

Jung, Hyungmin; Yun Jeong, Hoe

**Working Paper**

## Early Warning Systems in the Republic of Korea: Experiences, Lessons, and Future Steps

ADB Working Paper Series on Regional Economic Integration, No. 77

**Provided in Cooperation with:**

Asian Development Bank (ADB), Manila

*Suggested Citation:* Jung, Hyungmin; Yun Jeong, Hoe (2011) : Early Warning Systems in the Republic of Korea: Experiences, Lessons, and Future Steps, ADB Working Paper Series on Regional Economic Integration, No. 77, Asian Development Bank (ADB), Manila, <https://hdl.handle.net/11540/2035>

This Version is available at:

<https://hdl.handle.net/10419/109576>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



<http://creativecommons.org/licenses/by/3.0/igo>

## ADB Working Paper Series on Regional Economic Integration



### Early Warning Systems in the Republic of Korea: Experiences, Lessons, and Future Steps

---

Hyungmin Jung and Hoe Yun Jeong  
No. 77 | March 2011





ADB Working Paper Series on Regional Economic Integration

## Early Warning Systems in the Republic of Korea: Experiences, Lessons, and Future Steps

---

Hyungmin Jung<sup>+</sup> and Hoe Yun Jeong<sup>++</sup>

No. 77 | March 2011

<sup>+</sup>Head, Early Warning Office, Korea Center for International Finance. Tel: +82 2 3705 6130, hmjung@kcif.or.kr

<sup>++</sup>Economist, Office of Regional Economic Integration, Asian Development Bank. Tel: +63 2 632 4126, hyjeong@adb.org

The ADB Working Paper Series on Regional Economic Integration focuses on topics relating to regional cooperation and integration in the areas of infrastructure and software, trade and investment, money and finance, and regional public goods. The Series is a quick-disseminating, informal publication that seeks to provide information, generate discussion, and elicit comments. Working papers published under this Series may subsequently be published elsewhere.

Disclaimer:

The views expressed in this paper are those of the authors and do not necessarily reflect the views and policies of the Asian Development Bank (ADB) or its Board of Governors or the governments they represent.

ADB does not guarantee the accuracy of the data included in this publication and accepts no responsibility for any consequence of their use.

By making any designation of or reference to a particular territory or geographic area, or by using the term "country" in this document, ADB does not intend to make any judgments as to the legal or other status of any territory or area.

Unless otherwise noted, \$ refers to US dollars.

## Contents

Abstract	iv
1. Introduction	1
2. The Early Warning System in the Republic of Korea	2
2.1. Korea Center for International Finance's External Sector Early Warning System	4
2.2. Other Early Warning Systems	7
3. Policy Contributions of Early Warning Systems	11
3.1. Korea Center for International Finance's External Sector Early Warning System	11
3.2. Other Early Warning Systems	16
3.3. Lessons	19
3.4. Future Steps	23
3.5. Economic and Financial Monitoring	24
4. Message Delivery and Policy Guidance	30
References	33
ADB Working Paper Series on Regional Economic Integration	34
Figures	
1. The Republic of Korea's Early Warning System	3
2. Organization of Korea Center for International Finance	5
3. Quantitative Early Warning System of Korea Center for International Finance	7
4. Development of the Global Financial Crisis	12
5. Banking Sector Capital Adequacy and Profitability	15
6A. Housing Prices in the Republic of Korea	17
6B. Unsold Housing Units	17
7. Petroleum Early Warning System Index	19
8. International Financial Market Indicators	25
9. Indicators of Foreign Exchange Vulnerabilities	28
Tables	
1. Warning Levels and Corresponding Policy Actions	4
2. Financial Supervisory Services Quarterly Early Warning System	9
3. Examples of Qualitative Warnings before the Global Financial Crisis	13

## **Abstract**

This paper examines the cases of the Early Warning System (EWS) in the Republic of Korea, which was introduced in the wake of 1997/98 Asian financial crisis in a policy effort to prevent its recurrence. The EWS in the Republic of Korea was expanded into a national system in 2005 incorporating the finance, real estate, commodities, and labor sectors. This paper provides the descriptions of each EWS sector and documents several episodes of their policy contributions. The past experiences suggest that quantitative models tend to have difficulty predicting a crisis due to the changing nature of crises. Hence, it is desirable that quantitative models are supplemented by qualitative analysis reinforcing EWSs with various methodologies. To improve economic surveillance and message delivery to guide proper policy actions, the independence of surveillance unit should be maintained and the scope of monitoring should be expanded to incorporate regions and markets other than domestic ones given the growing influences of the external sector on the domestic economy through trade and financial linkages.

*Keywords:* EWS, crisis, surveillance, monitoring, quantitative model, qualitative analysis

*JEL Classification:* E44, E61, F37

## 1. Introduction

An early warning system (EWS) is a monitoring system to detect the possibility of economic crisis in advance and to alert policy makers to take preventive actions. A number of international organizations, governments, central banks, and financial institutions operate EWSs for various purposes. For example, the International Monetary Fund (IMF) operates a system to quantitatively monitor macroeconomic vulnerabilities of emerging economies. Central banks and financial supervisory agencies around the world maintain a system to check the soundness of financial institutions and industries. Investment banks also operate models to forecast the possibility of extraordinary events in foreign exchange and other financial markets.

Perhaps, one of the most active areas of EWS application is the so-called currency crisis, in which a country goes through a rapid loss of its currency value and foreign exchange reserves. Emerging economies whose currencies are not internationally accepted find themselves in trouble when they experience a shortage of foreign currency liquidity. Throughout modern economic history, a number of countries experienced a sudden stop or reversal of capital flows, and the consequent depreciation of their currency values. The syndrome is usually preceded by phenomena such as an accumulation of current account deficits, aggravations in foreign currency asset and/or liability positions, lax management of monetary or fiscal policy, or weak financial structure in the domestic banking sector.

A wave of currency crises swept through emerging economies in South America and Asia during the 1990s. As a result, the Republic of Korea, with excessive short-term external borrowing and little foreign exchange reserves with which to defend, had to request a rescue fund from the IMF and underwent a sharp depreciation of its currency. The cost of crisis was enormous. The country's gross domestic product (GDP) declined by almost 6% in 1998 and the government had to inject a huge amount of public funds into the economy for financial restructuring. One lesson from the crisis experience was that the Republic of Korea lacked the mechanism to predict and warn of upcoming crises. Accordingly, the need for an EWS was highlighted. In response, the Korea Center for International Finance (KCIF), whose sole mandate is to operate an EWS and monitor the possibility of crisis recurrence, was established.

In an effort to further strengthen crisis monitoring, the EWS in the Republic of Korea was expanded in 2005 and a national system of early warning was established. This system encompasses seven sectors: currency, financial industry, financial market, commodities, petroleum, real estate, and labor. Each EWS has a unique purpose to capture the possibility of crisis in relevant areas and its results are collected by the central government for reference in the policy-making process. The crisis prevention ability of the Republic of Korea has been strengthened with the operation of a national EWS.

The recent global financial crisis that began from the United States (US) subprime mortgages and spread to the rest of the world significantly impacted the economy of the Republic of Korea. The interest in crisis prevention has been heightened and it is opportune to look into how the national EWS responded to the developments of various crises and contributed to the policy-making processes. The Republic of Korea and other



Asian countries went through a number of crisis experiences and have a commonality in that they heavily rely on the stability of the external sector for growth. In this context, the lessons drawn could be useful not only to the Republic of Korea, but also to other entities, such as the newly established ASEAN+3 Macroeconomic Research Office (AMRO) and other Asian countries that are actively seeking the establishment of a national surveillance unit.<sup>1</sup>

This paper is structured as follows. In section 2, the national early warning system of the Republic of Korea is introduced. The policy contributions of the EWSs are reviewed in section 3, and the lessons learned from the operation of the EWSs are discussed in section 4. Section suggests future steps and conclusion.

## **2. The Early Warning System in the Republic of Korea<sup>2</sup>**

The 1997/98 Asian financial crisis imposed significant costs on the economy of the Republic of Korea. Reflections on the crisis experience have ensued. One common feature of the currency crisis across the region was that whatever initial conditions there were in a particular country for a particular episode of the crisis, there were sudden changes in the flows of funds into and out of the country, and there tended to be speculative attacks on the currency. In response to that, the need for monitoring capital flows was raised in the Republic of Korea and the government established the following monitoring organizations and systems:<sup>3</sup>

- (i) Korea Center for International Finance with currency EWS (April 1999),
- (ii) Online FX Flow Monitoring System (April 1999),
- (iii) Korea Financial Intelligence Unit (November 2001), and
- (iv) Strengthening foreign exchange (FX) position soundness by the Financial Supervisory Services (July 1998).

KCIF was mandated to monitor trends in the global financial market and world economy in order to analyze and warn of the possibility of a currency crisis. The government also built an online FX flow monitoring system that relays the FX transaction and position information of financial institutions into the central system in real time. The Korea Financial Intelligence Unit (KFIU) specialized in monitoring cross-border black market activity such as money laundering. The Financial Supervisory Service (FSS) introduced gap regulations on financial institutions' foreign currency asset and/or liability mismatches according to maturities and strengthened risk management on foreign currency funds.

---

<sup>1</sup> The Association of Southeast Asian Nations Plus Three (ASEAN+3) comprises the 10 member nations of ASEAN plus the People's Republic of China (PRC), Japan, and the Republic of Korea.

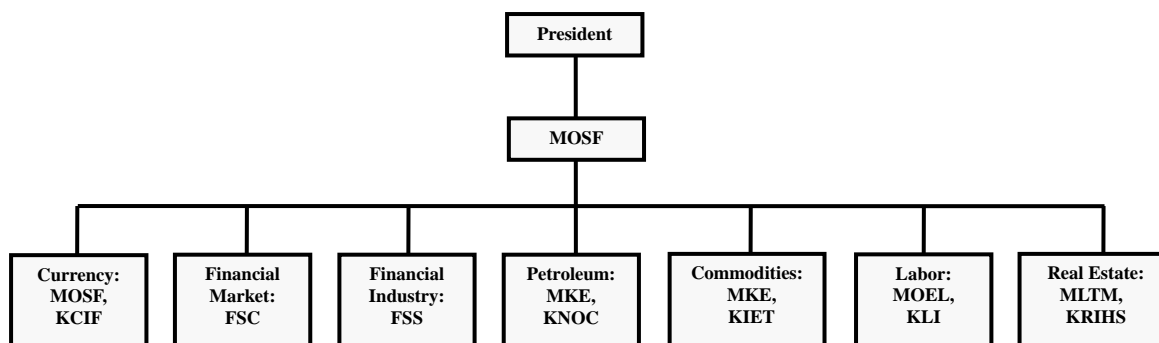
<sup>2</sup> The exact composition of models, operational features, and results of the national early warning system are regarded as confidential information by the government of the Republic of Korea and the operating organizations. Thus, the description of early warning models herein are limited to publicly announced information and to a level that does not undermine the confidentiality requirement.

<sup>3</sup> C. S. Oh (2006).

In early 2004, the President of the Republic of Korea launched the initiative to develop a national EWS in order to effectively monitor any symptoms of an economic crisis that may potentially affect the economy. An integrated operation of early warning systems of diverse areas was considered to be desirable for the effective management of crisis situations and for capturing contagions among interrelated sectors. The national EWS was established in January 2005 that incorporated seven sectors—currency, financial industry, financial market, commodities, petroleum, real estate, and labor—with some of these sectors further divided into subsectors.

Each EWS has an operating agency and a government organization that oversees its operation as shown in Figure 1. For example, the real estate EWS is operated by the Korea Research Institute for Human Settlements, and the Ministry of Land, Transport, and Maritime Affairs is the responsible authority. The Petroleum and Commodities EWS is operated by the Korea National Oil Corporation and the Korea Institute for Industrial Economics and Trade, respectively, and the Ministry of Knowledge and Economy oversees their operations.

**Figure 1: The Republic of Korea's Early Warning System**



FSC = Financial Services Commission; FSS = Financial Supervisory Services; KLI = Korea Labor Institute; KNOC = Korea National Oil Corporation; KIET = Korea Institute for Industrial Economics and Trade; KRIHS = Korea Research Institute for Human Settlements, MKE = Ministry of Knowledge and Economy; MLTM = Ministry of Land, Transportation, and Maritime Affairs; MOEL = Ministry of Employment and Labor; MOSF = Ministry of Strategy and Finance.

