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EFFECTIVENESS OF THE IMF EARLY WARNINGS SYSTEM IN THE PERIOD FROM THE MEXICAN CRISIS TO MAY 2001

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INTRODUCTION

Right after the Mexico financial crisis, a careful research by the United States General Accounting Office revealed that "… IMF staff did not closely monitor Mexican developments during the later half of 1994 and, like other informed observers, did not predict the crisis."[1] The shock of this crisis and the cry around the world on the IMF's inability to predict future crises have forced this organization to reform its framework for anticipating financial crises. A new framework has been introduced in which the findings of the World Economic Outlook and Early Warning System would be synthesized to predict the future financial crises. However, the Asian financial crisis and a series of crises in its aftermath showed that the new framework did not work well as its founder wished and a new mechanism with six components to forecast crisis were established in May 2001. As it is too early to evaluate the new six component mechanism, in this paper, we (i) discuss the effectiveness of the crisis early warning system in the period from the Mexican crisis to May 2001 and (ii) try to find out the main reasons of its ineffectiveness.

This paper is divided into five parts:

(i)   Structure of the IMF's vulnerability assessment framework;

(ii)   Effectiveness of crisis prediction;

(iii)   The early warning system models;

(iv)   Reasons for the ineffectiveness of the early warning system models; and

(v)   Conclusion

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[1] United General Accounting Office, *Mexico's financial crisis, Origins, Awareness, Assistance, and Initial Efforts to Recover* <http://www.gao.gov/archive/1996/gg96056.pdf> 105 (accessed November 29, 2003) [Hereinafter GAO, *Mexico's financial crisis*].

STRUCTURE OF THE IMF'S VULNARABILITY ASSESSMENT FRAMEWORK

Crisis prevention, vulnerability assessment and crisis early warning system:

First of all, it is necessary to distinguish the concepts of "crisis prevention", "vulnerability assessment", and "early warning system". *Crisis prevention* is one of the Fund's activities to "promote global growth and economic stability" meanwhile *vulnerability assessment* is one of various tools used by the Fund for that purpose[2]. Since the establishment of the Fund, vulnerability assessment has been a part of the surveillance under Article IV of the Articles of Agreement[3]. However, the costly lessons from Mexican and Asian crises force the IMF to develop a specialized tool called "*early warning system*" (EWS) that could "offer a systematic, objective and consistent method to predict crisis that avoids analysts' biases[4]". In brief, the findings of vulnerability assessment are used for two purposes: (i) to anticipate the crisis (in combination with the findings of EWS), and (ii) to help the Fund in other long-term activities such as lending and providing policy advice.

Structure of IMF's vulnerability assessment framework:

Before Mexican crisis:

Before 1995, anticipating financial crisis had been considered as an integral part of "article IV consultation". Every year, the Fund's staff, called the "mission", spend several weeks in a country, working with its government officials and sometimes with private sector representatives about the government's economic policies. The information collected through those meetings would be analyzed by the mission and commented by

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[2] The IMF Managing Director summarized the Fund's efforts to prevent crisis as: "… streamline conditionality, restructure Fund facilities, further the work on private sector involvement in the resolution of crises; and implement the initiatives on crisis prevention, in particular, *vulnerability assessment*, standards and codes, and transparency." See IMF, *Report of the Managing Director to the International Monetary and Financial Committee on the IMF in the Process of Change* <http://www.imf.org/external/np/omd/2001/042501.pdf > (accessed November 17, 2003) (emphasis added).

[3] According to a group of experts hired by the IMF to evaluate its surveillance activities, there are six objectives of surveillance: (i) policy advice, (ii) policy coordination and cooperation, (iii) information gathering and dissemination, (iv) technical assistance and aid, (v) *identification of vulnerabilities,* and (vi) "delivering the message. See IMF, *External Evaluation of IMF Surveillance,* <http://www.imf.org/external/pubs/ft/extev/surv/eval.pdf> (accessed November 17, 2003) (emphasis added).

[4] IMF, *Global Financial Stability Report-March 2002* <http://www.imf.org/External/Pubs/FT/GFSR/2002/01/pdf/chp4and5.pdf> 49 (accessed November 23, 2003) [Hereinafter IMF, *GFSR March 2002*].

departments of the Fund before submitting to the Executive Board to discuss. A summary of this discussion and advices of the Executive Board would be transmitted to the government.

