

II. Background

- ❖ Following the crises observed in South-East Asia in 1997, several authors began to emphasize the role played by an excessive accumulation of short-term debt *vis-à-vis* international reserves.
- ❖ Interest in using the international reserves/short-term external debt ratio as a vulnerability indicator became even more pronounced as a result of the importance attached to it by several distinguished economists.
- ❖ In addition, the IMF has incorporated this variable into the series of indicators used in its early warning systems, and the BIS has also begun to pay more attention to this ratio.

II. Background

- ❖ However, if the potential benefits of this ratio are to become a reality, at least three obstacles must be overcome when calculating the indicator:
 1. It must be borne in mind that defining the international reserves and short-term external debt components is not an easy task.
 2. The availability of the statistics needed to estimate this indicator appropriately is limited.
 3. Although it has been generally noted that the ratio of international reserves to short-term external debt must be at least equal to 1 to enable an economy to withstand shocks, it is necessary to evaluate whether this assertion is adequately supported by empirical evidence.

III. Methodology of the IMF for Calculating the Appropriate Vulnerability Indicator

- ❖ The IMF recently provided a detailed definition of the ideal characteristics both components of the ratio should display if it is to serve as a vulnerability indicator.
 - A. IMF recommendations for international reserves:
 - International reserves should be equivalent to all external assets controlled by the monetary authorities.
 - Undrawn, unconditional external credit lines should be included as international reserves.
 - The definition of official reserve assets should only cover the total amount of immediately available liquid external assets. In other words, predetermined and contingent future “drains” on reserves should be taken into account in the definition.

III. Methodology of the IMF for Calculating the Appropriate Vulnerability Indicator

- B. The methodology proposed by the IMF recommends that short-term external debt should:
- Be classified by residual maturity.
 - Cover both public sector or public sector-guaranteed external debt and private sector external debt.
 - Include all debt instruments held by nonresidents (irrespective of the currency in which the debt is denominated) rather than simply all debt instruments issued abroad.
 - Include all credits linked to foreign trade.
 - Consider monetary authority liabilities, including those stemming from derivative transactions.

IV.a. Estimating the Vulnerability Indicator for a Sample of Countries

- ❖ The main external data sources used in estimating the IR/STED ratio denominator are:
 - A. Statistics prepared jointly by the BIS, IMF, OECD, and World Bank. This database is the only source that estimates total short-term external debt stocks on the basis of residual maturities, and also has the advantage of supplying half-yearly data. However, domestically issued public debt held by nonresidents are not included in its instrument coverage.
 - B. Institute of International Finance (IIF) statistics. Although IIF data partly offset BIS-IMF-OECD-WB gaps in instrument coverage by including domestically issued public securities held by nonresidents, the main shortcomings of this database lie in the fact that it classifies debt on the basis of original maturities and only provides annual data.

IV.a. Estimating the Relevant Vulnerability Indicator for a Sample of Countries

- ❖ Estimations of the IR/STED ratio on a country-by-country basis were made for the period 1985 - 2001.
- ❖ Estimations include a sample of emerging countries in Latin America (Argentina, Brazil, Colombia, Chile, and Mexico) and Asia (South Korea, Indonesia, Malaysia, and Thailand).

IV.b. Analysis of the Factors that Explain the Economic Crisis

- ❖ The crisis episodes examined in this paper were identified on the basis of the definition proposed by Kaminsky, Lizondo, and Reinhart (1998), and also used by Kamin, Schindler, and Samuel (2001), Edison (2000), and in IMF crisis early warning models (IMF, 2000). On this basis, 15 crises were identified for the period 1985-2001.
- ❖ *Probit* and *Logit* methods were used for the estimations. In this context, the dependent variable is dichotomic and equal to 1 when a country suffers a currency crisis or 0 if this is not the case (Table 1).
- ❖ An analysis of the sensitivity of the estimations to alternative databases and an empirical assessment of possible vulnerability thresholds were made.

TABLE 1

Estimation Methods and Sources of Data				
Variable ²	Regression Coefficients¹, z value*			
	<i>Probit</i>		<i>Logit³</i>	
	BIS	IIF	BIS	IIF
IR/STED	-0.011	-0.007	-0.011	-0.007
	-2.538	-2.241	-2.481	-2.223
RERM	0.026	0.025	0.025	0.025
	2.826	2.765	2.904	2.800
MB/GDP	0.142	0.108	0.139	0.108
	2.494	2.127	2.576	2.227
TT	-0.072	-0.070	-0.073	-0.072
	-2.609	-2.593	-2.658	-2.659
CA/GDP	-0.297	-0.257	-0.290	-0.250
	-3.122	-3.045	-3.167	-3.090
Observations	153	153	153	153
P- value	0.0	0.0	0.0	0.0
Pseudo-R ²	0.384	0.354	0.378	0.347

* All coefficients are statistically significant at a level of less than or equal to 5 percent.

1/ Constants are included in all regressions.

2/ Variables are identified by the following signs:

IR/STED = International reserves as a percentage of short-term external debt.

RERM = Real exchange rate misalignment.

MB/GDP = Annual absolute variation in the nominal monetary base as a proportion of GDP.

TT = Terms of trade percentage variation.

CA/GDP = Current account balance as a proportion of GDP, with a one-year lag.

3/ Coefficients are divided by 1.8138 for comparison with coefficients obtained using the Probit model.

IV.b. Analysis of the Factors that Explain the Economic Crisis

- ❖ All equation coefficients have the expected signs and are statistically significant at the 5-percent level.
- ❖ The coefficients are stable in general and their level of statistical significance remains high even if new variables are introduced.
- ❖ In addition, the following comments can be made:
 - The IR/STED variable is highly significant and features the expected sign in all regressions estimated.
 - The IR/STED variable coefficients are database-sensitive, with regressions using BIS statistics resulting in higher ratios than those obtained on the basis of IIF data.

IV.b. Analysis of the Factors that Explain the Economic Crisis

- The regressions produce a small IR/STED coefficient compared to those obtained for the other variables. However, the relative size of this coefficient must be interpreted with caution.
- The current account balance as a proportion of GDP (CC/GDP) is the main variable in explaining economic crises in the exercises performed.
- The ratio of the monetary base to GDP (MB/GDP) is high and significant.
- The real exchange rate misalignment (RERM) and the terms of trade (TT), are the other two important variables in explaining economic crises.

IV.c. Graphic Analysis of the Behavior of the IR/STED Indicator

- ❖ The regressions show that the ratio's relevance is linked to the statistics used in its calculation.
- ❖ However, the problems derived from the availability of statistics are not serious when the assessment of the IR/STED indicator is made jointly for a group of countries.
- ❖ The problems stemming from the availability of statistics may, of course, be much more serious if the analysis is conducted for individual countries.
- ❖ To illustrate this point, Charts 1-9 present the behavior of the IR/STED indicator for the countries and the period described in the previous section.