Note: The organizations in each early warning system sector are the relevant government organizations and operating agencies.

The results of each EWS are reported monthly to the Ministry of Strategy and Finance for central collection and are used as inputs for policy making. The results are reported at high-level government meetings when needed. The government also prepared a manual for crisis management that dictates mandatory actions by relevant government organizations in case of crisis situations in order to prevent a void or overlap of mandates, and to deal with a crisis in an effective and cooperative manner. The key component of the manual is that it relates the level of crisis development with the proper policy actions that should be taken by authorities concerned. The five levels of crisis development and the descriptions of policy actions are summarized in Table 1.

**Table 1: Warning Levels and Corresponding Policy Actions**

<b>Warning Level</b>	<b>Policy Action</b>
Normal	-
Caution	<ul style="list-style-type: none"> <li>• Tighter monitoring of domestic and global markets, and cross-border short-term capital flows</li> <li>• Increase quantity and quality of information shared inside and outside of government for the risk factors identified</li> </ul>
Warning	<ul style="list-style-type: none"> <li>• Strengthen monitoring function of illegal foreign exchange (FX) transactions</li> <li>• Higher requirement for the FX liquidity soundness of financial institutions</li> <li>• Prepare policy action plans on risk factors identified</li> <li>• Active sovereign investor relation (IR)</li> </ul>
Quasi-Emergency	<ul style="list-style-type: none"> <li>• Prepare contingency plans for short-term FX liquidity shortage</li> <li>• Activate pan-government daily checking system and crisis management entity</li> <li>• Double-check SAFEGUARD trigger conditions</li> </ul>
Emergency	<ul style="list-style-type: none"> <li>• Activate SAFEGUARD following predetermined trigger conditions</li> </ul>

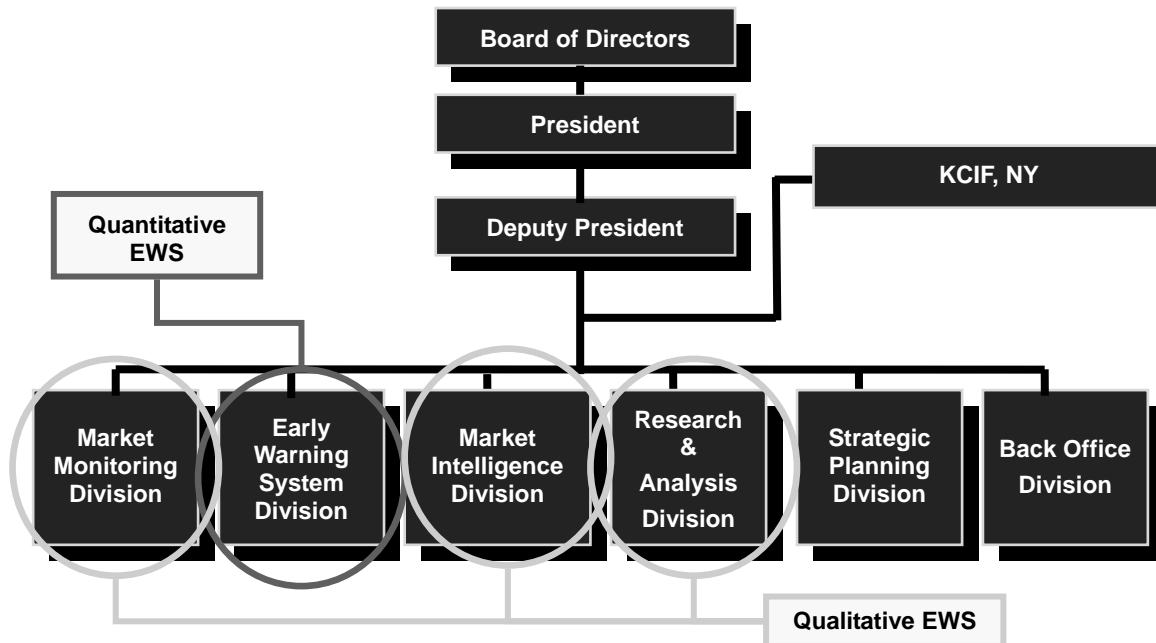
Source: Ministry of Strategy and Finance.

## **2.1. Korea Center for International Finance's External Sector Early Warning System**

The external sector (or currency) EWS was the first to be developed among the national EWS and began its operation with the establishment of KCIF in April 1999. The function of KCIF is divided into qualitative and quantitative analyses. KCIF has several divisions as shown in Figure 2. Four divisions are in charge of early warning and monitoring, three of which provide qualitative analysis and the other provides quantitative analysis.

### **(i) Qualitative Early Warning System**

The three divisions in charge of the qualitative EWS of KCIF are the market intelligence, research and analysis, and market monitoring divisions, as denoted in green circles in Figure 2. The market intelligence division covers the events of global financial markets. They produce reports on the trends in global foreign exchange, as well as the bond and stock markets, and analyze hot issues in the financial industry. The research and analysis division generally covers the regional economies around the world and reports their status at frequent intervals. Each division consists of experts who have been working in the relevant areas for a long time. The experts on financial markets are mostly ex-dealers who possess hands-on experience in financial institutions such as commercial banks and security companies. Their networks with other market dealers are also valuable assets for gathering information and making judgments about market situations.

**Figure 2: Organization of Korea Center for International Finance**

EWS = Early Warning System, KCIF = Korea Center for International Finance, NY = New York.

Source: KCIF's homepage at <http://www.kcif.or.kr>

The market monitoring division monitors what happens overnight in the overseas market and major foreign media, such as The Wall Street Journal and Financial Times. They provide quick reports of news bulletins every early morning so that policy makers and the general public are well informed before overseas events take any effect on the domestic market. Lastly, KCIF runs a branch in New York where the views of local economists and analysts on hot economic issues and the economy of the Republic of Korea are gathered and reported.

## (ii) Quantitative Early Warning System

The quantitative currency EWS model consists of variables that turned out to be useful in predicting the 1997/98 Asian financial crisis. The EWS could detect the symptoms if a similar crisis were going to be repeated. The model employs a signaling approach of Kaminsky, Lizondo and Reinhart (1998) for its methodology that detects the possibility of crisis recurrence by tracking those variables with a leading indicator property that showed abnormal behaviors such as extreme surges or plunges before the 1997/98 crisis.

The model consists of 21 variables divided among 4 sectors—domestic real, domestic financial, external real, and external financial. The domestic real sector consists of indicators that show changes in macroeconomic conditions, such as industrial production and the dishonored bill ratio. The domestic financial sector consists of price indicators in bond and stock markets, and other monetary aggregates. The external real

sector monitors the indicators of trade flows and relative prices of traded goods, including export growth, current account balance, and the real exchange rate. The external financial sector looks into the changes in foreign currency liquidity conditions using the indicators of external debt and foreign investment fund flows.

Individual indicators send risk signals when they pass their own thresholds, which are set to minimize noise-to-signal ratios<sup>4</sup> in predicting a crisis 12 months in advance. Then, a composite index is formed as a weighted average of signals of individual indicators where larger weights are assigned to an indicator with a lower noise-to-signal ratio. The composite index measures the overall risk of the external sector. Besides, the indexes for the four sectors are also formed to gauge the risks of each sector. The monthly report contains the results of a composite index, sectoral indexes, and the risk signals of individual indicators so that the risks in each aggregate level—overall, sectoral, and individual—are conveyed separately.

The quantitative early warning model is accompanied by qualitative analysis. Each month when the result of the quantitative model is reported, a more in-depth qualitative analysis on the domestic economy and financial market is provided. The qualitative analysis may be on a particular risk signal of the model indicator or any other risk factors of the economy. This has the merit of supplementing the quantitative model with detailed explanations as to how certain risk factors are developing. It can also somewhat address the problem of important risk signals getting watered down by other normal signals in the model, which tends to happen usually in the early stages of a crisis.

In early 2008, the quantitative EWS went through an extensive renovation as the developments of the crisis from the US subprime mortgage market deepened. First, the existing model was upgraded in order to enhance the model's sensitivity in risk detections. The model indicators' thresholds and noise-to-signal ratios were reestimated so that the recent changes in the indicators' behaviors were better reflected.

Moreover, three new models were added to the quantitative EWS in order to capture the development of a crisis from various angles. A model based on the episodes of other countries' currency crises was introduced to capture the patterns of currency crises that are similar to the early 1990s crisis in the European Monetary Union and Mexico's experience in the mid-1990s, among others. Another model to capture the possibility of domestic crises was also introduced, which is based on those crisis episodes that happened in the Republic of Korea after the 1997/98 crisis, such as the credit card bubble burst in 2003/04 and real estate market overheating in 2006. While the natures of these crises were domestic, the model was included since even the domestic events can bring about problems in the external sector when they are seriously aggravated. Finally, a rather discretionary model was introduced that is composed of risk factors that the economy might encounter in the near future. In this model, the choice of the indicators is discretionary rather than based on objective selection criteria, such as the noise-to-signal ratio, since new risks may not have past episodes.

---

<sup>4</sup> A noise-to-signal ratio is the ratio between false alarms and true signals. A true signal occurs when an indicator sends a risk signal during a crisis period. Similarly, a false alarm occurs when an indicator sends a risk signal during a noncrisis period.

Along with these renovations, a qualitative judgment process has been incorporated into the quantitative EWS. A committee of economic experts from the economic research institute, central bank, and the FSS was organized to make a final decision when there was a significant difference among the results of the four models. A simple summary of a quantitative EWS is illustrated in Figure 3.

**Figure 3: Quantitative Early Warning System of Korea Center for International Finance**

Model	Crisis Episodes	Indicators	
'97 Currency Crisis	1997 currency crisis	21 indicators including terms of trade, external debts, foreign reserves, etc.	=> Final Qualitative Judgment
Foreign Currency Crisis	1992–93 EMU, 1994–95 Latin America, 1999 Russia	19 indicators including domestic credit, oil prices, overseas interest rates, etc.	
New Crisis	2003–04 Credit card bubble, 2006 Real estate market bubble	8 indicators including housing prices, household debts, etc.	
Near Crisis	Recent risk factors, e.g., eurozone fiscal crisis	10 indicators (frequently changed)	

EMU = European Monetary Union.

## 2.2. Other Early Warning Systems<sup>5</sup>

### (i) Financial Industry (Market) Early Warning System

The financial industry EWS is operated by the FSS and is largely composed of a daily handy indicator evaluation system and quarterly EWS. A handy indicator system utilizes a small number of real-time variables that are reported daily from financial institutions to the FSS. It focuses on key variables that reflect the soundness, profitability, and liquidity of financial institutions. The handy indicator system is run by a number of internal supervisory departments of the FSS and is collected by the EWS team for monthly reporting.

<sup>5</sup> The descriptions of other EWSs depend on Baek's (2009) collection of government documents on sectoral EWSs.

The quarterly EWS consists of 6 indexes: risk index, leading risk index, statistical CAEL,<sup>6</sup> capital adequacy prediction model, credit rating prediction model, and expected default frequency model. The risk index and leading risk index are applied to nine financial industrial sectors, including banking, life insurance, liability insurance, securities, asset management, credit cards, installment financing, savings banks, and credit unions. Five indexes, with the exception of the leading risk index, are applied to individual financial institutions in each industrial sector so that hundreds of indexes are produced for monitoring.

The risk index covers the important aspects of financial soundness and financial institution management, such as capital adequacy, asset quality, profitability, and liquidity. It is composed of related indicators, including capital adequacy ratio, nonperforming loan ratio, net interest margin, and domestic and foreign currency liquidity ratios, with some variations in the composition of indicators according to the type of industry. This index is the most comprehensive and representative among the six quarterly indexes.

While the risk index measures the current soundness of the financial industry and institutions, the leading risk index is designed to measure the probability of future crisis by mainly using macroeconomic variables such as GDP growth rate, inflation rate, and corporate bond yields, among others.

The other indexes measure the risk with respect to a particular aspect of financial soundness in more detail. Operating various models and methodologies also has the merit of mitigating the errors that are more likely than when operating a single model. Statistical CAEL assesses the capital adequacy, asset quality, earnings, and liquidity of financial institutions from a purely statistical approach. The capital adequacy prediction model applies a logit model to predict the single most important indicator of financial soundness. The credit rating prediction model applies an ordered probit model to forecast the possible changes in market evaluations on a particular financial institution. The expected default frequency model incorporates information from balance sheets and the stock market to evaluate the probability of default of a financial institution.

