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Diagnostics of Financial Crisis: analysis, methods, models

CONTENTS

INTRODUCTION

The world financial crisis of 2007-2009 commenced with adverse dynamics of key macroeconomic indicators in transition economies as well as the developed ones, including developing economies. However, the impact of global crisis is not homogeneous on different countries.

Particularly, among the countries that were most affected by the crisis are those that alongside with drastic decrease in foreign investments inflow, life standards aggravation and social production decline suffered dramatic national currency depreciation. These countries are primarily countries of Southern America, Baltic States, African countries as well as some European states. The most illustrative and unexpected example is served by Iceland, with its national currency having lost half its value in the course of the crisis (judging by the Nominal Effective Exchange Rate Index).

At the same time, other countries, such as France, managed to maintain their financial system sustainability, although the global crisis aftermath is evident in their decreased GDP and increased prices.

The study of monetary policy in the respective countries alongside with the analysis of financial and economic premise of their relatively high financial sustainability constitutes a potential source of deeper insight into the essence of current crisis and post-crisis phenomena and, respectively, the basis for development and substantiation study of a more perfect and universal system of prevention and counteraction against permanent economic stagnation.

Apart from the above, it should be mentioned that the current financial crisis has caused unprecedented need to reconsider topical approaches toward risk evaluation and management on the macroeconomics level as well as microeconomics one. Therein an optimal insurance of national economy against abrupt drying up of foreign capital inflow and other crisis aftermaths, which can be achieved through implementation of gold and foreign currency reserves management and control over public debt dynamics, is becoming an urgent issue.

Thus, the urgency of this research can be described by the following:

- comprehensive comparative analysis of dynamics of key macroeconomic indicators for a wide range of countries before crisis, in crisis and after crisis with the view to detect premise that increase vulnerability of a country's financial system amidst global financial instability;

- systematization of experience of macroeconomic regulation in different countries in accordance with the level and nature of their involvement in global crisis;

- stating parameters that determine management of gold and foreign currency reserves and public debt in such a way as to take into account probability of crisis emergence (e.g. the risk of unexpected suspension of foreign investments inflow, etc.).

Correspondingly, **the aim of the research** is to analyze international practice of monetary regulation aimed at retaining stability of national currency, deduction of general regularities of crisis approximation prerequisites and calculation of gold and foreign currency reserves optimal level for Ukrainian financial system subject to crisis emergence probability.

In order to achieve the aforementioned aim, the following main tasks should be expounded:

- to carry out a thorough research on macro-financial plight within sampling of 10 countries most affected and 10 countries least affected by the crises basing on the system of representative macroeconomic data.;

- to single out and analyze key characteristics indicating approximation an and aggravation of crises and leading to a substantial depreciation of national currencies of the selected countries;

- to group the countries according to nature of economic processes in pre-crisis, crisis and post-crisis periods;

- to determine timetables of crisis course in every country of the selected ones on the basis of crisis indicators, including the Foreign Exchange Market Pressure Index;

- to figure out the gold and foreign currency reserves optimal level for Ukraine subject to crisis emergence probability.

The methods of the research are methods of Economics and Economic Analysis, Probability theory and Mathstatistics, Econometrics methods and models, in particular probability models, vector- autoregressive models and etc.

The findings of the research can be used to analzye and substantiate exchange rate policy, to improve prediction-analytical methods, used for long-term calculations of macroeconomic data and currency-exchange-rate politics indicators..

PART 1. COMPERATIVE ANALYSIS OF MACROECONOMIC DATA DYNAMICS IN PRE-CRISIS, CRISIS (2007-2009) AND POST-CRISIS (2010) PERIODS

1.1 General tendencies of world financial crisis 2007-2009 and the peculiarities of the early stage diagnostics of world's financial crisis tendencies' development

The global financial crisis of 2007-2009 is considered the most vigorous financial crisis since the Great Depression. The years 2001-2006 provided most favorable conditions for the development of one of the biggest speculative "bubbles'' in the history of humanity, the burst of which gave way to the global crisis. The thick of the events was the real-estate market in the USA, which due to unprecedented availability of lending was growing at a very high rate in the course of years 2001-2006. The inflow of foreign capital to the USA from Asian countries with actively developing markets and the OPEC-countries combined with low interest rates in the USA within years 2002-2004 created prerequisites for "bubbles" emergence on real-estate markets and credit markets, thus promoting debt financing of consumption. Thus, the number of households with a personal house increased from 64% in 1994 to 69,2% (the highest level) in 2004 [5]. The practice of subprime loans promoted the increase in the homeowners' quota, which in turn bulled housing prices. In the course of 1980-2001 average price of an American house exceeded annual average household income in 2,9 times, and in 2006 this ratio climbed to 4,6. The boost in prices fostered considerable speculations of the owners with mortgages. With the cost of housing rising, the owners used to refund their houses at lower rates or receive consumer credits collateralized by the increase in housing price exceeding that of a mortgage value. As the result, households were saving less and consuming more at the expense of credits extension. The USA households debt grew from 705 billion dollars in 1974, amounting to 60% of the then annual household income to 14,5 trillion dollars in the middle of 2008, otherwise 134% of the available income. The

gross increase in households' consumption resulting from value added of the housing since 2001 till 2005 is estimated at 5 trillion dollars. [21].

The increase in credits volume and in prices on real estate market caused the boom on development market. With interest rates having increased in 2006, credits availability decreased and a huge surplus of unplaced houses emerged. As a result, housing prices reached their high in the second six months of 2006 and headed downward. Credit availability in the previous years and confidence in the further increase in housing prices has motivated many borrowers to take out mortgage credits at adjustable rate ("adjustable-rate mortgages"). Such mortgage credits enabled borrowers to pay low interest within the determined period of time, which was succeeded by a period of higher interest. Such mortgage credits were usually taken out by low-income families and as a result, 80% of mortgage credits classified as subprime were "adjustable-rate mortgages" [12]. Borrowers that could not afford to pay higher interest, when the grace period ran out, tried to refund their mortgage credits. When housing prices began to decrease and the interest began to increase, the refunding became practically impossible and a lot of borrowers were forced to declare bankruptcy. Borrowers' houses passed into ownership of the banks who put them up for sale, as the result housing prices were plummeting and more and more borrowers were refusing to pay interest. The decrease in mortgage interest payments also wrote down the value of "mortgage-backed securities", thus aggravating financial plight of banks. This cycle was self-energizing process and was in the thick of crisis on real-estate market in the USA. From mid 2006 till September of 2008 the housing market prices plummeted by more than 20%. As a result houses of approximately 12 million borrowers cost less than mortgage on them by the end of 2008. Such owners had a direct financial interest in giving up mortgages and transferring the house into bank's ownership, which an owner is entitled to according to the USA legislation. In the wake of mass bankruptcies a surplus of 4 million unplaced houses emerged on the market thus bringing prices down, undermining creditworthiness of borrowers and aggravating balance sheet statements of financial institutions [2].

Many factors fostered growth of this “bubble”, among them are the following: gradual reduction in interest rates by Federal Reserve System within years 2000-2003, which created more favorable crediting conditions for general public and opened access to credit resources for commercial banks; financial market deregulation, invoking the emergence of the so called “shadow banking system”, excessive leverage of the commercial banks [30]; financial innovation on mortgage market manifested itself in practice of adjustable-rate mortgages, high-risk mortgages to borrowers with low creditworthiness (“subprime” class), overall crediting standards decrease; substantial owners’ gambling on increasing housing prices which provoked further big price rises; growing of practice of securitization, usage of mortgage-backed securities, the value of which was based on borrowers’ interest payments; overstatement of MBS’s credit ratings by rating agencies and etc [7].

A particular emphasis should be made on **development of securitization and “shadow banking system”**, without which the crisis in the USA would not have acquired its present scope and would have been unlikely to grow into global financial crisis. During the boom, the amount of transactions with mortgage-backed securities on real estate and credit markets was growing rapidly. The mortgage-backed security is a bond entitling its holder to receive interest payments from mortgages. Whereas traditional mortgage scheme involved a bank that granted a credit to the borrower and assumed risk of a default on it, popularization of securitization has changed this scheme. Banks used to issue mortgages to general public and then to sell these mortgages to investment banks and other financial intermediaries, which used to pack them in pulls and issue securities backed by cash flows from mortgages, packed in this pull. Thus, substantial part of credit risk was transferred to investors buying these securities, and it enabled banks to renovate their financial resources and give out more credits. Firstly, it spawned a problem of malpractice, since banks had incentives to issue more loans but didn’t have enough incentives to guarantee their high quality. Secondly, it was development of securitization that enabled investors from all over the world to invest in the USA real estate market. As a result of the above, the overall volume of mortgage-backed securities almost tripled since 1996 to 2007 and amounted to 7,3 trillion dollars. The percentage of mortgages of subprime class, that

had been securitized, grew from 54% in 2001 to 75% in 2006. American households and corporations owned approximately 25 trillion dollars in debts as of 2008. American banks held approximately 8 trillion dollars from this sum on their balance sheets as traditional mortgages. The owners of bonds amounted to another 7 trillion. The remaining 10 trillion were provided by securitization markets. [10].

This development of securitization was, in turn, induced by "shadow banking system", that flourished in the USA since 2001 till 2008 and its role in issuing loans was not less than that of traditional banks. The "shadow banking system" does not accept loans from general public and thus it is not an object of standard supervision over banking system. Prominent representatives of the "shadow banking system" are hedge-funds, investment banks, money market funds, structured investment vehicles and special purpose entities. All these institutions of "shadow banking system" virtually performed functions of banks, such as borrowing funds on money markets of short-term capital and investing them in long-term assets, as well as mortgage credits and mortgage-backed securities. At the same time, these financial institutions didn't meet the requirements to become an object of supervision over bank capital adequacy, and thus afforded to sustain higher levels of financial leverage. In the course of years preceding the crisis, four largest commercial banks of the USA transferred about 5,2 trillion dollars of their assets and liabilities value into special purpose entities and other institutions of "shadow financial system". It enabled them to evade capital adequacy requirements of those times and increase leverage and profit during the boom, and at the same time increase losses during the bust. Total amount of capital of the "shadow banking system" equaled approximately 10 trillion dollars of capital of the USA banking system at the beginning of 2007. Assets of five largest investment banks amounted to 4 trillion dollars and the amount of assets funded through repurchase operations on the open market equaled 2,5 trillion dollars. So, investment banks depended directly on money market conditions, since they were made to constantly refinance their liabilities. This circumstance together with high leverage undoubtedly made the system vulnerable to abrupt shocks on credit market [18].

Apart from the above, in the course of years 1998-2008, **Credit Default Swaps** market, derivatives markets used to protect owners of bonds against default risk were growing at high pace. Deregulation of this market and the possibility to conclude transactions irrespective of the fact of ownership of basic assets invoked increased speculations. Actually, credit default swaps enabled gamblers to bet on the very same securities more than once, as long as sellers or buyers of these contracts could be found. This all provoked excessive growth of credit default swaps market, the size of which increased 100 times in the course of years 1998-2008. According to different estimates, as of November 2008, the amount of liabilities, insured by credit default swaps equaled from 33 to 47 trillion US dollars. [24].

Since February 2007, in the wake of increasing defaults on mortgage credits, securities prices began to sink, the price of mortgage-backed securities also sagged – the crisis was spreading from local real estate market in the USA to financial market and to global one. Banks were resorting to mass write-offs of securities backed by mortgages, mass shutdowns and acquisitions of financial companies servicing mortgage market were taking place. The crisis caused panic on financial markets in 2007 and urged investors to take funds out of risky mortgage-backed securities and invest them in world raw materials markets. Gambling on futures on raw materials markets invoked rise in world prices on agricultural products and oil.

As of August 2008 року, financial institutions throughout the world incurred losses of 501 billion US dollars resulting from write-offs of mortgage-backed securities' value by banks. These losses undermined world banking system lending capacity. This effect was felt particularly adversely by banks in countries, which had introduced the "Basel" system of banking system regulation, since they were made to abide by the rules of maximal leverage level and therefore to cut down the number of loans issued to businesses and households. [18].

When Lehman Brothers and other prominent financial institutions of the USA went bankrupt in September 2008 року, the crisis reached its critical stage – mutual money market funds followed in the fate of banks. Withdrawal of capital from money

markets of the USA amounted to 144,5 billion dollars within one week compared to 7,1 billion dollars the week before. [23].

Such drastic outflow of funds from money markets can be explained by the inability of investors to make reasonable judgment of the situation. On the one hand, dispensing of risks through securitization made it difficult to estimate the cost of mortgage-backed securities adequately basing on real estate market default data. On the other hand, lack of public data on amount of such securities on balance sheets of "shadow banking system" made it practically impossible to estimate risks of every particular financial institution. Joseph Stiglitz summed up the role of credit default swaps in unfolding of systemic crises: "With such intricate system of rates of substantial value no-one could be certain in financial plight of any one else or even his or her own financial plight. No wonder, credit markets virtually froze" [43].

The Nobel Prize winner Paul Krugman and the Secretary of the US Treasury Timothy Geithner consider this winding down of the "shadow banking system" a key to understanding of financial crisis. Not having the possibility to receive short-term financing, investment banks and other institutions of "shadow banking system" were not able to grant financing to corporations and firms, issuing mortgages. Thus, more than one third of credit mechanism was unavailable to serve as resource of financing, which undermined propensity of corporations to refinance their short-term liabilities. According to Brookings Institution data, as of June 2009 the traditional banking system lacked necessary capital to compensate for this shortage in crediting. Money market freeze, which was key source of credits for banks and non-financial corporations, threatened to cause collapse of global financial system. [30, 18].

Responses from Federal Reserve System, the European Central Bank and other central banks did not take long to appear. In the last quarter of 2008 central banks bought out 2,5 trillion dollars of government bonds and toxic assets of banks. This was the biggest injection of liquidity in credit markets in the history of humanity. Governments of European States and the USA also increased capital of national banking systems by 1,5 trillion dollars through buy-out of newly issued preference shares of systemic banks.

However, the crisis swiftly transformed into global financial and economic ones, resulting in bankruptcies of many European banks, stock exchange indices slump, dramatic decrease in market price of shares and prices of raw materials. Rapid spread of the crisis was fostered by the fact that investment banks and institutional investors throughout the world kept considerable amount of mortgage-backed securities. Moreover, a widespread use of credit default swaps enhanced bonds among international financial institutions. Thus, bank losses led to deleveraging process and aggravation of credit terms for real economy, which kept escalating solvency crisis and foreign trade decline. According to the IMF estimates, big banks in the USA and Europe incurred losses of more than 1 trillion US dollars due to bad assets write-offs since the beginning of 2007 until September 2009. Total losses may amount to 4 trillions US dollars, according to the IMF forecasts. [25].

Stock markets' collapse had grave consequences on world financial system. Since the beginning of 2008 until October 2008 shareholders of US corporations sustained losses of approximately 8 trillion US dollars, with 40% of these losses being sustained by foreign investors. [47]. Resulting from stock and real estate markets' collapse the total welfare of US households decreased by 14 trillion US dollars in comparison to its peak value in the second quarter of 2007. In the wake of landslide of prices for real estate, another source of increase in total consumption of US households dwindled, whereas its pre-crisis input amounted to 5 trillion US dollars, namely it is use of real estate value increase to finance consumption expenditures. According to Brookings Institution, consumtion growth in the USA amounted to more than one third of world consumption growth in the course of years 2000-2007 pp. This consumption was primarily financed through the inflow of capitals from Asian countries and the OPEC countries, which were transformed into consumption and mortgage credits for general public by banking system. The rest of the world virtually depended on the USA as the prime source of world demand. With the beginning of recession in the USA and increase in savings' quota, the GDP growth rates' decrease was well felt in other countries as well. In the first quarter of 2009, the GDP decreased by 14,4% in Germany, 15,2% in Japan, 7,4% in Great Britain and 9,8% in Euro zone (annual estimate).

Heavy economic losses were incurred by developing countries. In the course of years 2003-2007 pp., these countries experienced economic boom: the GDP growth rate amounted on average to 7% per annum. Among four factors prerequisite to such growth were the following: accessibility of capital, high prices on raw materials and considerable flows of transfer payments. The first two factors coincided in 1970s, however the simultaneous influence of the three factors had taken place for the first time. The fourth factor, substantially influencing international trade and prices for raw materials, was an economic growth of Asian economies and, in particular, China. These conditions changed with the beginning of crisis in the middle of 2007. However, prices on raw materials kept climbing for a year after the crises had begun. This factor together with high levels of international reserves caused influx of capital to countries with developing markets even after the crisis on the US stock market had broken off. [22].

Crisis in developing countries was triggered by U-turn of positive tendencies taking place within the boom period, namely drastic increase of transfer payments, capital influx and trade enhancement.

Slowdown of transfer increase rates was taking place in 2007, primarily in Latin American and East European countries as the result of real estate market freeze in the USA and Europe. Although absolute slump of transfers was quite rare, its growth rate had slowed down dramatically.

One of the key channels of crisis transfer from developed countries to the developing ones was the channel of capital flows. Negative effects manifested themselves in the volumes of these flows as well as in the cost of capital.

As far as volume of capital flows is concerned, it had reached its peak since 2006 until 2007. After certain slowdown in the third quarter of 2007, in consequence of the crisis on the US equity market, it recovered in 2008 but then plummeted again since the third quarter of 2008 and turned out to be negative for some countries.

As far as financing cost is concerned, even though spreads of developing countries' bonds had grown since the middle of 2007, this effect was considerably smoothed over by interest rates decrease in developed countries and as the result, financing cost had not increased substantially. Only since June 2008, financing cost

had started to increase and virtually exploded in mid September 2008, in consequence of financial crisis unfolding.

Such dynamics of capital flows volume and their cost was the key mechanism of crisis transfer from equity markets in developed economies to those in developing ones. This channel of transfer of global financial crisis was more significant for countries with developing markets than for low-income countries, since the first ones were quite deeply integrated in international capital markets. Transition economies of Central and Eastern Europe were most badly affected by the crisis, since combination of negative expectations resulting from substantial current accounts deficits and their financial systems' vulnerability lead to immediate outflow of capital. U-turn of portfolio investments in East and South Asia was also drastic and in some cases rather unexpected. In particular, according to the Institute of International Finance, investors withdrew 45 billion dollars from South Korea only in 2008. Such countries as India and Taiwan also faced portfolio investments withdrawal. Major problems in Latin America, Brazil and Mexico were caused by the halt of "carry-trade" hedge strategy, which is investment of excessive liquidity of currency with low interest rates in assets in currencies of countries with higher profitability [16].

From the point of view of categories of capital flows, the most negative factors for developing countries was gap between issuing of bonds in the end of 2008 and considerable decrease in volume of interbank crediting. Both phenomena were a part of overall decrease in world crediting volume. According to the estimates of the Institute of International Finance, the volume of bank crediting at the developing markets decreased from its peak value of 410 billion dollars in 2007 down to 176 billion dollars in 2008 [42].

Another source of problems was high level of payments for repays of credits and bonds of private borrowers in developing countries, which according to the estimates amounted to 250 billion dollars in 2009. Some countries, in particular South Korea, Russia and Ukraine, substantially increased amounts of short-term debts in 2007-2008; difficulty in refinancing of these debts posed a serious problem for their economies [22].

Another category of problem capital flows is flows from non-bank sources, such as mutual funds and hedge funds. Withdrawal of capital from mutual funds in developed countries and the halt of "carry-trade" strategy since July 2008 resulted in closure of currency positions in profitable assets of developing countries and transition into developed countries' currencies. This phenomenon caused depreciation pressure on developing countries' exchange rates, even in the countries where current accounts surplus was quite substantial.

Another key channel of crisis transfer from developed countries to developing ones was the trade. In the course of years 2003-2006 international trade was growing at an average rate of 9,3% per annum, which was two times higher than world GDP growth rate (3,8%). It should be noted that trade growth rates substantially correlate with world GDP growth rates, thus being virtually pro-cyclical – that is why booms as well as recessions are enhanced. The growth rate of trading volume had decreased since the middle of 2007 року to 2% in September 2008 року. As early as at the end of 2008, the slump in international trading volume measured in absolute indeces took place. This slump in trading volume most significantly affected exporters of industrial products and services, whereas the most significant factor for raw materials' exporters was landslide of prices.

