GENERALIZED APPROACH TO CURRENCY CRISIS RISK ANALYSIS

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Abstract

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Three types of currency crisis models coexist in the literature: first generation models view speculative attacks as being caused by economic fundamentals which are inconsistent with a given parity. Second generation models claim self-fulfilling speculation are the main source of a currency crisis. Third generation models consider international illiquidity as necessary and sufficient condition for balance of payments crisis and/or banking sector collapse. This paper presents an empirical model that incorporates all three generations of currency crisis models using a pooled probit specification analysis. Data include thirteen countries that are asssumed to have similar market conditions. Time series data represents period from 1970 till 1997. The method used in the paper provides empirical justification for a set of macroeconomic indicators that represents different theoretical models. Obtained results may be quite useful for further more sophisticated approaches of currency crisis risk analysis. The applicability of the model is tested on a transition economy of Ukraine.

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INTRODUCTION

Three generations of currency crisis models coexist in the literature. Each model explains a particular aspect of the same problem. The first generation makes emphasis on the inconsistency between fundamentals and fixed parity. These inconsistencies will eventually lead to a currency crisis according to P.Krugman (1979). The second generation claims self-fulfilling speculation as a major source of the collapse. These scenarios were usual for EMS crisis in 1992-93. The third generation considers international financial illiquidity as a necessary and sufficient condition for currency crisis. This model fits best the recent Asian crisis in 1997. Models were developed one after another and all of them are still important. This means that any of the crises could be explained in terms of this "trio".

The primary purpose of my paper is to capture the multicausality nature of the currency crisis into a single model. The careful analysis of all previous crises shows that in each case there were present particular features of each generation. However, currency crises are different in a sense that they were triggered by mechanisms that are considered as major in different models. Time order of the each generation's development supports the hypothesis that dynamic of explanatory power of each generation of currency crisis models changes simultaneously with the development of international financial system. A priori expectation that can be drawn from the theory is a gradual decline of the first generation models' importance during the last two decades. At the same time, the third generation becomes more and more significant mainly because of technological development, which increases the speed of capital movements and further development of the international financial system. However, it is doubtful that any of the generations lost explanatory power at all. That is why another question that I am concerned about is the test of importance of each model.

Many empirical works devoted to the crisis problem are skewed toward technical analysis of macroeconomic indexes and sometimes leave theoretical justification of variables beyond the scope of well-known theoretical models. Importance of this paper is the strong theoretical background from which all explanatory variables are drawn. In some sense my paper could be considered as empirical realization of the theoretical models.

In fact, we could find a number of empirical estimations of well-known currency crises episodes in the last part of twentieth century. These events attract the attention of pundits mainly because of their huge destructive power for world financial system. But what about "mini" currency crises, that does not affect international finance like Asian (1997) or EMS (1992-93) crises? Each country that proceeded under fixed exchange rate from time to time faces so-called speculative attacks. In many cases the government is able to defend fixed parity, but sometimes it is forced to devalue. If the country is comparatively small (or its neighbours have strong financial systems), the devaluation will not cause serious distortion in the world financial markets. However, a small currency crisis is nevertheless a crisis and its probability is not directly dependent on the size of the country. The majority of formal models, developed by international economists are focused on explanation of the very nature of currency crisis. That is why they may be applied to the mini-crises as well. The strong side of this paper is in the choice of unbiased data set, which will include evidence of mini crises along with badly famous crashes of financial systems.

Countries that are included in the sample fall into one broad category: newly industrialized countries or so-called emerging markets. However, my model can be applied as well to the analysis of the countries in transition, which needs specific approach, but it does not require any significant changes of the model. That is why the model is strong in the sense of universality of application.

The last but not least task of this paper is to provide reliable technique for country's currency risk analysis. Reliable estimation of the probability of currency crisis could have an important positive effect for the stability of international financial system. Development of the practical technical approach to the currency sustainability will simplify the work of monetary authorities and will allow them to react quickly, that is, to decrease substantially negative side of globalisation.

The remaining part of the paper consists of four main parts, survey of literature and conclusions. Survey of literature gives a brief sketch of the papers in purely theoretical field as well as practical investigations. Part I (Chapter 2) represents main theoretical models that are now used to explain the currency crisis nature. Here I develop three sets of macroeconomic indexes with respect to each model that could be employed to predict the collapse of the country's currency. Part II (Chapter 3) is mostly technical part where I will present the econometric model (probit specification) that is used to test my hypotheses. Also here I will give answers to the questions mentioned above. Part III (Chapter 4) represents interpretation of results and provide in-sample test for the model. Part IV (Chapter 5) can be considered as the testing of the obtained results on a particular case of Ukraine. Conclusions will summarize results and will present the answer to main question: is it possible to build the generalized model of currency crisis risk analysis?

Chapter 1

SURVEY OF LITERATURE

The government can peg the exchange value of its currency in a variety of ways. Among those most often used are open-market operations, intervention in the forward exchange market and direct operation in foreign assets to defend exchange parity. Instruments such as changes in bank reserve requirements can extend this list. But all these instruments are subject to limits. If the government wants to protect the domestic currency from appreciation, there can occur a situation when the "cost" of domestic inflation becomes prohibitively large. Keeping currency from depreciation leads to decreasing foreign reserves. And once they are exhausted or borrowing approaches a limit, the government is no longer able to defend a fixed parity, and currency crisis takes place. Krugman's (1979) article is concerned with the analysis of such crises. That article raises a question of initial mechanisms, which in the end lead to a triggering of the effect known as speculative attack followed by the currency crisis. The author develops a formal model, which captures these sorts of events. By his definition, "a speculative attack can be viewed as a process by which investors change the composition of their portfolios, reducing the proportion of domestic currency and raising the proportion of foreign currency" (p.312). This change in composition Krugman explains "by a change in relative yields, for when the government is no longer able to defend the exchange rate the currency begins depreciating" (p.312). This famous paper initiates a great discussions in the economic literature and leads to a development of the currency crisis models, which view speculative attacks as being caused by economic fundamentals, which are inconsistent with a given parity. Market participants interpret such

inconsistencies as a signal that realignment will occur sooner or later. Krugman's type of models is often considered as First Generation of currency crisis models.

The second generation is best described in Obstfeld's models (1986 and 1995). According to the Obstfeld's logic "the discomfort a government suffers from speculation against its currency determines the strategic incentives of speculators and the scope for multiple currency market equilibria" (p.1). The author describes in particular a model in which high unemployment may cause an exchange rate crisis with self-fulfilling features. In addition Obstfeld reviews some other self-reinforcing mechanisms, which are supported by recent economic evidence. At the same time, Krugman has suggested another view of the self-fulfilling feature of the exchange rate crises. In his paper Krugman (1996) is concerned that "some authors have been willing to draw strong policy implications from this result, in particular that fixed exchange rates cannot coexist with free capital mobility" (p.1). He then tries to show in his paper that the reasons why currency crisis expectations can be self-fulfilling are due less to the new assumption of endogeneity of government policy than to the dropping of the classical assumption that fundamentals are deteriorating. Krugman argues that self-fulfilling expectations can play a role mainly in the case where fundamentals "evolve randomly and are not certain to deteriorate…though even here this role may be tempered by the presence of well-financed speculators" (Krugman, 1996, p.345). Also in his paper the author expresses doubts about empirical evidence for the self-fulfilling crisis hypothesis. However, later Krugman (January, 1999) finds that self-fulfilling hypothesis takes place in some crisis episodes and makes substantial improvements of existing theory. Krugman's words "Maury Obstfeld was right" (p.1) put the seeds of the next generation of currency crisis models into the fertile ground of economic theory.

In the beginning of 1997 few (if any) economists could foresee such global and deep crisis, as the "Asian Flu". Prosperous economies, which recently have been called as "Asian miracle", fell one after another raising a big question about the ability of conventional economic theory to predict or at least to explain the crash. From the beginning of the crisis there was a lack of theoretical explanations of why this crisis arose. However, according to Chang & Velasco (1998c) Asian crisis "is not a new and frightening creature just emerging from the depth of the South China Sea, but a classic financial crisis made possible by the illiquidity of the financial sectors, the likes of which we have seen before in so-called emerging markets" (p.1). Chang & Velasco (1998a, 1998b, and 1998c) articles initiate the development of the "Third generation" of currency crisis models, which considers the condition of financial illiquidity as the necessary and sufficient condition for collapse of the fixed exchange rate system.