The structure of the financial industry's quarterly EWS is summarized in Table 2. One important aspect of the financial industry EWS is that the management of the financial industry has been generally sound since the 1997/98 crisis and the samples for a high-risk period are somewhat limited, which poses difficulty in securing the significance of estimation models.

The financial market EWS operates a model composed of five sectors and 30 variables to measure macroeconomic and monetary conditions, and monitor anomalies in the financial market. The monetary and finance sector detects the symptoms of excessive credit expansion and rapid flow of funds for short-term overheating using indicators such as M2 growth rate, loan growth, etc. The stock market sector monitors the foreign investment fund flows into the stock market and evaluates the appropriateness of stock price level through dividend-yield rate. The macroeconomic sector tracks the changes in the conditions of real economy and business cycle phases. The foreign sector consists

---

<sup>6</sup> Capital adequacy, Asset quality, Earnings, and Liquidity (CAEL).

of indicators in international financial markets such as stock price index, credit spread, exchange rate, and differentials between domestic and foreign interest rates that affect the flow of funds across the border of the country. Finally, the instability sector is composed of volatility of stock prices, volatility of stock transaction volumes, term spread, and dishonored bill ratio, etc. to detect the anomalies in the domestic financial market.

**Table 2: Financial Supervisory Services Quarterly Early Warning System**

	Model	Banking	Life Ins.	Liab Ins.	Sec.	Asset Mgmt.	Savings Banks	Credit Cards	Install. Fin.	Credit Unions
Industry	Risk Index	○	○	○	○	○	○	○	○	○
	Leading Risk Index	○	○	○	○	○	○	○	○	
Individual Institution	Risk Index	○	○	○	○	○	○	○	○	○
	Statistical CAEL	○	○	○	○	○	○	○	○	○
	Capital Adequacy Prediction	○	○	○	○	○	○	○	○	
	Credit Rating Prediction	○	○	○	○			○		
	Expected Default Frequency	○	○	○		○	○			

CAEL = capital adequacy, asset quality, earnings, and profitability, Fin.= Finance, Install.=Installment, Ins.=Insurance, Liab.=Liability, Mgmt.=Management, Sec. = Securities.

Source: Shin-dong Jung, and Mi-young Lee (2008), pp.8.

## (ii) Real Estate Early Warning System

The real estate EWS is composed of national and regional models. Regional models cover those regions where real estate prices rise fast so that there is a high probability of overheating in the market, such as the metropolitan area around Seoul. National and regional models are each divided into a housing prices model and a land prices model. Both nonparametric and parametric methodologies are employed in the real estate EWS. A signaling approach is applied to the national model and a probit model is applied to regional models.

The national model tracks leading indicators of the real estate market such as financial institutions' liquidity, stock price index, interest rates, construction orders, industrial production, and other related indicators. The risk level of the market is assessed considering the number of indicators that exceed thresholds. The thresholds are set distinguishing when the market is expanding from when it is contracting, reflecting the fact that indicators' behaviors can change according to the business cycle. The regional



models utilize similar macroeconomic variables as in the national model, but with a number of additional regional variables that show factors unique to each region (e.g., regional real estate transactions, construction orders).

The real estate EWS is characteristic in that it formally incorporates a qualitative decision process in its EWS. A committee composed of experts from the real estate industry, academe, and the government meets once a month and determines the level of warning, taking into account both the quantitative model results and the market situation as the committee members perceive it.

### **(iii) Commodities Early Warning System**

The commodities EWS comprises two components: petroleum and the other commodities EWSs. The petroleum EWS applies an artificial neural network model to monitor indicators that influence world oil market prices such as the US petroleum inventory, the Organization of the Petroleum Exporting Countries' (OPEC) level of production, US industrial production, and noncommercial net long positions in futures contracts on crude oil (Yoon et al. 2004). However, the predictability of such a quantitative model is inevitably limited since oil prices are easily affected by noneconomic factors like natural disasters, war, terrorism, and OPEC's production policy.

One feature of the petroleum EWS is that the results are released to the public so that media, industry, and interested individuals can make use of them. Such an open approach is possible in the petroleum EWS because oil prices are determined in the world market and there is almost no way that the economy of the Republic of Korea can endogenously affect the prices.<sup>7</sup>

The EWS is also applied to various other commodities such as iron, non-iron metals, and petrochemical materials. Various indicators are monitored—such as business cycle indicators of the US and the People's Republic of China (PRC), inventories of commodities, commodities futures prices, and the freight charge index—as they influence the world economic conditions and commodity prices. However, the predictability is limited again in that the commodity prices can be also affected by non-economic factors. In order to mitigate such problems, the government consults with relevant industrial associations and research institutes on the result of the EWS when it is deemed necessary.

### **(iv) Labor Early Warning System**

The labor EWS is divided into two models that predict the employment rate and labor-management relations. The employment rate EWS comprises the sectors that reflect the stages of the business cycle—such as production, investment, consumption, and trade—which form the conditions for changes in employment. The model is designed to predict major aggravations in employment 3 months in advance to increase the accuracy of warning signals.

---

<sup>7</sup> In 2010, the government switched its policy to operate the petroleum EWS only internally. Yoon et al. (2004).

The operation of the labor–management relations EWS is rather unique and it was introduced because relations between labor and management in the Republic of Korea used to be one of the worst in the world as measured by the International Institute for Management Development (IMD) World Competitiveness Yearbook. The EWS keeps track of indicators that show the status of labor–management relations, including the number of strikes in each industry and region, yearly changes in strike occurrences, and increases in issues of labor–management relations (e.g., restructuring and wage negotiations).

### **3. Policy Contributions of Early Warning Systems**

This chapter introduces several cases of EWS performance with respect to crisis predictions. Several episodes of crisis are illustrated, varying in their type and timing, with a general focus on the performances of EWSs preceding the recent global financial crisis. The documentation covers both satisfactory and unsatisfactory aspects of EWS performances, and explanations for their respective performances are given.

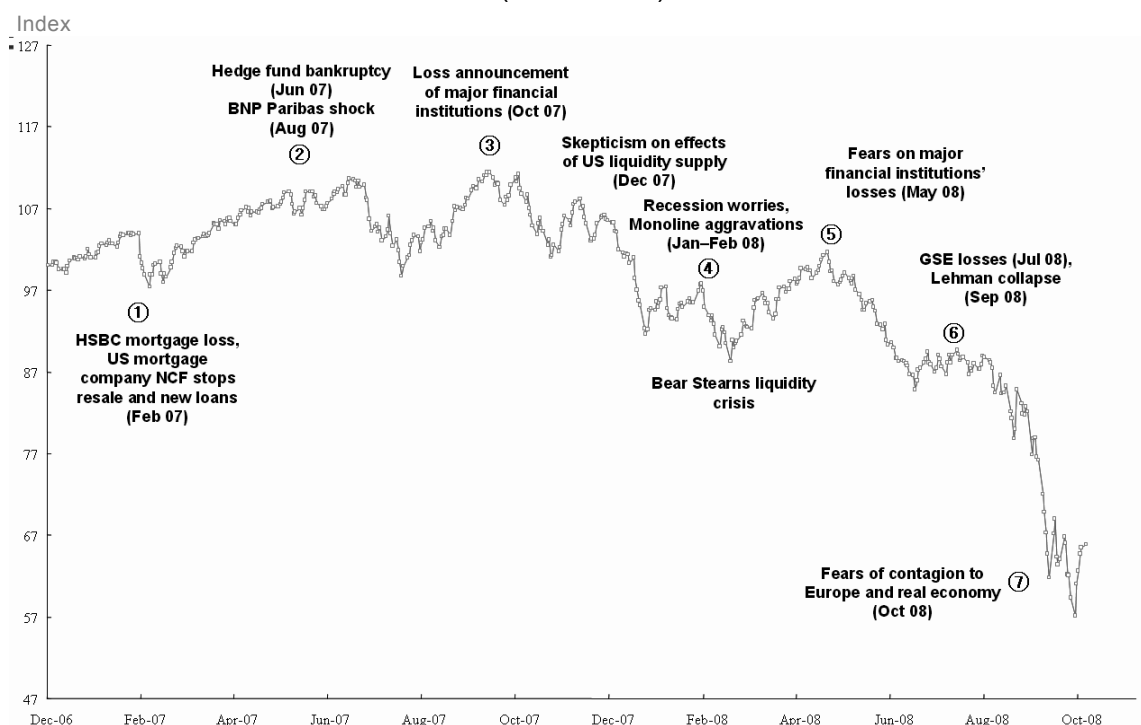
#### **3.1. Korea Center for International Finance’s External Sector Early Warning System**

In regard to the prediction of the recent crisis, the currency EWS performed its early warning function both in qualitative and quantitative terms, with more weight on the qualitative side. It is not surprising that it had to largely rely on the qualitative EWS considering the very different nature of the recent crisis from that of the 1997/98 Asian financial crisis. While the 1997/98 crisis was caused by domestic problems such as deterioration in the financial structure of the corporate and banking sectors, the recent crisis originated from financial failures in some systemically important economies and spread to the domestic economy of the Republic of Korea through a global credit crunch. Therefore, the quantitative model based on the experience of the 1997/98 Asian financial crisis had limited predictive value.

##### **(i) Qualitative Early Warning System**

As the symptoms of the financial crisis deepened (Figure 4), KCIF reinforced monitoring on domestic and international financial markets. KCIF reported to the government the trends and important events in the market, their outlooks and the expected impacts on the domestic economy, and policy implications. The center also supported the government by participating in governmental meetings, including emergency meetings for crisis management and check-up meetings for the financial situation.

**Figure 4: Development of the Global Financial Crisis**  
(2006 = 100)



Source: Morgan Stanley Capital International–All Country World Index (MSCI–ACWI), (Local).

Table 3 provides some examples of qualitative analysis that warned of the coming crisis. KCIF warned of the possibility of a credit crunch due to aggravations of funding conditions caused by the deterioration of asset qualities of major financial institutions. Right after the provision of rescue funds to Bear Stearns in March 2008, KCIF pointed out the possibility of a similar phenomenon affecting other investment banks. It also reported that the establishment of the Resolution Trust Corporation<sup>8</sup> was being viewed as a way of injecting public funds into financial institutions for the resolution of bad assets. KCIF reported the results of its performance analysis of major investment banks, including Lehman Brothers, and urged the authorities to pay attention to possible write-offs and deleveraging by them. It also relayed the worries in the financial market that Lehman Brothers was in the weakest position among its peers if there were to be a collapse of major financial firms.

<sup>8</sup> A type of asset management company established in 1989 to liquidate the insolvent assets of savings and loan associations.

**Table 3: Examples of Qualitative Warnings before the Global Financial Crisis**

Title	Date
The response of major financial institutions to the subprime crisis	5 Feb 2008
Recession worries in the midst of the credit crunch	4 Mar 2008
The possibility of further aggravations of subprime mortgages	6 Mar 2008
Rescue of Bear Stearns and Future Outlook	17 Mar 2008
Global credit crunch spillover	28 Mar 2008
Major international banks' write-offs and their effects	21 Apr 2008
The 2nd quarter major international banks' performance and outlook	17 Jun 2008
Global banks' bad asset accumulations and their effects	20 Jun 2008
Reemergence of the credit crisis and international financial market turmoil	1 Jul 2008
Risk factors in domestic financial market and policy measures	14 Jul 2008
Risks of US banks' bankruptcy	28 Jul 2008
Local views of US housing market, oil prices, and dollars	29 Aug 2008

Source: Korea Center for International Finance's homepage at <http://www.kcif.or.kr>

Immediately following the announcement of emergency support measures for Fannie Mae and Freddie Mac in July 2008, KCIF produced reports showing that the soundness and stability of financial institutions—such as Lehman Brothers, Wachovia, Merrill Lynch, as well as savings and loans associations like Washington Mutual and other regional banks—were being threatened. In August, the center reported to the government about the views of Wall Street experts on the Korea Development Bank's (KDB) attempt to take over Lehman Brothers. The New York branch of KCIF reported the negative views among Wall Street financial experts about KDB's potential acquisition and the concerns that, if realized, it would undermine the stability and privatization process of KDB because of Lehman Brothers' vast holdings of toxic mortgage-backed assets. The report was sent to KCIF about 2 weeks before the collapse of Lehman Brothers. Eventually, KDB gave up its plan to acquire Lehman Brothers.