Within recent years, international economy experienced the strongest raw materials prices boom in the last century, which was the strongest in duration, intensity and goods range [20]. The boom was more explicit for raw materials , including oil and other energy carriers, than for agricultural goods [38]. The boom was caused by underfunding of these branches in previous period owing to low prices, rapid economic growth of developing countries, as well as huge demand of China for metals. There occurred the deficit on raw materials market during the boom, even though investments in the respective production increased substantially, the time lag between investments and actual increase in supply existed. Increase in demand for biofuel on agricultural markets was key mechanism of transmission of high prices for energy carriers to agricultural products prices, particularly in the second six month of 2007 and first six month of 2008, which was the last phase of the boom on agricultural products [22]. Prices rise on raw materials and agricultural

products in 2007-2008, according to some estimates, as well as substantial speculative component – investors withdrawing funds from the US mortgage markets invested them in more then attractive raw materials markets. [4].

U-turn of the trend began in June 2008 for the majority of raw materials and in August for energy carriers, i.e. immediately before financial collapse of September 2008. However, further global crediting freeze caused drastic landslide of prices for raw materials.

Thus, the U-turn of positive tendencies existing during the boom in developing countries lead to crisis, particularly in foreign debt and exchange rate spheres. [32].

Analysis of financial crises and attempts at prediction is dedicated enough theoretical and empirical research. If the theoretical works dealt with the crisis within the construction of formal mathematical models to explain their origin, in practical research, the focus is on search and validation of such indices and indicators that would enable to define and predict the financial crisis.

It should be noted that there is no unambiguous definition of financial crisis. Moreover, even the definition of specific time frames that can be called financial crisis is a daunting task. The classical definition of the financial crisis associated with problematic events in the banking sector. In this classical sense, the crisis in the markets of assets that do not threaten the banking system are not considered financial crises [46]. However, most modern scholars and experts interpret the notion of financial crises more broadly [36]. In particular, the classification of financial crises from the perspective of empirical research considers three basic types of financial crises: banking crisis, currency crisis and the crisis in financial markets (including public finance crisis) [73].

Banking crisis characterized by massive withdrawal of deposits, leading to closure, nationalization or takeover of one or more banks. The signs of bank crisis also consider the closure, merger, nationalization, or massive state aid system-bank or group of banks, which initiates a series of similar events for other banks.

A significant number of researchers believe signs of bank crisis onset cases of public crisis management in the banking sector, including recapitalizing banks, the

moratorium on withdrawal of deposits, for the general public deposit or bank holidays announcement [9].

Thus, the banking crisis manifests itself as a situation in which problems arising from banks, leading to considerable reduction of capital of the banking system, increasing the ratio of problem assets to total assets of the banking system.

Currency crisis or balance of payments crisis manifests itself as a situation where the result of speculative attacks on currency, there is a sharp depreciation of the exchange rate, or massive central bank intervention to prevent it, leading to a drastic reduction of its international currency reserves. An alternative answer to the national bank in this situation may be raising interest rates. Thus, the value determined exchange rate depreciation, which can be considered an indicator of the currency crisis does not exist [3, 15, 35, 13, 27].

Crises in financial markets is the increasing volatility of prices for financial assets or fall, due to the change investors' expectations. The crisis of public finances and public debt shows a certain critical level of debt, cases of sovereign default or debt restructuring agreements with [11].

The important fact is that usually these types of crises occur simultaneously, so when the crisis offered by most scientists understand a set of problems in the financial system, which seriously affect economic activity [73].

The main indicators that determine the traits of economic systems of the world economies is the subject of extensive scientific discussions and their analysis, identification and substantiation devoted a significant amount of theoretical and empirical research.

In theoretical research focuses on modeling of currency crises. It is possible to identify two main conceptual approaches: the traditional approach, based on the assumption that the crisis caused by negative dynamics of basic macroeconomic indicators, and alternative approaches, including those in which the presumed possibility crises samozdiysnyuyutsya and self-support.

And systematic research work initiated currency crises P. Krugman, in which it was formulated the hypothesis that the main cause of currency crises is economic policy, namely the incompatibility of policies to support a fixed exchange rate and

incentive (fiscal or monetary) economic policy (monetary expansion) [29]. The author had constructed an economic model in which a fixed exchange rate of domestic credit expansion leads to a reduction in international reserves and, consequently, to speculative attacks on currencies. The attack instantly depletes reserves and forces the government abandon a fixed exchange rate policy. Calculations based on the proposed model show that the period before the currency crisis characterized by a gradual decrease in international reserves and the rapid growth of domestic credit relative to demand. Additionally, given that excessive money creation may result from the necessity of funding public sector budgetary imbalances (deficit) and public sector credit could also be considered indicators of approaching crisis.

Subsequent research expanded the basic model of Krugman in different directions. For example, it was found that speculative attacks generally should precede the actual strengthening currency and a worsening trade balance. These results were obtained with models in which expansionary fiscal and credit policies lead to higher demand for goods export and import group (which causes a deterioration in the trade balance) and goods which are not included in it (which triggers an increase in relative prices of these goods and hence the real appreciation of currencies).

Similar results were obtained with models in which expectations of future crisis led to an increase in nominal wages, which, in the presence of stiff price increases and real wages, but reduces competitiveness.

In addition, calculations based on models in which the ambiguity was taken into account credit policy or loss reserves amount to which the National Bank agrees to support the policy indicate that domestic interest rates should increase with increasing probability approaching crisis.

Thus, analysis models discussed above leads to the conclusion that the real exchange rate, trade or current account balance, real wages and domestic interest rates could be considered as leading indicators of crisis.

Note that under the traditional approach, the gradual reduction of international reserves is the main reason for the fall of the fixed exchange rate.

However, some scholars who base their conclusions on payments for management models, believe that the decision to abandon support for the exchange rate may go on concern the central bank (CB) of the negative dynamics of key economic variables. So these economic variables can be useful in predicting currency crises.

For example, Ozkinym and Sutherland, was developed and evaluated a model in which the central bank's objective function positively dependent on the benefits arising from the support of fixed exchange rate (such as enhancing the credibility of the central bank to reduce inflation) and negatively dependent on deviations from a GDP target level. In a fixed rate of growth of international interest rates leads to higher interest rates domestically, reducing the level of GDP, making the more costly for the Central Bank to maintain parity. When international interest rate exceeds a certain critical level, loss of retention rate exceed the benefits from it, forcing the central bank to refuse to support it. According to calculations by the above model, GDP growth and domestic and foreign interest rates may be considered a useful indicator of currency crisis.

Overall, the approach is suggested by the authors in [39] empirically confirms that the factors that may affect the goal function of the central bank can also be used as indicators ahead of the currency crisis. For example, rising domestic interest rates, which is essential to maintain the fixed exchange rate may increase the cost of debt financing for the government. Thus, depending on how much weight the government gives a negative fiscal impact of fixed exchange rate policy, the decision to cease support of parity may depend on the state debt. Also, higher interest rates could weaken the banking system and the government may prefer to depreciation than the costs for maintenance and recapitalization of banks. Thus, the presence of banking problems (reflected in the relative prices of bank shares, the percentage of non-performing loans, central bank credit to commercial banks or a significant reduction in deposits) also may indicate an increased likelihood of crisis. In addition, leading indicators can be considered and political variables.

Western scholars have recently been developed other than traditional approaches based on application of modern mathematical tools and shows that crises may develop without any noticeable changes in economic fundamentals [37]. In

particular, it was found that the unpredictable nature of economic policy may cause several simultaneously possible market equilibria and the generation of crises that come true as a result of the interaction of expectations.

This result is based on the assumption that economic policy is not determined in advance, and responds to changes in the economy and take into account that economic agents forming their expectations. At the same time, expectations of economic agents and affect the certain parameters, which influence economic policy. This cycle creates the possibility of multiple equilibria and the economy can move from one equilibrium to another with no significant change of the values of fundamental parameters. Thus, the economy may be in first position, with possible support for a fixed rate, but the sharp decline in expectations can lead to changes in economic policy, which as a result will lead to a collapse of fixed exchange rate, thus confirming expectations of economic agents. The main conclusion from the analysis of such models is that the problem of finding the close link between fundamental variables and crises can be quite difficult, and sometimes crises can occur without significant changes in economic fundamentals [37].

Recently, the rapid development of mathematical approaches, which consider the effects of infection as the main causes of crises, including balance of payments crises. For example, Zherlahom Smettsom and proposed a model in which it was shown as a currency depreciation in one country leads to the depreciation of currencies of its trading partners who seek to avoid loss of competitiveness [19]. The effects of infection can also occur if investors are paying enough attention to the analysis of fundamental behavior of key macroeconomic indicators of countries and thus are not easily distinguish the riskiness of investments in different countries. If the present effects of infection, the crisis in one country can be an indicator of future crisis in the neighboring country partners.

Thus, the analysis of different theoretical approaches to the possible emergence and development of financial crises (including balance of payments crises), to identify a list of possible indicators that determine the traits of the world economy, namely: 1) reduction of international reserves, 2) credit growth and public private sector (monetary expansion), 3) budget deficit (fiscal expansion), 4) the real

appreciation of the currency; 5) deterioration in the trade or current account balance, 6) increasing domestic interest rates, 7) fall in GDP, or deviation from trend; 8) growth in foreign interest rate, 9) amount of total debt, 10) for problems in the banking sector, 10) political variables.

Note that the problem of determining indicators of economic and financial crises has been a great number of not only theoretical, but empirical research, in particular, examined and approaches to early warning of financial crises. Considerable interest in models of early diagnosis of financial crises was caused by their distribution in 1990, especially in countries in transition. This fact has led to widespread discussion on the subject in economic literature.

Detailed review of empirical research on early diagnosis and prevention of financial crises are in the work of Kaminsky and Reinhardt [27]. In particular, the work the parameters used in the analysis of currency crises in 25 empirical studies covering the period from 1950 to mid 1990's, covering both the developed and developing countries. Most studies consider once a significant number of countries and crises, and few focus on specific crises.

Despite the fact that the studies are significantly different both from the methodological point of view, and considered a list of crises, the authors reached a number of general conclusions.

Firstly, the country's vulnerability to crisis is characterized by a significant number of changes in economic indicators, both internal and external related to this country.

Second, the authors chose indicators that showed the best results in studies that were statistically significant in probit-lohit regressions or behavior in which most episodes peredkryzovi significantly different from the control periods, or those who gave the most correct and least number of false signals before the crisis (in the methodology of signal approach ").

As a result, the most effective performance prediction of the crisis were: international reserves, real exchange rate, domestic credit growth, government loans, domestic inflation. Just as effective indicators are: trade balance, exports, money

supply growth, the ratio of M2 to international reserves, real GDP growth and scope of the budget deficit.

Third, the indicators relating to external debt were not effective in predicting currency crises. Also, contrary to expectations, the current account balance was not very effective indicator of financial crises. The authors explain this by saying that the information contained in the current account is somehow reflected in the dynamics of real exchange rate.

Empirical studies of banking crises were also conducted on a similar logic. So in the work of Kaminsky and Reinhardt [28] the "twin crises", namely the simultaneous currency and banking crises. Kaminsky and Reinhart fifteen describe the dynamics of macroeconomic indicators for 24 months before and after crises and compared it with the dynamics in quiet periods. Results relating to currency crises, in general, confirmed previous research. With regard to banking crises, the authors reached the following conclusions:

- crisis precedes the growth of money supply and interest rates (both loans and deposits), which indicates a high level of demand for money and credit resources;
- among the balance of payments indicators peredkryzovi periods in the growth of exports relative to trend down, and the real exchange rate increases;
- real GDP growth declining trend relative to about 8 months before the crisis and stock market index peaks at about the same time.

These findings confirm that the banking crisis often precedes the downward phase of the cycle. The most effective parameters in the above study found: the growth of the real exchange rate, stock market index and the money multiplier and the real interest rate.

Kunta Detrahiashe and made a detailed analysis of literature devoted to the construction of indicators, predictors of banking crises, which complement our own calculations [8].

The authors obtained the following main results:

• low GDP growth, high inflation and high real interest rates are strongly correlated with banking crises. Thus, crises tend to occur during periods of weak economic growth and lack of monetary control;

• Real interest rates and international interest rate is a source of risk to the stability of the banking system;

• ratio of money supply to international reserves, which shows the vulnerability to speculative attacks, are statistically significant in most models constructed, which proves that the vulnerability to currency crises increases the risks for the banking system;

• high growth in loans, and significant amounts of lending to the private sector increase the probability of a banking crisis. Thus, countries where the banking sector has a significant amount of loans to the private sector more vulnerable as a result of uncontrolled liberalization;

• high ratio of loans to deposits of the banking system and high ratio of total external debt to deposits is the risk of banking system stability;

• interest rates on loans and deposits, as well as growth spread between rates on loans and deposits may indicate a growing probability of occurrence of banking crises;

• With regard to institutional variables, the low GDP per capita and the availability of deposit insurance increase the likelihood of a banking crisis in the country;

• changes in trade and exchange rate depreciation • changes in trade and exchange rate depreciation does not significantly affect the probability of banking crisis.

Thus, after analysis of empirical studies of currency and banking crises can generate a list of possible indicators that define the crisis tendencies in the world economy:

1. Reduced or low level of international reserves.
2. Raising the real exchange rate.
3. Rapid growth and significant amounts of domestic credit.
4. Credit expansion of government.

5. High inflation.

6. The worsening trade balance.

7. Reduced exports.

8. Broad money growth.

9. The growth of the money multiplier.

10. Increasing the ratio of M2 to international reserves.

11. Reduced growth rate of real GDP.

12. A significant budget deficit.

13. Growth of real interest rates on loans and on deposits.

14. Growth spread between rates on loans and on deposits.

15. Falling stock index.

16. Growing international interest rate.

17. High ratio of loans to deposits of the banking system.

18. High ratio of total external debt to deposits of the banking system.

Thus, empirical studies confirm and extend the list of indicators arising from the theoretical models of crises. Based on detailed analysis of both theoretical and empirical research, can be identified for further detailed analysis of such indicators, grouped by sector:

• Real sector:

1. The fall in GDP, or deviation from trend.

2. Falling stock index.

• Debt burden:

1. Total external debt.

2. Total public external debt.

• Balance of payments:

1. The trade balance.

2. Current account balance.

3. Dynamics of international reserves.

4. Terms of trade.

5. Dynamics of imports.

6. Export dynamics.

7. The real exchange rate.

• International variables:

1. International interest rate.

2. The ratio of domestic and foreign interest rates.

• Financial liberalization:

1. Domestic credit.

2. The growth of the money multiplier.

3. Real interest rate on loans and deposits.

4. Spread between rates on loans and on deposits or their relationship.

5. The ratio of loans to deposits of the banking system.

• Other financial variables:

1. The consumer price index.

2. Broad money growth.

3. Increasing the ratio of M2 to the level of international reserves.

4. High ratio of total external debt to deposits of the banking system.

• Fiscal performance:

1. A significant budget deficit.

2. The growth of public sector lending.

Note that in practice, not all indicators can be used in the analysis of financial system stability, because the statistics for some of them may be unavailable. It should be noted that these indicators to achieve comparability of data should be considered in certain transformations, such as growth rate, the rate of growth compared with the trend, or normalized to a baseline (GDP, M1, M2 or the level of imports, etc.). Table 1.1. summarized the main indicators, which offer seen as leading indicators of occurrence of the crisis state of the economy.

Table 1.1 Leading indexes onset of economic crisis

Indices	Transformation	Formula	Behavior before crisis	Source	Explanation
Real sector					
GDP	**Increment rate, %**	$\left(\frac{GDP_t - GDP_{t-1}}{GDP_{t-1}}\right) * 100\%$	**Decrease**	**IFS**	Slowdown of the economy worsens the capacity of national lenders to pay its obligations, credit risk increases.
Stock Market Index	**Increment rate, %**	$\left(\frac{SPI_t - SPI_{t-1}}{SPI_{t-1}}\right) * 100\%$	**Decrease**	**IFS**	Reducing the stock market index may indicate outflow of foreign speculative capital from the market of a developing country, due to increasing risks.
Debt Load					
Joint external debt	**Attribution to GDP, %**	$\left(\frac{GEDP_t}{GDP_t}\right) * 100\%$	**Increase, high level**	**JEDH, IFS**	Significant amounts of foreign debt increases the vulnerability of the economy to rising global interest rates and a possible deterioration in access to global capital
Joint internal debt	**Attribution to Export, %**	$\left(\frac{GEDP_t}{EXPORT_t}\right) * 100\%$	**Increase, high level**	**JEDH, IFS**	Significant amounts of foreign debt increases the vulnerability of the economy to rising global interest rates and a possible deterioration in access to global capital
Joint external government debt	**Attribution to GDP, %**	$\left(\frac{FD\_GG_t}{GDP_t}\right) * 100\%$	**Increase, high level**	**JEDH, IFS**	Significant amounts of public debt impose certain costs on the fiscal budget, complicating the balance.
External debt	**Attribution to GDP, %**	$\left(\frac{FD\_DC\_ST_t + FD\_DC\_FC_t}{GDP_t}\right) * 100\%$	**Increase, high level**	**JEDH, IFS**	

Debt servicing	**Attribution to GDP, %**	$\left(\frac{FD\_GG_t}{GDP_t}\right)*100\%$	**Increase, high level**	**JEDH, IFS**	
Balance of payments					
Balance of payments	**Attribution to GDP, %**	$\left(\frac{BOP\_TR\_BAL_t}{GDP_t}\right)*100\%$	**Decrease, negative quantity**	**IFS**	The negative trade balance is decreasing competitiveness of exporters or falling global demand. Somehow, this leads to a drop in the volume of foreign exchange earnings of exporters and pressure for currency depreciation to the side, as well as the deteriorating financial situation of exporters.
Current account balance	**Attribution to GDP, %**	$\left(\frac{BOP\_CURACC_t}{GDP_t}\right)*100\%$	**Decrease, negative quantity**	**IFS**	Significant current account deficit may signal a reduction of liquidity of the financial system increase the probability of currency crisis. The growth of currency risks in turn may cause the outflow of short-term investments.
International reserves	**Attribution to Export, %**	$\left(\frac{INTERN\_RESERVES_t}{EXPORT_t}\right)*100\%$	**Decrease, low level**	**IFS**	The gradual reduction of international reserves could indicate pressures on the currency downward. Low level of international reserves, the central bank not long maintain a fixed exchange rate in adverse situations.
International reserves	**Attribution to Import, %**	$\left(\frac{INTERN\_RESERVES_t}{IMPORT_t}\right)*100\%$	**Decrease, low level**	**IFS**	The gradual reduction of international reserves could indicate pressures on the currency downward. Low level of international reserves, the central bank not long maintain a fixed exchange rate in adverse situations.
International reserves	**Attribution to GDP, %**	$\left(\frac{INTERN\_RESERVES_t}{GDP_t}\right)*100\%$	**Decrease, low level**	**IFS**	The gradual reduction of international reserves could indicate pressures on the currency downward. Low level of international reserves, the central bank not long maintain a fixed

					exchange rate in adverse situations.
Commercial Terms	**The ratio of export unit price for the unit price of imports, %**	$\left(\frac{EXPORT\_UNIT\_PRICES_t}{IMPORT\_UNIT\_PRICES_t}\right)*100\%$	**Deterioration**	**IFS**	Significant deterioration of terms of trade leads to difficulties in the financial sector. Most sensitive to changes in world demand is a small economy with a high dependence on exports of raw materials.
Import	**Increment rate, %**	$\left(\frac{IMPORT_t - IMPORT_{t-1}}{IMPORT_{t-1}}\right)*100\%$	**Increase, high level**	**IFS**	Import growth, especially if it occurs simultaneously with increasing inflow of funds on the capital account and credit liberalization often precedes the currency crisis.
Export	**Increment rate, %**	$\left(\frac{EXPORT_t - EXPORT_{t-1}}{EXPORT_{t-1}}\right)*100\%$	**Decrease**	**IFS**	Reduction of export competitiveness due to deterioration or decline in world demand may indicate a decrease of competitiveness of exporters or falling global demand. Somehow, this leads to a drop in the volume of foreign exchange earnings of exporters and pressure for currency depreciation to the side, as well as the deteriorating financial situation of exporters.
Real effective exchange rate	**Increment rate, %**	$\left(\frac{REER_t - REER_{t-1}}{REER_{t-1}}\right)*100\%$	**Increase**	**IFS**	REER growth leads to lower competitiveness of domestic producers, may lead to slower economic growth.
Nominal effective exchange rate	**Increment rate, %**	$\left(\frac{NEER_t - NEER_{t-1}}{NEER_{t-1}}\right)*100\%$	**Increase**	**IFS**	NEER growth leads to lower competitiveness of domestic producers, may lead to slower economic growth.
International variables					
International interest rate	**Rate, %**	$LIBOR$	**Increase**	**LIBOR**	Rising world interest rates increases the vulnerability of national financial systems, as is capital flight from emerging markets to developed markets, deteriorating creditworthiness of

					borrowers in emerging markets (for loans in foreign currency).
Real internal and external rate (lending and deposit)	**Rate, interest rate**	$\frac{LIBOR - LENDRATE}{LIBOR - DEPRATE}$	**Increase**	**LIBOR, IFS**	Differential between foreign and domestic interest rates showing the relative attractiveness of investment in assets of the country. With the growth of this indicator for a possible outflow of capital account.
Finance liberalization					
Internal lending	**Increment rate, %**	$\left(\frac{LOANS_t - LOANS_{t-1}}{LOANS_{t-1}}\right) * 100\%$	**Increase**	**IFS**	Financial crisis often precedes the expansion of domestic credit, including by increasing the share of more risky loans.
Money multiplier	**Rate**	$\frac{M2_t}{MBASE_t}$	**Increase**	**IFS**	Significant growth multiplier can be an indicator of the weakening of the selection procedures of borrowers by banks.
Real lending rate	**Rate, %**	$\frac{1+LENDRATE_t}{1+GDP\_DEFL_t} - 1$	**Increase**	**IFS**	Growth of real interest rate increases instability of the banking system, will boost the share of lenders that are unable to refinance or repay loans.
Real deposit rate	**Rate, %**	$\frac{1+DEPRATE_t}{1+GDP\_DEFL_t} - 1$	**Increase**	**IFS**	Growth of real interest rate increases instability of the banking system, will boost the share of lenders that are unable to refinance or repay loans.
Lending rate and deposit rate	**Rate, interest rate**	$\left(\frac{1+LENDRATE_t}{1+GDP\_DEFL_t} - 1\right) - \left(\frac{1+DEPRATE_t}{1+GDP\_DEFL_t} - 1\right)$	**Increase**	**IFS**	In many cases, before the currency crises are increasing the gap between rates on loans and on deposits. This is because, often before the crisis is the expansion of domestic credit. In this situation, an increasing proportion of unreliable lenders and banks raise rates on loans, trying to offset the risks. Rates on deposits are growing so fast.