The great Asian crisis of 1997 provided a lot of material for discussion by the authors of all generations of currency crisis models. In particular Krugman says "What we have actually seen is something both more complex and more drastic: collapses in domestic asset markets, widespread bank failures, bankruptcies on the part of many firms, and what looks to be much more severe real downturn that even the most negative-minded anticipated" (1998, p.1). The author points out that "this crisis did not play exactly in the way posited by standard currency crisis models". However Krugman still considers such models quite helpful in providing at least "a first-pass framework for both understanding and policy formation". Krugman (1998) slightly corrects his theory of balance-of-payments crises. He focuses on the two issues normally neglected in current crisis analysis: "the role of financial intermediaries" (and of moral hazard associated with such intermediaries when they are poorly regulated), and "prices of real assets such as capital and land". Later Krugman (1999) proposes another interpretation of the crisis reasons. In particular, he states that these problems cannot explain the

depth and severity of the crisis, nor the fact that it occurred in so many countries simultaneously, and instead switch his attention to financial panic and over-liberalized international and domestic financial systems. However, theoretical discussions do not still resolve the question: Was the Asian financial crisis a failure of Asian capitalism or a failure of international capitalism? But it is clear that we should consider as internal so external problems of the Asian economies. J.Sachs (October 20, 1998) raises a question about the importance of external factors in the recent Asian crisis. The author concludes that "the essence of recent emerging markets crises is that the exchange rate defence, typically ending in a devaluation, has often been followed by a rapid and ferocious withdrawal of credits by foreign investors" (p.5). The logical line can be continued by the paper of Sachs and Radelet (January 4, 1999) that provides a perfect complex analysis of the crisis' reasons. In particular, authors place a great emphasis on the aspect of creditors' panic and possibility of bad equilibriums that correspond to their behaviour. Also, this paper considers the applicability of moral hazard theory to the Asian case. A paper written by John G. Fernald and Oliver D. Babson (February, 1999) analyse the factors that allowed China to survive Asian Flu and assess the prospects of China's future development. According to authors, there were no good fundamentals that helped China to avoid financial crisis. The Chinese success is owed to factors that weaken a link between internal and external problems. Small debt to reserves ratio was another important factor that saved China and the whole region from even more severe crisis. Steven B. Kamin (June 1999) wrote the paper, which presents a complex analysis of recent financial crises in emerging markets. Author finds similarities in these episodes (Latin America in 1980s and 1994-95, and Asian in 1997) that brings some ideas about possibility to build a general model of currency crisis. Having two well-defined generations of currency crisis models, now it is time to turn to the "third generation". As was said above, in his paper Krugman (January 1999) makes a substantial addition to the third generation of the currency crisis models. In

particular, he connects the balance sheet difficulties with constraining investment by entrepreneurs, and the impact of the real exchange rate on those balance sheets. He shows "how these effects produce a feedback loop that can cause a potentially healthy economy to experience a self-fulfilling financial crisis" (p.4). Above-mentioned considerations lead us to the conclusion that, despite "third generation" of currency crisis models is not fully developed yet, we have enough information to apply theoretical models to empirical evidence.

One of the recent works that provides us with a complex approach to the currency crisis problem is one written by J. Dean (February, 2000). He wrote a paper that develops an excellent "pool" of the ideas that can be successfully applied to currency crises risk analysis. His paper discusses peculiarities of the recent Asian crises. However, the analytical framework can be applied as well to any of the crises that occurred earlier. Dean looks at the problem from two different points of view. First approach describes crises as a failure of Asian capitalism and second one considers the crises as a consequence of the market failure, that is, Western capitalism. Careful analysis provided by the author shows that in order to understand main reasons of currency crisis we should divide theory not only into three broad approaches, but also look at different mechanisms within each of generations. Only such detailed separation of causes can give us results that do not contradict to each other. The fact that in theory we still have "[n]o revelations, not even a consensus, just disparate views through a glass of darkly" (p.17) pushes us toward empirical methods to test hypotheses that sometimes may be quite controversial. My paper is in some sense makes a trial to develop a similar framework, which relies on the empirical evidence.

So far I discuss only papers that provide theoretical investigation of the currency crisis nature. Now it is important to mention some empirical studies. One of the papers in this area is written by Weber (1997). It proposes a new approach to

identifying the speculative and fundamental components of currency crises in the context of a structural vector autoregression model. The author's findings suggest that only a few countries demonstrate a speculative component as a potential source of the currency crises. Strictly speaking, only the French franc had a substantial speculative component during 1992-93 ERM crisis. The statement seems to be too strong. However, the hypothesis is testable and this paper presents one possible alternative approach.

Most economists today are concerned with the so-called contagion effect of the currency crisis. Some of them try to provide reliable theory, which can capture standard models of currency crises and be consistent with the new empirical evidence of currency crises widening. One of the related papers, which provides empirical support for the hypothesis of importance of international trade channels for currency crises (in 1971, 1973, 1992, 1994, and 1997) is Glick and Rose (1998). However, from my point of view the model suffers from selection bias problem. The authors concentrate their attention mainly on the well-known currency crises waves and do not consider mini crises that arise in different countries all over the world and do not distort the world financial system greatly. Thus, the importance of the trade contagion is overvalued. However, the contagion feature of currency crisis is obvious. But the nature of this effect is rather psychological than trade. Roughly speaking, the main reason for it may be collectively irrational behaviour of creditors and domestic agents. And this type of contagion, when appears substantial, adds a lot of problems for empirical works like this paper.

In the recent economic literature the contagion effect is often associated with collectively irrational behaviour of foreign creditors. In this sense a currency crisis arises in a fashion similar to a banking crisis. But not only triggering and enforcing mechanisms are similar. Two types of crises: balance of payment crisis

and banking crisis often correlate with each other. In this case we have so-called "Twin crisis" as it was defined by G. Kaminsky and C.Reinhart (1996). The next step toward the development of the third generation of currency crisis models and development of generalized model that could explain financial crashes is provided by the paper of G. Kaminsky (1999). In this research Dr.Kaminsky uses very sophisticated technique that allows capturing cross-country differe nces. The main idea behind this approach is in defining a single (across countries) critical interval for each macroeconomic indicator. As the indicator cross some threshold level within explicitly defined pre-crisis interval, this is considered to be a good signal of future crash. Thus, different threshold levels across countries capture country-specificity aspect like comparatively large volatility of stock market. At the same time critical region for the index is chosen in such manner, which minimizes noise-to-signal ratio, and thus has the highest possible explanatory power. This paper provides important inferences about the different indexes' potential ability to explain currency and banking crisis. However, there is a serious potential problem with such a sophisticated technique. From my point of view, it is very important to completely justify the inclusion of macroeconomic variable into the composite index. Otherwise, there might arise a spurious correlation when the value of index just coincides with currency crisis. Exogenous definition of the direction of the variable's impact also may be a problem when the effects may be controversial.

Helmut Reisen (June 1998) wrote another important article, which emphasises the sources of currency crisis. Careful analysis of the currency crisis episodes in Latin America and Asia leads author to a conclusion that crises "have hit countries with strong macroeconomic fundamentals but weak domestic financial systems" (p. 9). Reisen develops two sets of macroeconomic indexes that can be good candidates for explanatory variables. First group of indexes includes "traditional crisis indicators" and the second represents "indicators of financial

vulnerability". The former one, according to the author, has less explanatory power than the latter, when applying to the emerging markets. However, the importance of the first group becomes obvious when we look into the history of the currency crises. That is why in this paper I will use indicators from both groups.

A framework for analysing the evolution of financial sectors in economies transiting from command to market structures will be quite useful in application of currency crisis models for Ukraine. The article written by Roe, Siegelbaun and King (1998) proposes such a framework. The main idea of the paper relies heavily on the analytical approach of asymmetric information, which has proved so useful in understanding both the dangers to which financial institutions are exposed in all market-based economies and the special role of them in the development process. Transition changes the markets and institutions and it can and "does generate incentives which fundamentally distort the behaviour of economic agents in unpredictable ways.