IR/STED Ratio

Chart 1: Colombia

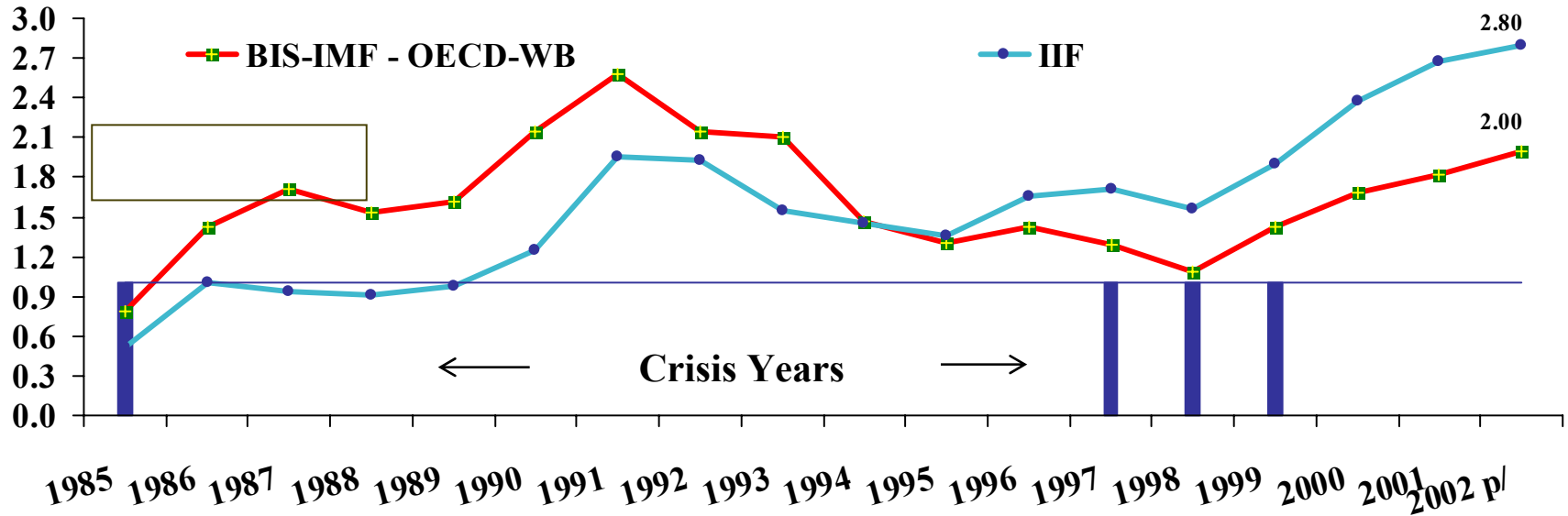
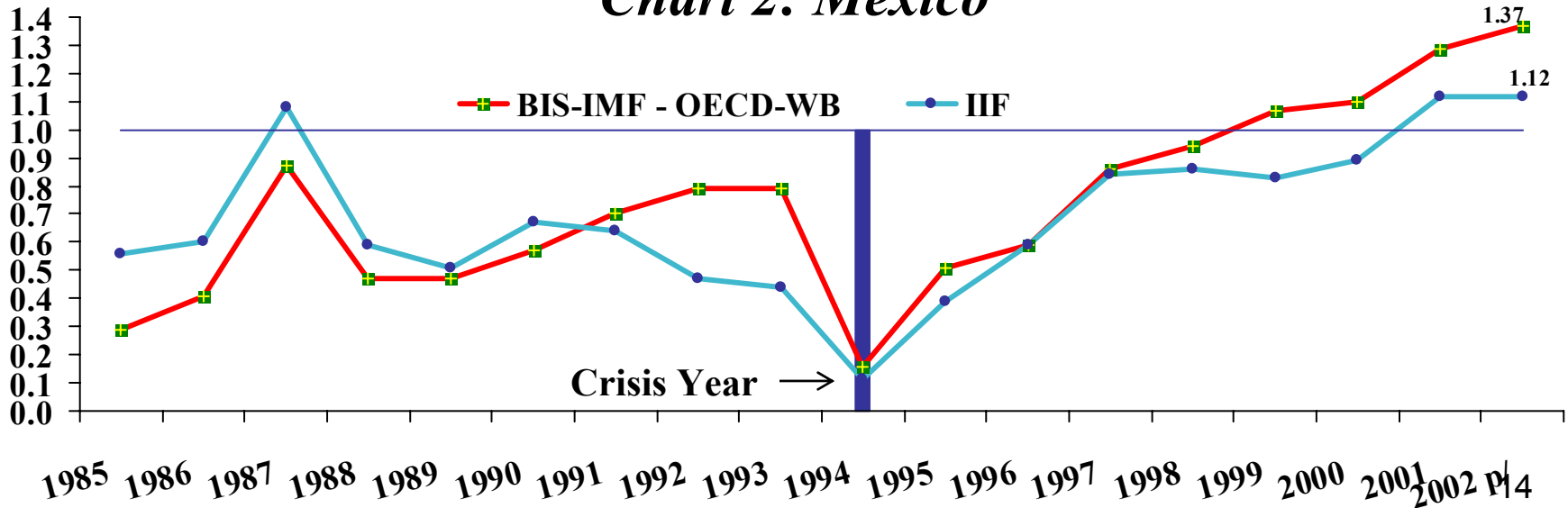


Chart 2: Mexico



p/ BIS data are as at June 2002, while IIF data cover estimations as at end-2002.