Besides the monitoring efforts during the period of deepening global financial crisis, KCIF did not loosen its attention on the way to gradual recovery. KCIF kept track of the money markets of major banks in advanced countries and analyzed the effects of governments' and central banks' emergency liquidity supply to the credit-crunched market. It also helped the government of the Republic of Korea and financial institutions by reporting the market conditions for issuing bonds overseas as financial markets gradually recovered. KCIF continued to release analyses on imminent issues in global financial markets and the world economy such as the possibility of crisis in Eastern European economies, risks in US commercial mortgages, and deterioration in the public finances of major advanced economies.

KCIF's ramped-up monitoring efforts are evident in the increase of the number of reports produced. The number of reports, including issue analysis, daily reports, and others,

increased from 1,642 in 2007 to 1,988 in 2008 and 2,189 in 2009. Regarding information on global financial markets and the world economy, KCIF has become quite the information hub in the economic community of the Republic of Korea, and a number of public organizations, economic research institutes, and financial institutions have relied on KCIF's swift and timely coverage of rapidly changing market situations.

## **(ii) Quantitative Early Warning System**

While EWSs largely rely on qualitative analysis that directly monitors the relevant areas of financial markets and regional economies, as mentioned earlier, the quantitative EWS had some difficulties in predicting the recent global financial crisis that originated from abroad. Some reasons can be found in the nature of the quantitative model and the domestic economic conditions before the crisis. First, composed mainly of domestic indicators reflecting the nature of the 1997/98 Asian financial crisis, the model had limits in capturing the changes in the markets outside the economy of the Republic of Korea. Moreover, the sound operation of the domestic economy following the 1997/98 crisis somewhat overshadowed several important risk signals produced in the quantitative model.

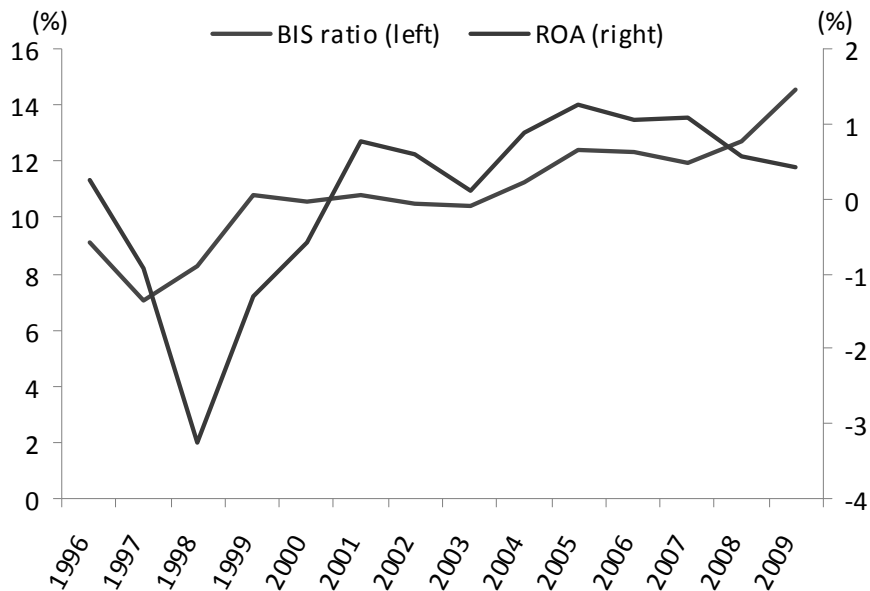
The quantitative model's performance regarding prediction of the 1997/98 Asian financial crisis and the recent global financial crisis can be compared. Since the model was based on the 1997/98 crisis, the composite index produced warning signals about a year before the 1997/98 crisis. However, with respect to the recent crisis, the model failed to produce such sensitive responses. Although the composite index ratcheted up with the growing symptoms of global financial turmoil, the risk signals of troubled indicators were watered down by normal signals from other indicators. As a result, the warning levels were not as high as they were before the 1997/98 crisis.

However, the quantitative model still captured some symptoms of the upcoming crisis. Even though there was a rather unsatisfactory aspect in the performance of the composite index as explained above, the model emitted signals in a number of important individual indicators that were closely related with the crisis. Before the crisis, the domestic economy and its main components, such as financial institutions and corporations, were in general regarded to be sound, but it was pointed out that a rapid increase in short-term external debts and consequent aggravations in the foreign currency positions of the banking sector posed some vulnerability to the economy of the Republic of Korea.

The model emitted risk signals for indicators mainly in the external financial sector that are related to external debts and foreign currency liquidity. The indicators—such as the ratio of short-term external debt to foreign exchange reserves, the ratio of external debt to exports, and financial institutions' foreign currency asset and/or liability positions—emitted warning signals a long time before the crisis occurred. The current account balance also showed risk signals as it worsened due to a hike in oil prices. Other indicators, such as the volatility of exchange rate and stock prices, sent signals during the contagion phase of the crisis.

Furthermore, the warning signals of individual indicators were studied by the quantitative EWS division. While the qualitative analyses of other divisions of KCIF focus largely on overseas economic events, the EWS division produced its own qualitative reports on the risk factors of the domestic economy. With qualitative reports, the EWS division analyzed the aggravations of the current account balance due to a hike in commodity prices and the appreciation of the won. It also analyzed the capital inflows due to arbitrage trades of foreign investors and warned of the possibility of a sudden transition to outflows. It also addressed the phenomenon of rapid external debt accumulations during the years before the crisis and the transition from a net external creditor to a net debtor position. Such analyses could be utilized as an important tool to predict the economic outlook, warn about potential risks to the economy, and alert policy makers of the worst-case scenario.<sup>9</sup>

**Figure 5: Banking Sector Capital Adequacy and Profitability**



Bank for International Settlements (BIS), Return On Assets (ROA).

Source: Financial Supervisory Services.

<sup>9</sup> Further renovations have been made since the draft was written in 2010. They are based on the lessons and future steps to be explained below in Sections 4 and 5. An index composed of key structural indicators of the external sector such as current account balance and short-term external debt to foreign reserves ratio has been introduced to sensitively capture structural weaknesses. Indexes composed of international and domestic financial indicators such as stock price volatility, credit spreads, and exchange rate volatility have been also added to the system. These renovations rendered the EWS capable of capturing risks from more diverse angles and more sensitive to risks developing in the financial market.

## **3.2. Other Early Warning Systems**

### **(i) Financial Market and Industry Early Warning System**

The banking industry of the Republic of Korea went through massive restructurings after the 1997/98 Asian financial crisis as the weak performance of the finance sector was identified as one of the culprits of the crisis. Banks were merged with or acquired by other banks in the process of resolving bad assets, and financial supervision was strengthened. As a result, the financial industry improved its structure considerably. Banks' capital adequacy ratios increased from 7.0% in 1997 to 12.0% in 2007, and profitability measured in terms of return on assets improved significantly from -0.9% to 1.1% during the same period. Largely, the financial industry has maintained its soundness throughout the last decade and the financial EWS helped complement the supervision of the health of the financial industry and its institutions.

The soundness of the financial industry during the last decade made it hard for the EWS to detect a significant problem before the occurrence of the global financial crisis. Also, the financial industry EWS has insufficient capacity to predict the possibility of future deterioration even though it is well composed of indicators in terms of monitoring the current soundness of financial institutions. In order to supplement these inadequacies, the prediction capability of the models has been reinforced through incorporating indicators related to asset growth since potential insolvencies tend to accumulate when the size of financial institutions expands rapidly.

### **(ii) Real Estate Early Warning System**

The Republic of Korea is a country of high population density, and land prices are subsequently high. The wealth of ordinary households consists mostly of real estate assets, of which the main component is housing. The trends in the housing market and policy changes are always hot-button issues in the country and the general public has a very high level of awareness with respect to these issues.

The economy of the Republic of Korea experienced a rapid rise in housing prices during the last decade. Nationwide housing prices, which fell more than 10% during the recession in the aftermath of the 1997/98 financial crisis, began to rise from the early 2000s, owing to the shortage of housing units in the Seoul metropolitan area and a low interest rate monetary policy. Housing prices rose 9.9% in 2001 and 16.9% in 2002. Prices further rose 4.0% in 2005 and 11.6% in 2006. The rise in housing prices was especially worrisome since household borrowing was rising rapidly through mortgage loans. A vicious cycle formed where an increase in loans and demand for housing caused higher housing prices, which in turn led to more borrowing by households.

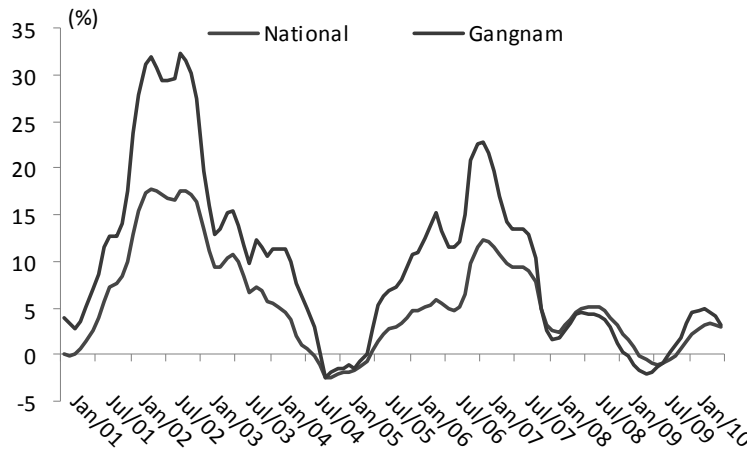
The government introduced measures to calm down the overheated housing market and regulations were placed on housing loans.<sup>10</sup> The government limited the debt-to-income

---

<sup>10</sup> A series of policy measures to restrain real estate market overheating was introduced in 2006 and 2007.

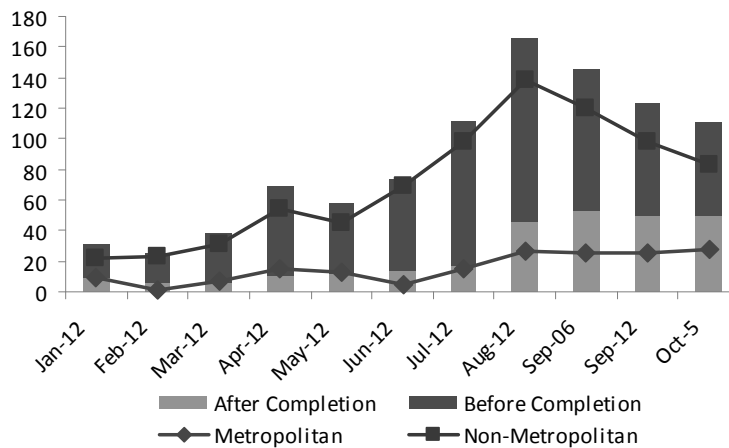
(DTI) ratio<sup>11</sup> to below 40% and strengthened the application of the loan-to-value (LTV) ratio<sup>12</sup> to 40% in the speculative areas where the housing market was overheating. The government also imposed other regulations on real estate transactions. The real estate EWS contributed to the process of policy making by pointing out the abnormal pace of increases in housing prices on a national level and in the so-called Gangnam area,<sup>13</sup> where the market was the most overheated.

**Figure 6A: Housing Prices in the Republic of Korea (y-o-y %)**



Source: Kookmin Bank.

**Figure 6B: Unsold Housing Units (thousands)**



Source: Ministry of Land, Transportation, and Maritime Affairs.

<sup>11</sup> The ratio of the annual repayment of principal and interest of a housing loan divided by annual income of the household.  
<sup>12</sup> The ratio of a housing loan divided by the value of housing.  
<sup>13</sup> The Gangnam area is the southern part of Seoul where the residential environment and educational opportunities are superior to other regions. The housing prices in this area rose much faster than in other regions. For example, in 2005 and 2006, prices in Gangnam rose by 15.1% and 24.5%, respectively, which is higher than the average increases in Seoul of 6.3% and 18.9%, respectively.



The real estate market has risks in both directions—not only when it overheats, but also when it declines. The recent crisis brought recession to the economy and the housing market was no exception. Housing prices fell for the first time in several years and the number of unsold housing units rose. The government released a series of real estate policy measures to guide the housing market to a soft landing, and the real estate EWS contributed to the proper policy direction by alerting policy makers of weaknesses in the construction industry.