Chapter 2

THEORY

First Generation

Let us begin with a brief description of the first generation of currency crisis models. The classical Krugman's (1979) scenario of the balance-of-payments collapse looks as following: (1) foreign reserves of the government gradually decline because of inconsistency between fundamentals and fixed exchange rate, (2) at some point a sudden speculative attack eliminates the last of the reserves, (3) government becomes unable to defend the exchange rate any more. However, there might be some variations. For instance, if there is an uncertainty about the level of reserves that government is ready to use for maintaining fixed parity, speculative attack does not necessarily erode the reserves at first time. In this case, the agents will return to initial composition of their portfolios (that is, one, which existed just before speculative attack). But the level of reserves will continue to decline through the time. Then there arises second, third, and so on speculative attacks, but finally the government becomes unable to defend exchange rate any more. Following Krugman's logic, the main incentive for agents to buy foreign currency is that the latter is expected to bring a higher yield than domestic currency (because of "perfect" anticipation of future price increase).

From the above-mentioned it follows that reserves themselves should be a very reliable explanatory variable. An overvalued exchange rate causes a change in the composition of portfolios of domestic individuals. Thus excess money balances may cause the willingness of domestic agents to exchange it for other currencies. Emerging economies' governments often experience a lack of resources for

managing the economy. Such kind of permanent budget deficit, which is financed simply by printing money, may cause domestic permanently overvaluation of domestic currency. M2 indicator describes the amount of domestic money in the economy. Growth of M2 itself is not necessarily a dangerous thing. Moreover, the growing GDP usually requires at least correspondent growth in M2. However, if increase in this aggregate becomes too big, we may observe the increase in the devaluation expectations. The willingness of the domestic agents to hold national currency is dependent on their perceptions of how strong it is. Quite often in the economic literature we can find the M2 to Reserves ratio, which is used to estimate the health of fundamentals in the economy. This ratio is also often put in the category "Capital Account Problems" (Kaminsky, 1999). It is obvious that increase in this ratio (increase in M2, fall in reserves or both) will mean that monetary authorities' power to defend fixed parity is weakened. Thus, the M2-to-reserves ratio is considered to be the key indicator for analysing currency crisis probability in terms of the first generation of currency crisis models. The second possible variable is M1, which is a narrower measure of the amount of national currency in the economy. Like M2, M1 usually grows with the economy. Usually monetary authorities allow M1 to grow at some rate per year to fight or constrain inflation. However, quite often the government uses money emission to finance public expenses or to reduce the budget deficit. In this case the rate of M1 growth significantly increases above normal rate of growth. I assume that normal rate of money growth in the economy should be backed by the reserves growth. Change in M1/Reserves ratio over time will give us a quick indicator of the direction of monetary policy. It also helps us to trace the magnitude of monetary expansion in the economy. While we have a general indicator of the fundamentals health – described as M2/Reserves ratio, M1/Reserves ratio changes measures marginal impact of additional money inflow. This variable is used as a proxy for "excess" money balances in the economy, which is defined in Kaminsky (1999) as M1 less demand for money. In

order to make the distinction between these indexes clearer I use the following definitions. M2/Reserves ratio can also be called as the measure of the government's ability to satisfy the demand for foreign exchange. M2 in the nominator is converted into the dollar terms. The ratio M1/Reserves calculated as the ratio of M1 in local currency to Reserves in dollar term. Thus it also can be called as exchange rate of domestic currency for existing foreign reserves. Positive growth in the M1/Reserves ratio means the devaluation of this exchange rate (this does not necessary means the actual devaluation!). Thus, the indicator, which measures the change in M1/Reserves rate, may be a reliable estimator of inconsistent monetary policy that eventually will lead to weakening of fundamentals.

Despite the fact that "fundamentalists" as they are defined by Krugman (January 1999) consider budget deficit as the major source of weak fundamentals I do not use this index as an explanatory variable because I try to concentrate on the fundamentals itself but not on the reasons of their weaknesses. Omission of permanent budget deficit as a measure of probability of currency crisis is not a mistake mainly because the methods that government may use to solve this problem either will be considered separately (as variables that appear in other models) or do not have direct impact on the stability of exchange rate.

It is necessary to say a couple of words about the interest rate differential and uncovered interest rate parity (IRP) condition. I do not use either interest rate differential or estimate from it expected devaluation of domestic currency. Primary reason for this is my purpose to define each generation at comparatively similar level of causality links. The IRP can be considered as higher-level instrument that already incorporates some features of low-level mechanisms. For instance, the huge amount of excess money balances will cause domestic agents to expect devaluation. This in turn leads to the change of the decomposition of

their portfolios. According to the IRP condition domestic interest rate should be increased up to the level that just equalizes the yields of foreign and domestic currency. However, there are other factors that may cause domestic agents' expectations to become negative. Some of these factors do not fall into a category of first generation of currency crisis models in a sense that they may be not classical fundamentals: self-fulfilling expectations when begin to realize also push domestic interest rate upward. In addition usage of such higher-level instrument is likely to generate multicollinearity problem. That is why I prefer to lose the degrees of freedom, but separate initial causes of crisis.

Thus, the following variables will be used to represent the first generation of currency crisis: (1) M2-to-reserves ratio, (2) Change in M1/Reserves ratio.

Second Generation

Second generation of currency crisis models perfectly fits the EMS currency crisis. Government of the country under consideration faces the trade-off between losses to defend fixed parity and losses from abandoning it. When losses in case of devaluation seem to the government less than the cost of maintaining the fixed parity the currency crisis occurs. Such situation arises in case of Great Britain when increasing interest rates becomes too expensive measure in terms of unemployment and deepening the recession. In his article, Obstfeld (1995) argues that there might be a case of "consequent worsening of employment conditional on the current parity's maintenance". Fast growing economy is not likely to suffer much from the moderate decrease in the growth. At the same time, economies that already experience a recession are more likely to abandon fixed parity. Such economies often may extract additional benefits from devaluation in terms of improvement in current account (Krugman, 1999). Thus, the most reliable

indicator for the second generation of currency crisis models is dummy variable that takes the value of 1 in case if there is a recession and 0 otherwise. There is a number of different definitions of recession. OECD defines a recession as 3 consecutive quarters at x% below previous moving average. NBER definition is simpler: fall in GDP during 3 quarters and the fourth is defined as a recession. The majority of definitions is based on the quarterly data. However, available data is presented in a yearly format only. That is why I consider a negative growth of GDP during a year as a good proxy for most of the recession definitions. Thus, recession dummy is defined according to the following rule: if the growth of GDP is negative during a year variables takes value 1, and 0 otherwise.

The second possible index that will be tasted is public debt. This index refers mostly to the government finance problems, which may influence its decision about exchange rate maintenance. The mechanism as it is described in Obstfeld (1995, p. 13) is the follows. "[M]arket expectations of devaluation drive up domestic interest rates. This may induce devaluation of domestic currency debt". Under these circumstances the highly indebted governments may "find their fiscal burden increased sharply", and abandon fixed exchange rate. To get the comparable measure of the internal government burden I will use the Claims on government to GDP ratio's deviation from mean. The index is calculated as a percentage deviation. The methodology of this index's construction can be found in the Appendix A (Data Description).

The rest of indexes that Obstfeld considers to be worth further discussion, are now associated with the third generation of currency crisis models and I discuss them below.

Thus, the following variables will be used to represent the second generation of currency crisis: (1) Recession dummy, (2) Claims on government to GDP ratio deviation from mean in percentage points.