IR/STED Ratio

Chart 3: South Korea

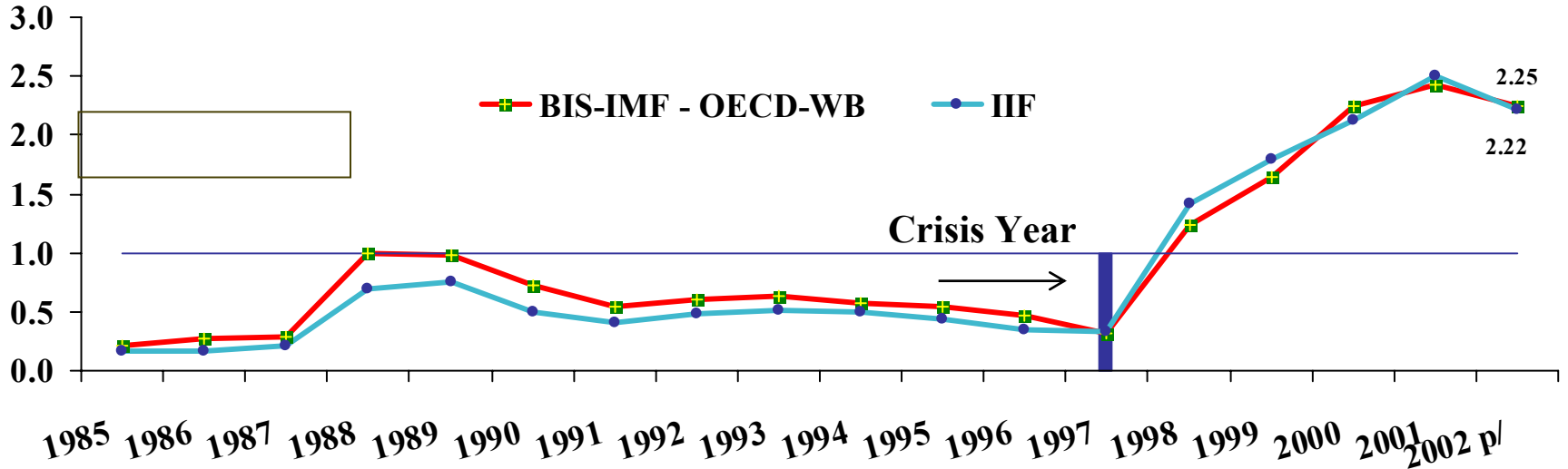
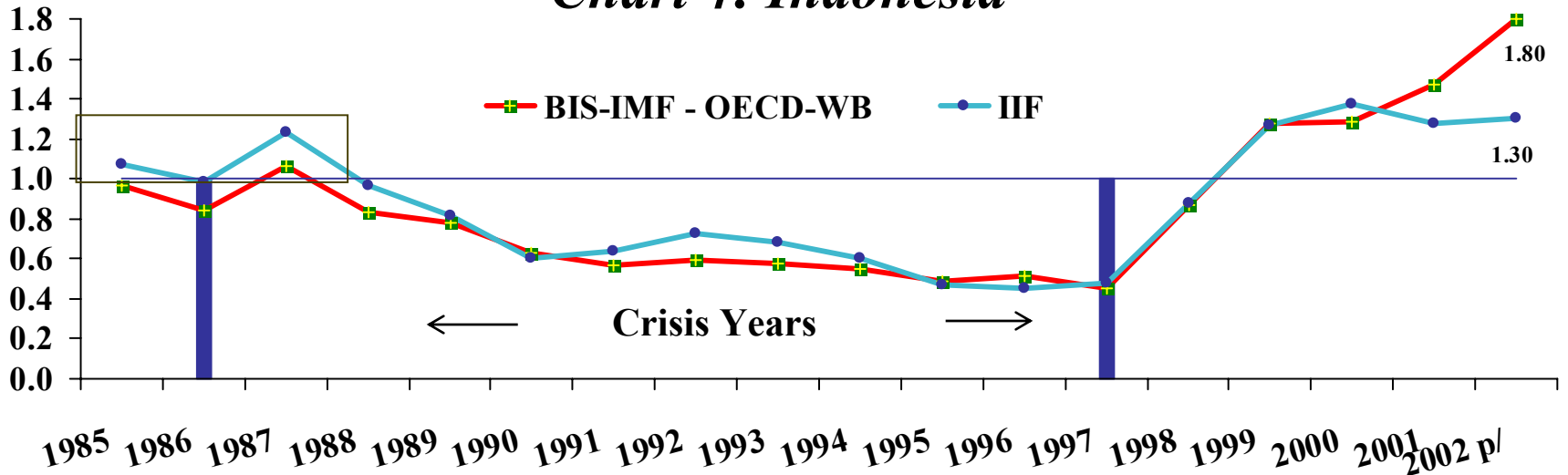


Chart 4: Indonesia



p/ BIS data are as at June 2002, while IIF data cover estimations as at end-2002.

IR/STED Ratio

Chart 5: Malaysia

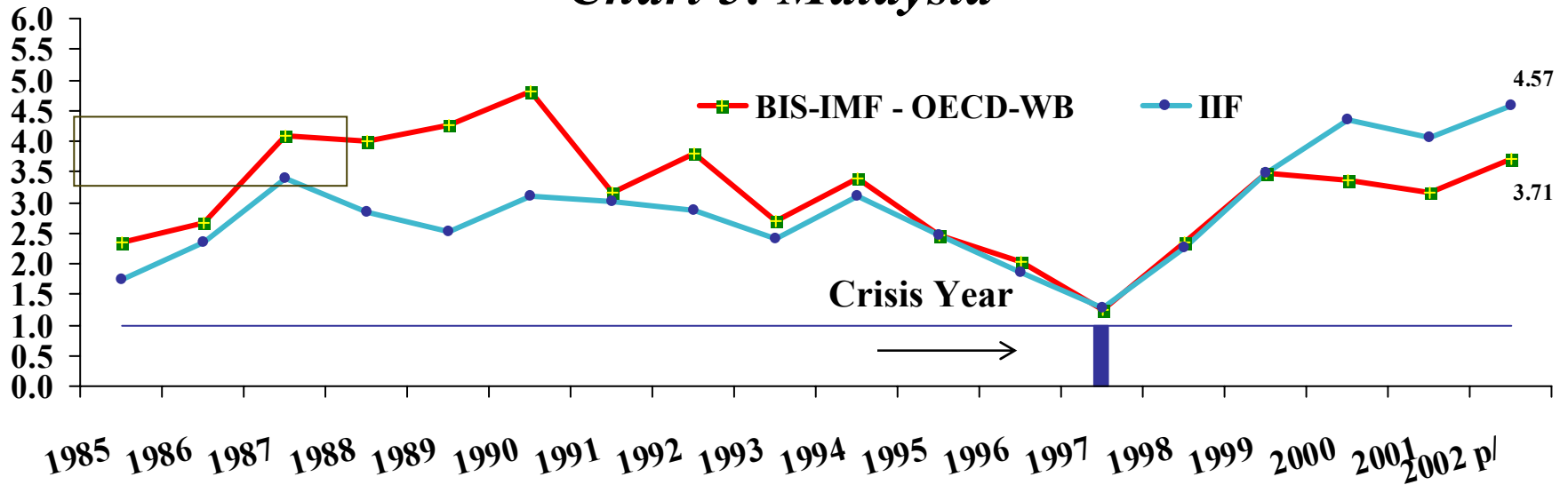
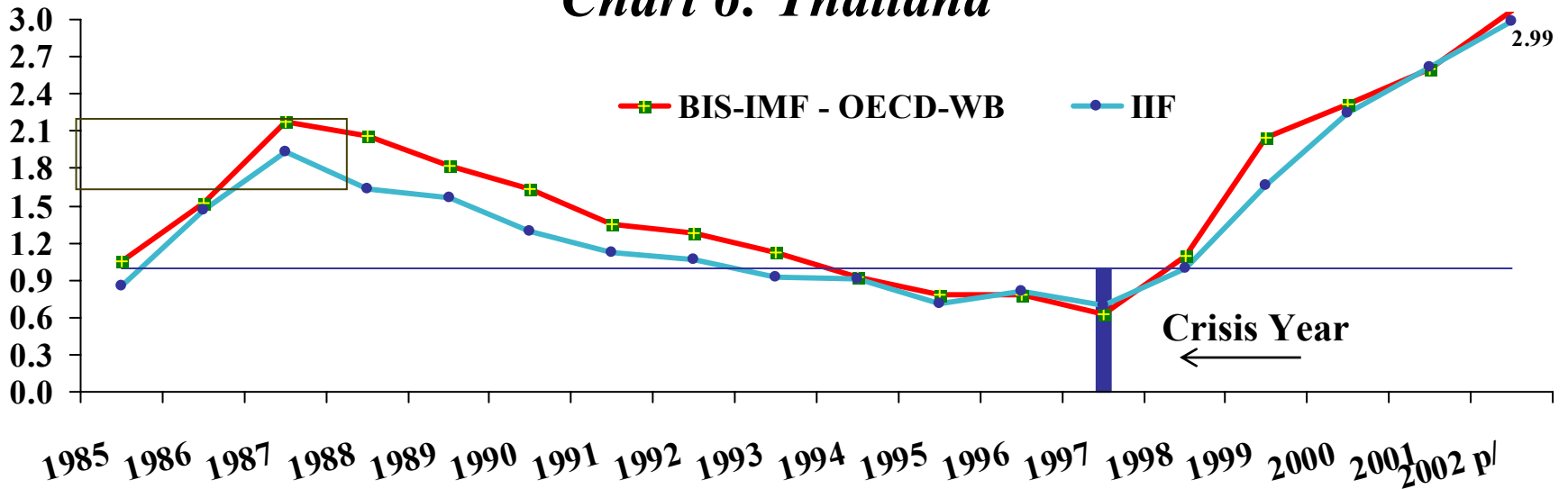


Chart 6: Thailand



p/ BIS data are as at June 2002, while IIF data cover estimations as at end-2002.