From Mexican crisis to May 2001:

After the Mexican crisis, the IMF developed some early warning system models hoping that it would help to scientifically anticipate the financial crisis without any influence of analysist's bias. These models were used along with other tools of the Fund such as the *World Economic Outlook*, the *International Capital Markets Report* and the *Emerging Market Financing*[5] in the surveillance.

From May 2001 to present:

In May 2001, the Fund once again refined the vulnerability assessment framework. According to a report of the United States General Accounting Office (GAO) in 2003, the Fund conducts vulnerability assessment based on six "independent inputs that represent the analyses and perspectives of different departments of the Fund"[6]:

- *World Economic Outlook (WEO):* This is a biannual report published by the Fund analyzing the global economic development. The forecasts of this report are used by the Fund as inputs in the vulnerability assessment in a global scope.

- *Early Warning System models:* several models are developed to analyze the vulnerability indicators and predict the possibility of financial crisis.

- *Country external financing requirements:* the Fund carries out an "internal assessment of a country's ability to meet its total external debt obligations and estimates whether that country has sufficient foreign exchange to avoid crisis". The assessment is on a quarterly basis.

- *Market information*: "the Fund analyzes the country's cost of borrowing on the international market. This analysis reflects the private sector's expectation of a country's likelihood of default on its foreign debt".

- *Financial sector vulnerability*: analysis of the financial sector vulnerability including banking system is used by the Fund to assess the strength and weakness of a country's financial sector.

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[5] The *International Capital Markets Report* (published since 1980) and the *Emerging Market Financing* (published since 2000) have been replaced by the *Global Financial Stability Report.* In this report, the Fund's staff assess the stability of global financial markets and identify the systematic weaknesses that could lead to crises.

[6] United States General Accounting Office, *International Financial Crises, Challenge Remain in IMF's Ability to Anticipate, Prevent, and Resolve Financial Crises* < http://www.gao.gov/new.items/d03734.pdf > 8-10 (accessed November 23, 20003) [herein after GAO, *International financial crises*].

- *Country expert perspectives*: "IMF country experts examine the data produced by the above analyses, supplementing those results with country-specific details such as the political risks of implementing certain government policies or the relevance of certain market information."

Although the GAO's report which was published on June 2003 did not mention about the *Global Financial Stability Report* (GFSR)[7], the contents of this report in fact were covered by four inputs: (i) country external financing requirements, (ii) market information, (iii) financial sector vulnerability and (iv) country expert perspectives.

Of the six inputs above, WEO and EWS are the primary tools of the Fund in anticipating the financial crisis. Meanwhile the WEO serves as the rather long-term and global view on the economic and financial issues, the later is rather short-term and specialized in the most concerned problem: financial crisis.

EFFECTIVENESS OF CRISIS PREDICTION

As the new vulnerability assessment framework has been applied in a very short time, it is too early and there is not enough information available to evaluate its effectiveness. Instead, this paper would focus on the effectiveness of EWS, which has been used in a time that is long enough for evaluation, and discuss some crisis-prediction-related-aspects of WEO.

According to a report of GAO in 2003, the WEO has performed poorly in the last decade. Statistics showed that the WEO had a poor record in anticipating the declines of GDP and the current account, the two key variables to forecast financial crisis.

GAO found that of 134 recessions occurred in 87 emerging countries in 1990-2001 period, "the WEO correctly forecast only 15, or 11 percent, of those recessions, while predicting an increase in GDP in the other 119 actual recession."[8] In addition, the WEO failed to anticipate the recessions that followed 14 major financial crises of this period, a clear proof of the Fund's failure in sensing the incoming crises.

The Fund's forecast of current account was not better than its prediction on GDP. Of 87 emerging market countries, GAO found that 75 percent of the Fund forecast were less accurate than "if the Fund had simply assumed that the next year's current account would be the same as this year's."[9] More dramatically, the Fund's prediction was not accurate even in six of seven G-7 economies. Although the statistic system of these countries provided full and reliable information, a no-change prediction would still be more accurate than the Fund's forecast[10].

