## Leading Indicators of Past Financial Crises -Do they Apply to the Current Financial Crisis?

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## **Executive Summary**

Frequently occurring financial crises in the last four decades motivated researcher to identify a set of potential indicators to model these events. The Latin American debt crisis at the beginning of the 1980s was the initial point for a first generation of theoretical models. The involved countries suffered a currency crisis, defined as the moment when they had to abandon a fixed-rate regime. Krugman (1979) was the main representative of this generation. To explain the crisis, he focussed on weak macroeconomic fundamentals of countries due to expansionary monetary and fiscal policy of governments. Based on events such as the ERM crisis around 1992 in Western Europe, authors like Obstfeld (1996) added features of self-fulfilling prophecies to currency crises. Expectations of investors entered the theory as a new element in addition to the weak economic fundamentals. After the Asian crisis and the so-called Tequila crisis in Latin America during the mid 1990s, the economic fundamentals of the affected countries were found to be rather sound before the onset of the specific events. Instead, problems in the financial sector were identified to trigger the financial crises. Hence, systematic banking crises started to play an important role in the third generation of theoretical models. Therefore, the new models additionaly included financial indicators derived from aggregate balance sheet data of banks.

Based on the identified indicators, different empirical approaches were developed to rank the vulnerability of countries and to predict future crises. In this thesis the so-called signalling approach is applied. Compared to other approaches, it offers the possibility to analyse the signalling behaviour of the indicators before a specific crisis event. In the signalling approach, the noise-to-signal ratio compares the amount of false signals to the number of good signals for each individual indicator. Good signals appear within the crisis window, which includes the 24 months prior to the actual event. A signal is issued whenever the variable crosses a certain threshold, defined as a percentile of its distribution. If the noise-to-signal ratio lies below one, i.e. the good signals outnumber the noise, the indicator is considered to be informative. The lower the ratio, the better the performance of an indicator. Composite indicators then collect the information of the useful indicators to issue crisis signals in a country. The probability of a crisis is calculated conditional to the value of the composite indicator. An increased crisis probability indicates a higher vulnerability of a country's economy at a certain point in time.

The selection of indicators that appears to be useful in explaining financial crises changes with different approaches and events. However, a common set of leading indicators seems to be informative in explaining financial crises independent of the underlying event or empirical approach. The aim of this thesis is to identify this set of leading indicators based on previous literature and to examine its signalling behaviour before the current financial crisis. Performing a signalling approach, first an in-sample model analyses whether the leading indicators show an increased vulnerability of the affected countries before the 2008 financial turmoil. In the key test, a model containing only data until the eve of the current crisis examines the out-of-sample predictability of this specific event. Monthly data from January 1990 until September 2009 (only until August 2008 in the out-of-sample model) from a sample of 20 emerging and developed economies is employed in this study. Crisis periods are defined using the exchange market pressure index (EMP) for currency crises and the money pressure index (MPI) for banking crises. The EMP equals the change in the real effective exchange rate, plus the change in the real interest rate, minus the change in foreign exchange reserves. The change in the ratio of central bank credits to banks divided by bank assets, plus the change in the interbank lending rate build the MPI. Therefore, the EMP and the MPI capture not only the outbreak of a financial crisis, but also events when defence actions implemented by governmental institutions successfully prevented an impending crisis.

The identified set of leading indicators basically consists of three different groups of variables: Macroeconomic indicators, financial indicators and indicators capturing contagion. In this context, contagion describes the phenomenon when financial troubles in one country spread over to other countries through cross-market linkages. The focus in recent contagion literature lies on financial linkages and multilateral trade. In this thesis, the sample countries get divided into regional clusters based on geographical criteria, to examine whether a crisis in one country can trigger a crisis in another country within the same region. The global contagion variable simply tests whether a crisis anywhere in the world can trigger a crisis in other countries. Alternatively, the US share returns and the world oil price test the contagion potential of shocks in the biggest stock market as well as in the price of the most important natural resource.

The group of macroeconomic indicators is the largest one. Different exchange rate figures capture a possible overvaluation of the domestic exchange rate, while variables such as export growth, terms of trade, or the current account to GDP ratio reflect the strength of the external sector. Capital account problems are measured by combinations of money aggregates and international reserves such as the ratio of M2 to foreign reserves. Different GDP figures, as well as an industrial production index, and the inflation are used to illustrate the actual position of the economy in the economic cycle. Previous literature shows that a recession may precede a financial crisis. Financial liberalisation and overborrowing are other phenomena attributed to past financial crises. To check for their role in the current crisis, variables reflecting the growth in domestic credits, real interest rates and foreign liabilities are included as well.

In the group of financial variables, share returns reflect the condition of the domestic stock markets, while aggregate bank deposits capture possible bank runs. The ratio of lending to deposit rates measures the quality of a bank's loan portfolio. Further, the ratio of bank reserves to assets and the growth in bank credits from the central bank express liquidity needs of the banking sector.