IR/STED Ratio

Chart 7: Argentina

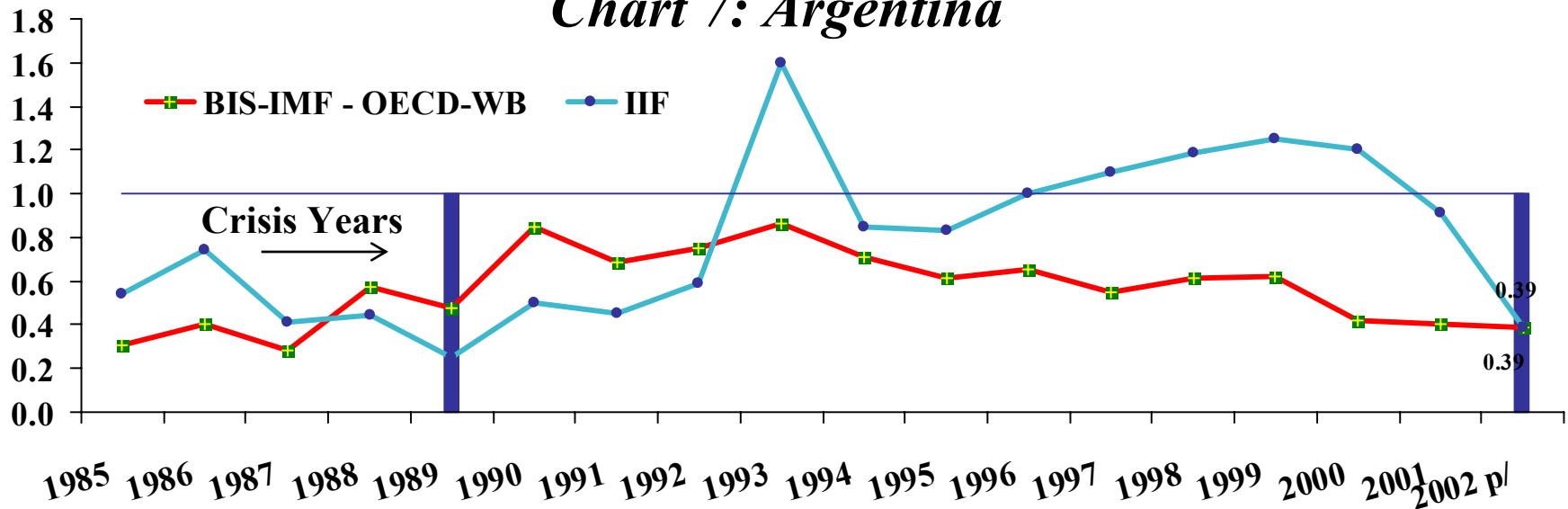
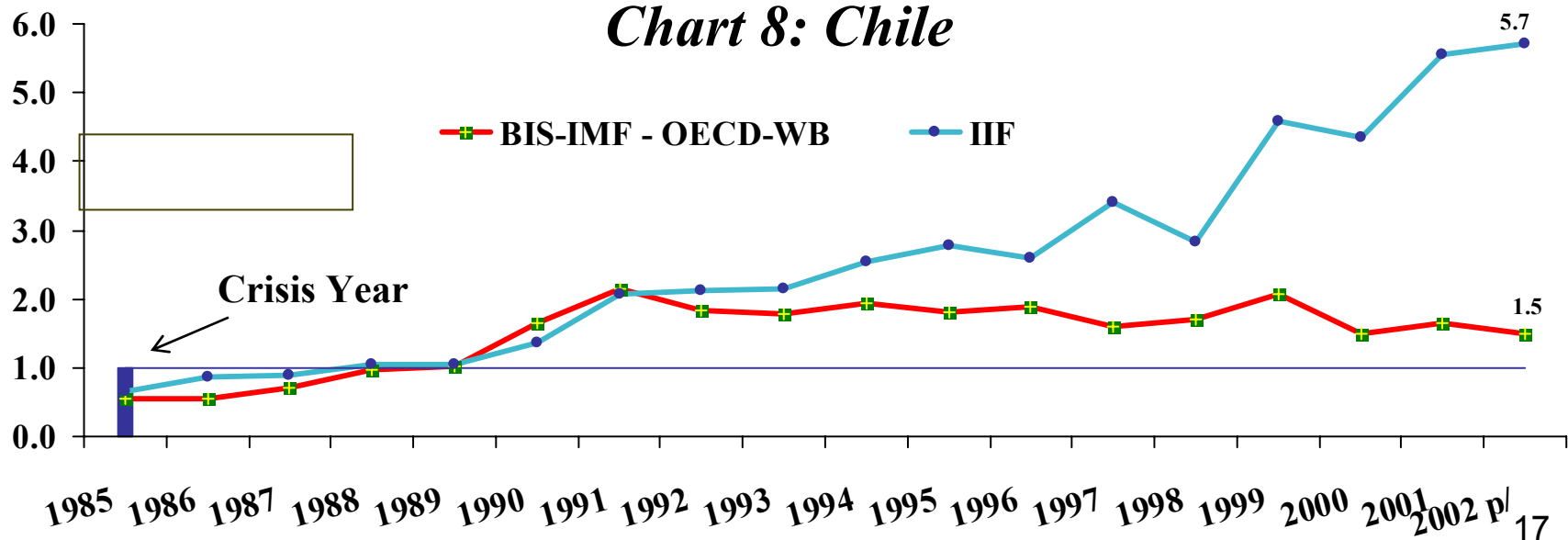