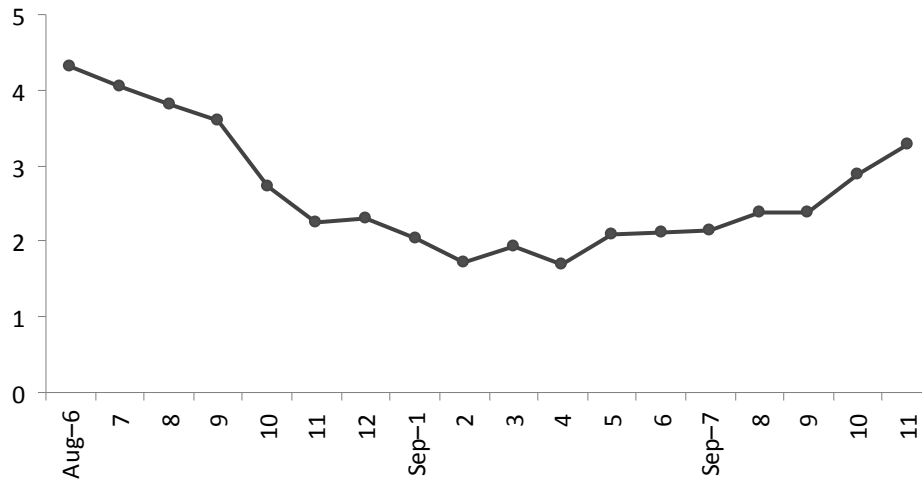
The real estate EWS is generally regarded to be effective in policy contributions. One important reason is that the real estate EWS is balanced between quantitative and qualitative processes. By incorporating a qualitative decision process in the EWS, it did not merely rely on the results of quantitative models but could flexibly deal with the status of the real estate market by reflecting the opinions of experts. Another circumstantial reason may be the high level of alertness in the real estate sector. If a crisis occurs once a decade, it would be difficult to expect changes in trends after a long period of peace. Probably, the frequent experience of crisis—and near-crisis situations of rapidly rising house prices—helped make the real estate EWS responsive to market realities.

### **(iii) Petroleum Early Warning System**

As is well known, the Republic of Korea's economy depends heavily on commodities imported from abroad. Crude oil makes up almost 20% of total imports and changes in oil prices have extensive effects on the economy of the Republic of Korea through changes in the current account and inflation, for example. The economy of the Republic of Korea is a price-taker in the world oil market and thus has to take any shocks to the price of oil. In 2008, when the oil price had surged to \$140 per barrel, the Republic of Korea's current account surplus shrank sharply to \$3.2 billion from \$21.8 billion in the previous year.

The petroleum EWS has contributed to policy making on a number of occasions. When oil prices showed symptoms of a rapid increase in the 2000s, the petroleum EWS sent warning signals to the authorities and helped them to prepare policy measures in advance. The petroleum EWS sent warning signals during the first half of 2006 when the price of oil rose to \$70 per barrel from around \$50 at the end of the previous year.

The EWS also sent warning signals from the middle of 2007 as the price of oil continued to rise owing to increases in speculation in the oil market, the weak US dollar, and strong demand in fast-growing emerging economies. The warning continued as oil prices hit historically high levels in early 2008 and contributed in bringing forth policy measures, such as an oil tax cut, to mitigate the oil price shock. Finally the warning level went down in late 2008 as the price of oil plummeted due to the worldwide recession triggered by the recent global financial crisis. In late 2009, the petroleum EWS showed warning signals again as the price of oil began to rise along with the recovery of global business cycles. The recent performance of the petroleum EWS is illustrated in Figure 7.

**Figure 7: Petroleum Early Warning System Index**

Source : Wong-ki Baek (2009).

### 3.3. Lessons

Key lessons learned through the experience of EWS operations in the Republic of Korea are presented below. These lessons may sound familiar, but they are worth pointing out once again since such basic principles are forgotten occasionally in the process of surveillance.

#### (i) Limits of Quantitative Analysis

Quantitative models tend to have difficulty predicting crises due to the changing nature of crises. Models are designed based on the experiences of past crises in order to secure samples, but the patterns of crises are prone to change when they do occur. This was also the case with the recent global financial crisis. The impact of the 1997/98 Asian financial crisis on the economy of the Republic of Korea was largely the result of domestic problems, such as the deterioration of the financial structure of the banking sector caused by corporations' excessive borrowing for unprofitable business projects, accumulation of current account deficits, and expansion of short-term external debts by financial institutions.<sup>14</sup> Therefore, the model was mainly composed of indicators that showed the status of the domestic economy in order to detect the symptoms of a similar crisis happening.

However, the recent crisis occurred with the burst of bubbles in the US housing market and the deterioration in the quality of assets possessed by financial institutions in advanced economies. The model composed of domestic indicators could detect the crisis only at the contagion phase when there were large-scale withdrawals of foreign

<sup>14</sup> There is plenty of literature that covers the 1997/98 currency crisis of the Republic of Korea. We referred to Koh et al. (2007) for the domestic economic backgrounds before the crisis.

investment out of the local financial market and foreign currency liquidity had already been significantly affected.

The basic problem with quantitative analysis is that it is hard to design a model to predict new crises without previous similar episodes. Since there are no samples of how indicators behaved before and during the crisis, the methodologies to select relevant indicators for the prediction of crises cannot be applied. One might try a simple and intuitive model at the cost of methodological rigor, but the physical time and cost needed to build a new model are not negligible either. Analyzing quantitatively the events of overseas markets and economies may require too many objects for monitoring, overwhelming researchers with such a large dataset.

Quantitative analysis has certain merits. It provides objective, numerical results that are not influenced by researchers' subjective views. Since the results are suggested as an index or probability, it is easy to understand and compare them with other periods. However, due to the difficulties and rigidities in applying the methodologies to changing economic environments, it is desirable that quantitative models are always supplemented by qualitative analysis.

#### **(ii) Limits of Qualitative Analysis**

The importance of qualitative analysis cannot be overemphasized. The merit of qualitative analysis is that it can cope with urgent issues in the economy in a very flexible manner since it looks directly into the sector or market in trouble. Regarding the recent crisis, qualitative analysis could capture a number of early symptoms of the crisis' development and warn of its occurrence to some degree, as mentioned in Section 3.

Although it is an effective monitoring tool, qualitative analysis also has difficulty predicting event risk. To predict whether a crisis will happen or not is extremely difficult since in many cases, crisis comes in a form of discrete, specific occurrence. For example, before the collapse of Lehman Brothers that triggered the recent global financial crisis, it was generally expected that the US authorities would rescue Lehman Brothers in a similar manner they dealt with Bear Stearns earlier in 2008 for the protection of transactions. The decision of US authorities to let Lehman Brothers go bankrupt could be called a policy mistake, considering its effect on global financial markets and the world economy. It is very hard to predict such a crisis triggered by event risk even with qualitative analysis, not to mention quantitative models.

However, a more fundamental problem exists with the qualitative approach. In spite of monitoring efforts through qualitative analysis, it often turns out that such qualitative warnings are not taken seriously. There is a tendency for qualitatively written reports to be treated only as one of many economic reports that are produced by a number of economic research institutes, and thus policy makers do not take proper actions. It is generally thought that qualitative analyses are prone to the subjective bias of researchers despite their merits.

One important reason for this can be found in the ways qualitative analyses provide assessments of economic events. Too often, they suggest the possibilities of both good

and bad outcomes of an event, so that the readers do not come to a definitive sense of the future outlook. For example, one simply ends up enumerating both optimistic and pessimistic views of the market outlook, or presenting the conclusion of an analysis in an ambiguous manner. For example: "It is expected that the market situations will not further aggravate thanks to the policy measures, but the possibility of extreme results cannot be ruled out." Therefore, policy makers have difficulty in making a judgment about the seriousness of an event.

Regarding this ambiguity problem with qualitative analysis, it is worth pointing out that, unlike quantitative monitoring systems, there usually is no guideline that connects the assessed seriousness of market situations and the appropriate policy actions to be taken. Absence of such a link can be a reason that qualitative monitoring does not necessarily lead to the actual implementation of policy.

### **(iii) Persistent Maintenance Efforts Required**

EWSs require constant efforts and attention in order to operate properly. The recent crisis raised interest in EWSs in a number of Asian countries, and some of them are trying to incorporate an EWS into their current surveillance systems. However, one mistake those pursuing the establishment of an EWS are apt to make is that once the EWS is built, its designers might not make enough effort to maintain and upgrade the system.

Early warning with respect to the economy is very different from early warning on engineering objects. Economic surveillance cannot be mechanical in the same manners as fire or gas detectors since the structure of the economy and the behavior of its agents are always changing and evolving. Therefore, after the establishment of an EWS, subsequent checkups and maintenance of the system should be followed. The worst-case scenario occurs when an EWS is operated mechanically without much feedback from policy making and without efforts to narrow the gap between the model and economic realities. In order to operate the system properly, some sense of ownership and responsibility is required. The government often entrusts the development and operation of an EWS to economic research institutes. The economic research institutes that are not very interested in EWS operations relegate the mission to junior researchers who just produce and relay the results mechanically. As a result, when the government needs further inquiries into the EWS, it is not properly advised.

Some EWSs are operated within a government office after the model has been developed by outsourcing. In this case, the government officials in charge often run into technical trouble due to lack of professional knowledge. The frequent reassignment of positions also hampers accumulation of experience and know-how.

Finally, one should be cautioned against a tendency to build an EWS without enough data. The importance of data should come first before the establishment of an EWS. From time to time, some government offices try to build EWSs without having a large enough dataset. In this case, there is the possibility that the EWS will not cover all relevant aspects of the economy for detecting crises. Without sufficient data, one is not

equipped with the proper measures of the economy that allow for gauging the situation in a balanced manner.

#### **(iv) Signals Are Warnings of the Preconditions for Crisis**

The statement above applies to both the staff operating an EWS and policy makers. While the generally recognized problem with the performance of EWSs regarding the prediction of the recent global financial crisis is that there was lack of advance warning, there could be some tendency among operating staff and policy makers involved to hesitate to accept the warning signals and take the subsequent policy actions. After the crisis has already happened, everything is clear: the origin of the crisis, the route of crisis development, and its impact. However, it is very hard to tell before the crisis whether the situation will actually develop into a crisis or not. A tendency could develop to hesitate to accept the warning signals because taking subsequent policy actions would be onerous.

In order to avoid such temptations, one needs to interpret the results of an EWS as a warning of the vulnerabilities and risks the economy is encountering. Since the prediction of exact timing of a crisis is extremely difficult, the signals should be taken as warnings of the preconditions that make the occurrence of crisis more likely and imminent. History repeatedly teaches us that a crisis, if realized, incurs enormous costs to the economy and an EWS cannot help but bear the risks of alarming unrealized events.

Moreover, in order to persuade policy makers to accept the warning signals and take preventive actions, the EWS results should be presented in a convincing manner with clear explanations of the (i) sources of vulnerabilities, (ii) shocks that may affect the economy, (iii) channels through which such shocks might propagate across the economy, and (iv) appropriate policy prescriptions to deal with such risks.

#### **(v) Confidential Operation Is Proper**

It is proper to operate an EWS in a confidential manner rather than open its results to the general public. If EWS results are released to the public, it may be difficult to exclude the possibility that the results affect the market, occasionally with significant impacts. The problem lies in the public nature of an EWS. Run by the government and authorities, those results may be taken too seriously while they are only part of various information inputs that policy makers take into account. Further, it is probable that frequent overestimations or underestimations of quantitative EWS results would be taken as official positions of the authorities.

#### **(vi) Sound Economic Operation Is the Key**

This obvious lesson is the key to the stability of the economy and financial markets. However, that we witness crises recur from time to time means that such obvious lessons are easily forgotten in practice.

The lesson that came home to the Republic of Korea through the 1997/98 Asian financial crisis and more recent global financial crisis was that maintaining the soundness of the

economy is the most fundamental way to cope with a crisis. If sectors that comprise the economy have weak structures and are vulnerable to shocks, the economy will not be able to overcome hardships or stresses caused by crises easily. Early warning is a useful tool that helps prevent extreme events, but sometimes the problems may not be prevented even with an EWS since structural weaknesses are not easily cured in a short period.