Regarding the EWS models, GAO found that these models created a high rate of false alarms: "[i]n about 80 percent of the cases where a crisis was predicted over the next 24

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[7] Issued the first time in March 2002, this semiannual report provides assessments of the stability of global financial markets and identifies potential systemic weaknesses that could lead to crises.
[8] GAO, *International financial crises,* s*upra* n.6, at 11.
[9] *Id.* at 13.
[10] *Id.* at 13.

months, no crisis occurred."[11]   In an report carried out by Andrew Berg, Eduardo Borensztein, Gian Maria Milesi-Ferretti, and Catherin Pattillo in 1999 showed that the false alarm rate was 60 percent[12]. Of the major financial crises of the last decade the IMF successfully predicted the Turkey crisis in 2001 but predicted too late the Thailand 1998 and Argentina 2002 crises.

EWS MODELS

To explain the poor record of the EWS models, it is necessary to mention about the models used by the Fund. Although in the literature of early warning system, there many EWS models developed by both international financial and private institutions, the Fund uses two core models: (i) the Developing Country Studies Division (DCSD) and (ii) the modified Kaminsky, Lizondo, and Reinhart (KLR) models[13].

"The DCSD model uses a multivariate panel probit regression technique to estimate the monthly probability that a country would suffer a crisis in the following 24 months"[14]. The variables used in this model are:

- Real exchange rate overvaluation,

- Current account balance,

- Foreign exchange reserve losses,

- Export growth, and

- The ratio of short-term debt to foreign exchange reserves

The variables will be analyzed and converted into a binary indicator that would present the value of either one or zero. The indicator equal to one when it exceeds a cutoff threshold meaning that a crisis within 24 months is anticipated. In case the indicator not exceeds the threshold, it presents zero and predicts no crisis.

"The econometric methodology of the KLR signals model is somewhat different from that of the DCSD model, except for the final stage that determines the threshold probability for an aggregate crisis index and a crisis is called. The KLR model assumes that each individual explanatory variable signals a crisis if its mean exceeds a variable-specific optimal threshold and a crisis occurs in the next 24 months. This threshold, which is expressed in percentile terms and is assumed equal across countries, is determined by minimizing the noise-tosignal ratio: the number of months during which the variable signaled a crisis incorrectly (false alarm or noise) divided by the number of months during which the variable signaled a crisis correctly. KLR constructs a single composite crisis

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[11] *Id.* at 14.

[12] See Andrew Berg, Eduardo Borensztein, Gian Maria Milesi-Ferretti, and Catherin Pattillo, *Anticipating Balance of Payments Crises: The Role of Early Warning Systems* < http://www.imf.org/external/pubs/nft/op/186/index.htm> (accessed November 23, 2003).

[13] Graciela Kaminsky, Saul Lizondo, and Carmen M. Reinhart, *Leading Indicators of Currency Crises* <http://www.imf.org/external/pubs/ft/wp/wp9779.pdf > (accessed Novermber 19, 2003) [Herein after KLR].

[14] IMF, *GFSR March 2002, supra* n. 4, at 50.

indicator equal to the weighted-sum of the explanatory variables, with the weights being equal to the inverse of each indicators' noise-to-signal ratio. The probability of crisis for each value of the aggregate index is then obtained by observing how often, within the sample, a given value of the aggregate index is followed by a crisis within 24 months, and the optimal probability threshold for the KLR model is determined in a similar way as for the DCSD model."[15]

The indicators used in KLR model include[16]:

- Real exchange rate overvaluation,

- Current account balance,

- Foreign exchange reserve losses,

- Export growth,

- Ratio of foreign exchange reserves to M2,

- The growth of the ratio of reserves to M2,

- Domestic credit growth,

- Change in the money multiplier,

- Real interest rate, and

- "Excess" M1 balances.

REASONS FOR THE UNSUCCESSFULNESS EWS MODELS

There are many reasons for the unsuccessfulness of the EWS models. Various independent evaluations and assessment of the Fund itself have found many problems in the EWS models themselves, within the Fund and its cooperation with countries. Generally, the problems are methodological issues, information, interdepartmental relationship within the Fund, language of the crisis warning and publication of crisis forecast.