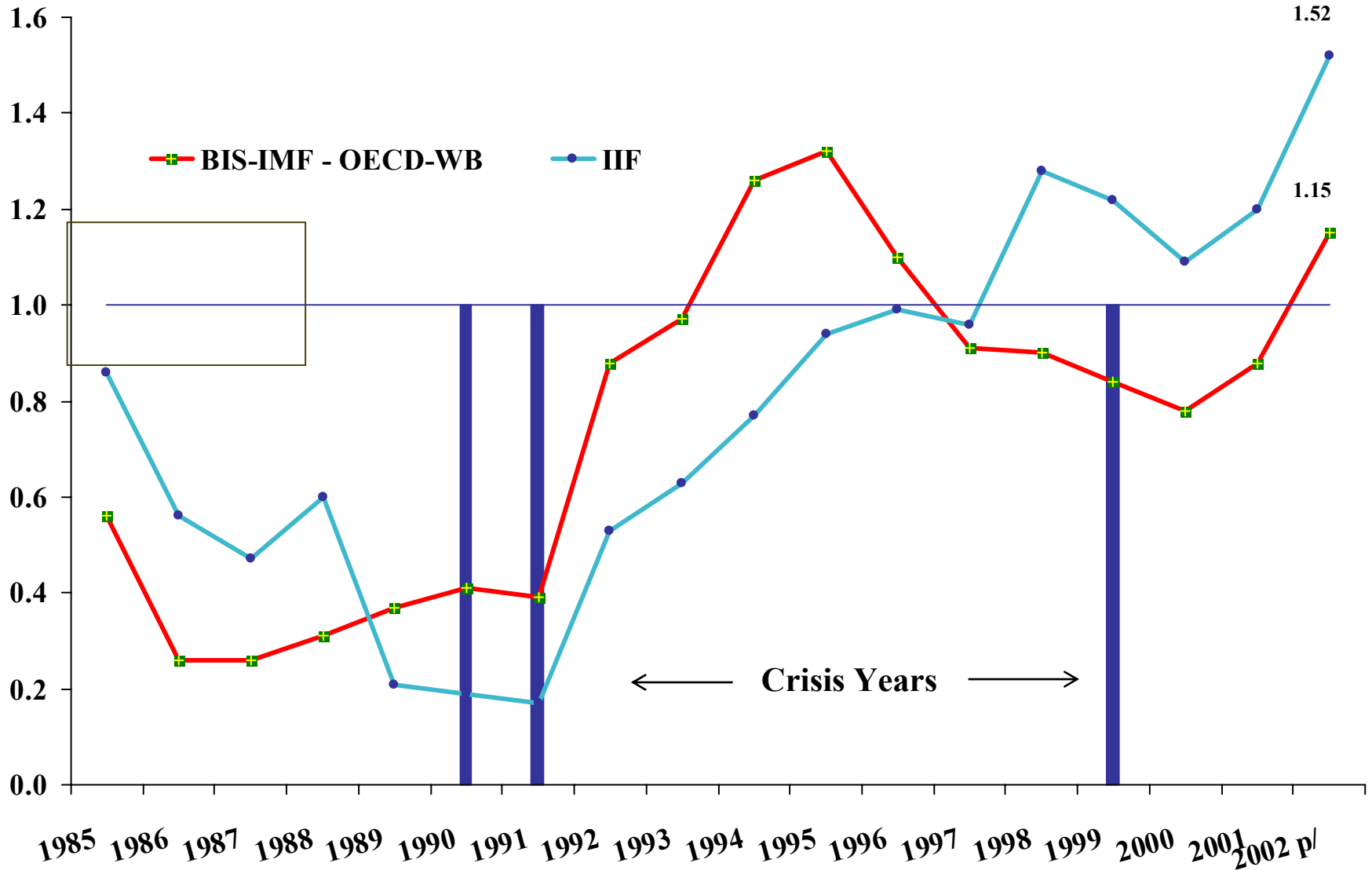
Chart 8: Chile



p/ BIS data are as at June 2002, while IIF data cover estimations as at end 2002.

IR/STED Ratio

Chart 9: Brazil



p/ BIS data are as at June 2002, while IIF data cover estimations as at end 2002.

IV.c. Graphic Analysis of the Behavior of the IR/STED Indicator

- ❖ The trend of this vulnerability indicator was generally similar for both data sources in six of the nine countries analyzed (Colombia, Mexico, South Korea, Indonesia, Malaysia, and Thailand).
- ❖ This is not the case for the three remaining countries (Argentina, Brazil, and Chile), where the differences in indicator behavior depending on the source used are more obvious for certain periods.
- ❖ However, possibly the most worrisome case can be observed in economies in which the tracking of ratios estimated on the basis of alternative statistical sources may have led to contradictory conclusions on the very eve of a crisis (Brazil in 1990 and 1999, and Colombia in 1997).

IV.d. Empirical Assessment of Possible Vulnerability Thresholds Based on the IR/STED Indicator

- ❖ Interest in the IR/STED ratio as an indicator of external vulnerability has been accompanied by proposals as to what the value of this indicator should be to ensure adequate safety margins.
- ❖ To explore this issue, the *Probit* model was estimated with restrictions for IR/STED values. In particular, IR/STED was made equal to zero for values of the ratio above a certain threshold. The value range for thresholds for which regressions were run is 0.5 to 4.4.

IV.d. Empirical Assessment of Possible Vulnerability Thresholds Based on the IR/STED Indicator

- ❖ It can be seen from Table 2 that, when the model is estimated with low IR/STED values, the relative significance of this variable as a determining factor of crises increases considerably. In addition, the regressions display a characteristic pattern for a threshold of 1.3. The IR/STED variable ceases to be relevant in explaining economic crises from a level of 1.3 onwards.
- ❖ The above has a further important implication. Given that the impact of the IR/STED variable on the likelihood of a crisis does not diminish for thresholds above a certain value, there is not much point in setting as policy goal to achieve ratios above this level.

TABLE 2

Vulnerability Thresholds (1985-2001, based on BIS source data)							
THRESHOLD	VARIABLE					P-value	Pseudo R²
Criterion ≤:	IR/STED	RERM	MB/GDP	TT	CA/GDP		
Basic equation	-0.011 *	0.026 *	0.142 *	-0.072 *	-0.297 *	0.0000	0.384
	-2.538	2.826	2.494	-2.609	-3.122		
0.5	-0.072	0.075	0.365	0.000	-0.857	0.0002	0.243
	-0.982	1.538	1.412	-0.005	-1.373		
0.6	-0.041	0.072 *	0.251 *	-0.004	-0.379 **	0.0001	0.273
	-1.445	2.173	2.102	-0.057	-1.693		
0.7	-0.049 **	0.066 *	0.262 *	-0.022	-0.476 *	0.0000	0.308
	-1.625	2.305	2.347	-0.343	-2.032		
0.8	-0.026 *	0.032 *	0.185 *	-0.020	-0.318 *	0.0002	0.246
	-2.071	2.685	2.856	-0.482	-2.477		
0.9	-0.019 **	0.026 *	0.149 *	-0.081 *	-0.323 *	0.0001	0.277
	-1.829	2.525	2.582	-2.563	-2.822		
1.0	-0.020 *	0.026 *	0.151 *	-0.083 *	-0.330 *	0.0000	0.284
	-2.089	2.559	2.635	-2.683	-2.929		
1.1	-0.018 *	0.027 *	0.142 *	-0.088 *	-0.338 *	0.0000	0.322
	-2.051	2.750	2.576	-2.946	-3.124		
1.2	-0.019 *	0.027 *	0.143 *	-0.089 *	-0.340 *	0.0000	0.322
	-2.114	2.779	2.588	-2.976	-3.127		
1.3	-0.007	0.026 *	0.164 *	-0.078 *	-0.311 *	0.0000	0.377
	-1.204	2.968	2.979	-2.874	-3.357		
2.2	-0.010 *	0.027 *	0.157 *	-0.078 *	-0.323 *	0.0000	0.377
	-2.136	3.022	2.843	-2.868	-3.540		
2.6	-0.010 *	0.027 *	0.153 *	-0.076 *	-0.316 *	0.0000	0.379
	-2.242	2.970	2.747	-2.800	-3.428		
3.0	-0.010 *	0.027 *	0.152 *	-0.076 *	-0.314 *	0.0000	0.380
	-2.290	2.953	2.721	-2.774	-3.403		
3.4	-0.010 *	0.026 *	0.149 *	-0.074 *	-0.309 *	0.0000	0.381
	-2.314	2.910	2.646	-2.720	-3.313		
3.8	-0.010 *	0.026 *	0.148 *	-0.074 *	-0.307 *	0.0000	0.382
	-2.319	2.897	2.625	-2.705	-3.287		
4.4	-0.011 *	0.026 *	0.143 *	-0.072 *	-0.299 *	0.0000	0.383
	-2.538	2.843	2.522	-2.631	-3.156		

* Statistically significant at a level less than or equal to 5 percent.