The Republic of Korea might have been one of the most successful countries in coping with the recent crisis thanks to its sound economic structures. Financial institutions are well capitalized and their loan assets are sound with only a small percentage of bad assets. Unlike most advanced countries that suffer from large budget deficits and public debts, the Republic of Korea's public finances are pretty healthy with its public-debt-to-GDP ratio among the lowest in the Organisation for Economic Co-operation and Development (OECD). The country has also accumulated significant foreign exchange reserves, which are the world's sixth in size.<sup>15</sup> The sound structure of the economy provided room to absorb the shocks and allowed the government to take preventive and aggressive policy measures to cope with the crisis.

### **3.4. Future Steps**

So far we have discussed the performances of the EWS in several cases of crises in the Republic of Korea and the lessons drawn from the experiences of EWS operations. Below are some future steps that are being planned or considered to reflect these lessons. The direction is toward improving quantitative and qualitative monitoring, and enhancing the linkage between warning messages and policy actions.

We divide this discussion on surveillance mechanisms into two categories: (i) economic and financial monitoring, and (ii) message delivery and policy guidance. In the first, we discuss how the economic and financial monitoring process can be improved in terms of fulfilling its functions of identifying a specific country's economic vulnerabilities and risks, and recommending necessary policy responses.

The discussions in the second category are on the framework for effective delivery of surveillance outcomes and desirable organizational structure to ensure better policy guidance. We insist that the major outcomes of surveillance activities should be delivered to stakeholders through relevant channels for contributions to policy making and capacity building through peer review. We also argue that the independence of a surveillance unit make the realization of a recommended policy more likely and practical.

The suggestions contained in this will be generally applicable to any national surveillance unit operating an EWS. It is hoped that the following suggestions would be useful not only to countries seeking to establish an EWS, but also the newly established ASEAN+3 Macroeconomic and Research Office (AMRO) as an independent regional surveillance vehicle to support the Chiang Mai Initiative Multilateralization (CMIM).

---

<sup>15</sup> As of the end of 2010.

### 3.5. Economic and Financial Monitoring

#### (i) Expand the Scope of Monitoring

The world economy is becoming more and more integrated as the trade and financial linkages between economies grow due to factors such as the deepening division of production processes and cross-border holdings of assets that originate from different regions and markets. The economy of the Republic of Korea has been closely integrated with the rest of the world. For example, the Republic of Korea's external trade-to-GNI ratio rose from 67.1% in 2002 to 98.6% in 2009.<sup>16</sup> The economy also has high degree of openness in the capital market<sup>17</sup> and liberalization in foreign exchange transactions.

Therefore, what happens in the global economy and financial markets has become more important and can exert a rapid influence on the domestic economy. As witnessed during the recent crisis, the economy of the Republic of Korea—despite its by-and-large sound operation—suffered through a recession and credit crunch because of problems that occurred outside its own economy. With the 1997/98 Asian financial crisis, the Republic of Korea has learned that a crisis can be contagious among emerging economies that have similarities in economic conditions and structures. However, when there are major failures in systemically important economies, the impact can be overwhelming regardless of the status of the domestic economy. The propagation of the crisis can be very rapid and widespread, owing to the growing economic and financial linkages with the rest of the world.

Effective surveillance should not be confined to monitoring the domestic economy, but should also look at the economies of other regions and trends in international financial markets. The implication of growing global linkages and integration for operating an EWS is that it is desirable to expand the scope of surveillance to include the many important economies and financial markets around the world. If we limit surveillance to the domestic economy only, then such a surveillance will be able to capture the coming of crisis only at the contagion stage after the economy has already been seriously affected.

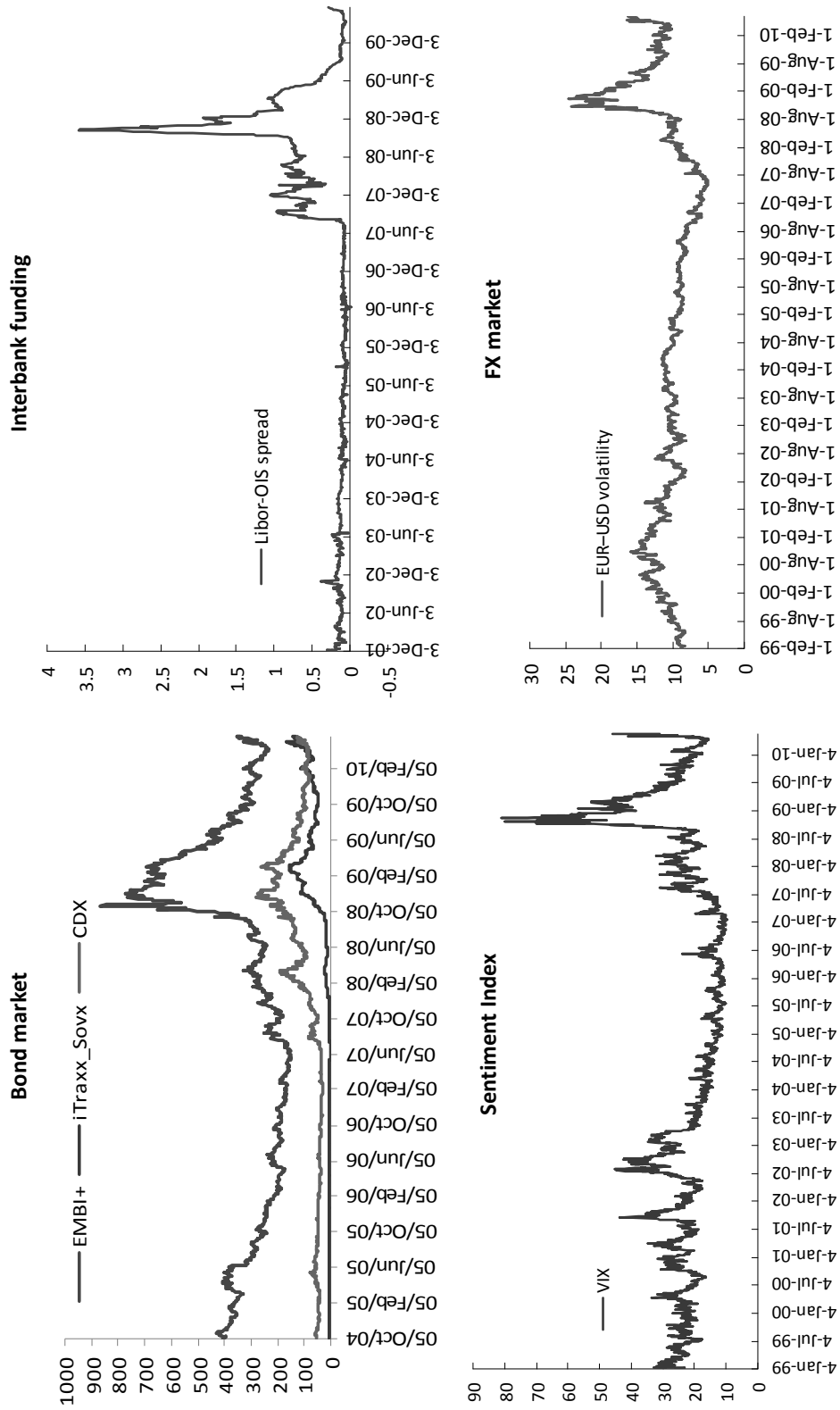
Figure 8 illustrates some international financial indicators that could have been useful for predicting the recent crisis. Utilizing financial market indicators can be useful for monitoring crisis risks since they swiftly reflect market situations and investors' sentiments, which often change from moment to moment, and they contain important information regarding market participants' evaluations of crisis risks. Financial indicators are also useful considering many crises occur with financial phenomena such as a currency crisis, debt crisis, or banking crisis.

---

<sup>16</sup> The ratio of external trade (exports and imports) to gross national income (GNI).

<sup>17</sup> In 2007, the foreign investors' share in the stock market capitalization was the third among OECD member countries.

Figure 8: International Financial Market Indicators



CDX = Central Data Exchange, EMBI = Emerging Markets Bond Index , iTraxx\_Sovx = iTraxx Sovx Western Europe Index, VIX = Volatility Index, FX=foreign exchange, Libor=London interbank offered rate, OIS=overnight index swap.

Source: Bloomberg.



The indicators in the panels<sup>18</sup> display the aggravations in financial market conditions around the period of the recent crisis. The bond market indicators show significant increases in the credit risks in the US, European, and emerging economies. The LIBOR-OIS<sup>19</sup> spread demonstrates a distinctive deterioration in the interbank funding market from about a year before the crisis. The other indicators also exhibit increased volatilities in the international FX market and growing negative sentiments among market participants.

Both qualitative and quantitative approaches can be employed for monitoring enlarged sets of economies and markets. Qualitative analysis should come first given the wide scope of surveillance and the approach's merit of flexible and swift response to changing situations. The analysis should be able to explain what the sources of the problem are, how the problem has been developing, what its impacts will be on the domestic economy, and what the appropriate policy measures should be to deal with the problem.

Quantitative analysis on such a wide scope can be intimidating and some parsimony in modeling is necessary. One may begin with a model composed of the most relevant and important indicators that well represent each region and financial sector. Or one can focus on the most serious and imminent risks identified by qualitative analysis and track the related indicators. Then, the coverage of quantitative models can be expanded as time, resources, and manpower allow.

Finally, there may be the need for compromise between the rigor of methodologies and the practical need that all relevant aspects for detecting potential crises should be properly monitored. The basic problem is that the more we pursue methodological rigor in the models, the more we come to rely on past experiences. As a result, the important factors that might play a role in the next crisis may be missing from the surveillance targets.

As explained before, the models that were based on the 1997/98 Asian financial crisis, which largely occurred due to domestic vulnerabilities, had limits in predicting the recent crisis caused by external factors. Also, some variables that would have been useful in detecting the US housing market bubble may not be useful in predicting the next crisis since the next crisis may develop in a different manner than the recent one.

It is, therefore, desirable to try to reflect in a model the relevant factors necessary for crisis surveillance rather than adhere to methodological rigor. The evaluation of a model should be based not only on methodological criteria, but also on whether the model incorporates all the relevant factors that have the potential to affect the stability of the system and whether such a model emits risk signals that are appropriate for the situation. For the practical purposes of early warning, it is important that the model produce

---

<sup>18</sup> Embi+ is the index of premiums on emerging market bonds. CDX and iTraxx\_Sovx are indexes of credit default swap premiums on North American corporate bonds and European sovereign bonds. LIBOR-OIS spread is the difference between the 3-month US LIBOR and overnight indexed swap rates. VIX, a popular measure of investors' sentiments, reflects market expectation on the volatility of the S&P500 over the next 30 days. The indicator for the FX market is the implied volatility of the 3-month euro-dollar FX option.

<sup>19</sup> London Interbank Offered Rate (LIBOR) and overnight index swap (OIS).

historical behavior that is reasonably consistent with reality and intuitively suggests the potential dangers the economy may encounter ahead.

## **(ii) More Attention on Structural Vulnerabilities**

The models operated in an EWS are generally for prediction of crisis occurrence. This objective deserves significant effort considering the harsh impact felt when a crisis is realized. However, predicting the exact timing of a crisis is extremely difficult. Further, a crisis can exert such a heavy impact because vulnerabilities have accumulated over an extended period of time that render the economy susceptible to shocks.

For example, the underlying cause of the recent crisis and its unprecedented scale of financial losses can be found in the US housing market bubble that created large discrepancies between housing prices and economic fundamentals, with consequent overvaluations of financial commodities based on mortgage loans. The currency crises of some South American economies during the mid-1990s did not happen only because of sudden capital outflows seeking higher interest rates in the US, but also because of weak economic conditions caused by lax fiscal management and large public debts, along with overvalued domestic currencies and accumulations of large current account deficits.