Third Generation

Roberto Chang and Andres Velsco can be considered as parents of the third generation of currency crisis models. According to J.Sachs (October, 1998), Chang & Velasco (1998a, 1998b) give the "important theoretical treatments" of recent Asian crises. That is why I begin with the analysis of their approach and then describe the recent findings of Paul Krugman (1999). According to Chang & Velasco the international illiquidity position of a country is a necessary and sufficient condition for balance-of-payment crisis and/or financial crisis. Authors (Chang and Velasco, 1998a) use the modified version of Diamond-Dybvig model to theoretically test their hypotheses. According to them, an increase in short-term foreign debt causes the financial system of the countries to be more fragile. This is true as long as foreign reserves rise at smaller rate than the short-term debt. In this case sudden reverse in the expectation of the foreign creditors will lead to the massive withdrawals of the money from country and rejection to roll over the previous credits. This is something similar to a bank run but happens at the international level: individual behaviour of the creditors is rational, but collectively they behave irrationally. Thus the first variable that represents the third generation of currency crisis in my model is the deviation from mean of the Short-term-debt-to-reserve ratio. This variable may be also called as an international illiquidity index. An increase in this index will simply means that the country's financial system becomes more fragile and thus moves toward illiquidity position. At the same time, this index may also stand for insolvency of the country, if the total debt obligations exceed the potential capacity of the country to generate enough income to repay it. If there is a continuum between illiquidity and insolvency, it is quite difficult to define where the country is. However, the former is less strict but still sufficient condition for currency crisis, and thus the mentioned above variable seems to be a good candidate for prediction of currency crisis.

Another measure of the fragility in a financial system is the Domestic credit to GDP ratio. This measure shows how much assets of financial system are locked in the private sector. Kaminsky (1999) put this ratio into a category "Over-borrowing Cycles". Domestic banking system can achieve a quick expansion of its credits by borrowing abroad and lending at home. Quality of domestic credits directly correlates with the return on assets that domestic banking system expects to get. However, as it is often stated in recent economic literature (Krugman, 1998), Asian economies demonstrates a high ratio of non-performing loans. This worsens the domestic banks balance sheets and in turn forces banks to refuse in rolling over other (often good) loans. Thus, a vicious circle is created, which weakens domestic banking system. The logic behind this relation between domestic credit expansion and financial system fragility can be also traced using simplified version of Diamond-Dybvig model represented in Chang and Velasco (1998c). The domestic credits usually are of longer maturity than foreign borrowing by domestic banks. If there is a great necessity in quick liquidation of assets the return on the domestic credit could be small or even negative. Liquidity that financial system can access at short notice becomes less than its foreign short-term obligations. This is a classical condition of financial illiquidity but from the private sector side. Thus, domestic banking credit to GDP ratio stands for two possible problems with domestic economy that are often mentioned in the economic literature: (1) it shows the potential liquidity of the banking sector and (2) it is a good proxy for banking balance sheet problems. However, this problems will arise under certain conditions: if the sentiments of foreign investors will sharply turns negative causing costly liquidation of assets, and/or if there is a clear moral hazard problem that leads to substantial losses for banks-lenders.

According to Krugman (January, 1999), sharp reversal in the current account may signal about "massive real depreciation", which was exactly the case of Thailand. This depreciation leads to worsening the balance sheets of domestic firms, which

in turns trigger the lost of confidence. The private sector problems immediately translate into the whole financial system problems. A country that experiences a long period of real appreciation may find itself with huge CA deficit. Recession may force the government to take measures that improve CA. Such measures then fits best the Krugman's scenario. Thus real exchange rate is considered to be a good estimator of currency crisis probability in this paper and appears in levels. Problems with the data availability made impossible usage of the conventional index – real effective exchange rate (REER). Thus in this paper I use the proxy for REER, which is calculated using the following formula:

$$\text{RER} = q_{\frac{UA}{US}} = \frac{1}{IND} * \frac{CPI_{UA(1995)}}{CPI_{US(1995)}}, \text{ where } IND = \frac{E_{UAH/\$}}{E_{UAH/\$}(1995)}.$$

Data description is given in Appendix A.

As you can see an increase in this index means real appreciation in the country and decrease in this index means real depreciation for the country.

Finally, the banking sector crisis could itself be a good predictor of currency crisis as it was pointed out in Kaminsky (December, 1999). According to the technique that Kaminky uses in her paper, the noise-to-signal ratio of banking crisis as explanatory variable for currency crisis is 0.3 (the second best explanatory power after the real exchange rate index). At the same time, currency crisis shows significantly worse results when applying to explain banking crisis - the noise-to-signal ratio is above 1. This test provided by Kaminsky can be interprated as causality links between two crises. Thus, the relationship turns out to be unidirectional – from banking crisis to currency crisis, and not vice versa. The logic behind such causality links may be as follows: (1) fragile banking sector makes losses; (2) government acts as a lender of last resort to keep financial system alive; (3) foreign reserves gradually decline, and, simultaneously, central

bank experience an outflow of reserves because domestic agents try to avoid excess money on hands; (4) after reserves fall below certain level speculative attack causes the currency crisis. Usually, reserves cannot erode immediately. Thus there might be some lag between banking and balance-of-payment crisis. This explanation perfectly fit Reisen's (1999) argument about comparatively good fundamentals and weak financial systems in emerging economies. The scenario may vary a bit, but the general sense remains the same. For example, if the central bank does not act as a lender of last resort, banking system makes losses and will be in extremely bad state. Thus, it cannot perform its functions well in the nearest future. The destroyed financial system brings a lot of uncertainty and will mean that sooner or later foreign reserves will be exhausted because the amount of national currency on hands of domestic agents will increase even in case of Central Bank's rejection to act as a lender of last resort. Reasons are simple - bank runs will cause depositors to withdraw their deposits. The excess of national currency will be immediately converted into foreign exchange. Thus pooling together Reisen and Kaminsky arguments we obtain a good reason to include banking crisis as explanatory variable into the model. We also should consider different lags because of the reasons mentioned above.

Free trade is often considered to be a positive factor for economic development of country and its growth. However, there are some drawbacks in this concept. First of all the more open country is for international trade the larger impact will be on this country in case of problems with its trade partners. Some authors (Glick and Rose, 1998) argue that currency crisis in one country may lead to currency crises in other. The suggested mechanism of such a "contagion" is trade links. It is not surprisingly that the devaluation usually leads to improvement in the current account. By the same fashion the revaluation or comparative revaluation will lead to the worsening of the current account. My hypothesis is that the trade links with the "ground zero" country are neither necessary nor a

sufficient condition for currency crisis in "victim" country. Well-balanced and wise monetary and fiscal policies will almost completely eliminate the threat of such kind of contagion. The negative impact of trade contagion will be significant only in case if trade is not well diversified. Trade links with a small number of countries mean that in case of country-partner devaluation, trade balance will be significantly negatively influenced. Otherwise, the devaluation of one of the countries-partners will worsen only a small part of trade balance and the impact will not be sufficient to cause currency crisis. To test this hypothesis I introduce an additional variable "Openness to the rest of the world", which is the sum of export and import divided by GDP. If the trade factor is important for currency crisis occurrence then this ratio will be positively related to the probability of currency crisis. There might be another important indicator that could be useful – degree of trade diversification. However, the data constraints do not allow me to introduce such a variable (moreover, this is a separate question for further research). Thus, this paper is concerned with openness, as a measure of vulnerability to trade contagion, assuming that trade diversification is similar in in-sample countries. The variable does not correspond to the third generation theoretical framework, however, and is introduced as a separate factor.

Thus, the following variables will be used to represent the third generation of currency crisis: (1) Short term debt to reserve ratio deviation from mean in percentage points, (2) Domestic credit to GDP ratio, (3) Real exchange rate, (4) Banking crisis, and an additional variable – Openness to the rest of the world.

Chapter 3

TECHNICAL DETAILS

Probit Specification

Now we could summarize discussion above and move to the empirical part of my work. The table below list mentioned-above indicators as they belong to the different models. The third column shows the expected influence on the probability of currency crisis.

Table 1. Variables.