** Statistically significant at a level less than or equal to 10 percent.

IV.d. Empirical Assessment of Possible Vulnerability Thresholds Based on the IR/STED Indicator

- ❖ In other words, the vulnerability threshold not only has a lower limit (floor) as suggested by the IMF, it also has an upper limit (ceiling).
- ❖ The econometric calculations do not provide any conclusive data regarding the lower threshold limit.
- ❖ Bearing in mind that the coefficient estimated for the IR/STED ratio remains practically constant for all thresholds in the 0.9 to 1.2 range, and the practical advantages of using a reference value of 1, it would seem useful to regard the value of 1 as the minimum.

V.a. Estimating the Vulnerability Indicator for Mexico

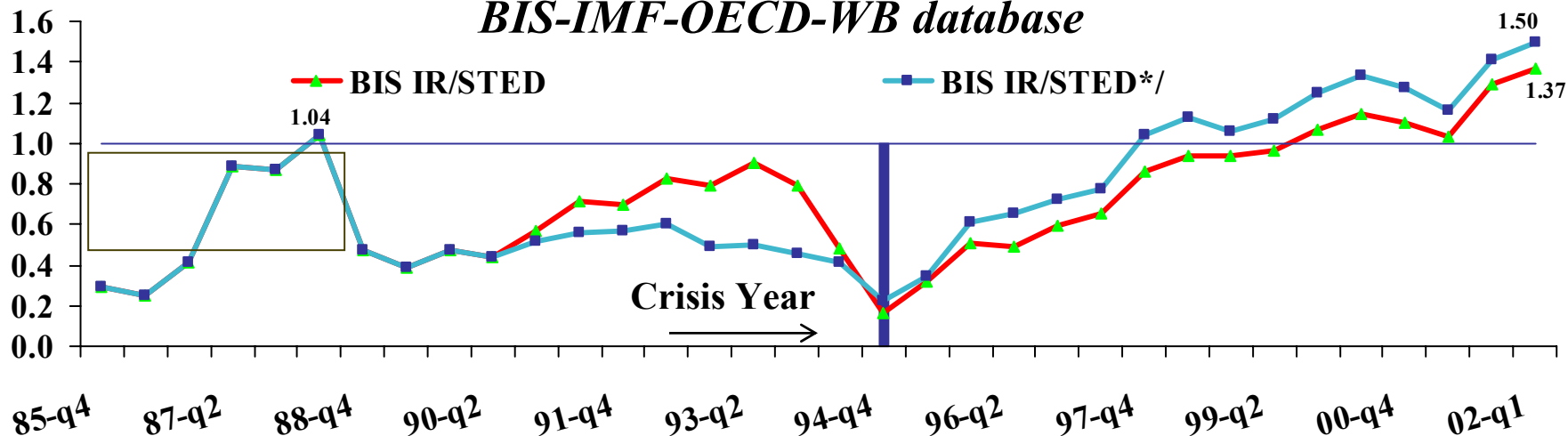
- ❖ Three types of exercises are conducted for Mexico in this section.
 1. BIS and IIF statistics are combined with official national data in order to incorporate some of the methodological adjustments recommended by the IMF.
 2. The IR/STED ratio is estimated exclusively on the basis of official national data.
 3. The breakdown of official national data on short-term amortizations is used to construct an “adjusted” version of the IR/STED ratio, that allows a more timely detection of liquidity problems.

V.b. Estimating the Vulnerability Indicator for Mexico: Exercises Using International Databases

- ❖ Estimations for Mexico based on BIS-IMF-OECD-WB and IIF data are supplemented by calculating an IR/STED* ratio for each database, to bring these databases as closely into line as possible with the methodology proposed by the IMF.
- ❖ The IR/STED* ratio features the following differences with respect to the IR/STED ratio:
 1. The stock of international reserves includes the undisbursed component of the credit line opened with the United States and Canada in April 1994, and the contingency liquidity credit line negotiated with 33 international financial institutions from 10 countries in November 1997; and
 2. Short-term public external debt includes the stock in circulation of fixed-income government securities issued domestically and held by nonresidents.

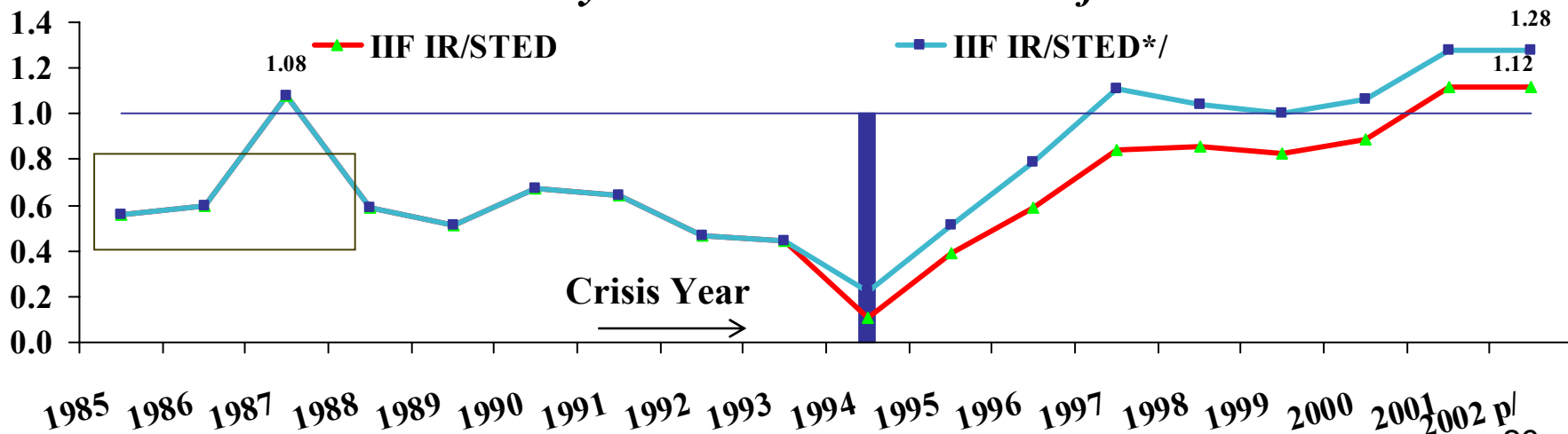
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Chart 10: Vulnerability indicator based on data from BIS-IMF-OECD-WB database



*/ Includes nonresident holdings of peso-denominated domestically-issued government securities, the NAFA credit line, and the liquidity credit line available from commercial banks.