Methodological issues of EWS models:

Threshold

The most troublesome issue is how "threshold" of the EWS models is set. It is necessary to describe briefly how an analysist use the EWS model. To identify a coming crisis, the analysist would take changes in vulnerability indicators and then combine them into an index of speculative pressure. He then predicts crises if the index exceeds an established

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[15] *Id.* at 52.
[16] *Id.* at 49.

threshold[17]. However, how the threshold is established is the problem that heavily affects the accuracy of the forecast. There are at least three problems have been identified in connection with the threshold.

First, there is no common threshold for the EWS models. In fact, threshold is differently determined by analysists based on the past crisis[18]. Different thresholds lead to different prediction on crisis dates or even the possibility of that crisis. Setting the threshold too high would result in a no-crisis prediction, but setting it too low would result in many too-early-or-even-false alarms[19].

Second, determining the width of "exclusion windows" is also a problem. "Exclusion window" is the period following a financial crisis in which the vulnerability indicators are considered as they reflect the past crisis than predict a new one. However, as the case of thresholds, there is not an agreement among analysts on the width of "exclusion windows". Setting the exclusion windows too broad could screen out the true indicators of a coming crisis, and reversely, a too narrow exclusion window could result in false alarms.

New variables

Recent crises have showed that new variables should be added to the set of indicators used as inputs of the EWS models. The most recent research proposed a set of the indicators as follows[20]:

Category	Concept	Measure
Macroeconomic indicators	External imbalance/real overvaluation	1 Deviations of real exchange rate from trend 2 Current account balance/GDP 3 Export growth rate
	Inadequacy of reserve cover	4 M2/reserves, level 5 M2/reserves, growth rate 6 Reserves growth rate
	Overexpansion of credit	7 Growth rate of real domestic credit, deflated by nominal GDP
	Slowdown in the real economy	

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[17] See Adul Abiad, *Early Warning System: a survey and a regime switching approach* <http://www.imf.org/external/pubs/ft/wp/2003/wp0332.pdf > (accessed November 24, 2003).

[18] For more details on how threshold is established see KLR, *supra* n. 13 and Abdul Abiad, *supra* n. 17.

[19] In its comments on the GAO report, the Fund explained that "[t]he user can set a threshold probability at which to "call" a crisis: this involves a clear tradeoff, since if this threshold is set conservatively low, there will inevitably be false alarm, while if it is set higher we would fail to predict real crises. Given that the purpose for which we use these models is not to make final predictions of crises but to supplement other approaches to identifying vulnerable countries that require further scrutiny, *setting a conservatively low threshold is appropriate*." See GAO, *International financial crises, supra* n. 6 at 68 (emphasis added).

[20] See Adul Abiad, *supra* n.17.

		8 Industrial production, growth rate
	Asset price boom/burst Monetary tightening	9 Real GDP, growth rate (interpolated from quarterly GDP) 10 Stock market performance, growth rate 11 Real interest rate
Capital flows indicators	Possible cause of reversal of flows Lending boom Short-term debt Composition of capital flows	12 LIBOR 13 Bank assets/GDP, growth rate 14 Short-term debt to reserves 15 Cumulative non-FDI flows/GDP 16 Portfolio flows, share in stock of total capital flows
Financial fragility indicators	Capital adequacy Bailing out by the central bank Confidence in banks Ability of banks to mobilize deposits	17 Bank reserves/total bank assets 18 CB credit to banks/ total bank liabilities 19 Bank deposits/M2, level 20 Bank deposits/M2, growth rate 21 Loans/deposits, level 22 Loans/deposits, growth rate

The change of vulnerability indicators seems unavoidable because the markets and policy makers would take into account the indicators that have successfully indicated the crisis in their decisions to prevent its occurrence. Consequently, the indicators would lose its accuracy in predicting crises in terms of dating or even posibility of crisis[21].