Theory	Indicator	Expected influence on the probability of currency crisis.
First Generation	M2/Rreserves ratio	+
	Changes in M1/Reserves ratio (%)	+
Second Generation	Recession dummy	+
	Claims on government to GDP ratio deviation from mean (%)	+
Third Generation	Short term debt to reserve ratio deviation from mean (%)	+
	Domestic credit to GDP ratio	+
	Real exchange rate	+
	Banking crisis	+
	Openness to the rest of the world	+

The general form of the probit specification can be written as follows:

$$I + 5 = C + \alpha FIRST\_GEN + \beta SECOND\_GEN + \gamma THIRD\_GEN + u,$$

Where:

- I is the normal equivalent deviate (n.e.d) or, simply normit
- $FIRST\_GEN$ is a vector of variables that stand for the first generation of currency crisis models, that is, "fundamentalistic" indicators
- $SECOND\_GEN$ is a vector of variables that stand for the second generation of currency crisis models, that is "self-fulfilling" indicators
- $THIRD\_GEN$ is a vector of variables that stand for the third generation of currency crisis models, that is, "fragility" indicators
- α, β, and γ are the vectors of coefficients
- u – is a vector of the stochastic disturbance terms

Data set consists from the following countries: Argentina, Bolivia, Brazil, Chile, Colombia, Indonesia, Malaysia, Mexico, Peru, Philippines, Thailand, Uruguay, and Venezuela. The time series observations represent period from 1970 till 1999. Description of data sources is presented in Appendix A.

The pool is created by stacking the data by cross-section. To estimate the regression, I use the econometrical package E-Views. Summary outputs and tests are listed as attachments to the paper (see references in the correspondent sections). The following few paragraphs briefly describe possible problems with given specification.

Problems

Before the presentation of results, it is necessary to mention one quite important assumption, which implicitly present in my model (data are stacked by cross-

section). In particular, I assume that the countries in the sample are identical in the sense that they exhibit similar variability of the key indicators. Also these countries are assumed to have similar administrative regulations (or their absence) of financial sector. The differences in the GDP, nominal exchange rates, inflations, etc. are mostly eliminated by specific construction of the explanatory variables. The assumption may be quite strong because it may seriously worsen significance of the coefficients and model explanatory power as a whole. But as you can see from the country list above, all countries refer to the groups of emerging markets or newly industrialized countries. That is why I believe that the violation from this assumption will not be significant.

A couple of things worth noting

So far I discussed the each generation's indexes as if they were the explanatory variables that belong to only one particular model. However, it is not absolutely true. Even if we leave the interrelation problem of different indexes between each other (we must be sure in this to prevent multicollinearity problem) beyond our attention, there are still some tricks in the specification that I suggest to you. The problem is in the fact that each index may stand for not only a single model, but for two or even three simultaneously. For instance, the RECESSION dummy variable means not only that the government will experience a trade off between maintaining exchange rate and economic recovery. Recession will also stand for the third generation of currency crisis models as it was defined by Krugman (January 1999): reversal of capital flow has been achieved "partly through severe recession that produces compression of imports" (p. 9).

The next drawback of the model is in fact that if government chooses to have banking system crisis rather than financial crisis then currency crises will be delayed or eliminated because of wise policy of the government during the next period. However, the significant improvement in fundamentals and reduction of

international illiquidity becomes extremely difficult during such a short period of time. And if we add current problem with weakened banking sector this task seems practically impossible.

Time scale of the data was chosen to be one year. There is no explicitly defined pre-crisis time period. Kaminsky (1999), for example, chooses an interval during 24 month before the crisis. However, I think that this period is too long that makes macroeconomic variables noisy. That is why my additional assumption is that a year interval is sufficient to get reliable values of estimators. Shorter period was not chosen mainly for the same reasons as longer one.

The last but not least feature of the model that I would like to point out is the differences between statistical significance and economic significance. Because of assumptions that were mentioned above and the very nature of the probit specification I do not expect to get a perfect explanatory power of the model. Also I foresee some problems with significance of the coefficients. That is why I will not use statistical significance (or insignificance) of coefficients as a decision rule for acceptance (rejection) of variable. Under given circumstances, I believe that a-priori expected signs and comparative significance are more important. For instance, the international illiquidity condition may be satisfied for a country during some period of time. Foreign creditors and domestic depositors sentiments do not change mainly because of imperfect information or just because of perceived good quality of the country's debt that may be formed on the basis of financial rating agencies. Government deficit may also have a little influence on the government's decision to maintain fixed parity if all other things, like expectation of future growth, are in good shape. In addition, psychological contagion effect, if appears to be quite strong, may also distort the coefficients' significance.

Chapter 4

RESULTS

The following table represents results of the generalized model of currency crisis risk analysis:

Table 1. First Specification Results.

Generation	**Variable**	**Coefficient**	**Standard error**	**P-Value**
First	M2 to reserves ratio	0.067428	0.028889	0.0196
	Change in M1/Reserves rate	0.026353	0.013485	0.0507
Second	Recession dummy	0.609663	0.255163	0.0169
	Claims on government to GDP ratio deviation from mean	0.247967	0.071058	0.0005
Third	Short term debt to reserve ratio deviation from mean	0.233980	0.105466	0.0265
	Domestic credit to GDP ratio	0.000652	0.004141	0.8748
	Real exchange rate	0.519437	0.232825	0.0257
	Banking crisis (-1)	0.979427	0.327321	0.0028
Contagion effect (trade)	Openness to the rest of the world	0.189702	0.462008	0.6814

The insignificant coefficient "Domestic credit to GDP ratio" is removed from the model. This does not make substantial changes to the rest of coefficients.

The following table represents final version of the regression estimation:

Table 2. Final Specification Results.

Generation	**Variable**	**Coefficient**	**Standard error**	**P-Value**
First	M2 to reserves ratio	0.069724	0.025947	0.0072
	Change in M1/Reserves rate	0.026362	0.013473	0.0504
Second	Recession dummy	0.617682	0.252546	0.0145
	Claims on government to GDP ratio deviation from mean	0.249027	0.070915	0.0004
Third	Short term debt to reserve ratio deviation from mean	0.234100	0.105375	0.0263
	Real exchange rate	0.513609	0.227046	0.0237
	Banking crisis (-1)	0.990028	0.322570	0.0021
Contagion effect (trade)	Openness to the rest of the world	0.241089	0.351408	0.4927

The final version of E-Views summary output (without non-significant coefficient) is represented in the Appendix F.

The general form of the estimated equation with substituted coefficients represented below (E-Views representation):

CC = 1-@CNORM(-(-2.441007346 + 0.0697241289*M2TORES + 0.02636248376*M1_RES_GR + 0.6176822674*RECESSION + 0.2490268131*CLG_GDP_DEV_M + 0.234099561*SDT_RES_DEV_M + 0.5136094546*RER + 0.9900278641*BC(-1) + 0.2410886298*OPENNESS))

As it could be easily seen from the table above, the results are quite compatible with the theory.

Interpretation

First generation variables have consistent with theory signs. M2/Reserves ratio turns out to be a good predictor of currency crisis. Second variable that represents "fundamentalists'" view also statistically significant. This means that first generation of currency crisis models could be used for explanation and prediction of currency crashes. Comparatively low statistical significance of the second variable means that the in-sample countries may have different attitudes to the administrative regulation of the currency markets. That is why the critical levels for the ratio may differ across countries and becomes less significant. The question of multicollinearity is not valid here because of the reasons mentioned in the previous section. For those who are interested in statistical tests I represent the correlation matrix in the Appendix B for all coefficients used in the model.

Second generation variables also have right signs, and recession perfectly predicts the currency crisis. But we should not neglect the question of causality. It is quite possible that the currency crisis itself causes the recession. In order to test this hypothesis I run Granger causality test for each country and found that in most cases the causality is unidirectional, that is, from recession to currency crisis, but not vice versa. Thus, the recession variable may be a good indicator of currency crisis probability. The second variable, claims on government to GDP ratio deviation from mean in percentage points, has positive and statistically significant correlation with currency crisis. In economic sense we could interpret this fact in a way that internal government debt has a positive influence on decision of the government to abandon the exchange rate.

Third generation variables also have a-priori expected signs. Banking crisis in the previous period turns out to be a good predictor of future currency crisis. The Granger causality test demonstrates a unidirectional nature of causality from banking crisis to currency crisis almost in all cases (see Appendix C). These results perfectly fit the theory (see Chapter 4). It seems reasonable that the previous banking crisis cause a lot of harm to the economy and government needs to increase the credibility of its banking sector. That is why it acts as a lender of last resort in order to prevent second banking crisis that will be, without doubt, more deep and will have negative long-term consequences for the economy. In addition, the previous banking crisis may turn the sentiments of the foreign creditors to be negative and cause the outflow of money from the economy.