Chart 11: Vulnerability indicator based on data from IIF database



*/ Includes the NAFA credit line and the liquidity credit line available from commercial banks .

p/ IIF data are for estimations as at end-2002.

V.b. Estimating the Vulnerability Indicator for Mexico: Exercises Using International Databases

- ❖ If BIS-IMF-OECD-WB data are used, a very marked difference is observed between IR/STED and IR/STED* indicator levels for the period 1990-1994 .
- ❖ Although it can be concluded that both ratios foresaw the possibility of a crisis prior to the close of 1994, in that they recorded a downward trend for several consecutive semesters and stood at very low levels, the IR/STED* indicator is more useful, as its downtrend began before that for IR/STED, and the IR/STED* value was lower for most of this period and thus suggested a higher element of risk.
- ❖ When IIF data are used, there is practically no difference between the predictive power of the IR/STED and IR/STED* indicators.

V.c. Estimating the Vulnerability Indicator for Mexico: Exercises Using Official National Databases

- ❖ Two estimations of the short-term external debt stock measured by residual maturity were obtained on the basis of data published by the Ministry of Finance and Public Credit:
 1. Total Amortizations. Short-term external debt at the end of each year is equivalent to total amortizations scheduled for the next twelve months.
 2. Market Amortizations. Short-term external debt only includes components with a higher degree of sensitivity to changes in the perception of the economic climate in Mexico, i.e. amortizations scheduled for the next twelve months for:
 - Public sector debt liabilities in capital markets and liabilities stemming from debt restructuring; and
 - Nonbank private sector debt liabilities with the commercial banking sector and international capital markets.

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Chart 12: Vulnerability indicator based on data from official national databases

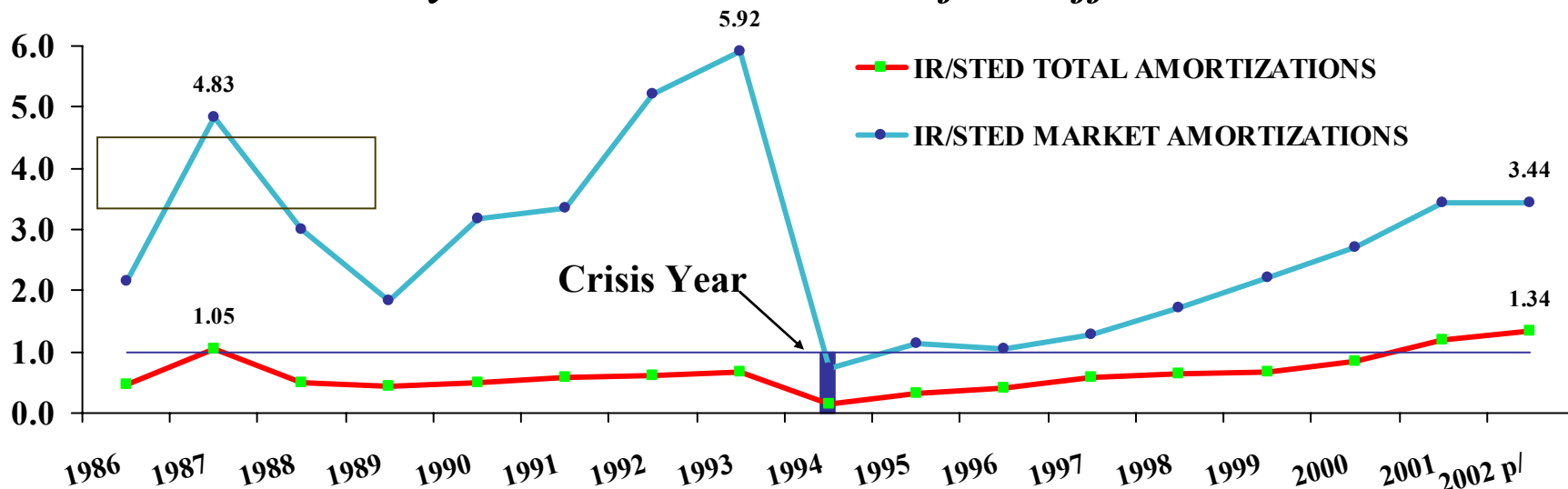
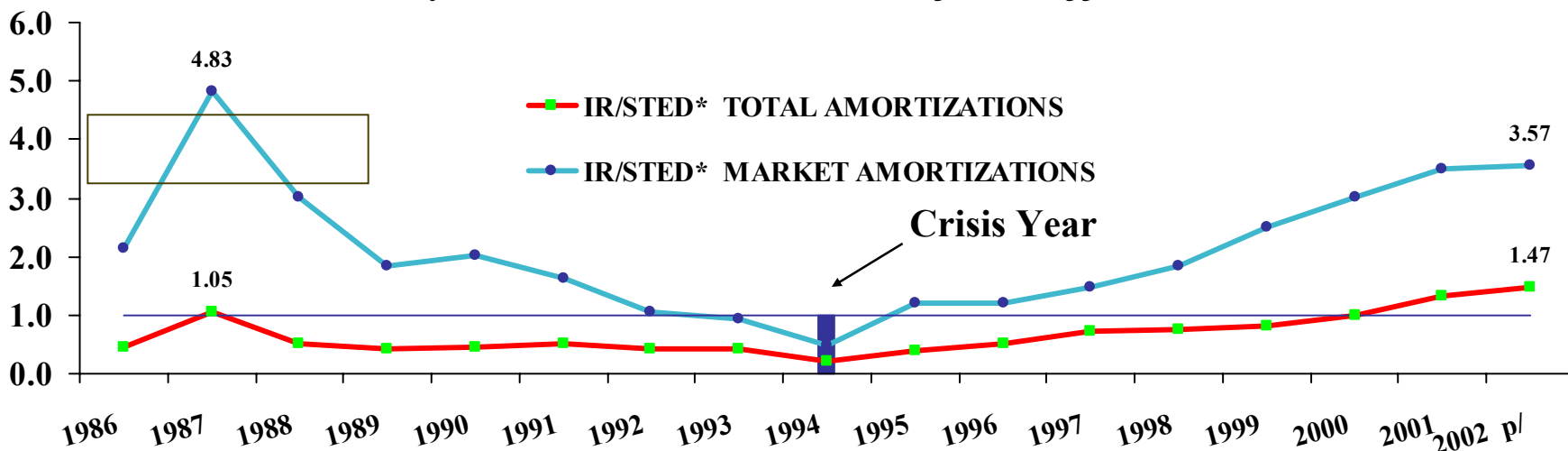


Chart 13: Vulnerability indicator based on data from official national databases



*/ Includes nonresident holdings of peso-denominated domestically-issued government securities, the NAFTA credit line, and the liquidity credit line available from commercial banks.

p/ Forecast prepared using the stock of international reserves as at June 2002 and the Data Book amortization schedule for the second half of 2002, and 50 percent of total amortizations scheduled for 2003, based on the external debt balance as at June 2002.

V.c. Estimating the Vulnerability Indicator for Mexico: Exercises Using Official National Databases

- ❖ The IR/STED and IR/STED* ratios both clearly reflect the 1994 Mexican crisis ex-post in all calculations performed.
- ❖ However, IR/STED* ratios prove to be more useful in predicting this crisis, as they record a downtrend and feature very low values in the several years leading up to the crisis.
- ❖ In fact, the IR/STED ratio is of no use in detecting the 1994 crisis, as it records an upward trend in the preceding years in both versions (total amortizations and market amortizations).