Financial market linkages and contagious effect

The modern financial markets have a so closed and sophisticated interdependence that a currency crisis could lead to a debt crisis and vice versa. This interdependence still requires more intensive study although there have been several studies recently on this

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[21] IMF, *World Economic Outlook May 1998*
<http://www.imf.org/External/Pubs/FT/weo/weo0598/pdf/0598ch4.pdf > 88 (accessed November 12, 2003).

issue (such as the study of Flood and Marion (2001) on the linkages between currency and banking crises[22], the study of Chang and Velasco (2000))

Contagious effect also an issue that needs more study. Inappropriate study on contagious effect and linkages of capital markets has contributed to the failure of the IMF in forecasting the Mexican and Asian crises. According to an IMF senior official, the most important event that IMF staff and Mexican officials missed in their analyses during 1995 was the rise in U.S. interest rates and how that affected investment in Mexico. He said that rising U.S. interest rates changed the investment calculation for most investments.[23] Of course the increasing interest rates in the U.S were one of the reasons for the outflows of capital of Mexico before the crises. In Asia crisis, the Fund predicted that Thailand government was going to deal with an imminent crisis (although it was considered that the IMF warning was too late and therefore, could not help this country), but it failed to predicted that crisis would spread out to other countries like Malaysia, Indonesia and Korea.

It is unable to say that contagious effect have been fully studied and understood. Yet there are still many aspects of contagious effect need to be studied. (e.g. the relationship between four types of financial crisis and possibilities that one crisis could lead to a crisis of other type[24], or contagious effects in the scope of a country and a region.)

Information:

Quality and timeliness of information

Information plays a key role in the success of EWS models. However, the Fund found that it does not often get data of good quality from member countries. The timeliness of the data is also a problem. For example, in the cases of Korean and Thailand crises, the Fund was not able to obtain from these countries all statistical information on international reserves and foreign debt. Especially in the case of Korea, the modest information on fiscal and current account deficits played was the main reason of the Fund's failure to anticipate the crisis.

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[22] See general, Robert P. Flood and Nancy Marion, *A Model of the Joint Distribution of Banking and Exchange-Rate Crises* < http://www.imf.org/external/pubs/ft/wp/2001/wp01213.pdf > (accessed November 20, 2003).

[23] GAO, *Mexico's financial crisis, supra* n. 1 at 106.

[24] According to the IMF, a *currency crisis* can be seen when a currency is sharply devalued (or depreciated) under a speculative attack. This devaluation or depreciation normally forces the authorities to spend large volumes of its foreign currency reserve or sharply rise interest rates. A *banking crisis* occurs when banks are forced to suspend the internal convertibility of their abilities or when the government has to assists the banks by large scale loans or aids to prevent a bank run. A *systematic financial crisis* is "potentially severe disruptions of financial disruptions of financial market, by impairing markets' ability to function effectively, can have large adverse effects on the real economy." The last, *foreign debt crisis* can be simply understood as "a situation in which a country cannot service its foreign debt, whether sovereign or private. See IMF, *World Economic Outlook, May 1998* <http://www.imf.org/External/Pubs/FT/weo/weo0598/pdf/0598ch4.pdf > 74 (accessed November 23, 2003).

However, the Fund also has its responsibility on this issue. A report of GAO right after the Mexican crisis has found that:

(i) "IMF was not monitoring countries on a "real-time" basis. For example, staff were not tracking real-time data on Mexican tesobonos during 1994";

(ii) "IMF had become too tolerant of a fall off in the quality and timeliness of data provided by member countries that were no longer in an IMF-supported adjustment program. Mexico had not had a program with IMF since May 1993."[25]

In order to improve information quality, since 1995 the Fund developed a General Data Dissemination System to (i) "encourage member countries to improve data quality"; (ii) "provide a framework for evaluating needs for data improvement and setting priorities in this respect"; and (iii) "guide member countries in the dissemination to the public of comprehensive, timely, accessible, and reliable economic, financial, and socio-demographic statistics."[26] The participation of member countries to this system is based on voluntary basis taking into account the difference in the ability of the governments in applying the system. At present time, there are 64 countries, most of them are developing countries, participating in this system. With the number of participating countries is increasing it is hopeful that problem of information quality and timeliness will be solved.