The size of loans to deposits of the banking system	**Rate, %**	$\left(\frac{LOANS_t}{DEPOSITS_t}\right)*100\%$	**Increase**	**IFS**	Ratio of accumulated credits to deposits characterizes the ability of the banking system to obtain financial resources that are necessary to meet the demand for loans. A high rate may indicate potential problems with bank liquidity.
Other financial variables					
Consumer price index (CPI)	**Increment rate, %**	$\left(\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}\right)*100\%$	**Increase**	**IFS**	Accelerating inflation complicates the assessment of credit risks and increase uncertainty in the economy.
Money supply	**Increment rate, %**	$\left(\frac{BRMONEY_t - BRMONEY_{t-1}}{BRMONEY_{t-1}}\right)*100\%$	**Increase**	**IFS**	The rapid growth of money supply under fixed exchange rate can lead to speculative attacks on currencies in the direction девальвації.
The ratio of M2 to international reserves	**Rate, %**	$\left(\frac{M2_t}{INTERN\_RESERVES_t}\right)*100\%$	**Increase**	**IFS**	Growth (may be an indicator of the credit boom or too soft monetary policy and low level of reserves).
The ratio of liabilities to deposits of the banking system	**Rate, %**	$\left(\frac{BANK\_LIAB_t}{DEPOSITS_t}\right)*100\%$	**Increase**	**JEDH, IFS**	Growth (may be an indicator too high inflow of debt capital as opposed to banks on deposits).
Fiscal indices					
Fiscal deficit	**Attribution to GDP, %**		**Increase, high level**	**IFS**	Significant budget deficits under fixed exchange rate leads to increased speculative pressure on the currency depreciation in its side and forced to spend central bank gold reserves.
Government lending	**Attribution to GDP, %**		**Increase, high level**	**IFS**	Lending to the central bank the government is "hidden" emissions.

where JEDH - Joint External Debt Hub ; IFS – International Financial Statistics .

1.2. Determination of the period that takes an economy to get in the crisis and grouping economies by the level of crisis on the basis of index of currency market pressure

It is necessary to analyze the existing statistical information and its quality in order to make the final selection of indexes and countries which will be used for further analysis of the preconditions of sharp exchange rate depreciation and determining periods of the crisis state occurrence for the countries. The total number of indexes that have been preliminarily selected for detailed analysis is 71 (see paragraph 1.2), and the total number of countries is 239.

The output has been stored in a table with each row consisting of following data attrubutes: specific country code, variable full name, designation of the variable (for the purposes of further research), source database name and its corresponding indexes. To avoid variable scaling issues, all variables except those measured in units (such as exchange rate or price of gold), percentages and percentage points, were converted to millions of corresponding units.

Hence, the output data array is three-dimensional with country, index and time period attributes. The analysis covers quarterly data for the period from the 1st quarter of 2002 to the 2nd quarter of 2010.

Since equally-meaning variables in the database may have different names for different countries, all the variables required for the calculation of selected indexes have been additionally encoded for convenience with a unified (intermediate) system of variable names. Table 1.2. presents the decoding for the introduced unified system of (intermediate) variable names.

Table 1.2. Additional (intermediate) variable (index) unified coding system

№	Variable (index) name	Variable description	№	Variable (index) name	Variable description

1	CPI_CHNG	% change in CPI over the previous period	37	FD_GG	External debt: the government
2	EXPORT	Exports, FOB, mln. U.S.	38	FD_GG_ST	Short-term external debt: the government
3	EXPORT_UNT_PRICES	Export unit price, USD . U.S.	39	FD_MA	External debt: central bank
4	GDP_DEFL_CHNG	% change GDP deflator, to the previous quarter	40	FD_MA_ST	Short-term external debt: central bank
5	GDP_VOL_CHNG	GDP% change over previous quarter	41	FD_OS	External debt: other sectors
6	GOLD_OUNC	Gold, U.S.. ounces	42	FD_OS_ST	Short-term external debt: other sectors
7	IMPORT	Imports, C.I.F., mln. U.S.	43	GDP_DEFL_2005	GDP deflator,% (2005 = 100%)
8	IMPORT_UNT_PRICES	Unit price of imports, USD U.S.	44	GDP_VOL_2000	The volume of real GDP,% (2000 = 100%)
9	INTERN_RESERVES	International reserves, (SDR)	45	GEDP	Gross external debt position
10	RMG	International reserves minus gold, (SDR)	46	GFCF	Gross fixed capital formation
11	BOP_CURACC	Current account balance, errors are not incl.	47	M3	M3
12	BOP_GS	Balance of goods and services	48	NGDP	Nominal GDP
13	BOP_GSI	Balance of goods and services and incomes	49	NEER	NEER
14	BOP_TR_BAL	Trade balance	50	REER	REER based on the relative purchasing power parity Capacity
15	BRMONEY	Monetary aggregate of money in the broad sense - BROAD MONEY	51	GDP_VOL_2005	The volume of real GDP,% (2005 = 100%)
16	DEP_EXCL	Deposits not included in BROAD MONEY	52	GNDI	Gross national income at the disposal
17	DEP_OTH	Other deposits included in BROAD MONEY	53	GNI	Gross national income
18	DEP_TRANS	Transferable deposits, are not included in BROAD MONEY	54	SPI	Index of stock market
19	ER	Official / national market exchange rate. monetary unit to the USD	55	BIS_GOLD_HOLD	Pure gold reserves, BIS data
20	GVT_CLAIMS	Claims on Government, mln of monetary units	56	GOLD_IMF	Gold reserves, IMF data
21	LENDRATE	crediting rate	57	WIG20	WIG-20 – period average
22	LOANS	The volume of loans	58	WIG20EP	WIG-20 – end of period
23	M2	M2	59	MICEX	MICEX 9/22/97 = 100
24	MBASE	Monetary base	60	FTSE100	FTSE 100
25	BOP_CAPACC	Capital account balance, errors are not incl.	61	GOLD_LOND	The price of gold, London
26	CONS_GOV	Governmental consumption	62	GOLD_SDR_OUNC	Gold, SDR price(London)
27	CONS_H	Private consumption	63	AMEX	AMEX, period average
28	DEPRATE	Deposit rate	64	NASDAQ	NASDAQ COMPOSITE
29	FD_CB	External debt: commercial banks	65	SP_IND	S&P INDUSTRIALS
30	FD_CB_ST	Short-term external debt: commercial banks	66	USD_SDR	US DOLLARS PER SDR, end of period
31	FD_DC	External debt denominated in local currency	67	GOLD_MARKET	Gold at market price
32	FD_DC_LT	Long-term external debt denominated in local currency	68	GOLD_SDR	Gold(SDR)
33	FD_DC_ST	Short-term external debt denominated in local currency	69	LIBOR	3-MONTH US DEP. LONDON OFFER
34	FD_FC	External debt denominated in foreign currency	70	RTS	RUSSIAN TRADING SYSTEM (RTS)
35	FD_FC_LT	Long-term external debt denominated in foreign currency			
36	FD_FC_ST	Short-term external debt denominated in foreign currency			

To effectively analyze output information availability and completeness on the basis of existing data structures (see appendix 1), a three-dimensional data model, that is, a three-dimensional matrix having values indexed by name, country and time, should be created.

A special procedure was written in Matlab in order to construct such three-dimensional matrices. It filters data by each of the attributes (country, index and time period) consistently, places it in a multidimensional matrix object, converting it into a new MDData object with three-dimensional data matrix and code vectors, which correspond to the value sets for each attribute – country names, variable names and time period denotations.

In order to analyze the availability and completeness of statistical data the quantity of empty observations (NaN) for each country (all attributes) and each index (all countries) must be computed. The number of empty observations for each index and country through all time periods is represented by the graph in Figure 1.1.

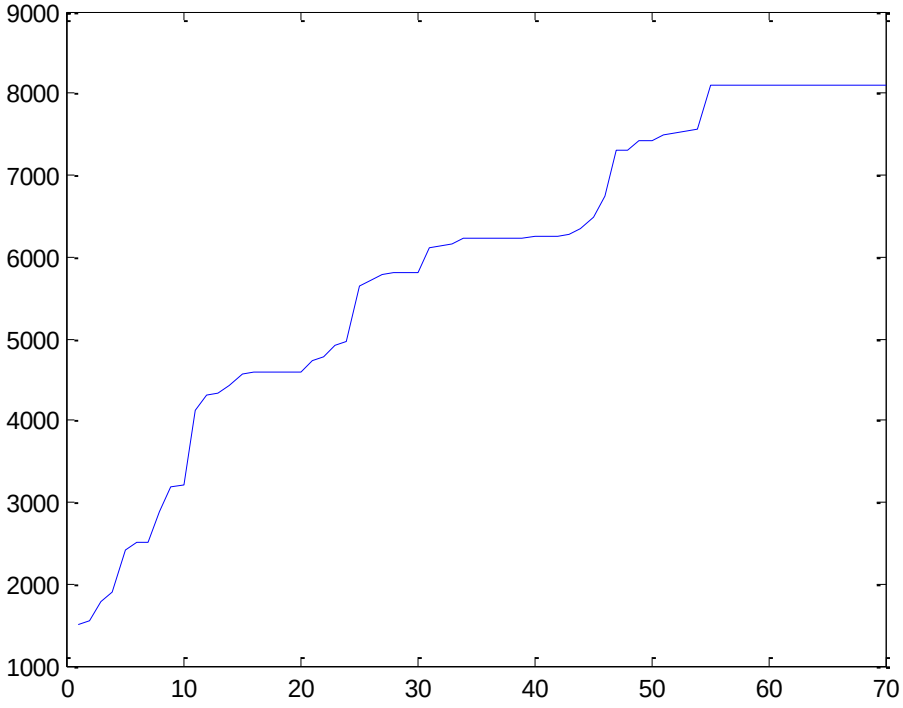


Figure 1.1. Graphical representation for the total number of empty observations for each index and country through all time periods.

Note that the horizontal axis (X-axis) represents the index list position (see table 1.3.), and the vertical axis (Y-axis) shows the quantity of empty observations for every separate index for all countries through all time periods. The correspondence between index list position and its designation is shown in Table 1.3.

Table 1.3. The correspondents between index list position and its short description as used in the research.

№ n/n	Designation of index	№ n/n	Designation of index	№ n/n	Designation of index	№ n/n	Designation of index
1	RMG	19	MBASE	37	FD_OS	55	GDP_DEF_2005
2	INTERN_RESERVES	20	DEP_EXCL	38	GEDP	56	BIS_GOLD_HOLD
3	ER	21	BOP_CAPACC	39	GDP_VOL_2005	57	GOLD_IMF
4	CPI_CHNG	22	NEER	40	FD_CB_ST	58	WIG20
5	DEPRATE	23	LOANS	41	FD_GG_ST	59	WIG20EP
6	GOLD_OUNC	24	REER	42	FD_MA_ST	60	FTSE100
7	BRMONEY	25	SPI	43	FD_OS_ST	61	GOLD_LOND
8	LENDRATE	26	GDP_VOL_CHNG	44	GDP_DEFL_2005	62	GOLD_SDR_OUNC
9	IMPORT	27	GDP_DEFL_CHNG	45	IMPORT_UNT_PRICES	63	AMEX
10	EXPORT	28	CONS_H	46	GNI	64	NASDAQ
11	GVT_CLAIMS	29	GFCF	47	GNDI	65	SP_IND
12	DEP_TRANS	30	CONS_GOV	48	GDP_VOL_2000	66	USD_SDR
13	DEP_OTH	31	NGDP	49	FD_FC	67	GOLD_MARKET
14	M2	32	M3	50	FD_DC	68	GOLD_SDR
15	BOP_CURACC	33	EXPORT_UNT_PRICES	51	FD_FC_LT	69	LIBOR
16	BOP_GS	34	FD_CB	52	FD_FC_ST	70	RTS

17	BOP_GSI	35	FD_GG	53	FD_DC_LT	71	MICEX
18	BOP_TR_BAL	36	FD_MA	54	FD_DC_ST		

The graph for the quantity of empty observations for each index and country through all time periods is shown on Figure 1.2.

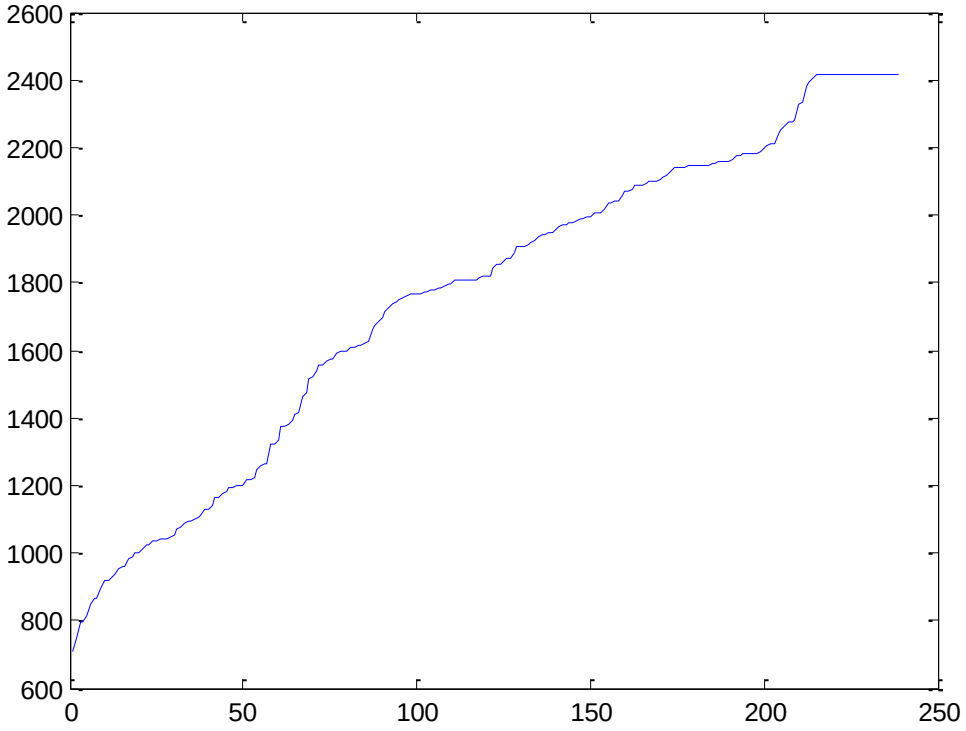


Figure.1.2. Graphical representation of the quantity of empty observations for each index and country through all time periods

Note that the Y-axis (vertical axis) shows the quantity of empty observations for every separate country for all indexes through all time periods. The X-axis (horizontal axis) represents country id. The correspondence between country id and its real name is provided in Table 1.4.

Table 1.4. The correspondence between country id and its name.