V.c. Estimating the Vulnerability Indicator for Mexico: Exercises Using Official National Databases

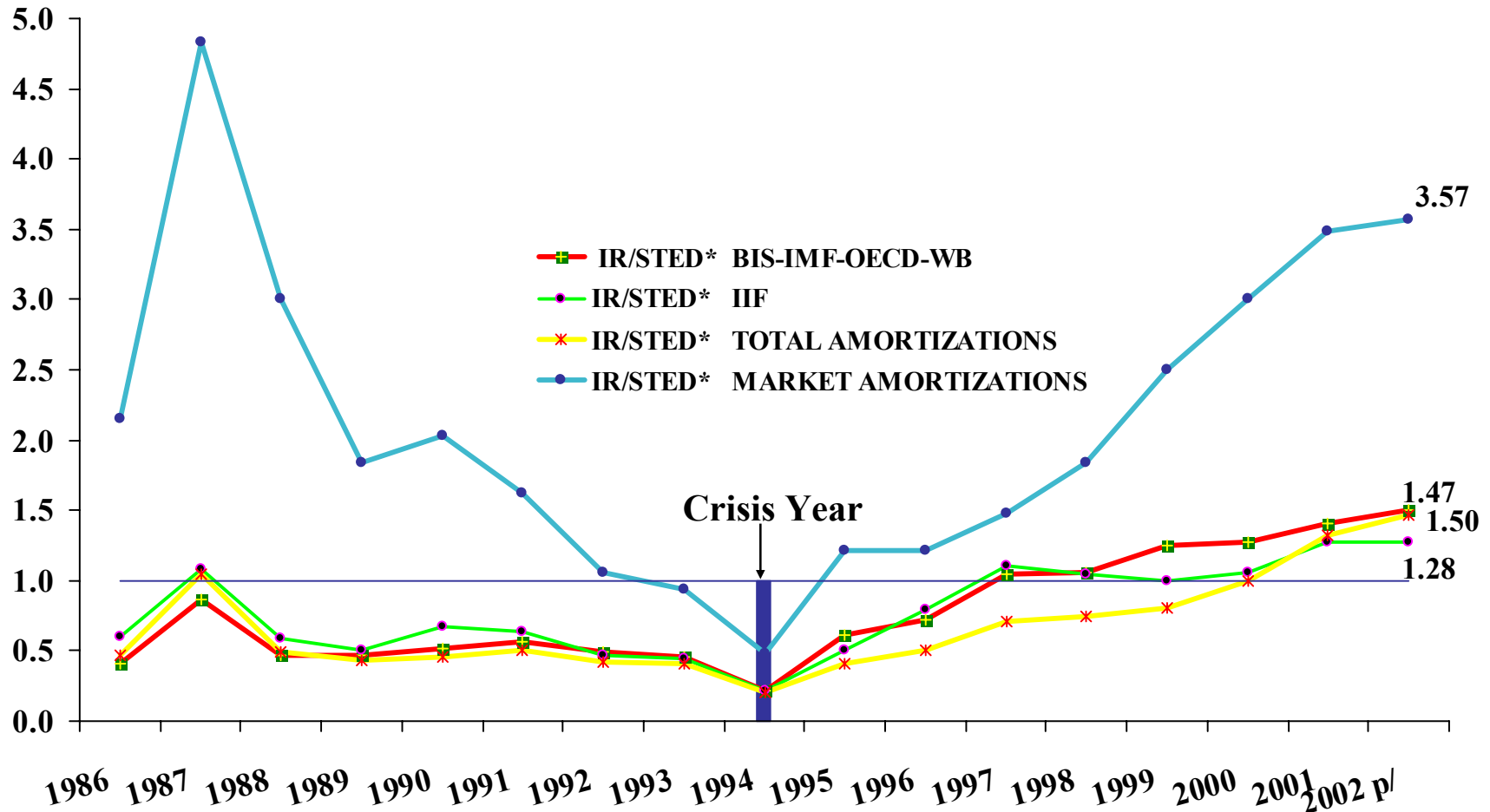
- ❖ The great advantage of the IR/STED* indicator based on market amortizations lies in its higher degree of sensitivity to changes in liquidity availability, which allows to detect the risk of problems with external payments in a more timely manner. However, as this indicator only provides a low level of coverage, is it advisable to use data obtained by this means in conjunction with broader indicators, such as the total amortizations indicator.

V.d. Estimating the IR/STED* for Mexico Using International and Official National Databases

- ❖ The evolution of the IR/STED* ratio based on data from official national and international sources shows that three of the four indicators (BIS, IIF, and Total Amortizations) behave almost identically and record very similar levels for the period 1986-1994.
- ❖ However, although they all display low values and a downward trend as from 1991, none of the three predict the emergence of liquidity problems in the Mexican economy with the clarity and timeliness of the “adjusted” ratio (IR/STED* estimated on the basis of market amortizations).
- ❖ Finally, it should be pointed out that all IR/STED* ratios show a marked upward trend as from 1995 and levels higher than 1 since 2001, irrespective of the data source employed.

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Chart 14: Vulnerability indicator based on data from international and official national databases



*/ Includes nonresident holdings of peso-denominated domestically issued government securities, the NAFA credit line, and the liquidity credit live available from commercial banks .

p/ BIS data are as at June 2002, while IIF data cover estimations as at end-2002. Total amortization and market amortization forecasts were prepared using the stock of international reserves as at June 2002, the Data Book amortization schedule for the second half of 2002, and 50 percent of total amortizations scheduled for 2003, based on the external debt balance as at June 2002.

VI. Concluding Remarks

- ❖ Estimations based on a *Probit* model for 9 emerging economies confirm that the IR/STED ratio is a highly relevant variable in explaining economic crises.
- ❖ This conclusion holds firm regardless of the database used. However, the relative significance of the variable as an indicator of external vulnerability changes when alternative databases with different characteristics are employed.
- ❖ Graphic analysis of individual cases show that, for some countries, the assessment of the IR/STED ratio as a factor in explaining crises depends fundamentally on the database used.

VI. Concluding Remarks

- ❖ The estimation of the *Probit* model with restrictions for IR/STED values suggests, on one hand, that this threshold must be regarded as an interval and not simply as a minimum value, as there comes a point beyond which there is not much to be gained from increasing the value of this variable. This aspect must be borne in mind, as accumulating international reserves also implies costs.
- ❖ The econometric estimations performed support the assertion that achieving a minimum vulnerability threshold value of approximately 1 is in general a reasonable goal.

VI. Concluding Remarks

- ❖ The Mexican case was analyzed in more detail using data from international and official national sources. Two fundamental aspects emerged:
 - Some of the methodological adjustments recommended by the IMF for calculating the IR/STED ratio may be crucial in ensuring that this ratio proves useful as a tool for crisis prevention.
 - Although it is worth incorporating total amortizations in determining the indicator's STED component, the sensitivity of this variable to changes in external conditions may be limited. In the case of Mexico, the use of the market amortizations component of STED allows a more timely detection of liquidity problems.



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