The international illiquidity index short-term debt to reserves ratio deviation from mean can be considered as statistically significant and one that may play a crucial role for currency crisis occurrence. This is not surprising inference because most of the international economists consider the Asian crisis as the consequence of international illiquidity position.

Real exchange rate also may be called statistically significant. The index was calculated in such a way that increase in it means that the US goods becomes cheaper in terms of domestic goods. In other words the increase in this index means the real appreciation for domestic currency.

The next variable that comes from third generation camp is Domestic banking credit to GDP ratio. The variable is statistically insignificant. Moreover, in different specifications it changes not only the significance, but also a sign. This behaviour of index shows its non-robustness. The appropriate explanation may be given as follows. The greater is the ratios of domestic credits the more domestic banks are fragile and the greater the ratio of non-performing loans.

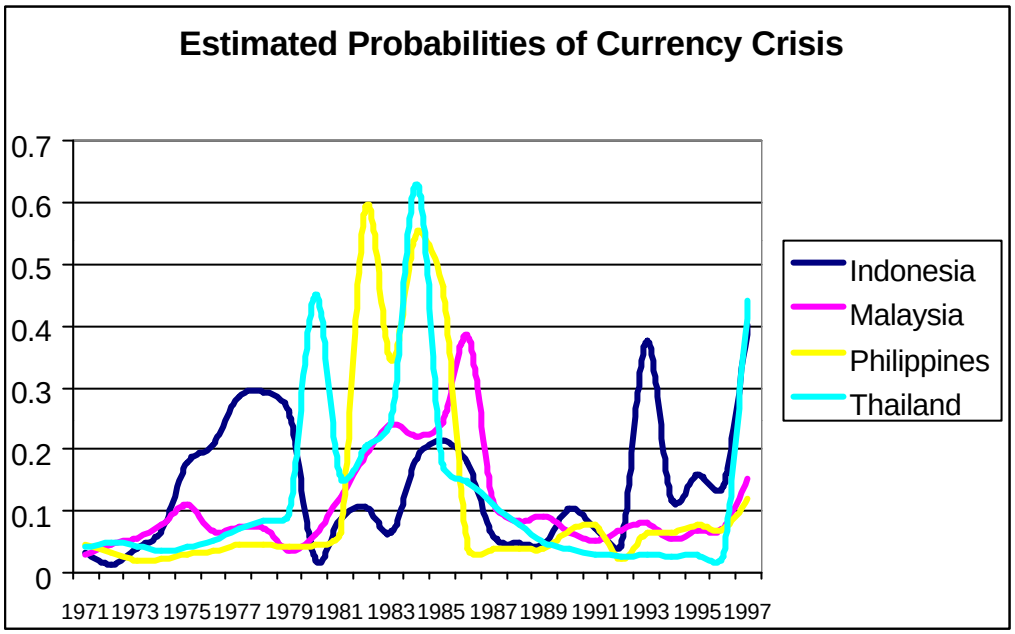
However, it is true only in case of moral hazard problem and "over-borrowing" as they are defined in McKinnon, R.I. and Pill, H. (1997 and 1998). My opinion is that the problem of moral hazard is common for all economies. The beautiful numbers and figures that describe how bad was domestic banking loans in the Asian economy may be biased because during crisis times the ratio of non-performing loans skyrocketed. Krugmans (1999) approach also sheds light on these problems in terms of domestic entrepreneurs burden imposed by change in real exchange rate. If the credits are sound, however, this ratio may even show the increase in the performance of economic system as a whole. In the absence of serious moral hazard problem, and, if creditors and depositors sentiments are good, this ratio may demonstrate negative correlation with currency crisis probability (as it were in earlier specifications, when developed countries were included into sample). For the current specification there is a positive sign before this variable. But the variable itself is completely insignificant (p-value = 0.84!) and cannot be taken as into attention. Without doubts continuous discussions in the economic literature about the moral hazard as a potential reason for currency crisis give us the reason to consider this question as ambiguous. In any case the usage of this index may cause serious problems because it is not clear what impact this variable has on the currency crisis probability.

The last variable that was introduced to test the hypothesis of trade contagion shows the positive relation to the currency crisis probability as it appears in theory. However, this coefficient cannot be considered as statistically significant. That is why we could accept the above-mentioned statement that trade links with countries in trouble (or openness to the rest of the world) are neither necessary nor a sufficient condition for currency crisis. However, this condition may add to the probability of the currency crisis, if the other macroeconomic indexes are not in a good shape or if the trade is not well diversified.

In-Sample Prediction Test

In order to show the applicability of the model to the real world below I represent the case of the recent Asian crisis. The application to the out-of-sample country will be studied in Chapter 7 below.

Figure 1. In-Sample Prediction Test



Country	Dates of Currency Crises				
Indonesia	1978	1983	1986	1997	
Malaysia	1975	1997			
Philippines	1970	1983	1984	1986	1997
Thailand	1978	1981	1984	1997	

The scenario of the Asian crisis was as follows: Thailand currency baht devalue first in July 1997, within days speculators attacked Malaysia, the Philippines, and Indonesia; Hong Kong and Korea were attacked somewhat later on. As it can be easily seen from the figure, the model predicts perfectly the so-called "ground-

zero" country – Thailand. Also it is obvious that the estimated probability rises during pre-crisis time in all countries, especially in Indonesia. The fact that all these countries experience crises may be explained by psychological contagion that arises on the fertile ground of increasing vulnerability in these countries. Thus the test for applicability to in-sample countries can be considered as satisfactorily passed.

For those who are interested in general test of the model for prediction power Appendix E to this paper includes a figure, which represents the expectation-prediction table as a test of the model. The success cutoff is chosen to be 0.5. The reason for this is quite simple. When the probability becomes greater than 0.5 to exchange the domestic currency for foreign one becomes strictly dominant strategy for domestic agents assuming the transaction cost very low and amount of potential loss (gain) great, that is, the incentive becomes greater for wealthy persons. The table, however, shows great Type I error made by the model, that is, rejection of hypothesis about crisis when in fact there is a crisis. This drawback follows from the specific features of the second and third generation of currency crisis models. Presence of the self-fulfilling features in both cases reduces the accuracy of prediction. Some possible remedies are mentioned in the conclusion section of the paper.

So far we discuss model in terms of its applicability to the Asian economy and to the in-sample countries in general. Now it is time to test it on the country that has somewhere different conditions and a specific feature – transition economy. Thus the following section represents this kind of test on a particular example of country in transition - Ukraine.

Chapter 5

UKRAINE

Specifics

As stated earlier econometric estimation was based on the sample that includes a specific type of countries: newly industrialized countries or emerging economies. However, I argue that the model can be useful for analysis economies in transition as well. In order to develop appropriate methodology we should first discuss the aspects in which transition economy is different from conventional economy.

The most important distinction is administrative regulation. If there is a continuum between laissez-faire economy and over-regulated planned economy then economies in transition are closer to the second. A classical example of regulatory measures can be punishment (in the form of abrogation of license for foreign currency operations) of commercial banks for speculation against national currency in crisis times. In other words, central bank simply prohibits buying foreign currency during some time periods. Under this condition currency crisis may not occur. However, over-regulation imposed on currency market may push domestic currency far from what is called freely convertible currency. In addition administrative regulation has limits. It is impossible to stop fully exchange of national currency for foreign one. The greater the distortions on the domestic markets, the greater potential benefits from exchange, and as a consequence – the greater the incentives for rent-seeking activity and corruption. Also, too much regulation may impose a burden on domestic financial institutions that are under control. And when the distortions in the domestic market become too great,

regulatory measures fail to protect currency from devaluation. We could see such episodes in Ukraine several times. Similar difficulties experience China when it becomes prohibitively expensive to control outflow of foreign reserves through free-market arrears.