№ n/n	Name of the country	№ n/n	Name of the country	№ n/n	Name of the country	№ n/n	Name of the country

1	Hungary	61	Ecuador	121	Haiti	181	EmerDevelopEco
2	Colombia	62	ChinaPRHongKong	122	Tanzania	182	ExpEarnNonFuel
3	Turkey	63	Morocco	123	StKittsandNevis	183	Benin
4	Chile	64	Luxembourg	124	SriLanka	184	ExportEarnFuel
5	KoreaRepublicof	65	Malta	125	Fiji	185	Chad
6	United States	66	India	126	Anguilla	186	CongoRepublicof
7	SouthAfrica	67	ElSalvador	127	Maldives	187	MidEastNAfrica
8	Thailand	68	Guatemala	128	Barbados	188	DevelopingAsia
9	Sweden	69	NewZealand	129	ChinaPRMainland	189	Mali
10	Croatia	70	Jordan	130	Samoa	190	WAEMU
11	Denmark	71	Singapore	131	Global	191	MiddleEast
12	CostaRica	72	Cyprus	132	NetherlandsAntilles	192	Libya
13	Brazil	73	Albania	133	Aruba	193	MicronesiaFedSts
14	Bulgaria	74	ChinaPRMacao	134	Ghana	194	Niger
15	CzechRepublic	75	Pakistan	135	TrinidadandTobago	195	Africa
16	Malaysia	76	Botswana	136	SaudiArabia	196	SubSaharanAfrica
17	Poland	77	Cambodia	137	Swaziland	197	GuineaBissau
18	Switzerland	78	AzerbaijanRepof	138	Comoros	198	Djibouti
19	Japan	79	Nicaragua	139	Yemen	199	CEMAC
20	Latvia	80	BruneiDarussalam	140	IranIRof	200	Montenegro
21	Germany	81	EuroArea	141	SoTomPrncipe	201	Liberia
22	RussianFederation	82	Bangladesh	142	Ethiopia	202	CIS
23	Ukraine	83	MacedoniaFYR	143	Montserrat	203	UnitedArabEmirates
24	Iceland	84	Belize	144	BosniaHerzegovina	204	SanMarino
25	Lithuania	85	Jamaica	145	ECCU	205	AfghanistanIRof
26	Belarus	86	Uganda	146	LaoPeoplesDemRep	206	Mauritania

27	Estonia	87	Honduras	147	Eritrea	207	Zimbabwe
28	Argentina	88	Tunisia	148	Vietnam	208	TaiwanProvofChina
29	Canada	89	Suriname	149	Sudan	209	Guinea
30	SlovakRepublic	90	SolomonIslands	150	SyrianArabRepublic	210	EUROArea
31	Finland	91	Lesotho	151	TimorLeste	211	Macedonia
32	Greece	92	Panama	152	BahrainKingdomof	212	Kiribati
33	Indonesia	93	CapeVerde	153	Malawi	213	NewCaledonia
34	Moldova	94	Tonga	154	Bhutan	214	FrenchPolynesia
35	Ireland	95	Mongolia	155	SierraLeone	215	AmericanSamoa
36	Belgium	96	Mozambique	156	Togo	216	BelgiumLuxembourg
37	Georgia	97	Namibia	157	Myanmar	217	Bermuda
38	Bolivia	98	PapuaNewGuinea	158	Tajikistan	218	CaymanIslands
39	Mexico	99	Zambia	159	CentralAfricanRep	219	CookIslands
40	Israel	100	Burundi	160	KosovoRepublicof	220	Czechoslovakia
41	Romania	101	Vanuatu	161	Iraq	221	FalklandIslands
42	Norway	102	Kenya	162	Angola	222	FaroeIslands
43	Slovenia	103	Kuwait	163	Cameroon	223	Gibraltar
44	Austria	104	Algeria	164	Gabon	224	Greenland
45	Peru	105	Oman	165	GambiaThe	225	Guadeloupe
46	Italy	106	BahamasThe	166	EquatorialGuinea	226	Guam
47	Spain	107	VenezuelaRepBol	167	Senegal	227	GuianaFrench
48	France	108	Nigeria	168	BurkinaFaso	228	Martinique
49	Portugal	109	Nepal	169	HongKongChina	229	Nauru
50	Uruguay	110	SerbiaRepublicof	170	Rwanda	230	PanamaCanalZone
51	Armenia	111	Dominica	171	CtedIvoire	231	Runion
52	Kazakhstan	112	DominicanRepublic	172	Madagascar	232	Ryukyus
53	Netherlands	113	Grenada	173	WestBankandGaza	233	Somalia
54	Australia	114	StLucia	174	AdvancedEconomies	234	StHelena
55	Philippines	115	StVincentGrens	175	APEC	235	StPierreMiquelo

							n
56	KyrgyzRepublic	116	Seychelles	176	CongoDemRepof	236	Timor
57	UnitedKingdom	117	AntiguaandBarbuda	177	World	237	Turkmenistan
58	Paraguay	118	Lebanon	178	Europe	238	Uzbekistan
59	Mauritius	119	Guyana	179	WesternHemisphere	239	YugoslaviaSFR
60	Egypt	120	Qatar	180	CentEastEurope		

Note that the list of indexes includes some variables that are not bound to a specific country, but are used in calculations as global economic indicators. These include **gold prices and stock indexes**. These variables have their "country" attribute assigned to value “Global”. Also note that for them the number of empty observations is the largest as shown in chart 1.2.

The analysis of statistical data allowed reducing the sample of countries from 239 to 60 one, those that have been observed to possess the most complete information. According to the analysis, the list of indexes was also shortened to 60 items. Therefore, the final subset contains 41 of the best indexes with the availability of complete information for all countries and through all time periods and 19 (stock) indexes, for which a single time series is sufficient (such as variables that have global impact on all countries).

The graph for the quantity of empty observations for each index and country through all time periods, as well as the graph for each index and country from the final sample through all time periods are shown on Figures 1.3 and 1.4 respectively. The list of descriptions and names of indexes and countries included in the final sample is presented in Appendix 2.

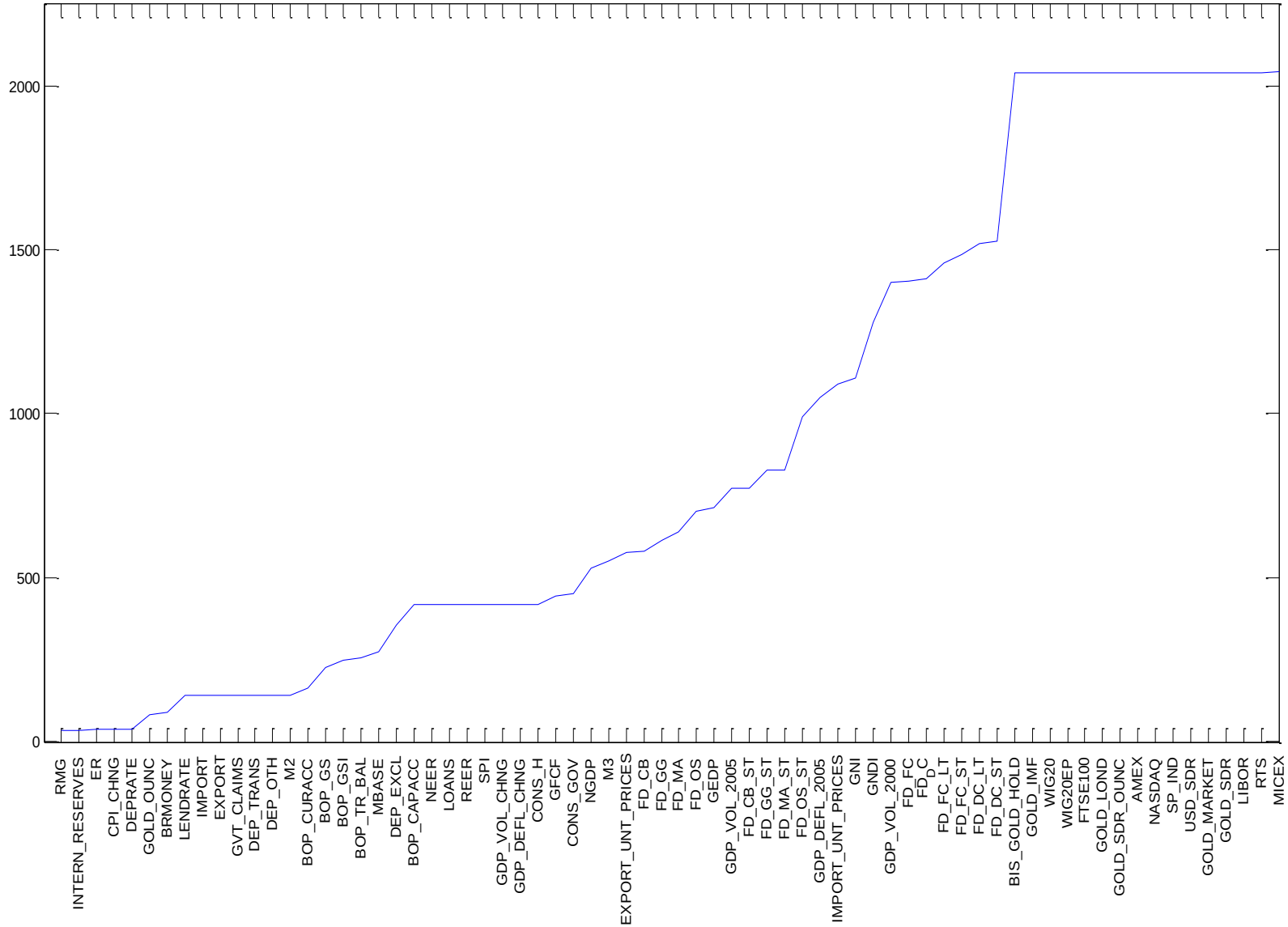


Figure.1.3. Graphical representation of the total quantity of empty observations for each index and all countries from the final sample through all time periods

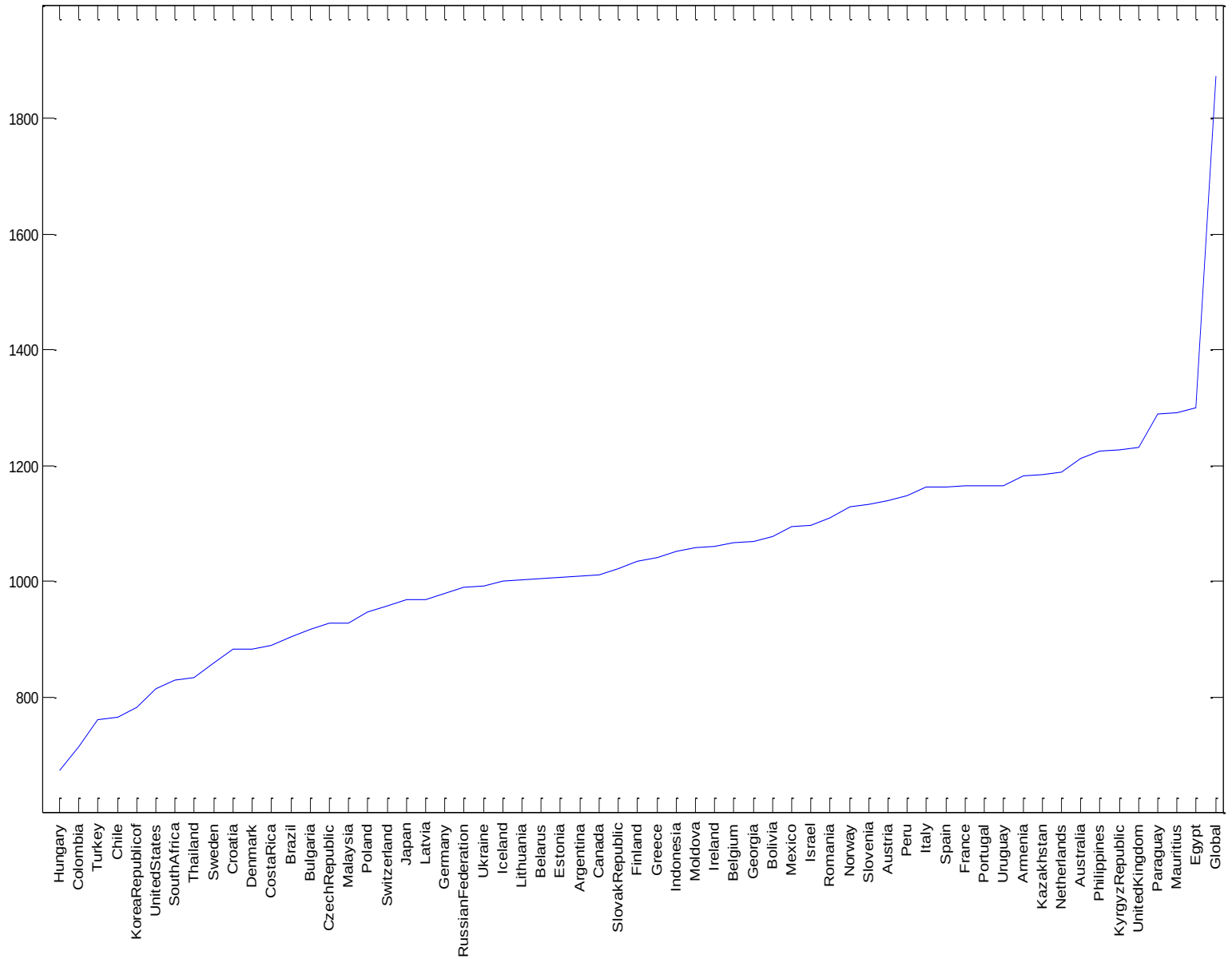


Figure.1.4. Graphical representation of total quantity of empty observations for all countries and indexes from the final sample through all time periods.

Note that the Y-axis (vertical axis) in Figure 3.1 shows the quantity of empty observations for every separate index and all countries from the final sample through all time periods, while the X-axis (horizontal axis) shows the description of every index from the final sample.

The quantity of empty observations for every separate country and all indexes from the final sample through all time periods is shown on Y-axis (vertical axis) in Figure 4.1, while the names of countries included in the final sample are presented on X-axis (horizontal axis).

The aforementioned graphs prove that for the majority of indexes the information loss in all countries through all time periods reaches up to 500 observations, which is on average less than 8 observations per country. Consequently, a conclusion can be drawn that the acquired information is sufficiently complete and thus suitebale as an input statistical database for further analysis, including grouping countries by level of involvement in the global crisis.

Exchange Market Pressure index (EMP) is widely used to identify currency crises and to study changes of pressure upon the currency through monetary instruments of a country. Accordingly, this index can be used as a universal indicator for grouping countries by the level of involvement into the global crisis of recent years.

The formula of the EMP index is the following:

$$EMP_t = \Delta e_t - \beta \Delta r_t + \gamma \Delta i_t \qquad (1.1)$$

where EMP_t is the index of pressure on the currency market: e_t is the exchange rate, expressed as the value of national currency through the unit value of foreign currency; r_t - a change of international reserves; i_t - a modified domestic rate of interest of the country; β та γ - elasticity levels of exchange rate and interest rate respectively.

In general, the behavior of EMP index gives an idea about the absence or approaching exchange rate crisis. In particular, if there is a significant increase in the EMP index, it is possible to assume that the exchange rate is in crisis.

Two approaches are used to calculate the index of exchange market pressure: precision weighting and equal weighting.

Researchers criticize the approach of precision weighting method for its limited ability to reflect the political reaction on speculative attacks. Thus, it is believed that this approach has no clear economic interpretation, as it is generated by a combination of market volatility and political reaction to it. Precision weighting method is likely to be applied if the information about indicators of flexibility of exchange rate and interest rate is absent [33].

We have used both approaches to calculate the exchange market pressure index. To simplify the calculations, it was assumed that the money market is balanced: a one percent change in exchande rate is equivalent to one percent change in reserves and interest rate.

For the calculations of the exchange rate pressure index, based on real information, the general formula is used:

$$ER = \omega_{ER}\Delta logER + \omega_{IR}\Delta \log IR - \omega_{RES}\frac{\Delta(\frac{M2}{M0}INTERN\_RESERVES)}{M2_{t-1}/ER_{t-1}} \quad (1.2)$$

where: ER - the official or market exchange rate; $\Delta logER$ - the difference between logarithms of ER's current and previous value; $\Delta \log IR$ - the difference between logarithms of current and previous loan rates; $\frac{M2}{M0}$ - the approximation of money multiplier; $INTERN\_RESERVES$ - the amount of international reserves, expressed in special drawing rights (SDR); $M2_{t-1}/ER_{t-1}$ - the approximation of money supply, expressed in dollars, for the preceding period; $\omega_{ER}, \omega_{IR}, \omega_{RES}$ - the weights of the index.

We offer the procedure of the calculation carried out in three stages, two of which are common for the first and second approaches (i.e. precision weighting and equal weights), and the third stage specifies the process of weighting for each of them, in order to give the final index, calculated on the base of precision weighting or equal weights approach. Note that the program for calculating the index based on real information for each country in the final sample using the Matlab environment for each

of the analyzed approach is given in Appendix 3-4 respectively.

It is important to analyze the characteristics of each of the offered approaches.

The peculiarities of calculating the Exchange Market Pressure index based on the precision weighting approach.

The EMP index calculations based on the precision weighting approach is conducted using the formula (1.2) in three stages:

Stage 1. On the first stage the individual components of the formula (1.2) are calculated, or the following variables are obtained:

$$MM = \frac{M2}{M0}$$
$$LOGER = \log ER$$
$$LOGIR = \log IR \qquad (1.3).$$

Stage 2. On the second stage, values DER, DIR, DRES are calculated on the basis of variables, obtained on the first stage:

$$DER = LOGER_t - LOGER_{t-1}$$
$$DIR = LOGIR_t - LOGIR_{t-1} \qquad (1.4)$$
$$DRES = \frac{MM_t INTERN\_RESERVES_t - MM_{t-1} INTERN\_RESERVES_{t-1}}{M2_{t-1} / ER_{t-1}}$$

Stage 3. It is the stage of weighing and calculating the exchange rate pressure index. This stage is different for two selected approaches. For precision weighting, weights are defined as inverse standard deviation of each of the components of **DER, DIR, DRES, and EMP index** is calculated using the formula:

$$EMP = \frac{DER}{\sigma_{DER}} + \frac{DIR}{\sigma_{DIR}} - \frac{DRES}{\sigma_{DRES}} \qquad (1.5)$$

As a result of consecutive calculations, the exchange market pressure index (EMP index) is formed, based on the precision weighting approach.

Note that the program for calculating exchange market pressure index based on the precision weighting approach for each country in the final sample using Matlab environment is given in Appendix 3.

The peculiarities of calculating the Exchange Market Pressure index based on the equal weighting approach

The EMP index calculations based on the equal weights approach is also conducted using the formula (1.2) in three stages:

Stage 1. On the first stage the individual components of the formula (1.2) are calculated, or the following variables are obtained:

$$MM = \frac{M2}{M0}$$
$$LOGER = \log ER$$
$$LOGIR = \log IR \qquad (1.7).$$

Stage 2. On the second stage, values DER, DIR, DRES are calculated on the basis of variables, obtained on the first stage:

$$DER = LOGER_t - LOGER_{t-1}$$
$$DIR = LOGIR_t - LOGIR_{t-1} \qquad (1.8)$$
$$DRES = \frac{MM_t INTERN\_RESERVES_t - MM_{t-1} INTERN\_RESERVES_{t-1}}{M2_{t-1} / ER_{t-1}}$$

Note that Steps 1 and 2 coincide completely with steps of EMP index calculations using the considered above precision weighting approach.

Stage 3. It is the stage of weighing and calculating the exchange rate pressure index. For the examined equal weighting approach, weights for all three components of **DER, DIR, DRES** are equal to one, and **the EMP index** is calculated according to the formula:

$$EMP = DER + DIR + DRES \qquad (1.9)$$

As a result of consecutive calculations, the exchange market pressure index (EMP index) is formed, based on the precision weighting approach.

Note that the program for calculating exchange market pressure index based on the precision weighting approach for each country in the final sample using Matlab environment is given in Appendix 4.

The country is determined as being in a condition of the financial crisis, when the deviation of index EMP (calculated using one of the approaches discussed above) of the country from its mean exceeds a certain threshold.

As a threshold that characterizes the deep currency crisis of a country, we offer 2 standard deviations of EMP in a positive direction (the pressure on depreciation of the currency) or negative side (the pressure on the appreciation). According to the hypothesis about the normal distribution of this index, the probability of such events is less than 10 percent.

Meanwhile, countries that are less affected by the crisis in terms of pressure on the exchange rate are determined as those, for which the deviation from the EMP index average is equal to one to two standard deviations in either direction.

The selection of countries into two main groups: most and least affected by the crisis of 2008-2009 on the basis of calculations on real data for the years 2002-2010 in terms of pressure on the exchange rate (calculated on the basis precision approach) is presented in Table 1.5.