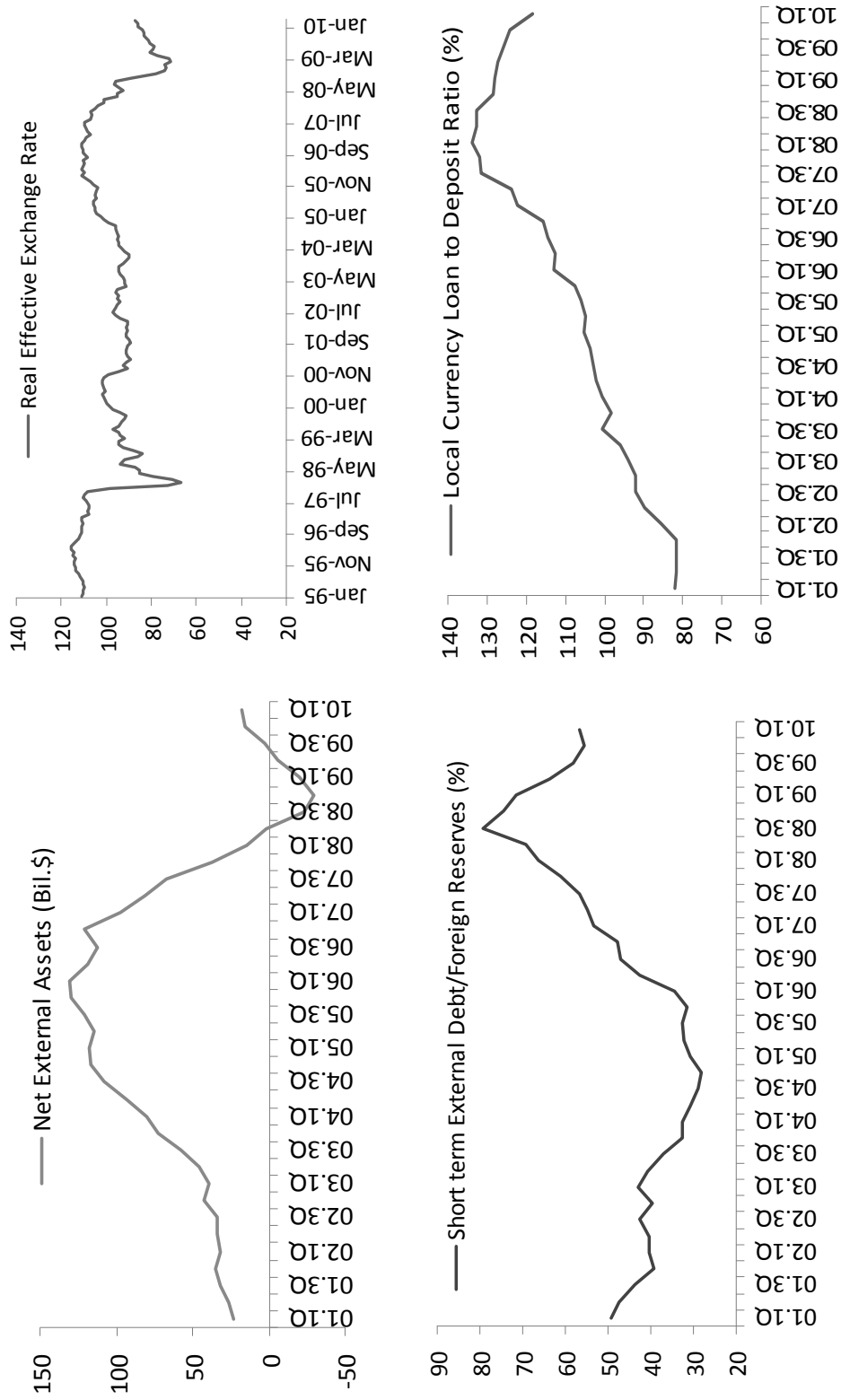
Vulnerabilities play an important role not only in the occurrence of crisis but also in its spillover. The panels in Figure 9 show that the economy of the Republic of Korea witnessed an increase in structural vulnerabilities in terms of foreign currency liquidity before the recent crisis. Short-term external debts jumped rapidly compared to the increase in FX reserves. Due to a fast increase in external debt and capital inflows, the net external asset position of the economy worsened, and its currency value measured by the real effective exchange rate was overestimated, resulting in the growing possibility of subsequent adjustment. The expansion of loan assets compared with the deposit base in the domestic banking sector led to the increasing demand for funds, which indirectly affected foreign currency liquidity. The ratio of short-term external debt to foreign exchange reserves ratio ascended to a higher level than in Asian peer countries. These vulnerabilities raised the level of risk to the economy, as recognized by market participants, and caused its currency to depreciate seriously during the crisis.

Since the underlying vulnerabilities serve as preconditions for economic hardship and tend to precede the occurrence of a crisis, monitoring for structurally vulnerable sectors can be a good way to enhance the capability of an EWS. Apart from the purpose of crisis prediction, monitoring structural vulnerabilities might also be of use for maintaining the soundness of the economy, which is crucial to avoid the harsh consequence of economic crisis. It is known that the IMF largely focuses on monitoring vulnerabilities in its surveillance of crisis.<sup>20</sup>

---

<sup>20</sup> See Gosh, Ostry, and Tamirisa (2009).

**Figure 9: Indicators of Foreign Exchange Vulnerabilities**



Source: Bank of Korea, Financial Supervisory Services.

### **(iii) Reinforce Early Warning Systems with Various Methodologies**

In order to complement the existing models and enhance the capabilities of an EWS to detect the possibility of crisis, various methodologies and auxiliary models can be considered. As one way to improve the function of alerting policy makers in the case of crisis realization, stress tests of EWS models can be considered. One difficulty with crisis prediction is that from time to time a crisis realizes abruptly in a short period. Accordingly, it is already too late for policy makers to take any meaningful preventive actions.

The surveillance unit first prepares a list of potential risks that the economy may encounter in the future and performs stress tests under the assumption of variables that are affected by a particular risk and the degree of impacts. Then, the assumed values are used as inputs to simulate the EWS model, and it can be observed to what degree of seriousness the assumed crisis event may affect the economy. The values of variables can be assumed qualitatively with reasonable sense and in comparisons with past experiences, or they can be produced using statistical models.

Also, various financial indicators can be incorporated into quantitative models in order to enhance the performance of EWS. Most of the main EWS models operated in surveillance units rely on macroeconomic variables—such as exports, current account balance, industrial production, and monetary aggregates. However, various financial indicators—such as spreads, premiums on interest rates, and volatilities—measured by financial commodities are used by researchers and practitioners in the market as good measures of the financial and economic conditions. The financial indicators are also usually available in high frequency while macro-variables can be obtained with some or significant time lags. Difficulties with utilizing financial indicators are that they are sometimes too volatile or that they usually have a short time-series so that their behavior during past crises is not observed. One can consider a separate model composed of high frequency financial indicators for this purpose, such as a daily checkup of the market.

Linkages among markets and economies also warrant serious attention. Understanding the channels through which a crisis in one economy is transferred to others is no less important than the prediction of the crisis itself. This is especially the case as the integration among regions and economies become more intensive and extensive. The volumes and structures of trade with particular regions and financial exposures through portfolio investments, borrowing, and lending should be well understood. Introducing quantitative measures of such linkages can be useful to capture the various risks and channels of spillover to which the economy may be exposed.

### **(iv) Incorporate Qualitative Judgment Process**

Finally, it is desirable that an EWS incorporate a qualitative judgment process. As mentioned earlier, quantitative methodology, while rigorous and objective, generally relies on past experiences and may miss some important factors for predicting the next crisis. As qualitative analysis is able to supplement quantitative models by flexibly dealing with various economic events, a qualitative judgment process should be incorporated into the EWS to assess the appropriateness of the warning signals

compared with the actual situation of the economy. If the quantitative model fails to produce warning signals for threats the economy is facing, the qualitative judgment process can directly issue a warning. Or, when the model overstates the true status of the economy, the qualitative judgment process can adjust the warning level properly according to the situation.

Qualitative judgment can be introduced in many different ways. The surveillance unit can adjust warning levels itself, or through a committee of economic experts from organizations such as economic research institutes, central bank, and financial supervisory authorities. The adjustment of warning levels can be limited or limitless.

Combining a qualitative approach into quantitative models can deal with the problems of qualitative analysis as well. By making an explicit choice of warning level, the ambiguity and vagueness that tend to be present in qualitative assessment can be overcome.

In a world that is becoming more and more integrated, economic phenomena are involved in more complicated and changeable manners. The surveillance unit has more objects to monitor and more relationships between more variables to consider. Incorporating a qualitative judgment process into an EWS can be an effective way of coping with the changing nature of economic environments while also maintaining the objectivity and rigor of quantitative methodologies.

## **4. Message Delivery and Policy Guidance**

### **(i) Establish Communication Channels to Deliver Messages to Every Stakeholder**

In addition to the completion of effective surveillance tools, a national surveillance process must aim to have a direct influence on senior policy makers for intended policy responses. To this end, first and foremost, it is recommended to build a direct and periodic reporting channel for end-consumers of the surveillance reports.

In particular, reporting via middle-level officials might obstruct the flow of precise information since they tend to water down the seriousness of the economic surveillance results. To avoid this, direct contact between a surveillance unit and senior policy makers on a periodic basis is strongly recommended.

In the meantime, a national surveillance unit should also pay attention to keeping parallel dialogue channels with other stakeholders in place. They should try to strengthen efforts for collaboration with other national surveillance units in the region and international institutions like AMRO and the IMF, as proper surveillance of an EWS requires not only detecting country-level vulnerabilities, but also taking a close look at the vulnerabilities of other regions and their possible evolution into broader systemic risks, as well as cross-border and inter-market spillovers.

It is desirable that national surveillance units in individual countries have the opportunity to exchange views on economic issues and discuss measures to cope with discovered

vulnerabilities. Peer reviews of surveillance activities and outcomes will contribute to improving the efficiency and effectiveness of the national surveillance mechanism as a whole.

Also, national surveillance units can cooperate with international institutions, such as AMRO and the IMF, in an effort to supplement their activities through information sharing and a mutual evaluation process. National surveillance units could be helped in fostering their technical expertise and in recognizing economic vulnerabilities of broader regions with possible spillover effects. Drawing on the outputs of international institutions should strengthen national surveillance units rather than act as a substitute for their own assessments. Such cooperation can help the international institutions as well in better understanding a particular country's economic situations.

The roles of international institutions can be important in cooperation among surveillance units. Since the operations of most national surveillance units are conducted in a confidential manner, international institutions committed with common interests have an advantage in bringing forth more open discussions. International institutions could have informal yet regular meetings with national surveillance units and discuss surveillance outcomes; for example, when they visit member countries on a surveillance mission.

Active communication and cooperation among the three layers of surveillance—IMF (global), AMRO (regional), and national surveillance units (national)—would ensure monitoring of a specific economy from various perspectives and angles. Moreover, a broader and multilateral perspective would underscore that ensuring the orderly flow of economic and financial resources across borders is a joint responsibility, which needs to be taken into account among the policy choices.

## **(ii) Promote Independence of the Surveillance Unit**

The final stage of surveillance activities for a national surveillance unit includes providing policy advice based on its analysis on how to address identified problems. To realize such a purpose properly, a national surveillance unit should be independent in order to work objectively and impartially, particularly when signs of crisis are brewing. If a national surveillance unit is to play a significant role in accomplishing its purpose, its staff should be provided not only with incentives, but also with whistle-blowing immunity when raising issues that policy makers may find uncomfortable to openly discuss. Whether to allow the free flow of information related to the surveillance results will decide the success or failure of an EWS. In other words, a national surveillance unit free from the influence of the authorities will be one key to an effective crisis prevention mechanism.

Independence, however, does not necessarily mean that the national surveillance unit can open its surveillance to the public without any restrictions. As explained before, this might confuse economic players, possibly leading to a self-fulfilling prophecy. Since the primary objective of the surveillance unit is early detection of the risk factors in the economy and recommendation of policy measures to prevent a crisis, the end-consumer of the surveillance report should be the authorities rather than the market or the public. From this perspective, independence should be limited to ensuring trust in a surveillance model and free message delivery to senior policy makers.

Lastly, the people in charge of surveillance need to continuously build upon their capabilities to ensure independence of the surveillance unit. Otherwise, the authorities would not have full confidence in the surveillance output and the independence of the surveillance unit could ultimately be harmed and threatened. Capacity building is also necessary for the policy makers to ensure effective communication and informed policy decisions. Hence, it will be of great use to establish a program to develop the capacity of all those involved in surveillance. This can be an area for international cooperation as capacity building is one of the most basic and common interests among national surveillance units.