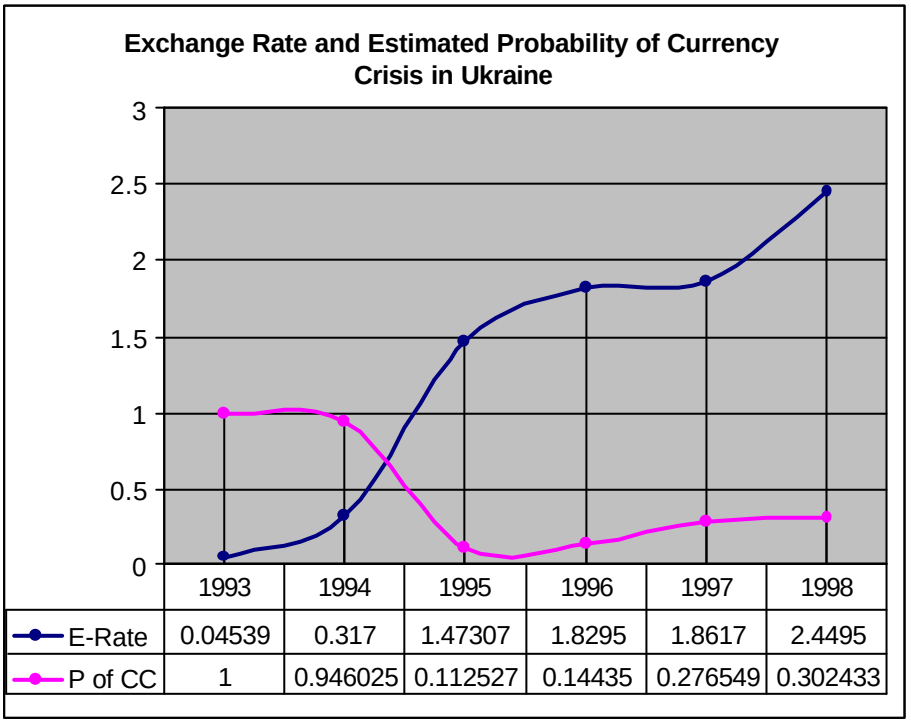
Inclusion of the countries in transition into the sample will mean that the coefficients of the model will be distorted by the regulatory measures in these countries. In a couple with periods of hyperinflation it will be extremely difficult to distinguish between market factors that influence domestic currency exchange rate and factors dependent on exogenous government decision. That is why I propose the following approach when applying my model to economies in transition. The model built in the previous chapter describes objective factors that may influence sustainability of the exchange rate. Countries in the sample have little administrative regulation and usually intervene into foreign exchange market using conventional, that is, market mechanisms, like open market operations. That is why model shows how market forces actually interact in the economy. When the government experiences a lack of resources to defend fixed parity it may use non-market mechanism. Such behaviour is quite rare for economies in the sample, but may be called usual for Ukraine. However, as long as Ukraine wishes to have a freely convertible currency, market mechanisms are present in Ukrainian economy as well. When such objective factors push probability of currency crisis up, this creates an increasing pressure on administrative barriers. This could be easily seen from the graph below. Really, when the probability is quite high the exchange rate moves upward at increasing rate. The greater is the probability of currency crisis – the greater is the correspondent pressure. In early years of its independence Ukraine experiences trade-off, when it was less costly to devalue than to continue regulation.

The next feature of transition economy is great volatility of the markets. However, similar volatility can be observed in the emerging economies. In order to test the model on a practical example of the country that is not in-sample one we will estimate the time-path of the probability of currency crisis in Ukraine.

Results

The following figure represents the official exchange rate of Ukrainian hryvna for US dollar and probability of currency crisis for the correspondent period.

Figure 2. Out-of-Sample Prediction Test.



	1993	1994	1995	1996	1997	1998
E-Rate	0.04539	0.317	1.47307	1.8295	1.8617	2.4495
P of CC	1	0.946025	0.112527	0.14435	0.276549	0.302433

It is quite interesting fact that during 1995 – 1996 period the probability of currency crisis in Ukraine was low according to the "objective" market factors. This can be explained in terms of stabilization package measures, the most

important of which was an adjusted horizontal bands system for the national currency. As you can see from the graph during the time when probability of crisis was high exchange rate rises at increasing rate. As the probability decreases the rate of devaluation also falls. The lag after, which devaluation responds to fall in probability of crisis can be explained by the following factors:

1. *Inertia* – expectations of inflation often demonstrate similar phenomenon
2. *Imperfect information* – there should be some time when the market participants will obtain necessary information
3. *Technical problems* – information used for the analysis is not continuous, that is figure may not describe the change in trend properly.

Another very important issue is the bi-directional links between currency crisis probability and rate of devaluation. As it is perfectly noted in Krugman (1999), country can choose to devalue a little to avoid a serious currency crisis. Such a devaluation will improve current account, and increase the ability of government to protect fixed exchange parity in the future through influencing key economic variables. It is clear that the losses from a huge currency crisis are incompatible with losses from small devaluation. Thus it is obvious from the picture the devaluation itself causes the probability of currency crisis to fall.

Next problem is with the definition of currency crisis itself for Ukrainian case. The definition of currency crisis as a violation from fixed exchange rate during some period of time (several weeks or months) that is free float of exchange rate cannot be applied to Ukrainian case. This is mainly because of the type of exchange rate management. The adjusted bend allows devaluing currency by small amount when adjusting a new corridor for the next period. Usually such adjustment takes place only in extreme cases when the maintenance of fixed exchange rate is impossible. Thus, when the government experience the great need in devaluation of its currency, it can announce the new corridor at any time. Such exchange rate management leads to a continuous devaluation of national

currency. The rate of this devaluation does not perfectly correspond to the market condition because of government resistance. Following this logic the application of the generalised model can be useful in a sense of defining the speed (rate) of devaluation and the time when it should take place.

Very interesting in this context is the period of 1997-1998. As you can see from the picture, in 1997 year the probability of currency crisis doubles in comparison with previous year. However, there were not correspondent adjustments in the exchange rate corridor. Next year the probability of currency crisis grows even further and this leads to the large devaluation. From the said above, it is clear that when the government avoid small devaluation when it was necessary this cause a severe crisis next period. In other words, when the probability of currency crisis was not reduced in proper time by small devaluation, as it was done before, it causes greater losses for Ukraine in the next period. It is also clear that if the government would have tried to continue fixing exchange rate at the same level the probability skyrocketed next period and the future crisis would be inevitable. This logic perfectly fits Krugman's (1999) arguments while he applies them to Hong Kong in 1997.

The results of the model application cannot be called perfect mainly because the time series data set on the country under consideration is short. Data constraints did not allow me to test the model on other out-of-sample countries yet. That is why the question about real world application remains to be an open question and will be highlighted in further research.

CONCLUSIONS

The major inference of this paper is that the generalized approach to currency crisis risk analysis is possible. The estimated model represents the simplest way of pooling together all generations of currency crisis models. Despite the fact that model has some drawbacks and is based on quite strong assumptions, obtained results are consistent with theory and can be applied to the first-glance analysis of the economy's performance. Another important inference of the paper is the fact that at least such kind of analysis should be applied to the different economic indicators that are possible candidates to explain the crisis phenomena. Variables that pass this first stage of economic significance then could be used in more sophisticated models to explain or predict the currency crisis. In particular, the hypothesis of moral hazard and usage of domestic banks credit to GDP ratio variable, as an explanatory in some papers seems at least not careful. The doubtful features of trade contagion require further study and cannot be used in pure form to estimate the currency crisis probability.

It is worth to point out some features that correspond to the specific nature of the theoretical approaches. First generation variables can be used in levels or other suitable forms when the model's instruments capture the cross-countries differences. There are no great potential problems with their significance or explanatory power, when specification is chosen correctly. Second generation variables are more problematic. The very idea of self-fulfilling crisis introduces difficulties with the testing of the hypothesis. In fact the regime fails if attacked but can survive indefinitely otherwise. One possible solution may be construction of a composite index that from one hand shows the fraction of two loss functions (one in case of abandoning exchange peg, another in case of defending

it). From the other hand index takes only a fraction of its actual value dependent on some exogenous variable. For instance the following index may be a good candidate for the second generation: $\left(\frac{L^{fixed}}{L^{flexible}}\right) * \frac{1}{\text{Political Stability}}$, where the Political Stability variable measures the sentiments of agents to their government. Third generation variables are also problematic. In some sense the nature of the problem is similar to one of "self-fulfilling" variables. In this case possible solution may be an introduction of the index that include stability in the world, for instance the number of financial crashes in correspondent year or the degree of perceived similarity between countries some of which already in trouble.