Table 1.5. ***Distribution of the most and least affected countries during the crisis of 2008-2009, based on the value of EMP index***

Countries that suffered greatly during the crisis	**Countries that have not suffered significant losses during the crisis**
Armenia	Argentina
Belarus	Australia
Chile	Austria
Costa Rica	Belgium
Georgia	Bolivia
Iceland	Canada

Indonesia	Croatia
Republic of Korea	Denmark
Malaysia	Finland
Mexico	France
Moldova	Germany
Paraguay	Greece
Romania	Ireland
Russian Federation	Israel
Ukraine	Italy
	Kazakhstan
	Kyrgyz Republic
	Mauritius
	Netherlands
	Norway
	Peru
	Philippines
	Poland
	Portugal
	SlovakRepublic
	Slovenia
	Spain
	Sweden
	Switzerland
	Thailand
	Turkey
	United Kingdom

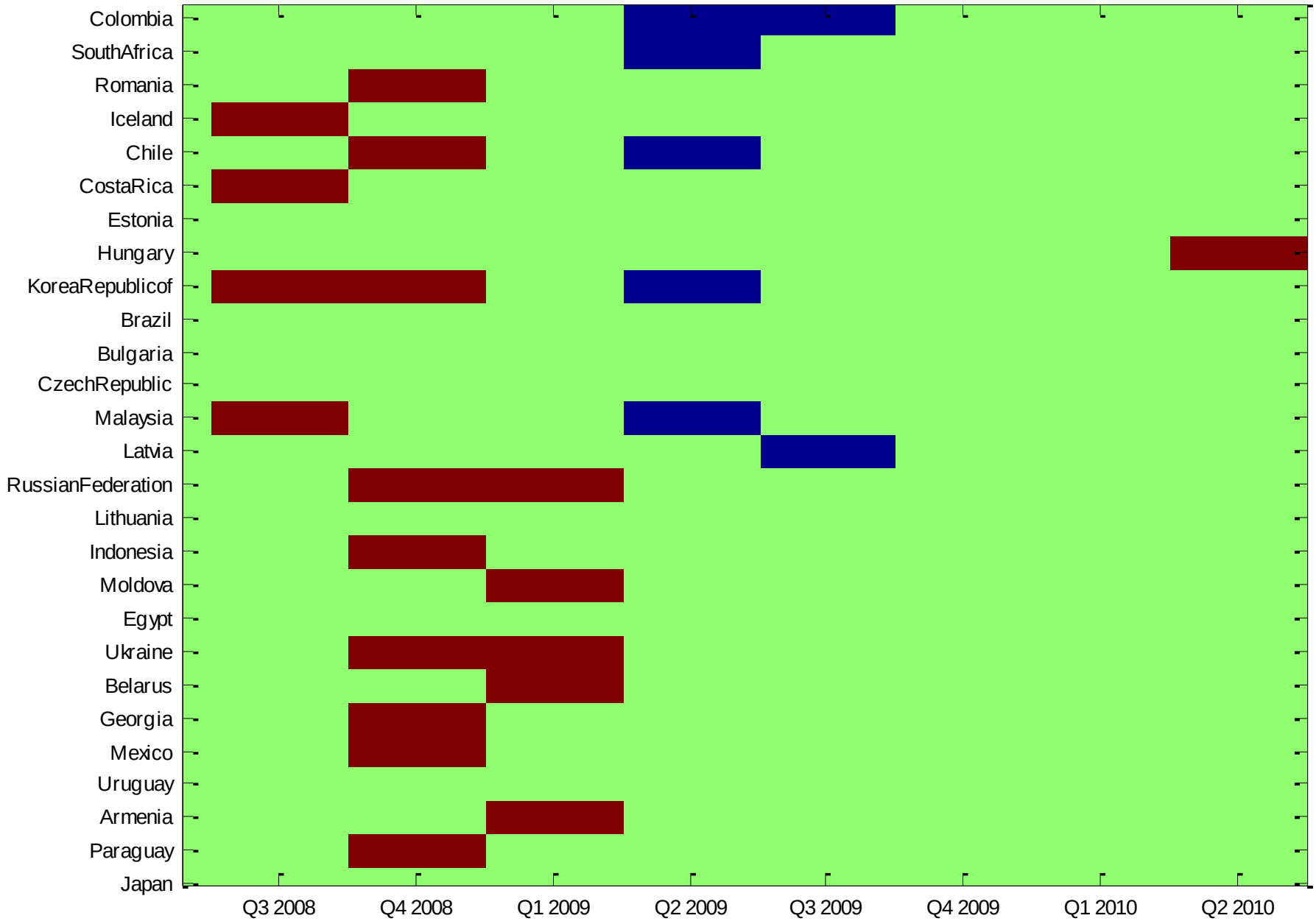
For the ease of analysis of current crises, the countries in the final sample were ranked by time of occurrence of the crisis (based on the Exchange Market Pressure index, calculated using precision weighting approach), beginning from the 3rd quarter of 2007.

Graphically, the results of ranking of the countries with deep financial crisis (the threshold is $\pm 2\sigma_{EMP}$) by the time of occurrence and duration of the crisis are presented in the form of "periods and countries" maps on picture 1.5.

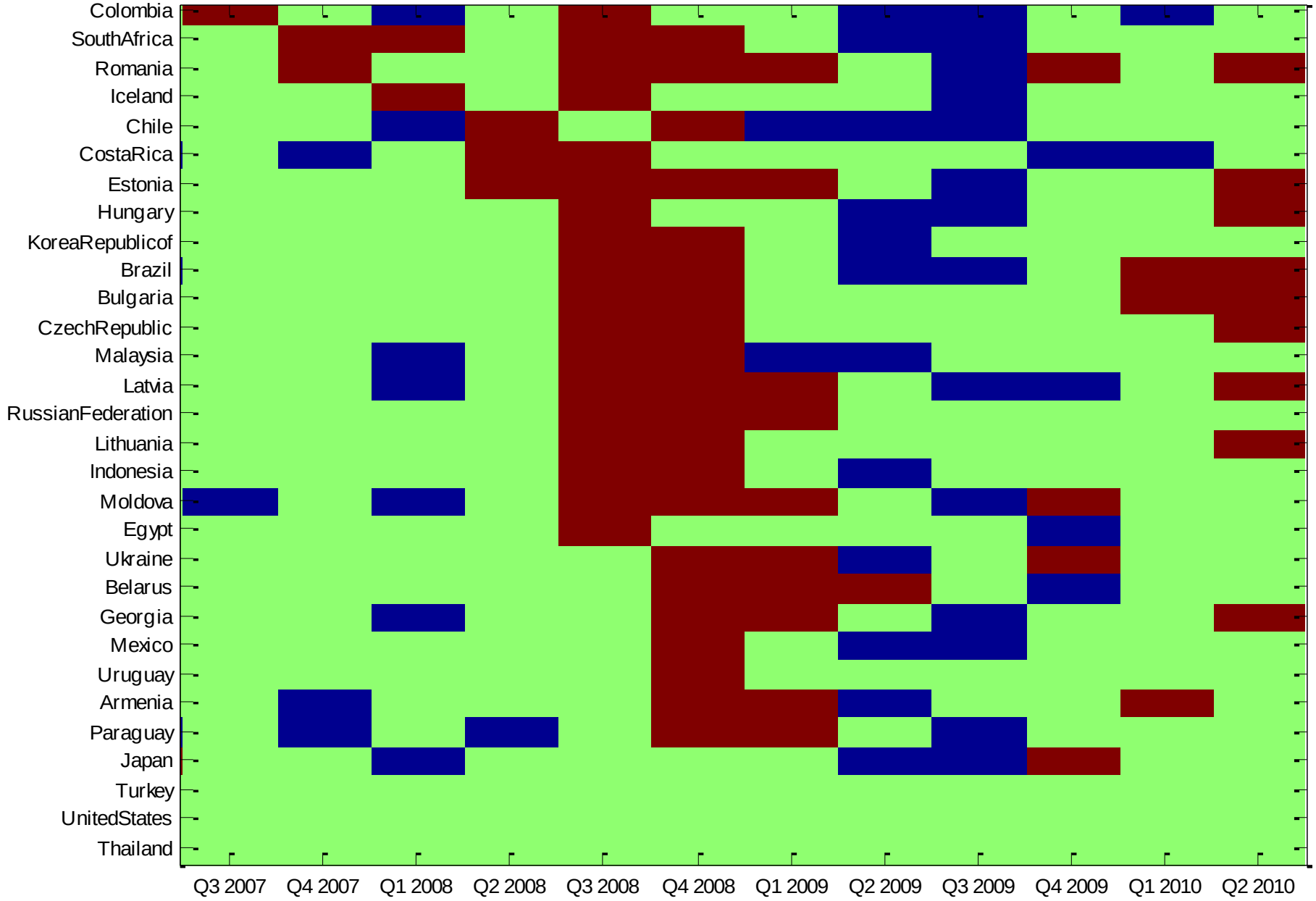
The results of countries ranking by the time of occurrence and duration of the crisis for the loose threshold ($\pm \sigma_{EMP}$) are shown on picture 1.6.

It should be noted that Greece entered the group of countries that have not suffered from crisis. This can be explained by the fact that this state is characterized by a budget crisis (or government regulation crisis), but not currency crisis.

Note that the program in Matlab environment for ranking of countries for different thresholds and graphical representation of results in the form of "periods and countries" maps is listed in Appendix 5.



Picture.1.5. The map of occurrence and duration of the currency crisis (red - depreciation pressure, blue - appreciation). The threshold is equal to two standard deviations.



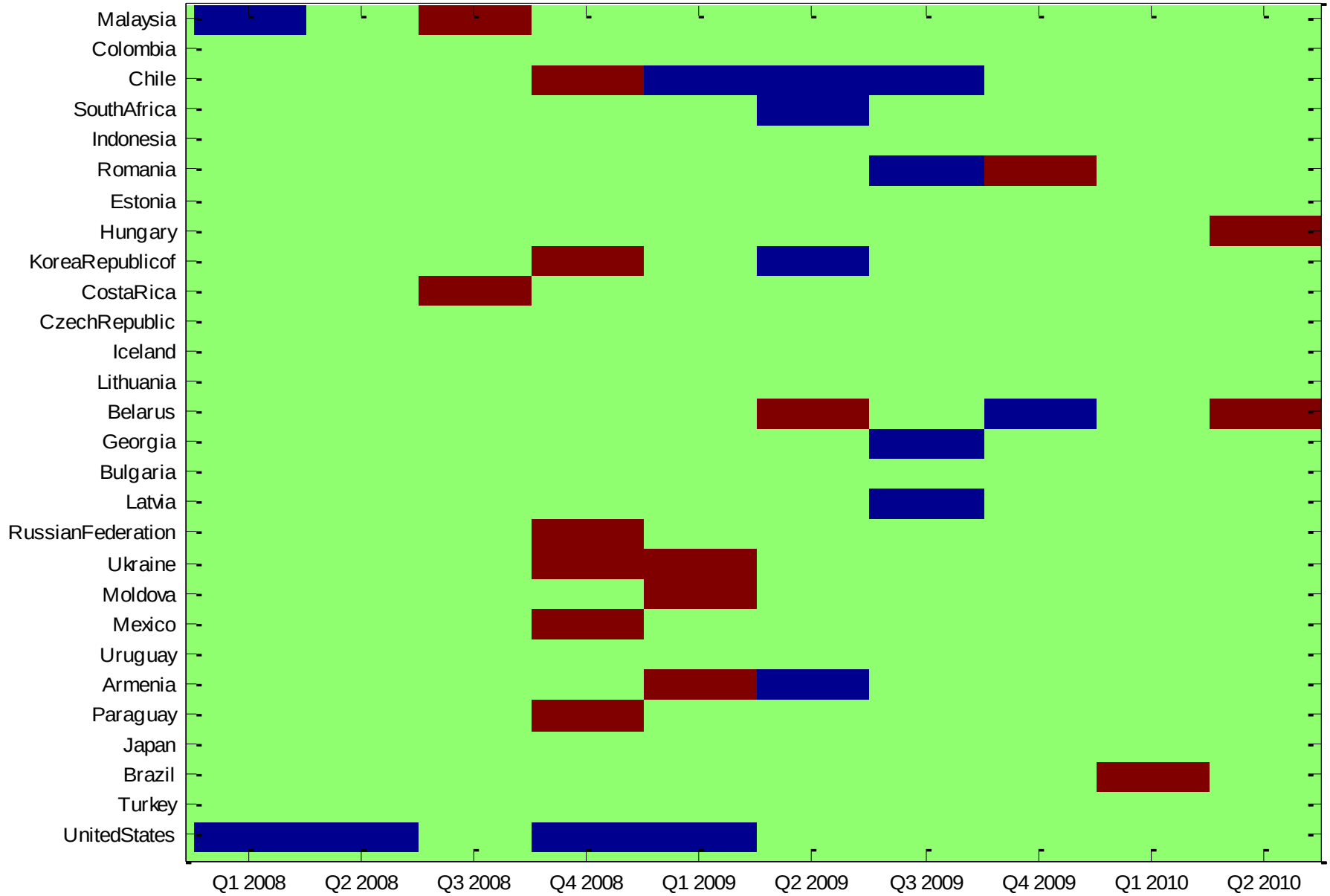
Picture.1.6. The map of occurrence and duration of the currency crisis (red - depreciation pressure, blue - appreciation). The threshold is equal to one standard deviations. EMP Index is calculated on the base of precision weighting approach.

The visual analysis of graphs 1.5. and 1.6. leads to the conclusion that a significant number of states have the critical state; also there is a significant increase in the duration of the crisis period while reducing the threshold for the index from two standard deviations ($\pm 2\sigma_{EMP}$) to one standard deviation ($\pm \sigma_{EMP}$). This fact can be considered a confirmation of our assumptions about the logical definition of the set of countries that are in a deep financial crisis by setting the threshold for rejection of the index EMP beyond two standard deviations (see table 1.5.)

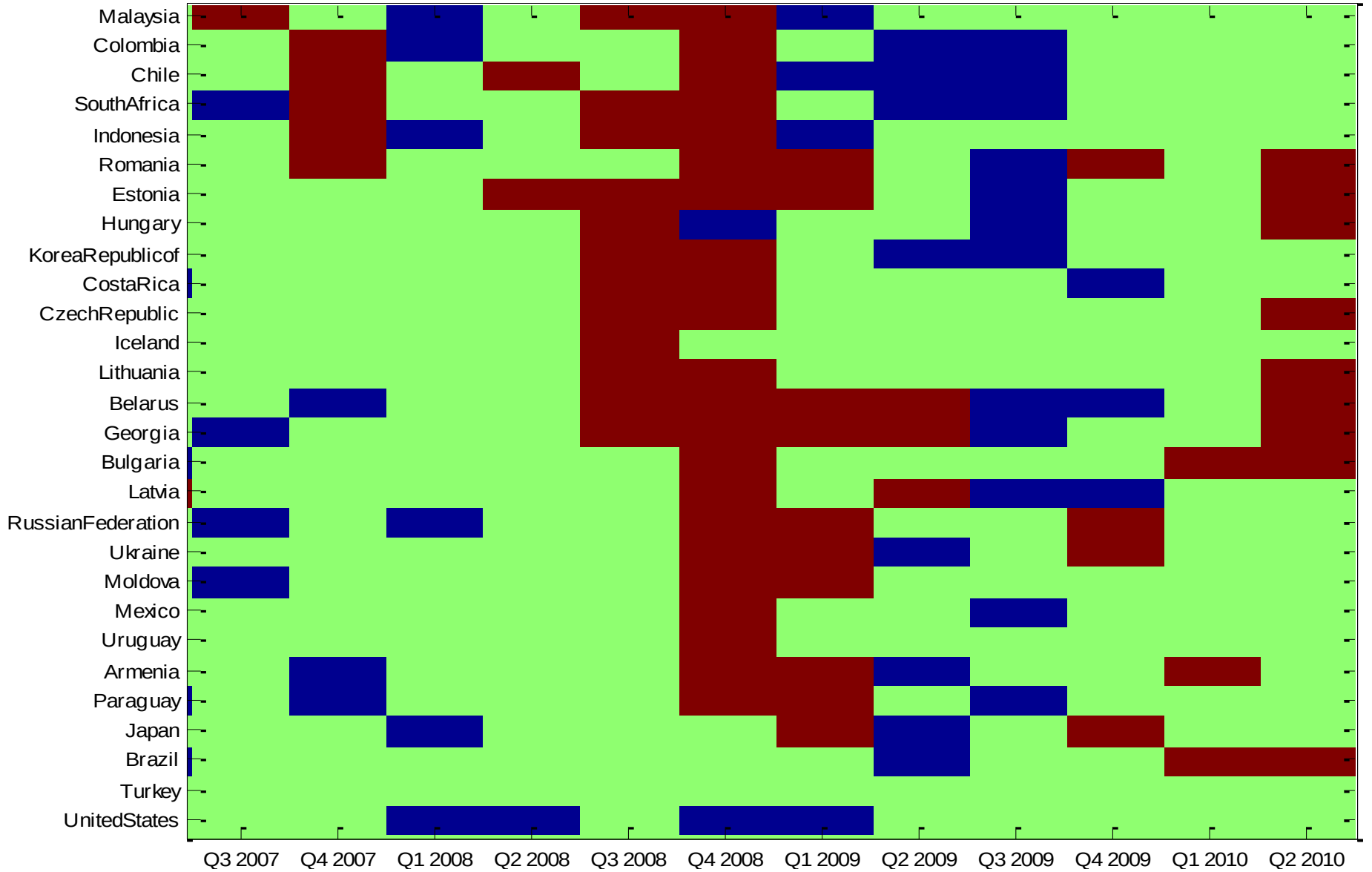
To finalize the conclusions, we made the ranking of countries based on exchange rate pressure index calculated with the help of the equal weights approach. Similar to the previous case, we built graphics-maps of the crisis with different levels of threshold ($\pm 2\sigma_{EMP}; \pm \sigma_{EMP}$). Graphically, the results of ranking of countries which had a state of deep financial crisis (threshold is $\pm 2\sigma_{EMP}$) by the time of occurrence and duration of the crisis are shown in the form of maps: “periods and countries” on picture 1.7.

The results of ranking of countries by the time of occurrence and duration of the crisis for the loose threshold ($\pm \sigma_{EMP}$) is shown on picture 1.8.

Note that the program in Matlab environment for ranking of countries for different thresholds and graphical representation of results in the form of maps: "periods and countries" is listed in Appendix 5.



Picture.1.7. The map of occurrence and duration of the currency crisis (red - depreciation pressure, blue - appreciation). The threshold is equal to two standard deviations. EMP Index is calculated on the base of equal weighting approach.



Picture.1.8. The map of occurrence and duration of the currency crisis (red - depreciation pressure, blue - appreciation). The threshold is equal to one standard deviation. EMP Index is calculated on the base of equal weighting approach.

The analysis of the calculations to determine the period of onset of the crisis, based on the exchange rate pressure index using two approaches discussed above, allows to determine the general algorithm of ranking countries based on the involvement into the global crisis and to justify the set of countries with high state of financial crisis and set of countries little affected by it.

According to the chosen approach, the initial grouping of countries is based on the currency market pressure index (EMP) using the following general rule:

• The group of countries, significantly affected by the crisis, includes countries for which the EMP index's deviation from its average value is more than two standard deviations, calculated on the basis of historical values of the EMP index for the analyzed countries

• The group of countries, relatively little affected by the global financial crisis, includes countries for which the EMP index's deviation from its average value is more than one and less than two standard deviations, calculated on the basis of historical values of the EMP index for the analyzed countries

Justification of the final selection of countries that suffered from crisis

According to the rules of the calculations and visual analysis of graphs 1.7. and 1.8., a group of countries was selected and the beginning of the crisis period for them based on the exchange rate pressure index, calculated using the precision weighting method. The results of grouping are presented in Table 1.6.

Table 1.6. ***Groups of countries with a significant crisis in the beginning and the onset of the crisis for them (according to the EMP index calculated using the precision weighting method)***

3 rd quarter 2008	4 th quarter 2008	1 st quarter 2009
Costa Rica	Romania	Russian Federation
Republic of Korea	Chile	Moldova
Malaysia	Republic of Korea	Ukraine
Iceland	Russian Federation	Belarus
	Indonesia	Armenia
	Ukraine	
	Georgia	

	Mexico	
	Paraguay	

However, if to use the EMP index calculated using the equal weighting method, the group of countries in the Table 1.7 can be distinguished.

Table 1.7. ***Groups of countries with a significant crisis in the beginning and the onset of the crisis for them (according to the EMP index calculated using the equal weighting method)***

3 rd quarter 2008	4 th quarter 2008	1 st quarter 2009
Costa Rica	Chile	Ukraine
Malaysia	Republic of Korea	Moldova
	Russian Federation	Armenia
	Ukraine	
	Mexico	
	Paraguay	

Thus, by comparing both approaches, and including the potential interest to a country in terms of similarity or relationship to the economy of Ukraine, for further analysis a pool of 10 countries that experienced a **deep crisis condition** was formed:

1. Ukraine ; 2. Republic of Korea; 3. Russian Federation; 4. Moldova; 5. Armenia; 6. Costa Rica; 7.Chile; 8. Iceland; 9. Romania; 10.Georgia.

Let's briefly characterize the features of economic processes in each country from the group.

Ukraine. Survived the sharp depreciation of the currency during the 4th quarter of 2008. Targets the exchange rate against the U.S. dollar. Is characterized as a small open economy, the main drivers of economic development of which are the following: exports of ferrous metals, chemicals, heavy engineering products. Is characterized by the high inflation and bank interest in local currency.

Iceland. Is characterized by the largest value of national currency depreciation during the last crisis. NEER declined almost twice within 2-4 quarters of 2008. The inflation is targeted, exchange rate is floating. In 2007 the economy was among the ten most productive economies in the world per capita. Export commodities: fish and fish products, aluminum and ferosilicon.