Interdepartmental relations

It seems traditional that departments of the Fund works independently. This independence sometimes helps the Fund seeing an issue from many points of view but sometimes it leads into a poor relationship between departments. This poor relationship, of course affects the works that required the cooperation of these departments. The most outstanding example was the poor cooperation between the Research Department responsible for capital market surveillance and the Asia and Pacific Department responsible for country surveillance in the Asian crisis. The disagreement and the following breakdown communication between these two departments partly led to the fact that "the health of Korea's financial system were not properly reflected in surveillance nor communicated to the Executive Board."[27] Indeed, in this case, the Research Department had identified indicators of a crisis from the Korean financial system but the Executive Board were not informed that.

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[25] GAO, *Mexico's financial crisis*, *supra* n. 106.

[26] IMF, *What is the General Data Dissemination System (GDDS)?* <http://dsbb.imf.org/Applications/web/gdds/gddswhatgdds/ > (accessed November 20, 2003).

[27] IMF, *External Evaluation of IMF Surveillance* < http://www.imf.org/external/pubs/ft/extev/surv/eval.pdf> 32 (accessed November 20, 2003) [Hereinafter IMF, *External Evaluation*].

The language of IMF surveillance report and publication of crisis prediction

The language of IMF surveillance report

The language of IMF surveillance report, especially those related to vulnerabilities are considered as too diplomatic and not frank enough for the under-surveillance government to take actions. The case Thailand is an example in which the Fund had predicted the crisis but its warning language were not frank enough for the Thailand government[28]. There are two reasons for this diplomatic style of the Fund.

First, it is difficult to date a crisis especially in case of currency crisis or a banking crisis. In these types of crisis, the date is normally determined by a sharp devaluation of a currency or a bank run. However, when and how a currency devaluation and a bank run occur, in many cases, seems to depend on the psychological status of the public than a scientific prediction.

Second, in some area departments, the Fund's staff want to maintain a good relationship with the government under their surveillance because a too-critical-and-less-diplomatic-official of the IMF would have less cooperation from their counterparts in that government.

Publication of crisis prediction

How to use crisis predictions is also a matter to be considered. As financial markets are more and more globally dependent and sensitive, a "crisis prediction" rather than prevent a crisis would cause a might-be-crisis become a real one or may cause it happen earlier than predicted. The consequence of such prediction is more serious in the case of the IMF as if its prediction is right, the market may be overheated and cause crisis; but if the prediction is wrong, the IMF reputation would be undermined and its prediction becomes less persuasive.

At present time, only concerned governments are informed crisis predictions and this practice still save the Fund from "moral hazard" of its forecasts. However, recent crises have showed that the private sector plays more and more important role in the cause of crisis. The lack of transparancy in vulnerabilities of a country could lead to a sharp change in capital inflows and outflows of a country as private investors are always the most sensitive before any indicators of crisis.

CONCLUSION

Since the Mexican crisis, the IMF has developed a new mechanism to detect financial vulnerabilities of countries and predict crisis. From 1995 to 2001, this mechanism mainly consisted of the Early Warning System models, World Economic Outlook, the International Capital Markets Report and the Emerging Market Financing. Since 2001,

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[28] *Id.* at 36.

the mechanism has been refined and include six components which are World Economic Outlook (WEO), Early Warning System models, Country external financing requirements, Market information, Financial sector vulnerability, and Country expert perspectives. Since the time is rather short to evaluate the new six component mechanism, this paper is limited in reviewing its effectiveness since the Mexican crisis to May 2001, the time when the new one was introduced by the IMF.

The early warning system has had a of high false alarm rates and poor performance record in predicting crisis. The reasons for this ineffectiveness include: (i) the lack of good early warning models and intensive studies in new issues such as contagious effect and new vulnerability indicators, (ii) the problems of cooperation of departments within the IMF, (iii) the quality and timeliness of information provided by countries, (iv) the difficulties of the Fund in dealing with the publication and transparency of its prediction and its relationship with under-surveillance governments.

The Fund is also aware of the problems and has significant efforts to improve this mechanism through refining methodologies of the EWS models, reorganizing its structure, improve transparency of its works, and so on. However, as the financial markets are becoming more and more sophisticatedly interdependent, the world economy is changing by the globalization with a speed that have ever seen in human history, it is certain that any models which work perfectly today would become less accurate in future as the economy is changing day after day. No one will find a model that work perfectly in all the time but with efforts, one could find out a model that would help to effectively reduce the consequences of financial crisis.

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