Nevertheless, even rough estimation technique shows clear relationships between chosen variables and probability of currency crisis. That is why it is now a question about more appropriate pool of all generation into a single model.

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APPENDIX A
Data Description

The Indicators

Sources: International Financial Statistics (IFS), World Development Indicators (WDI), Ukrainian Economic Trends Quarterly Issue.

1. Currency Crises and Banking Crisis episodes: Data obtained from Dr. Graciela Kaminsky. Incomplete version (without recent Asian currency crises) can be found in Kaminsky (December 1999).

2. M2 to Reserve ratio: WDI CD-ROM.

3. M1 to Reserve ratio: M1 and Reserves (Excluding gold) drawn from WDI CD-ROM. Growth of this ratio is calculated as future value less previous value divided by previous value.

4. Recession Dummy: Calculated on the Basis of GDP growth, which is drawn from WDI CD-ROM. Variable takes value of 1, when the growth is negative and zero otherwise.

5. Claims on Government to GDP ratio deviation from mean: The ratio calculated as claims on government in local currency units (WDI) divided by GDP (WDI) in local currency units. Then the mean for the whole period is calculated. The deviation from mean appears in percentage points.

6. Short Term Debt to Reserves ratio deviation from mean: Short Term Debt variable (in $) and Reserves (in $, excluding gold) variable are drawn from WDI CD-ROM.

7. RER (Real Exchange Rate): Calculated using formula $\text{RER} = q_{\frac{UA}{US}} = \frac{1}{IND} * \frac{CPI_{UA(1995)}}{CPI_{US(1995)}}$, where $IND = \frac{E_{UAH/\$}}{E_{UAH/\$}(1995)}$. Exchange Rate and CPI values are drawn from WDI CD-ROM.

8. Openness: Variable calculated as (EXPORT + IMPORT) / GDP. All indexes are taken from WDI and represented in local currency units.

Data on Ukraine (Short-term Foreign Debt to Reserve ratio and Claims on Government to GDP ratio): Are drawn from Ukrainian Economic Trends Quarterly Issue in electronic form.

Short-term foreign debt to Reserve ratio: Data is taken from on-line Joint BIS-IMF-OECD-World Bank statistics "External Debt" (Short-term foreign debt and Reserves indexes).

Claims on Government to GDP ratio: Data is taken from IFS CD-ROM (GDP and Claims on Government Indexes).

APPENDIX B

Coefficients' Correlation Matrix

	M2TORES	M1_RES_GR	RECESSION	CLG_GDP_DEV_M	SDT_RES_DEV_M	RER	BC(-1)	OPENNESS
M2TORES	1.000000	0.108356	0.147866	0.156410	0.435738	0.108627	0.018003	-0.258349
M1_RES_GR	0.108356	1.000000	0.268200	0.064339	0.200311	-0.070094	-0.014314	-0.128547
RECESSION	0.147866	0.268200	1.000000	0.090537	0.299360	-0.056284	0.169802	-0.152052
CLG_GDP_DEV_M	0.156410	0.064339	0.090537	1.000000	0.078332	-0.142521	0.069975	-0.037902
SDT_RES_DEV_M	0.435738	0.200311	0.299360	0.078332	1.000000	0.073003	0.057276	-0.051280
RER	0.108627	-0.070094	-0.056284	-0.142521	0.073003	1.000000	-0.052584	0.044693
BC(-1)	0.018003	-0.014314	0.169802	0.069975	0.057276	-0.052584	1.000000	-0.058024
OPENNESS	-0.258349	-0.128547	-0.152052	-0.037902	-0.051280	0.044693	-0.058024	1.000000

APPENDIX C

Granger Causality Test for Banking Crisis – Financial Crisis

Pairwise Granger Causality Tests
Date: 05/14/00 Time: 22:06
Sample: 1 390
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
BC does not Granger Cause CC (Reject)	338	10.9495	2.5E-05
CC does not Granger Cause BC (Cannot Reject)		0.48793	0.61434

APPENDIX D

Summary Output (First Specification)

Dependent Variable: CC
Method: ML - Binary Probit
Sample(adjusted): 2 388
Included observations: 331

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-2.440645	0.372991	-6.543448	0.0000
M2TORES	0.067428	0.028889	2.334023	0.0196
M1_RES_GR	0.026353	0.013485	1.954223	0.0507
RECESSION	0.609663	0.255163	2.389311	0.0169
CLG_GDP_DEV_M	0.247967	0.071058	3.489667	0.0005
SDT_RES_DEV_M	0.233980	0.105466	2.218535	0.0265
D_B_CR_GDP	0.000652	0.004141	0.157537	0.8748
RER	0.519437	0.232825	2.231022	0.0257
BC(-1)	0.979427	0.327321	2.992250	0.0028
OPENNESS	0.189702	0.462008	0.410604	0.6814

Mean dependent var	0.148036	S.D. dependent var	0.355674
S.E. of regression	0.304007	Akaike info criterion	0.660045
Sum squared resid	29.66680	Schwarz criterion	0.774912
Log likelihood	-99.23741	Hannan-Quinn criter.	0.705859
Restr. log likelihood	-138.7842	Avg. log likelihood	-0.299811
LR statistic (9 df)	79.09357	McFadden R-squared	0.284952
Probability(LR stat)	2.45E-13		

APPENDIX E

Expectation-Prediction Table

Dependent Variable: CC
Method: ML - Binary Probit
Date: 05/14/00 Time: 22:14
Sample(adjusted): 2 388
Included observations: 333
Excluded observations: 54 after adjusting endpoints
Prediction Evaluation (success cutoff C = 0.5)

	Estimated Equation			Constant Probability		
	Dep=0	Dep=1	Total	Dep=0	Dep=1	Total
P(Dep=1)<= C	279	34	313	284	49	333
P(Dep=1)>C	5	15	20	0	0	0
Total	284	49	333	284	49	333
Correct	279	15	294	284	0	284
% Correct	98.24	30.61	88.29	100.00	0.00	85.29
% Incorrect	1.76	69.39	11.71	0.00	100.00	14.71
Total Gain*	-1.76	30.61	3.00			
Percent Gain**	NA	30.61	20.41			

Expectation-Prediction Table (Continuation)

	Estimated Equation			Constant Probability		
	Dep=0	Dep=1	Total	Dep=0	Dep=1	Total
E(# of Dep=0)	254.54	29.41	283.95	242.21	41.79	284.00
E(# of Dep=1)	29.46	19.59	49.05	41.79	7.21	49.00
Total	284.00	49.00	333.00	284.00	49.00	333.00
Correct	254.54	19.59	274.13	242.21	7.21	249.42
% Correct	89.63	39.98	82.32	85.29	14.71	74.90
% Incorrect	10.37	60.02	17.68	14.71	85.29	25.10
Total Gain*	4.34	25.27	7.42			
Percent Gain**	29.50	29.62	29.56			

*Change in "% Correct" from default (constant probability) specification
**Percent of incorrect (default) prediction corrected by equation

APPENDIX F

Final Summary Output

Dependent Variable: CC
Method: ML - Binary Probit
Sample(adjusted): 2 388
Included observations: 333

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-2.441007	0.368671	-6.621097	0.0000
M2TORES	0.069724	0.025947	2.687144	0.0072
M1_RES_GR	0.026362	0.013473	1.956725	0.0504
RECESSION	0.617682	0.252546	2.445817	0.0145
CLG_GDP_DEV_M	0.249027	0.070915	3.511638	0.0004
SDT_RES_DEV_M	0.234100	0.105375	2.221578	0.0263
RER	0.513609	0.227046	2.262139	0.0237
BC(-1)	0.990028	0.322570	3.069188	0.0021
OPENNESS	0.241089	0.351408	0.686064	0.4927

Mean dependent var	0.147147	S.D. dependent var	0.354786
S.E. of regression	0.302502	Akaike info criterion	0.650544
Sum squared resid	29.64849	Schwarz criterion	0.753467
Log likelihood	-99.31556	Hannan-Quinn criter.	0.691585
Restr. log likelihood	-139.1036	Avg. log likelihood	-0.298245
LR statistic (8 df)	79.57603	McFadden R-squared	0.286032
Probability(LR stat)	5.95E-14		