The determination of crisis episodes revealed that five sample countries, namely Canada, Ireland, Sweden, Switzerland, and the USA suffered banking crises in either September or October 2008. Clearly, the current financial crisis broke out as a systematic banking crisis. The burst of the subprime bubble had a major impact on the asset side of bank balance sheets, leading to financial distress in many institutions. Unexpectedly, also a couple of currency crisis periods are identified around this time. Bolivia, Cyprus, Ireland, Japan, Malaysia, Switzerland, the USA, and Venezuela identify at least one period of high currency pressure between July 2008 and February 2009. A closer look at the single components of the EMP shows that an increasing volatility of the real effective exchange rate is the main reason for the identification of these currency crisis periods.

When calculating the noise-to-signal ratio of the individual indicators in the insample model, it gets clear that macroeconomic variables perform best. Indicators capturing the general condition of the economy, such as inflation and GDP figures, as well as the ones reflecting exchange rate overvaluations and the strength of the external sector have the lowest noise-to-signal ratios for both types of crises. Overborrowing and financial liberalisation still seem to play a role in the current crisis, because the domestic credit variables and the real interest rates appear to be informative for banking and currency crises. On the other hand, financial variables perform better when indicating banking crises than currency crises. Still, their ratios are higher than for most macroeconomic variables and some of them have to be dropped from the model. Furthermore, the results of the contagion variables are rather bad. Interestingly, only a currency crisis either anywhere in the world or within the same regional cluster is a useful indicator of a banking crisis, but not a banking crisis itself. When indicating currency crises, the contagion variables are not very informative. All their noise-to-signal ratios lie only slightly below one. In addition, the alternative contagion variables US stock returns and world oil price are dropped from the model since their ratios lie above one for both types of crises.

The in-sample composite indicator for banking crises issues signals in all countries affected by the current crisis. Indeed, first signals are only issued simultaneously to the outbreak of the crisis, except for Canada, where the signals start two months prior to the event. This result has obviously not turned out satisfactory. Not even the two months in Canada are an appropriate time range for policy makers to implement reasonable defence actions. Lowering the signalling threshold of the composite indicators would offer more early signals, but for the cost of more false signals in tranquil times. In the countries suffering high currency pressure during the current financial crisis, the composite indicator for currency crises does not perform much better. At least, in six out of eight countries, there are early signals of a currency crisis. However, they get outnumbered by false signals issued outside the crisis windows in most cases. In general, the identified set of leading indicators does not adequately model the vulnerability of the affected countries before the current financial crisis.

In the last step, only data until the eve of the current crisis is used to build the out-of-sample model. The exclusion of the 2008 crisis data leads to some changes in the individual performance of the indicators. The average noise-to-signal ratio for both types of crises is lower compared to the in-sample model. As one would expect, the identified set of leading indicators performs better when predicting exclusively the very crises that motivated their development. This provides evidence for new factors playing a role in the current financial crisis, which are not yet covered by the indicators of past financial crises. The noise-to-signal ratio of some individual indicators is now clearly lower than in the in-sample model, while the ratio of other variables increased. This delivers information on whether an indicator signalled before the current crisis or not. For example the out-of-sample performance of the world oil price as indicator for banking crises has clearly improved. This indicates that shocks in oil prices did not play a role in the current crisis, but they were more important in earlier events.

The out-of-sample signalling behaviour of the composite indicator shows only very few signs of an upcoming banking crisis in the affected countries. Only in Switzerland there is an early signal almost a year before the onset of the crisis. In the USA the signals appear only two months prior to September 2008, while there are no signals issued in Canada, Ireland, and Sweden. When transforming the values of the composite indicators into conditional crisis probabilities, the picture improves a little. Still, there is no explicit indication of an upcoming crisis in Ireland and Sweden. On the other hand, in Canada, the USA, and especially Switzerland, the crisis probability is on a higher level during several months prior to the current financial crisis. Certainly, there are also periods of high crisis probability outside the crisis windows. Nevertheless, there is an obvious indication of increased vulnerability of these countries to a negative shock in the financial system before the 2008 financial crisis. In the case of countries with high currency pressure in 2008, the forecasting ability of the out-of-sample model is very limited. Only in Cyprus and Japan there are two months with significantly increased crisis probability in an appropriate time distance to the actual event. In the six other countries, there is no indication on an upcoming currency crisis at all.

In general, the performance of the out-of-sample model as a forecasting instrument of the current crisis is rather poor. This seems to fit in nicely with earlier tries to predict future crises using indicators of past events. They typically failed, as it was illustrated in previous literature. Indicators developed after the ERM crisis failed to predict the Mexican crisis, whereas indicators developed after the Mexican crisis failed to predict the Asian crisis, and so on. The story kept repeating itself during the last decades. Even though it is not yet possible to forecast the exact time and place of the next financial crisis, the model is at least able to send some alarm signals to make policy makers aware of an increased vulnerability of the economy.