## References

- ADB. 2009. Special Section—Regional Surveillance for Economic Stability. *Asia Economic Monitor*. <http://www.aric.adb.org/asia-economic-monitor/2009-December>.
- W-k. Baek. 2009. The Improvement Plans of Early Warning System on Economic Crises (in the Korean language). *Policy Research Series*. The National Assembly of the Republic of Korea.
- A. Ghosh, J. Ostry, and N. Tamirisa. 2009. Anticipating the Next Crisis. *Finance & Development*. Washington, DC: International Monetary Fund.
- S. Ghosh and A. Ghosh. 2002. Structural Vulnerability and Currency Crises. *IMF Working Paper*. 02/9.
- S-d. Jung and M-y. Lee. 2008. The Directions of Early Warning System Development of the Financial Supervisory Service (in the Korean language). *Investigation and Research Review*. 23. The Financial Supervisory Service.
- G. Kaminsky, S. Lizondo, and C. Reinhart. 1998. Leading Indicators of Currency Crises. *IMF Staff Papers*. 45 (1).
- Y. Koh et al. 2007. *10 Years since the Economic Crisis: Evaluations and Future Steps* (in the Korean language). Seoul: Korea Development Institute.
- C. S. Oh. 2006. Developing an Effective Early Warning System for Financial Crises for Indonesia, Consisting of a Quantitative Sub-system and a Qualitative Sub-system. *2005 Knowledge Sharing Program Consultation Report: Indonesia*. Ministry of Strategy and Finance.
- D. R. Yoon et al. 2004. *The Development of an Early Warning Model for Oil Crisis* (in the Korean language). Seoul: Korea Institute for International Economic Policy.



## **ADB Working Paper Series on Regional Economic Integration\***

1. "The ASEAN Economic Community and the European Experience" by Michael G. Plummer
2. "Economic Integration in East Asia: Trends, Prospects, and a Possible Roadmap" by Pradumna B. Rana
3. "Central Asia after Fifteen Years of Transition: Growth, Regional Cooperation, and Policy Choices" by Malcolm Dowling and Ganeshan Wignaraja
4. "Global Imbalances and the Asian Economies: Implications for Regional Cooperation" by Barry Eichengreen
5. "Toward Win-Win Regionalism in Asia: Issues and Challenges in Forming Efficient Trade Agreements" by Michael G. Plummer
6. "Liberalizing Cross-Border Capital Flows: How Effective Are Institutional Arrangements against Crisis in Southeast Asia" by Alfred Steinherr, Alessandro Cisotta, Erik Klär, and Kenan Šehović
7. "Managing the Noodle Bowl: The Fragility of East Asian Regionalism" by Richard E. Baldwin
8. "Measuring Regional Market Integration in Developing Asia: a Dynamic Factor Error Correction Model (DF-ECM) Approach" by Duo Qin, Marie Anne Cagas, Geoffrey Ducanes, Nedelyn Magtibay-Ramos, and Pilipinas F. Quising
9. "The Post-Crisis Sequencing of Economic Integration in Asia: Trade as a Complement to a Monetary Future" by Michael G. Plummer and Ganeshan Wignaraja
10. "Trade Intensity and Business Cycle Synchronization: The Case of East Asia" by Pradumna B. Rana
11. "Inequality and Growth Revisited" by Robert J. Barro
12. "Securitization in East Asia" by Paul Lejot, Douglas Arner, and Lotte Schou-Zibell
13. "Patterns and Determinants of Cross-border Financial Asset Holdings in East Asia" by Jong-Wha Lee
14. "Regionalism as an Engine of Multilateralism: A Case for a Single East Asian FTA" by Masahiro Kawai and Ganeshan Wignaraja

15. "The Impact of Capital Inflows on Emerging East Asian Economies: Is Too Much Money Chasing Too Little Good?" by Soyoung Kim and Doo Yong Yang
16. "Emerging East Asian Banking Systems Ten Years after the 1997/98 Crisis" by Charles Adams
17. "Real and Financial Integration in East Asia" by Soyoung Kim and Jong-Wha Lee
18. "Global Financial Turmoil: Impact and Challenges for Asia's Financial Systems" by Jong-Wha Lee and Cyn-Young Park
19. "Cambodia's Persistent Dollarization: Causes and Policy Options" by Jayant Menon
20. "Welfare Implications of International Financial Integration" by Jong-Wha Lee and Kwanho Shin
21. "Is the ASEAN-Korea Free Trade Area (AKFTA) an Optimal Free Trade Area?" by Donghyun Park, Innwon Park, and Gemma Esther B. Estrada
22. "India's Bond Market—Developments and Challenges Ahead" by Stephen Wells and Lotte Schou- Zibell
23. "Commodity Prices and Monetary Policy in Emerging East Asia" by Hsiao Chink Tang
24. "Does Trade Integration Contribute to Peace?" by Jong-Wha Lee and Ju Hyun Pyun
25. "Aging in Asia: Trends, Impacts, and Responses" by Jayant Menon and Anna Melendez-Nakamura
26. "Re-considering Asian Financial Regionalism in the 1990s" by Shintaro Hamanaka
27. "Managing Success in Viet Nam: Macroeconomic Consequences of Large Capital Inflows with Limited Policy Tools" by Jayant Menon
28. "The Building Block versus Stumbling Block Debate of Regionalism: From the Perspective of Service Trade Liberalization in Asia" by Shintaro Hamanaka
29. "East Asian and European Economic Integration: A Comparative Analysis" by Giovanni Capannelli and Carlo Filippini
30. "Promoting Trade and Investment in India's Northeastern Region" by M. Govinda Rao

31. "Emerging Asia: Decoupling or Recoupling" by Soyoung Kim, Jong-Wha Lee, and Cyn-Young Park
32. "India's Role in South Asia Trade and Investment Integration" by Rajiv Kumar and Manjeeta Singh
33. "Developing Indicators for Regional Economic Integration and Cooperation" by Giovanni Capannelli, Jong-Wha Lee, and Peter Petri
34. "Beyond the Crisis: Financial Regulatory Reform in Emerging Asia" by Chee Sung Lee and Cyn-Young Park
35. "Regional Economic Impacts of Cross-Border Infrastructure: A General Equilibrium Application to Thailand and Lao PDR" by Peter Warr, Jayant Menon, and Arief Anshory Yusuf
36. "Exchange Rate Regimes in the Asia-Pacific Region and the Global Financial Crisis" by Warwick J. McKibbin and Waranya Pim Chanthapun
37. "Roads for Asian Integration: Measuring ADB's Contribution to the Asian Highway Network" by Srinivasa Madhur, Ganeshan Wignaraja, and Peter Darjes
38. "The Financial Crisis and Money Markets in Emerging Asia" by Robert Rigg and Lotte Schou-Zibell
39. "Complements or Substitutes? Preferential and Multilateral Trade Liberalization at the Sectoral Level" by Mitsuyo Ando, Antoni Esteveordal, and Christian Volpe Martincus
40. "Regulatory Reforms for Improving the Business Environment in Selected Asian Economies—How Monitoring and Comparative Benchmarking can Provide Incentive for Reform" by Lotte Schou-Zibell and Srinivasa Madhur
41. "Global Production Sharing, Trade Patterns, and Determinants of Trade Flows in East Asia" by Prema-Chandra Athukorala and Jayant Menon
42. "Regionalism Cycle in Asia (-Pacific): A Game Theory Approach to the Rise and Fall of Asian Regional Institutions" by Shintaro Hamanaka
43. "A Macroprudential Framework for Monitoring and Examining Financial Soundness" by Lotte Schou-Zibell, Jose Ramon Albert, and Lei Lei Song
44. "A Macroprudential Framework for the Early Detection of Banking Problems in Emerging Economies" by Claudio Loser, Miguel Kiguel, and David Mermelstein
45. "The 2008 Financial Crisis and Potential Output in Asia: Impact and Policy Implications" by Cyn-Young Park, Ruperto Majuca, and Josef Yap

46. "Do Hub-and-Spoke Free Trade Agreements Increase Trade? A Panel Data Analysis" by Jung Hur, Joseph Alba, and Donghyun Park
47. "Does a Leapfrogging Growth Strategy Raise Growth Rate? Some International Evidence" by Zhi Wang, Shang-Jin Wei, and Anna Wong
48. "Crises in Asia: Recovery and Policy Responses" by Kiseok Hong and Hsiao Chink Tang
49. "A New Multi-Dimensional Framework for Analyzing Regional Integration: Regional Integration Evaluation (RIE) Methodology" by Donghyun Park and Mario Arturo Ruiz Estrada
50. "Regional Surveillance for East Asia: How Can It Be Designed to Complement Global Surveillance?" by Shinji Takagi
51. "Poverty Impacts of Government Expenditure from Natural Resource Revenues" by Peter Warr, Jayant Menon, and Arief Anshory Yusuf
52. "Methods for Ex Ante Economic Evaluation of Free Trade Agreements" by David Cheong
53. "The Role of Membership Rules in Regional Organizations" by Judith Kelley
54. "The Political Economy of Regional Cooperation in South Asia" by V.V. Desai
55. "Trade Facilitation Measures under Free Trade Agreements: Are They Discriminatory against Non-Members?" by Shintaro Hamanaka, Aiken Tafgar, and Dorothea Lazaro
56. "Production Networks and Trade Patterns in East Asia: Regionalization or Globalization?" by Prema-chandra Athukorala
57. "Global Financial Regulatory Reforms: Implications for Developing Asia" by Douglas W. Arner and Cyn-Young Park
58. "Asia's Contribution to Global Rebalancing" by Charles Adams, Hoe Yun Jeong, and Cyn-Young Park
59. "Methods for Ex Post Economic Evaluation of Free Trade Agreements" by David Cheong
60. "Responding to the Global Financial and Economic Crisis: Meeting the Challenges in Asia" by Douglas W. Arner and Lotte Schou-Zibell
61. "Shaping New Regionalism in the Pacific Islands: Back to the Future?" by Satish Chand

62. "Organizing the Wider East Asia Region" by Christopher M. Dent
63. "Labour and Grassroots Civic Interests In Regional Institutions" by Helen E.S. Nesadurai
64. "Institutional Design of Regional Integration: Balancing Delegation and Representation" by Simon Hix
65. "Regional Judicial Institutions and Economic Cooperation: Lessons for Asia?" by Erik Voeten
66. "The Awakening Chinese Economy: Macro and Terms of Trade Impacts on 10 Major Asia-Pacific Countries" by Yin Hua Mai, Philip Adams, Peter Dixon, and Jayant Menon
67. "Institutional Parameters of a Region-Wide Economic Agreement in Asia: Examination of Trans-Pacific Partnership and ASEAN+ $\alpha$  Free Trade Agreement Approaches" by Shintaro Hamanaka
68. "Evolving Asian Power Balances and Alternate Conceptions for Building Regional Institutions" by Yong Wang
69. "ASEAN Economic Integration: Features, Fulfillments, Failures and the Future" by Hal Hill and Jayant Menon
70. "Changing Impact of Fiscal Policy on Selected ASEAN Countries" by Hsiao Chink Tang, Philip Liu, and Eddie C. Cheung
71. "The Organizational Architecture of the Asia-Pacific: Insights from the New Institutionalism" by Stephan Haggard
72. "The Impact of Monetary Policy on Financial Markets in Small Open Economies: More or Less Effective During the Global Financial Crisis?" by Steven Pennings, Arief Ramayandi, and Hsiao Chink Tang
73. "What do Asian Countries Want the Seat at the High Table for? G20 as a New Global Economic Governance Forum and the Role of Asia" by Yoon Je Cho
74. "Asia's Strategic Participation in the Group of 20 for Global Economic Governance Reform: From the Perspective of International Trade" by Taeho Bark and Moonsung Kang
75. "ASEAN's Free Trade Agreements with the People's Republic of China, Japan, and the Republic of Korea: A Qualitative and Quantitative Analysis" by Gemma Estrada, Donghyun Park, Innwon Park, and Soonchan Park

76. "ASEAN-5 Macroeconomic Forecasting Using a GVAR Model" by Fei Han and Thiam Hee Ng

\* These papers can be downloaded from (ARIC) <http://aric.adb.org/reipapers/> or (ADB) [http://adb.org/Economics/publications.asp?fs=fm\\_9:999](http://adb.org/Economics/publications.asp?fs=fm_9:999)







## **Early Warning Systems in the Republic of Korea: Experiences, Lessons, and Future Steps**

In the wake of the 1997/98 financial crisis, the Republic of Korea introduced an early warning system (EWS) to prevent the recurrence of a similar crisis. This paper examines the country's EWS and provides key lessons and policy recommendations to other national surveillance units seeking to improve their EWSs.

### **About the Asian Development Bank**

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to two-thirds of the world's poor: 1.8 billion people who live on less than \$2 a day, with 903 million struggling on less than \$1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.