Republic of Korea. More than 30% depreciation of the currency during the last crisis in terms of NEER. The market economy is 15th in the world by nominal GDP and 12th by purchasing power parity. Monetary policy regime: since 1998 - inflation targeting with the help of money market interest rate controlled by the central bank. Floating exchange rates. Exports: engineering goods, electronics. One of the few countries that have avoided major economic recession during the global crisis.

Russian Federation. 12th economy in the world by nominal GDP and the 7th largest economy by purchasing power parity. Monetary regime: the regime of "повзучої прив'язки", in fact - an active exchange rate management based on the discretionary decisions of the central bank. Export: energy, heavy machinery.

Moldova. Agro-industrial economy that is in the process of structural adjustment. Monetary regime – managed exchange rate float with no pre-defined path, monetary aggregates targeting. Main industries: the service sector, agricultural industry. Moldova receives monetary support from the IMF and other international financial organizations.

Romania. EU member since 2007, the economy with the income level above average. Driver of economic growth in recent years is the agricultural industry. Export commodities: textiles, industrial machinery, electronics and electrical appliances. Regime of monetary policy: inflation targeting through the exchange rate management, without a specific direction. In late 2008-early 2009 the exchange rate depreciation took place, about 15% of the NEER. The country receives financial support from international financial organizations.

Armenia. The transitional post-soviet economy, befor independence - industrial, now – agrarian. Is experiencing a series of structural rearrangements, including the emergence and development of new industries such as electronics and jewelry industry. Supports floating exchange rate, monetary benchmarks are defined by the programs of IMF, WB and EBRD, which also help.

Chile. Market-oriented economy, focused on international trade. Has one of the highest credit rating (S&P A+) in South America. Supports floating exchange rate

and inflation targeting at the level of 2-4 percent per year. The crisis caused a drop in GDP, despite a massive program to support the economy by the government.

Georgia. Country in transition, which is developing very rapidly. Thus, in 2007 the real GDP growth reached 12 percent. The exchange rate is in the managed floating regime, without a specific direction of change. The objectives of monetary policy are determined by the requirements of international financial programs.

Costa Rica. Main areas - pharmaceuticals, software development, financial outsourcing, ecotourism. GDP per capita in 2009 was $11,122 PPP. However, the economy has the fourth highest level of annual inflation in Latin America. Central Bank targets the exchange rate using the regime of the "повзучої прив'язки", the gradually devaluating the currency.

Justification of the final selection of countries were not significantly affected by the financial crisis.

The selection of countries, which are relatively less affected by the crisis, is proposed to make on the base of EMP index using this general rule:

• The group of countries, which are not affected by the crisis, includes countries for which the EMP index's deviation from its average value is less than one standard deviation, calculated on the basis of historical values of the EMP index for the analyzed countries

• When choosing countries, it is proposed to take into consideration the factors of territorial proximity to Ukraine, the similarities to the Ukrainian economy and the possibility to reach more continents.

Based on the EMP index, calculated with the help of the precision weighting method and the method of equal weighting, a group of countries without a deep state of currency crisis during the period: 3rd quarter of 2008 - 1st quarter of 2009 was selected. The group includes 33 countries, listed in Table 1.8.

Table 1.8. ***Countries without a deep currency crisis during the period: 3rd quarter of 2008 - 1st quarter of 2009 (based on the ERP index, calculated by the two approaches).***

№ n/n	Name of the country	№ n/n	Name of the country
1	Turkey	18	Israel
2	United States	19	Norway
3	Thailand	20	Slovenia
4	Sweden	21	Austria
5	Croatia	22	Peru
6	Denmark	23	Italy
7	Poland	24	Spain
8	Switzerland	25	France
9	Germany	26	Portugal
10	Argentina	27	Kazakhstan
11	Canada	28	Netherlands
12	Slovakia	29	Australia
13	Finland	30	Philippines
14	Greece	31	Kyrgyz Republic
15	Ireland	32	United Kingdom
16	Belgium	33	Republic of Mauritius
17	Bolivia		

Considering the factors of territorial proximity to Ukraine, Ukrainian economy similarities and the possibility to include more continents, a pool for the analysis of 10 countries that has not significantly affected by the crisis during the period: 3rd quarter of 2008 – 1st quarter of 2009 was formed: 1.Canada; 2. Sweden; 3.Croatia; 4. Poland; 5. Germany; 6.Argentina; 7. Slovakia; 8. Norway; 9. Kazakhstan; 10. Australia.

Let’s briefly characterize the features of economic processes in each country selected from the group.

Canada. The country managed to avoid currency and banking crises through a strong system of bank regulators and lack of the wide range of financial instruments in the market. Canada's banking system and government financial institutions conduct a conservative politics. They are reluctant to give loans to potential home buyers at reduced interest rates, which allowed avoiding high-risks in attracting questionable borrowers. Interestingly, Canada is the only country from the "Big

Seven" that is characterized by a balanced budget for 11 years, which enabled the country to avoid deficit. None of the banks in Canada needed financial support from the state during the crisis period. The economy of Canada is innovative [1], with the advanced infrastructure, institutions, education, and high productivity. During the World Economic Forum 2010 Canada's financial system was recognized as 10th (from 139 countries) strongest and healthiest in the world. GDP per capita is U.S. $39.669 thousand.

Sweden. The economy of Sweden managed to avoid possible negative consequences due to practical steps in resolving the balance of payments, which kept the demand high, and the interest rates – low. Financial oversight and limiting of the size of mortgage loans were introduced. The continuous growth of incomes of Swedish population and the partial decrease of the tax burden compensated financial troubles. However, the banking crisis of 1992 was felt . The economy of Sweden is innovative, with the developed advanced system of institutions and infrastructure, higher education system, macroeconomic environment and technological security. During the World Economic Forum in 2010 Sweden's financial system was recognized as second strongest and healthiest in the world. Size of GDP per capita is U.S. $ 43.986 thousand.

Croatia. You can not say that this country did not suffer from the crisis; however, as evidenced by relevant statistics, Croatia managed to restrain the crisis

[1] According to the methodology of Potrero, there are five groups of countries depending on their stage of their development. Salaries increase with the development, and it is needed to raise productivity for increasing revenue. In the first stage, the economic development depends on the availability of factors; countries compete in the sustainability of resources: unskilled labor and natural resources. Companies compete on the base of prices and sell products and elementary goods. Low productivity is reflected in low wages. Staying competitive at this stage depends on the stable functioning of public and private institutions, adequate infrastructure, stable macroeconomic situation and a healthy labor force.

With the growth of wages, the countries are moving to the stage of development where their growth depends on efficiency. At this stage it is important to develop more rational production processes and to improve the product quality. Strengthening of the competitiveness depends on higher and professional education, efficient markets for goods and services, stable functioning of labor market, financial market development, ability to use new technology and large capacity of internal and external markets.

When countries move to the stage of dependence on the innovation, high wages and living standards are possible when companies can compete, using new and unique products. At this stage, companies have to compete through innovation and develop new products using various production processes.

Thus, three main stages are distinguished:

1. Dependence on factors (factors-oriented country).
2. Dependence on effectiveness (efficiency-oriented country).
3. Dependence on innovation (innovative country).

In the methodology there are also two more stages: the transitional stage from the factor-oriented to the efficiency-oriented and from efficiency-oriented to innovative country.

and to avoid receiving credits from the International Monetary Fund. The main explanation may be the pretty quick recovery of the country's main partners, namely the euro-zone, including Germany, Austria and Italy. Mistake, for which the government of Croatia was criticized, has been described as a high level of social spending during the financial crisis and the external debt. Economy of Croatia is in transition from orientation on effectiveness to innovation group, the strengths of which are the infrastructure, health care and education, technology. During the World Economic Forum in 2010 the financial system of Croatia was recognized as seventy-seventh in the world by the Global Competitiveness Index. Size of GDP per capita is U.S. $ 14.243 thousand.

Poland. The economy of this country even before the crisis was characterized by a stronger system of state regulation, compared with the states of its type, which diminished the impact of the financial crisis. In addition, the Polish financial market is not strong enough to provoke negative trends of a crisis. The economy of Poland is in transition from focusing on the efficiency to innovation, the benefits of the country are: the high-quality system of higher education, the development of the domestic market. During the World Economic Forum in 2010 Poland's financial system was recognized as thirty-ninth in the world by the Global Competitiveness Index. Size of GDP per capita is U.S. $ 11.288 thousand.

Germany. The conservative policy of state regulation, financial injections into the market and deep economic integration of Germany's economy in the European Union contributed to overcoming of crisis. To reduce the budget deficit, Germany focused on the increasing the demand for exports and the related increase in industrial production, which contributed to job growth. The economy of Germany is innovative, with the advanced system of institutions and infrastructure, and good higher education system. During the World Economic Forum in 2010 the German financial system was recognized as the fifth healthiest and strongest in the world. Size of GDP per capita is U.S. $ 40.875 thousand.

Argentina. This country is hardly affected by the crisis of 2008-2009, but experienced the crisis of the early 2000's, when its national currency was devalued by 70%. According to the National Bank of Argentina, in 2008 the economy grew

by 6%, but in December the industrial production declined by only by 0,9% compared to the previous month, while the national currency (peso) devalued only by 13,5%. Peso was not characterized by high levels of fluctuations, because the National Bank conducted the relevant policy. The lack of external funding stimulated the development of the domestic market. Argentine economy is oriented on efficiency; its advantages are the developed macroeconomic environment and the domestic market. During the World Economic Forum in 2010 Argentina's financial system was recognized as eighty-seventh in the world by the Global Competitiveness Index. Size of GDP per capita is 7.726 thousand dollars.

Slovakia. The country, which in 2009 joined the euro zone, was characterized by one of the highest levels of development among the EU countries even before the crisis. After accession to the euro zone, Slovakia managed to avoid significant fluctuations in financial sector. With the onset of the crisis, despite temporary difficulties due to the adjustment to the policy of the euro zone, the economy continued to grow with the highest rates in the European Union. Labor force in Slovakia is three times cheaper than in its nearest neighbors: Hungary, the Czech Republic and Poland, and six times than in Western Europe. So, thanks to low unemployment and avoiding significant social costs, the country is in a more advantageous position compared to others. The economy of Slovakia is in transition from focusing on efficiency to innovation; the benefits of the country are developed financial and domestic markets, labor productivity and potential technological development. During the World Economic Forum's in 2010 the financial system of Slovakia was recognized as sixtieth in the world by the Global Competitiveness Index. Size of GDP per capita is U.S. $ 16.282 thousand.

Norway. Thanks to receiving substantial income from the sale of oil and gas in recent years, Norway was able to accumulate enough assets, which in times of financial instability were used to stimulate industry and support the level of social services. In addition, the governmental policy in regulation of financial markets is stronger, compared to other countries. The economy of Norway is innovative; its strengths are institutional and infrastructural development and high level of financial market development, technology and higher education. During the World Economic

Forum in 2010 Norway's financial system was recognized as fourteenth healthiest and strongest in the world. Size of GDP per capita is U.S. $ 79.085 thousand.

Kazakhstan. Constant demand for raw materials (oil and agricultural products), which are major exports of Kazakhstan, allowed the country's GDP to grow during 2008-2009. The country benefited from the fact that during several years oil prices were based not on fundamental approaches, but on speculative transactions, which allowed Kazakhstan to grow a sufficient level of international reserves. In addition, the policy the government was aimed at reducing the social component in public expenditures. Problematic aspects of this country are underdeveloped banking and real sectors, but now these factors have not become a hurdle for Kazakhstan. The economy of this country is in transition from factor-oriented to efficiency-oriented, with a sufficiently developed macroeconomic environment and high productivity of labor potential. During the World Economic Forum in 2010 the financial system of Kazakhstan was recognized as seventy-second in the world by the Global Competitiveness Index. Size of GDP per capita is U.S. $7.019 thousand.

Australia. Australian economy was initially less financially unstable compared with other developed countries, which was achieved through a rigid system of state regulation. The growth continued even during the crisis years thanks to the successful economic reforms: privatization, deregulation and tax reforms. GDP in 2009 increased by 9,2%. Australian economy is innovative, its benefits are institutional and infrastructural development, high level of macroeconomic and financial market performance, and employment potential. During the World Economic Forum in 2010 Australia's financial system was considered as sixteenth in the world. Size of GDP per capita is U.S. $45.587 thousand.

1.3. Comparative statistical analysis of macroeconomic indexes dynamics of world’s countries before and during crisis periods

The analysis of macroeconomic indicators were conducted based on the data before, during and after the currency crisis as follows:

- Based on the approach that was described in the Chapter 1.4 – exchange market pressure index (EMP) – it was identified two groups of countries: "countries that are significantly affected by the crisis" and "countries that are not significantly affected by the crisis".
- For "the countries that are significantly affected by the crisis" it was defined crisis periods based on pointed weights and equivalent weights methods. Distribution of periods to the pre-crisis, crisis and post-crisis took place on the basis of the average exchange market pressure index (EMP). The crisis periods for "the countries that are significantly affected by the crisis" are shown in the Table 1.10.

Table 1.9. ***The list of "countries that are significantly affected by the crisis" with the the respective periods of crisis indicating***

Crisis Period / Country Name	3rd Quarter 2008	4th Quarter 2008	1st Quarter 2009
Armenia			
Chile			
Costa Rica			
Georgia			
Iceland			
Republic of Korea			
Moldova			
Romania			
The Russian Federation			
Ukraine			

	crisis is observed
	crisis is not observed

- On the basis of scientific sources analysis, empirical calculations and synthesis of international experts' conclusions crisis periods for "countries that are not significantly affected by the crisis" is defined as follows:

1. pre-crisis period: 1st quarter of 2002 year –2nd quarter of 2008 year
2. crisis period: 3rd quarter of 2008 year – 1st quarter of 2009 year
3. post-crisis period: 2nd quarter of 2009 year – 2nd quarter of 2010 year

The crisis periods for the "countries that are significantly affected by the crisis" are shown in the Table 1.10.

Table 1.10. ***The list of "countries that are not significantly affected by the crisis" with the the respective periods of crisis indicating***

Crisis Period / Country Name	3rd Quarter 2008	4th Quarter 2008	1st Quarter 2009
Argentina			
Australia			
Canada			
Croatia			
Germany			
Kazakhstan			
Norway			
Poland			
Slovakia			
Sweden			

	crisis is observed
	crisis is not observed

Under the chosen approach, we do not consider countries for which the exchange market pressure index does not identify any signs of the currency crisis. This would mean that the crisis has not affected the foreign exchange market of a

country (country is the object of direct interest in the context of this study) or that country is not sufficiently integrated into the global financial system (its experience in crisis resistance is not relevant and applicable).

Indicator Analysis

In order to conduct statistical analysis of macroeconomic dynamics of world economies during the pre-crisis, crisis, and post-crisis periods, the following parameter groups, chosen according to the Chapter 1.2, were analyzed:

- Real sector:
    1. Real GDP growth.
    2. Gross fixed capital formation.
    5. Consumption of fixed capital.
- Debt Load:
    1. Total external debt.
    2. Short-term external debt.
- Balance of Payments:
    1. The trade balance.
    2. Current account balance.
    3. International reserves.
    4. Real effective exchange rate growth.
    5. Nominal effective exchange rate growth.
- International variables:
    1. The ratio of real domestic and foreign interest rates.
- Financial liberalization:
    1. Money multiplier.
- Other financial variables:
    1. CPI growth rate.

- Money supply growth rate.

Indicators of two country groups are investigated based on the statistical analysis of means and medians. The results of the analysis are shown in the Tables 1.11-1.38.

Real sector

Table 1.11. ***Average real GDP growth rate during the pre-crisis, crisis, and post-crisis periods for "the countries that are not significantly affected by the crisis"***

(growth rate to the previous period, %)

	Before the crisis		During the crisis		After the crisis	
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**
Argentina	5.76	8.64	4.34	4.05	2.06	1.13
Australia	3.51	3.55	1.27	0.88	2.04	2.58
Canada	2.56	2.58	-1.00	-0.88	-0.36	-1.10
Croatia	4.77	4.73	-1.61	0.21	-3.82	-4.48
Germany	1.36	1.10	-2.70	-1.97	-1.26	-2.00
Norway	2.42	2.70	0.83	1.17	-1.72	-1.13
Poland	4.68	4.46	3.06	2.75	2.55	2.86
Slovakia	6.81	7.20	0.90	1.63	-0.73	-2.57
Sweden	3.17	3.34	-3.67	-4.99	-1.23	-1.20
Mean	3.89	4.25	0.16	0.32	-0.27	-0.66

Real GDP growth rate for **"the countries that are not significantly affected by the crisis"** (Table 1.11) is:

- during the pre-crisis period: the average for countries 3.89% with the maximum value for Slovakia (6.8%) and minimum for Germany (1.36%);
- during the crisis period: the average for countries 0.16% with the maximum value for Argentina (4.34%) and minimum for Sweden (-3.67%);
- during the post-crisis period: the average for countries 0.27% with the maximum value for Poland (2.55%) and minimum for Croatia (-3.82%).

Table 1.12. ***Average real GDP growth rate during the pre-crisis, crisis, and post-crisis periods for "the countries that are significantly affected by the crisis"***

(growth rate to the previous period, %)

	Before the crisis		During the crisis		After the crisis	
	Mean	**Median**	**Mean**	**Mean**	**Median**	**Mean**
Chile	4.51	4.71	0.74	0.74	-1.49	-1.77
Costa Rica	5.96	6.04	3.13	3.13	-0.85	-0.15
Georgia	8.38	8.57	-0.82	-0.82	-2.67	-0.62
Iceland	4.57	4.48	-0.19	-0.19	-6.01	-6.27

Republic of Korea	4.81	4.98	-0.03	-0.03	2.64	3.52
Romania	6.47	6.05	3.13	3.13	-5.28	-6.37
The Russian Federation	7.06	7.48	-4.33	-4.33	-9.92	-9.92
Ukraine	7.33	14.82	2.05	2.05	4.77	6.35
Mean	6.14	7.14	0.46	0.46	-2.35	-1.90

Real GDP growth rate for **"the countries that are significantly affected by the crisis"** (Table 1.12) is:

- during the pre-crisis period: the average for countries 6.14% with the maximum value for Georgia (8.38%) and minimum for Chile (4.51%);
- during the crisis period: the average for countries 0.46% with the maximum value for Costa Rica (3.13%) and minimum for the Russian Federation (-4.33%);
- during the post-crisis period: the average for countries 2.35% with the maximum value for Ukraine (4.77%) and minimum for the Russian Federation (-9.92%).

According to the analysis of average real GDP growth, a group of **"countries that are significantly affected by the crisis"** is characterized by a sharp decline in this indicator of 5.68 percentage points: from 6.14% in pre-crisis period to 0.46% during the crisis period (compared to another group of countries where the decline was 3.73 percentage points: from 3.89% to 0.16%). Total depth fall for this group of countries is 8.49 percentage points, unlike the other group, where it was 4.16 pct. Moreover, countries that are significantly affected by the crisis, suffer larger recession in post-crisis period (-2.35% vs. -0.27%).

Table 1.13. The average rate of gross fixed capital formation in the pre-crisis, crisis, and post-crisis periods for "the countries that are not significantly affected by the crisis"

(% of GDP)

	Before the crisis		**During the crisis**		**After the crisis**	
	Mean	**Median**	**Mean**	**Mean**	**Median**	**Mean**
Argentina	19.42	20.69	22.82	23.40	16.75	20.98
Croatia	24.95	24.81	26.12	25.93	18.93	23.80

Kazakhstan	26.73	26.03	24.87	24.99	18.76	27.57
Norway	19.08	18.18	21.56	21.66	16.72	21.29
Poland	18.65	17.24	22.22	20.78	19.62	19.40
Sweden	18.05	18.02	19.00	18.77	17.86	18.58
Mean	18.22	17.94	19.63	19.48	15.63	18.91

Gross fixed capital formation for **"the countries that are not significantly affected by the crisis"** (Table 1.13) is:

- during the pre-crisis period: the average for countries 18.22% with the maximum value for Kazakhstan (26.73%) and minimum for Sweden (18.05%).
- during the crisis period: the average for countries 19.63% with the maximum value for Croatia (26.12%) and minimum for Sweden (19.00%).
- during the post-crisis period: the average for countries 15.63% with the maximum value for Poland (19.62%) and minimum for Norway (16.72%).

Table 1.14. The average rate of gross fixed capital formation in the pre-crisis, crisis, and post-crisis periods for "the countries that are significantly affected by the crisis"

(% of GDP)

	Before the crisis		**During the crisis**		**After the crisis**	
	Mean	**Median**	**Mean**	**Mean**	**Median**	**Mean**
Chile	20.46	20.45	27.87	27.87	14.30	21.02
Costa Rica	19.71	19.29	24.51	24.51	15.32	20.67
Georgia	25.67	26.02	23.70	23.70	9.50	12.76
Iceland	25.30	24.77	25.76	25.76	14.47	13.72
Republic of Korea	28.93	29.35	31.13	31.13	23.77	27.53
Romania	24.12	23.05	30.82	30.82	23.52	23.32
Russian Federation	18.38	18.16	22.81	22.81	16.33	19.23
Ukraine	23.02	22.89	21.29	21.29	14.02	17.16
Mean	23.74	23.13	23.73	23.73	17.01	20.16

Gross fixed capital formation for **"the countries that are significantly affected by the crisis"** (Table 1.14) is:

- during the pre-crisis period: the average for countries 23.74% with the maximum value for Republic of Korea (28.93%) and minimum for the Russian Federation (18.38%).

- during the crisis period: the average for countries 23.73% with the maximum value for Republic of Korea (31.13%) and minimum for Ukraine (21.29%).
- during the post-crisis period: the average for countries 17.01% with the maximum value for Republic of Korea (23.77%) and minimum for Georgia (9.50%).

According to the analysis of average gross fixed capital formation, a group of **"countries that are significantly affected by the crisis"**, is characterized by the decline of this index to 0.01 percentage points (from 23.74% in pre-crisis to 23.73% in the crisis period) compared with the group of countries that are not significantly affected by the crisis, where was an increase of 1.41 pct during the crisis period (from 18.22% to 19.63%). A decrease in the next period for the first group of countries was 6.72 pct for the second - 4 pct. Thus, the depth of drop for substantially affected countries is 6.73 pct. against 2.59 pct for another group.

Table 1.15. The average rate of fixed capital consumption in the pre-crisis, crisis, and post-crisis periods for "the countries that are not significantly affected by the crisis"

(% of GDP)

	Before the crisis		During the crisis		After the crisis	
	Mean	**Median**	**Mean**	**Mean**	**Median**	**Mean**
Argentina	73.12	73.06	72.78	72.07	58.55	72.47
Croatia	80.74	82.62	77.51	80.49	61.38	77.67
Kazakhstan	62.03	61.55	58.97	63.20	35.60	54.95
Norway	63.87	63.82	59.55	59.26	52.39	64.50
Poland	82.43	84.33	80.37	80.88	80.38	80.84
Sweden	73.76	74.04	73.37	73.18	75.84	75.98
Mean	62.56	63.05	60.73	61.67	52.39	61.29

Rate of fixed capital consumption for **"the countries that are not significantly affected by the crisis"** (Table 1.13) is:

- during the pre-crisis period: the average for countries 62.56% with the maximum value for Poland (82.43%) and minimum for Kazakhstan (62.03%).
- during the crisis period: the average for countries 60.73% with the maximum value for Poland (80.38%) and minimum for Kazakhstan (58.97%).

- during the post-crisis period: the average for countries 52.39% with the maximum value for Poland (80.38%) and minimum for Kazakhstan (35.60%).

Table 1.15. The average rate of fixed capital consumption in the pre-crisis, crisis, and post-crisis periods for "the countries that are significantly affected by the crisis"

(% of GDP)

	Before the crisis		During the crisis		After the crisis	
	Mean	**Median**	**Mean**	**Mean**	**Median**	**Mean**
Chile	70.06	69.96	77.12	77.12	48.79	72.88
Costa Rica	80.32	79.37	81.93	81.93	62.73	82.13
Georgia	90.31	87.36	98.10	98.10	71.92	101.06
Iceland	82.46	82.38	75.94	75.94	77.04	78.19
Republic of Korea	67.90	67.62	69.96	69.96	59.12	69.35
Romania	85.99	84.71	78.84	78.84	82.70	81.37
The Russian Federation	67.13	67.85	75.27	75.27	58.48	71.11
Ukraine	76.12	76.96	91.01	91.01	67.63	83.81
Mean	82.40	81.79	87.93	87.93	67.33	83.65

Rate of fixed capital consumption for **"the countries that are significantly affected by the crisis"** (Table 1.13) is:

- during the pre-crisis period: the average for countries 82.40% with the maximum value for Georgia (90.31%) and minimum for the Russian Federation (62.03%).
- during the crisis period: the average for countries 87.93% with the maximum value for Georgia (98.10%) and minimum for Republic of Korea (69.96%).
- during the post-crisis period: the average for countries 67.33% with the maximum value for Romania (82.70%) and minimum for Chile (48.79%).

According to the values of the average rate of fixed capital consumption, a group **of countries that are significantly affected by the crisis** is characterized by generally higher levels of fixed capital consumption, compared with a group of countries, which are not significantly affected by the crisis, during all three periods. Score for the first group of countries grew by 5.53 pct. (from 82.40% in the pre-crisis to 87.93% in the crisis period) unlike the second group, where it decreased by

1.83 pct. (from 62.54% to 60.73%, respectively). A decrease of the indicator in the next period for the first group of countries is equal to 20.6 pct., while for the second it is 8.34 pct. Total depth of drop for the substantially affected countries is15.07 pct. against 10.17 pct. for another group.

Debt Load

Table 1.17. The average rate of total external debt durinf the pre-crisis, crisis and post-crisis periods for countries that are not significantly affected by the crisis

(% of GDP)

	Before the crisis		During the crisis		After the crisis	
	Mean	**Median**	**Mean**	**Mean**	**Median**	**Mean**
Argentina	52	42	34	33	25	31
Croatia	176	242	289	297	260	307
Kazakhstan	142	131	234	202	140	208
Norway	297	359	528	555	403	492
Poland	146	148	176	164	150	191
Slovakia	128	155	109	158	-	-
Sweden	251	400	609	588	619	632
Mean	170	211	282	285	266	310

Value of total external debt to **"the countries that are not significantly affected by the crisis"** (Table 1.17) is:

- during the pre-crisis period: the average for countries 170% with the maximum value for Norway (297%) and minimum for Argentina (52%).
- during the crisis period: the average for countries 282% with the maximum value for Sweden (609%) and minimum for Argentina (34%).
- during the post-crisis period: the average for countries 266% with the maximum value for Sweden (82.70%) and minimum for Argentina (48.79%).

Table 1.18. The average rate of total external debt durinf the pre-crisis, crisis and post-crisis periods for countries that are significantly affected by the crisis

(% of GDP)

	Before the crisis		During the crisis		After the crisis	
	Mean	**Median**	**Mean**	**Mean**	**Median**	**Mean**
Armenia	109	99	248	248	180	169
Chile	110	125	174	174	100	141

Costa Rica	75	92	112	112	74	102
Georgia	139	140	185	185	152	217
Iceland	76	49	297	297	436	439
Republic of Korea	106	98	187	187	149	170
Moldova	173	195	314	314	151	238
Romania	154	154	140	140	238	235
The Russian Federation	105	115	144	144	102	123
Ukraine	130	163	349	349	263	317
Mean	117	123	215	215	185	215

Value of total external debt to **"the countries that are significantly affected by the crisis"** (Table 1.17) is:

- during the pre-crisis period: the average for countries 117% with the maximum value for Moldova (173%) and minimum for Costa Rica (75%).
- during the crisis period: the average for countries 215% with the maximum value for Ukraine (349%) and minimum for Costa Rica (112%).
- during the post-crisis period: the average for countries 185% with the maximum value for Iceland (436%) and minimum for Costa Rica (74%).

Group of **countries that are significantly affected by the crisis** in general is characterized by lower rate of total external debt than the group of countries that are not significantly affected by the crisis, during all periods. The score for the first group of countries increased by 98 pct (from 117% in the pre-crisis to 215% in the crisis period), unlike the second group, where growth was 112 pct. (from 170% to 282%). In the subsequent period, both indices decreased: by 30 pct. for the first group and by 53 pct. for the second one. Overall, according to the data of all periods, indices increased: for the substantially affected countries by 68 pct. and by 59 pct. for another group.

Table 1.19. ***The average of the index of short term debt before, during and after crisis period for countries insignificantly damaged by crisis***

(y %, from GDP)

	Before Crisis		**During Crisis**		**After Crisis**	
	average	**median**	**average**	**median**	**average**	**median**

Argentina	30	30	31	32	30	30
Australia	33	34	34	34	32	32
Canada	38	38	41	42	38	38
Croatia	13	13	12	12	12	12
Germany	39	39	39	37	37	37
Kazakhstan	23	24	14	14	15	15
Norway	46	56	53	52	47	47
Poland	18	17	27	26	24	24
Slovakia	48	50	54	51	60	60
Sweden	32	44	51	51	44	44
Average	32	34	36	35	34	34

The index of short term debt for countries "**insignificantly damaged by the crisis**" (see table 1.19)

- Before the crisis period in average is 32% with maximum for Slovakia (48%) and minimum for Croatia (13%)
- During the crisis period in average is 36% with maximum for Slovakia (54%) and minimum for Croatia (12%)
- After the crisis period in average is 34% with maximum for Slovakia (60%) and minimum for Croatia (12%)

Table 1.20. ***The average of the index of short term debt before, during and after crisis period for countries significantly damaged by crisis (y %, from GDP)***

	Before Crisis		**During Crisis**		**After Crisis**	
	average	**median**	**average**	**median**	**average**	**median**
Armenia	19	19	14	14	11	12
Chili	19	18	24	24	23	23
Costa-Rika	26	36	45	45	35	31
Georgia	20	20	18	18	14	14
The Republic of Korea	38	36	43	43	39	38
Moldova	39	40	41	41	38	38
Romania	33	33	32	32	20	18
The Russian Federation	20	20	15	15	12	12
Ukraine	32	29	20	20	20	20

Average	27	28	28	28	24	23

The index of short term debt for countries "**significantly damaged by the crisis**" (see table 1.120)

- Before the crisis period in average is 27% with maximum for Moldova (39%) and minimum for Armenia and Chili (19%)

- During the crisis period in average is 28 with maximum for Costa-Rika (45%) and minimum for Armenia (14%)

- After the crisis period in average is 24% with maximum for The Republic of Korea (39%) and minimum for Armenia (11%)

According to the analysis of the average of the short term debt, the group of countries that were significantly damaged by the crisis show the rise of this index for about 1 percentage point (from 27% in before-crisis period to 28% in during-crisis period); for the other group of countries the index rose for 4 percentage points (from 32% to 36%). For both group of countries the index fell for 4 percentage points in the next period. This means that the average meaning of short term debt for the significantly damaged countries in after crisis period equals 24%, and for insignificantly damaged - 34%. In total the index of the first group fell for 3 percentage points, and for the second there was a rise for 2 percentage points.

Balance of payments

Table 1.21. ***The average of trade balance in before, during and after crisis periods for countries insignificantly damaged by the crisis***

(fraction from GDP)

	Before Crisis		**During Crisis**		**After Crisis**	
	average	**median**	**average**	**median**	**average**	**median**
Argentina	0,02	0,02	0,01	0,01	0,01	0,01
Croatia	-0,08	-0,15	-0,05	-0,15	-0,03	-0,05
Kazakhstan	0,08	0,09	0,12	0,11	0,06	0,03
Norway	0,15	0,15	0,18	0,19	0,08	0,12
Poland	-0,02	-0,02	-0,03	-0,04	0,00	0,00
Slovakia	-0,03	-0,02	-0,01	-0,01	0,00	0,00
Sweden	0,07	0,07	0,07	0,07	0,05	0,06
Average	0,03	0,02	0,04	0,03	0,03	0,03

The index of trade balance for countries "**insignificantly damaged by the crisis**" (see table 1.21)

- Before the crisis period in average is 3% with maximum for Norway (15%) and minimum for Croatia (-8%)
- During the crisis period in average is 4% with maximum for Norway (18%) and minimum for Croatia (-5%)
- After the crisis period in average is 3% with maximum for Poland (8%) and minimum for Croatia (-3%)

Table 1.22. ***The average of trade balance in before, during and after crisis periods for countries significantly damaged by the crisis***

(fraction from GDP)

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**average**	**median**
Armenia	-0,20	-0,18	-0,36	-0,36	-0,24	-0,27
Chili	0,09	0,09	-0,02	-0,02	0,05	0,07
Costa-Rika	-0,04	-0,04	-0,12	-0,12	-0,01	0,00
Georgia	-0,20	-0,18	-0,34	-0,34	-0,13	-0,17
Iceland	-0,08	-0,08	-0,06	-0,06	0,09	0,08
The Republic of Korea	0,02	0,01	-0,01	-0,01	0,03	0,04
Moldova	-0,40	-0,41	-0,45	-0,45	-0,22	-0,32
Romania	-0,10	-0,10	-0,10	-0,10	-0,06	-0,06
The Russian Federation	0,12	0,11	0,06	0,06	0,07	0,08
Ukraine	0,00	0,01	-0,07	-0,07	-0,01	-0,01
Average	-0,08	-0,08	-0,15	-0,15	-0,04	-0,06

The index of trade balance for countries "**significantly damaged by the crisis**" (see table 1.22)

- Before the crisis period in average is -8% with maximum for The Russian Federation (12%) and minimum for Moldova (-40%)

- During the crisis period in average is -15% with maximum for The Russian Federation (6%) and minimum for Moldova (-45%)

- After the crisis period in average is -4% with maximum for Iceland (9%) and minimum for Armenia (-24%)

The main defining feature for the trade balance of countries that were significantly damaged by the crisis is a negative dynamics of the index during all periods of analysis. For the group of countries that were insignificantly damaged from the crisis the index is above zero (positive). First group of country show the decrease of the index for 7 percentage points (from -8 in before crisis period to -15 in the during the crisis period); in contrast to the second group, where there was a growth of the index for 1 percentage point (from 3% to 4%). In the next period the index of the first group of countries grew for 1 percentage point, and for the second group there was a decrease for 1 percentage point (to -4% and 3 accordingly). Therefore, the trade balance hadn't changed dramatically for the countries insignificantly damaged by the crisis and rose for those significantly damaged in average for 4 percentage points still maintaining negative meaning.

Table 1.23. ***The average meaning of the current account index of trade balance index before, during and after crisis periods for countries insignificantly damaged by the crisis***
(fraction to GDP)

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**average**	**median**
Argentina	0,01	0,01	0,01	0,01	0,00	0,00
Croatia	-0,08	-0,15	-0,06	-0,16	-0,04	-0,07
Kazakhstan	-0,02	-0,02	0,00	-0,01	-0,02	0,00
Norway	0,15	0,13	0,18	0,21	0,09	0,12
Poland	-0,03	-0,03	-0,03	-0,05	-0,01	-0,01
Slovakia	-0,06	-0,06	-0,04	-0,05	0,00	0,00
Sweden	0,07	0,07	0,09	0,09	0,06	0,08
Average	0,01	-0,01	0,02	0,01	0,01	0,02

The current account index of the trade balance for countries "**insignificantly damaged by the crisis**" (see table 1.23)

- Before the crisis period in average is 1% with maximum for Norway (15%) and minimum for Croatia (-8%)

- During the crisis period in average is 2% with maximum for Norway (18%) and minimum for Croatia (-6%)

- After the crisis period in average is 1% with maximum for Norway (9%) and minimum for Croatia (-4%)

Table 1.24. ***The average meaning of the current account index of trade balance before, during and after crisis periods for countries significantly damaged by the crisis***

(fractions, to GDP)

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**average**	**median**
Armenia	-0,06	-0,04	-0,20	-0,20	-0,14	-0,15
Chili	0,02	0,02	-0,06	-0,06	0,02	0,02
Costa-Rika	-0,05	-0,06	-0,12	-0,12	-0,02	0,00
Georgia	-0,14	-0,13	-0,24	-0,24	-0,09	-0,09
Iceland	-0,13	-0,13	-0,36	-0,36	-0,03	-0,03
The Republic of Korea	0,01	0,01	0,00	0,00	0,03	0,04
Moldova	-0,09	-0,08	-0,21	-0,21	-0,04	-0,05
Romania	-0,09	-0,09	-0,07	-0,07	-0,05	-0,05
The Russian Federation	0,09	0,09	0,03	0,03	0,04	0,04
Ukraine	0,03	0,03	-0,07	-0,07	-0,01	-0,01
Average	-0,04	-0,04	-0,13	-0,13	-0,03	-0,03

The current account index of trade balance for countries "**significantly damaged by the crisis**" (see table 1.24)

- Before the crisis period in average is -4% with maximum for The Russian Federation (9%) and minimum for Georgia (-14%)

- During the crisis period in average is -13% with maximum for The Russian Federation (3%) and minimum for Iceland (-36%)

- After the crisis period in average is 34% with maximum for The Russian Federation (4%) and minimum for Armenia (-14%)

For countries that were significantly damaged by the crisis the current account index is characterized by the negative level and it is positive for the other group of the countries. First group of the countries is defined by the decrease of the index for 9 percentage points (from -4% in before crisis period to -13% in the during the crisis period), while the second shows the slight increase of the index for 1 percentage points (from 1% to 2%). In the next period index of the first group of countries has increased for 1 percentage points, and for the second there was a decrease for 1 percentage point (to -3 and 1 respectively). Therefore the current account of trade balance has change little for the countries that experienced insignificant damage from the crisis and did increased for 1 percentage point for the countries that suffered significantly from the crisis.

Table 1.25. ***The average meaning of the international reserves index before, during and after crisis periods for countries insignificantly damaged by the crisis***

(fractions, to GDP)

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**average**	**median**
Argentina	12	12	15	14	14	14
Croatia	82	82	80	81	86	86
Kazakhstan	58	55	62	53	68	69
Norway	58	60	49	51	50	50
Poland	54	55	57	54	68	65
Slovakia	108	115	72	72		
Sweden	23	24	27	26	39	39
Average	57	57	52	50	54	54

The index of international reserves for countries "**insignificantly damaged by the crisis**" (see table 1.25)

- Before the crisis period in average is 57% with maximum for Slovakia (108%) and minimum for Argentina (12%)

- During the crisis period in average is 52% with maximum for Croatia (80%) and minimum for Argentina (15%)

- After the crisis period in average is 54% with maximum for Croatia (86%) and minimum for Argentina (14%)

Table 1.26. ***The average meaning of the international reserves index before, during and after crisis periods for countries significantly damaged by the crisis***

(fractions, to GDP)

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**average**	**median**
Armenia	63	52	101	101	99	94
Chili	62	58	66	66	58	58
Costa-Rika	46	44	54	54	55	55
Georgia	30	27	48	48	66	66
Iceland	31	26	97	97	118	116
The Republic of Korea	96	96	104	104	113	112
Moldova	76	75	110	110	96	100
Romania	67	67	65	65	106	105
The Russian Federation	90	83	130	130	123	121
Ukraine	61	65	99	99	87	87
Average	62	59	87	87	92	91

The international reserves index for countries "**significantly damaged by the crisis**" (see table 1.26)

- Before the crisis period in average is 63% with maximum for the Republic of Korea (96%) and minimum for Georgia (30%)

- During the crisis period in average is 87% with maximum for The Russian Federation (130%) and minimum for Georgia (48%)

- After the crisis period in average is 74% with maximum for The Russian Federation (123%) and minimum for Costa-Rika (55%)

In accordance to the analysis of the average meaning of international reserves, the group of countries that were damaged significantly from the crisis are

characterized by the rise of the index for 25 percentage points (from 62% in the before-crisis period to 87% in the during-crisis period). As for the other set of countries the index decreased for 5 percentage points (from 57% to 52%). For the first group of countries the index increased for 5 percentage points in the next period, reaching 92%, and as for the other group of countries it rose by 2 percentage points and reached 54 percentage points. The depth of the decrease for the insignificantly damaged countries accounts for 3 percentage points, while for the other countries the index rose substantially – for 30 percentage points.

Table 1.27. ***The average meaning of the growth rate of the real effective exchange rate before, during and after crisis periods for countries insignificantly damaged by the crisis***
(y% to the previous period)

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**Average**	**median**
Argentina	1,20	1,20	-7,42	-2,95	5,02	5,62
Canada	0,94	0,88	-3,42	-1,73	3,03	3,48
Croatia	0,50	0,37	-0,41	-0,53	-0,01	-0,58
Kazakhstan	0,36	0,22	-0,54	-1,53	-0,99	0,54
Norway	0,34	0,28	-3,26	-1,53	1,92	1,83
Poland	0,53	0,61	-9,03	-13,97	2,18	2,66
Slovakia	1,96	1,10	2,82	3,92	-1,15	0,01
Sweden	0,28	0,39	-5,49	-5,02	1,54	1,53
Average	0,76	0,63	-3,34	-2,91	1,44	1,88

The growth rate of the real effective exchange rate for countries "**insignificantly damaged by the crisis**" (see table 1.27)

- Before the crisis period in average is 0,76% with maximum for Slovakia (1,96%) and minimum for Sweden (0,28%)

- During the crisis period in average is -3,34% with maximum for Slovakia (2,82%) and minimum for Poland (-9,03%)

- After the crisis period in average is 1,44% with maximum for Australia (5,02%) and minimum for Slovakia (-1,15%)

Table 1.28. ***The average meaning of the growth rate of the real effective exchange rate before, during and after crisis periods for countries significantly damaged by the crisis***

(y% to the previous period)

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**average**	**median**
Armenia	1,56	1,47	-1,52	-1,52	-4,33	-6,31
Chili	0,02	0,11	-7,12	-7,12	2,05	2,17
Costa-Rika	-0,31	-0,18	-2,48	-2,48	3,11	1,13
Georgia	1,19	0,35	4,63	4,63	-2,58	-2,08
Iceland	0,13	1,00	-3,36	-3,36	-1,86	0,37
Moldova	1,82	1,82	4,23	4,23	-4,60	-3,42
Romania	0,92	1,16	-5,49	-5,49	-0,81	-0,40
The Russian Federation	1,53	1,33	-7,61	-7,61	3,96	4,33
Ukraine	0,52	0,03	-9,60	-9,60	-0,12	-1,49
Average	0,82	0,79	-3,14	-3,14	-0,57	-0,63

The growth rate of the real effective exchange rate for countries "**significantly damaged by the crisis**" (see table 1.28)

- Before the crisis period in average is 0,82% with maximum for Moldova (1,82%) and minimum for Costa-Rika (-0,31%)

- During the crisis period in average is -3,14% with maximum for Georgia (4,63%) and minimum for Ukraine (-9,6%)

- After the crisis period in average is -0,57% with maximum for The Russian Federation (3,96%) and minimum for Moldova (-4,6%)

According to the average meaning of the growth rate of the real effective exchange rate the group of countries that experienced significant loses from the crisis show the decrease in the index for 3,96 percentage points (from 0,82% to -3,14% in the before-crisis and after-crisis periods respectively), while the second set of countries had suffered a decrease for 4,1 percentage points (from 0,76 to -3,34%). In the next period the index rose for the 2,57 percentage points for the first group of countries and for 4,78 percentage points – for the second. All in all, the rate of growth of real effective exchange rate decreased for 1,39 percentage points for the

countries significantly influenced by the crisis and the increase for 0,68 percentage point for the other set of countries.

Table 1.29. ***The average meaning of the nominal effective exchange rate before, during and after crisis periods for countries insignificantly damaged by the crisis*** **(%, level)**

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**Average**	**median**
Argentina	96,53	98,37	93,30	86,57	105,10	107,74
Canada	96,06	97,45	98,77	96,91	105,03	103,73
Croatia	99,77	99,98	103,84	104,48	103,82	103,79
Kazakhstan	99,64	100,26	103,63	104,11	104,09	104,83
Norway	99,78	99,65	96,75	94,15	99,74	101,57
Poland	100,19	101,33	108,85	108,55	100,18	101,08
Slovakia	101,47	99,38	129,37	128,73	131,17	132,14
Sweden	100,15	101,17	94,20	92,60	94,16	94,54
Average	99,20	99,70	103,59	102,01	105,41	106,18

The index of the nominal effective exchange rate for countries "**insignificantly damaged by the crisis**" (see table 1.29)

- Before the crisis period in average is 99,20% with maximum for Slovakia (101,47%) and minimum for Canada (96,06%)

- During the crisis period in average is 103,59% with maximum for Slovakia (131,17%) and minimum for Australia (03,30%)

- After the crisis period in average is 105,41% with maximum for Slovakia (131,17%) and minimum for Sweden (94,16%)

Table 1.30. ***The average meaning of the nominal effective exchange rate before, during and after crisis periods for countries significantly damaged by the crisis***

(%, level)

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**average**	**median**
Armenia	104,49	101,62	142,47	142,47	115,64	115,87
Chili	97,63	97,93	86,98	86,98	98,85	98,68
Costa-Rika	107,77	101,14	80,25	80,25	82,46	82,48
Georgia	99,80	100,23	122,49	122,49	112,18	110,35
Iceland	89,59	89,50	65,94	65,94	47,76	47,60
The Republic of	98,03	95,80	80,99	80,99	77,89	78,00

Korea						
Moldova	101,59	99,25	125,49	125,49	106,49	105,77
Romania	102,10	102,35	96,87	96,87	89,23	89,24
The Russian Federation	101,38	101,08	92,63	92,63	89,86	89,95
Ukraine	100,15	99,96	76,33	76,33	63,60	63,46
Average	100,25	98,89	97,04	97,04	88,40	88,14

The index of the nominal effective exchange rate for countries "**significantly damaged by the crisis**" (see table 1.30)

- Before the crisis period in average is 100,25% with maximum for Costa-Rika (107,77%) and minimum for Iceland (89,59%)

- During the crisis period in average is 97,04% with maximum for Armenia (142,47%) and minimum for Iceland (47,76%)

- After the crisis period in average is 88,04% with maximum for Armenia (115,64%) and minimum for Iceland (47,76%)

Following the analysis of the nominal effective exchange rate, the group of countries that were significantly damaged by the crisis are characterized by the fall of the index for 3,21 percentage points (from 100,25 to 97,04 in before-crisis and after crisis periods respectively), while the index of the second group of countries rose for 4,39 percentage points (from 99,2 to 103,59%). In the following period the index went on to decrease for the first group of countries (for 8,64 percentage points to 88,4%) and to increase for the second set of countries (for 1,82 percentage points to 105,41%). The whole depth of decrease for the countries significantly influenced by the crisis accounts for 11,85 percentage points, when the total growth of the index for the countries of the second group amounts for 6,21 percentage points.

International variables

Table 1.31. ***The average meaning of the real internal and external interest rate before, during and after crisis periods for countries insignificantly damaged by the crisis***

(y%, level)

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**Average**	**median**
Argentina	-12,40	-4,58	-20,14	-18,26	-12,24	-11,27
Australia	-5,62	-6,02	-5,49	-4,94	-5,95	-6,07
Canada	-1,79	-1,90	-1,52	-1,59	-1,82	-1,90
Croatia	-7,90	-8,55	-8,40	-8,06	-10,74	-10,67
Germany	-1,82	-1,32	-3,24	-3,36	-4,18	-4,06
Norway	-2,53	-2,06	-4,49	-4,56	-3,10	-3,77
Average	-5,43	-4,07	-7,21	-6,80	-6,33	-6,29

The index of the real internal and external interest rate for countries "**insignificantly damaged by the crisis**" (see table 1.31)

- Before the crisis period in average is -5,43% with maximum for Canada (-1,79%) and minimum for Argentina (-12,40%)

- During the crisis period in average is -7,21% with maximum for Canada (-1,52%) and minimum for Argentina (-20,14%)

- After the crisis period in average is -6,33% with maximum for Canada (-1,82%) and minimum for Argentina (-12,24%)

Table 1.32. ***The average meaning of the real internal and external interest rate before, during and after crisis periods for countries significantly damaged by the crisis***

(y%, level)

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**average**	**median**
Armenia	-15,44	-14,57	-17,94	-17,94	-18,51	-18,44
Chili	-4,48	-3,69	-15,29	-15,29	-5,57	-3,93
Costa-Rika	-18,69	-21,32	-14,26	-14,26	-18,17	-17,87
Georgia	-22,32	-18,65	-20,43	-20,43	-24,60	-25,02
Iceland	-12,48	-11,54	-17,70	-17,70	-10,45	-16,26
The Republic of Korea	-3,13	-3,53	-4,53	-4,53	-5,06	-5,10
Moldova	-17,06	-17,88	-21,86	-21,86	-18,18	-17,81
Romania	-18,25	-17,14	-14,46	-14,46	-15,90	-16,31
The Russian Federation	-8,72	-8,24	-13,75	-13,75	-13,32	-13,60
Ukraine	-14,40	-14,46	-22,07	-22,07	-17,67	-17,89

Average	-13,50	-13,10	-16,23	-16,23	-14,74	-15,22

The index of the real internal and external interest rate for countries "**significantly damaged by the crisis**" (see table 1.32)

- Before the crisis period in average is -13,50% with maximum for The Republic of Korea (-3,13%) and minimum for Georgia (-22,32%)

- During the crisis period in average is -16,23% with maximum for Republic of Korea (-4,53%) and minimum for Ukraine (-22,07%)

- After the crisis period in average is -14,74% with maximum for Republic of Korea (-5,06%) and minimum for Georgia (-24,60%)

The average meaning of the index of real internal and external interest rates is negative for both group of countries during all 3 periods. The dynamics of the decrease of the index for the countries that suffered significantly from the crisis amounts for 2,73 percentage points (from -13,5% in before-crisis to -16,23% in during the crisis periods), while for the other group of countries the decrease accounts for 1,78 percentage points (from -5,43% to 7,21%). During the next period the index grew for both countries – for 1,49 percentage points to -14,74% for the first group and for 0,88 percentage points to -6,33% for the second group. All in all the depth of the decrease for the countries damaged significantly amounts for 1,24 for 1,49 percentage points to -14,74 for the first group, for the other set of countries – 0,9 percentage point.

Financial liberalization

Table 1.33. ***The average meaning of the monetary multiplication index before, during and after crisis periods for countries insignificantly damaged by the crisis***

(fraction, level)

	Before Crisis		**During Crisis**		**After Crisis**	
	average	**median**	**average**	**median**	**Average**	**median**
Kazakhstan	2,18	2,23	2,49	2,46	2,06	2,09
Poland	5,40	5,40	5,15	5,13	5,65	5,71
Sweden	12,23	11,63	10,74	10,04	8,17	8,55

Average	6,60	6,42	6,12	5,88	5,30	5,45

The index of the monetary multiplication for the countries "**insignificantly damaged by the crisis**" (see table 1.33)

- Before the crisis period in average is 6,60 with maximum for Sweden (12,23) and minimum for Kazakhstan (2,18)

- During the crisis period in average is 6,12 with maximum for Sweden (10,74) and minimum for Kazakhstan (2,49)

- After the crisis period in average is 5,30 with maximum for Sweden (8,17) and minimum for Kazakhstan (2,06)

Table 1.34. ***The average meaning of the monetary multiplication index before, during and after crisis periods for countries significantly damaged by the crisis***

(fraction, level)

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**average**	**median**
Armenia	1,19	1,16	0,91	0,91	0,92	0,91
Chili	3,93	3,82	4,43	4,43	4,22	4,13
Costa-Rika	1,17	1,17	1,39	1,39	1,48	1,46
Georgia	1,04	1,00	1,13	1,13	1,15	1,14
Iceland	7,16	6,56	4,20	4,20	4,17	5,45
The Republic of Korea	25,41	25,18	26,24	26,24	20,52	24,75
Moldova	1,69	1,66	1,94	1,94	1,99	2,00
Romania	3,97	4,15	3,44	3,44	3,86	3,78
The Russian Federation	2,13	2,07	2,62	2,62	2,75	2,51
Ukraine	2,45	2,44	2,69	2,69	2,51	2,49
Average	5,01	4,92	4,90	4,90	4,36	4,86

The index of the monetary multiplication for countries "**significantly damaged by the crisis**" (see table 1.34)

- Before the crisis period in average is 5,01 with maximum for The Republic of Korea (25,41) and minimum for Georgia (1,04)

- During the crisis period in average is 4,90 with maximum for The Republic of Korea (26,24) and minimum for Armenia (0,91)

- After the crisis period in average is 4,36 with maximum for The Republic of Korea (20,52) and minimum for Armenia (0,92)

According to the analysis of the money multiplier , the set of countries that significantly suffered from the crisis are characterized by the decrease of the index for 1,1 percentage points (from 5,01 to 4,90 in before-crisis and during-crisis periods respectively). In the next period index continued to decrease for both set of countries (for the first group for 0,54 point to 4,36; for the second – for 0,82 to 5,30). The total depth of the fall for the countries that were damaged significantly by the crisis amount for 0,65 points, and for insignificantly damaged – 1,3 points.

Other financial variables

Table 1.35. ***The average meaning of the growth rate of CPI index before, during and after crisis periods for countries insignificantly damaged by the crisis***

(y% to previous year)

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**Average**	**median**
Argentina	12,14	8,95	7,79	7,84	7,63	7,12
Australia	2,90	2,82	3,71	3,69	2,15	2,11
Canada	2,20	2,16	2,19	1,91	0,60	0,79
Croatia	2,77	2,26	5,24	4,49	1,47	1,23
Germany	1,69	1,65	1,85	1,65	0,46	0,44
Kazakhstan	8,55	7,49	13,25	11,53	6,97	6,94
Norway	1,62	1,49	3,58	3,60	2,36	2,60
Poland	2,17	1,87	4,10	3,85	3,46	3,64
Slovakia	4,85	4,19	4,27	4,80	1,05	1,12
Sweden	1,58	1,59	2,51	2,45	0,04	-0,37
Average	4,05	3,45	4,85	4,58	2,62	2,56

The index of the growth rate of CPI for countries "**insignificantly damaged by the crisis**" (see table 1.35)

- Before the crisis period in average is 4,05% with maximum for Argentina (12,14%) and minimum for Sweden (1,58%)

- During the crisis period in average is 4,85% with maximum for Kazakhstan (13,25%) and minimum for Germany (1,85%)

- After the crisis period in average is 2,62% with maximum for Argentina (7,63%) and minimum for Sweden (0,04%)

- **Table 1.36.** ***The average meaning of the growth rate of CPI index before, during and after crisis periods for countries significantly damaged by the crisis***

- **(y% to previous year)**

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**average**	**median**
Armenia	4,26	4,35	2,00	2,00	5,26	4,87
Chili	3,52	2,86	8,61	8,61	1,28	0,70
Costa-Rika	10,97	10,62	15,11	15,11	8,45	6,03
Georgia	7,59	7,03	6,25	6,25	2,68	2,84
Iceland	4,78	4,12	14,04	14,04	11,46	11,01
The Republic of Korea	3,01	3,05	5,02	5,02	2,74	2,63
Moldova	11,37	11,83	3,12	3,12	2,12	-0,60
Romania	11,34	8,85	6,81	6,81	5,23	4,81
The Russian Federation	12,21	12,55	13,74	13,74	9,24	9,21
Ukraine	10,38	9,65	21,50	21,50	12,65	13,34
Average	7,94	7,49	9,62	9,62	6,11	5,48

The index of the growth rate of CPI for countries "**significantly damaged by the crisis**" (see table 1.36)

- Before the crisis period in average is 7,94% with maximum for The Russian Federation (12,21%) and minimum for The Republic of Korea (3,01%)

- During the crisis period in average is 9,62% with maximum for Ukraine (21,50%) and minimum for Armenia (2,00%)

- After the crisis period in average is 6,11% with maximum for Ukraine (12,65%) and minimum for Chili (1,28%)

In accordance to the conducted analysis of the CPI, the group of countries that were influenced significantly by the crises is characterized by the rise for 1,68 percentage points (from 7.94% in the before-crisis period to 9,62% in the during-crises period); while the index of the second group increased for 0,8 percentage points (from 4,05% to 4,85%). During the following period the index increased: for the first group for 3,51 percentage points (to 6,11%), for the second group of countries for 2,23 percentage points (to 2,62%). The total fall of the index of the CPI for the first group of countries amounts 1,83 percentage points, and for the second – 1,43 percentage points.

Table 1.37. ***The average meaning of the growth rate of money supply before, during and after crisis periods for countries insignificantly damaged by the crisis***

(y% to previous year)

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**Average**	**median**
Argentina	6,20	6,38	3,02	3,06	6,50	6,68
Kazakhstan	7,15	6,94	4,31	7,07	6,77	7,25
Norway	2,19	2,31	-0,15	-	-	-
Poland	2,42	2,76	4,47	4,05	1,66	1,27
Slovakia	1,84	2,23	1,88	1,52	-	-
Sweden	1,82	2,00	2,79	2,81	1,08	1,23
Average	3,60	3,77	2,72	3,09	2,67	2,74

The index of the growth rate of money supply for countries "**insignificantly damaged by the crisis**" (see table 1.37)

- Before the crisis period in average is 3,60% with maximum for Kazakhstan (7,15%) and minimum for Sweden (1,82%)

- During the crisis period in average is 2,72% with maximum for Poland (4,47%) and minimum for Norway (-0,15%)

- After the crisis period in average is 2,67% with maximum for kazakhstan (6,77%) and minimum for Sweden (1,08%)

Table 1.38. ***The average meaning of the growth rate of money supply before, during and after crisis periods for countries significantly damaged by the crisis***

(y% to previous year)

	Before Crisis		During Crisis		After Crisis	
	average	**median**	**average**	**median**	**average**	**median**
Armenia	7,65	7,16	-33,54	-33,54	4,22	6,48
Chili	3,24	3,22	5,94	5,94	-0,28	-1,01
Costa-Rika	5,34	5,92	-0,38	-0,38	2,15	2,47
Georgia	6,85	6,87	-18,33	-18,33	4,29	5,22
Iceland	8,30	5,01	5,24	5,24	4,25	0,00
The Republic of Korea	2,07	1,81	2,07	2,07	2,04	2,40
Moldova	6,96	5,79	-21,17	-21,17	4,99	3,57
Romania	6,99	6,23	4,65	4,65	1,71	2,04
The Russian Federation	8,68	7,40	-8,19	-8,19	7,35	7,46
Ukraine	9,03	9,63	-0,93	-0,93	2,95	1,96
Average	6,51	5,90	-6,46	-6,46	3,37	3,06

The index of the growth rate of money supply for countries "**insignificantly damaged by the crisis**" (see table 1.38)

- Before the crisis period in average is 6,51% with maximum for Ukraine (9,03%) and minimum for The Republic of Korea (2,07%)

- During the crisis period in average is -6,46% with maximum for Chili (5,94%) and minimum for Armenia (-33,54%)

- After the crisis period in average is 3,37% with maximum for The Russian Federation (7,35%) and minimum for Chili (-0,28%)

According to the analyses of the growth of the money supply, the index for the countries that suffered significantly from the crisis experienced the fall for 12,97 percentage points (from 6,51% to 6,46%), while the other group the decline was minor and reached the level of the 0,88 percentage points (from 3,6% to 2,72%). During the next period the index increased for the first group for 9,83 percentage points (to 3,37%) and decreased for the 0,05 percentage point (to 2,67%) for the second group. The total decrease of the index of the growth rate of the money

supply for the first set of countries amounts for 3,4 percentage points, and for the group of countries - 0,93 percentage point.

The conducted comparative statistical analysis of the dynamics of the macroeconomics variables of the worlds economies for the before, during and after-crisis periods showed that there is one characteristic tendency: for the set of countries that experienced a significant damage from the crisis during the transition from the before-crisis to the crisis period there is obvious decrease in indexes such as growth rate of the real GDP (from 6,145 to 0,46%), the trade balance (from -8% to -15%), the current account of the trade balance (from -4% to -13%), the growth rate of the real effective exchange rate (from 0,82% to 3,14%), the growth rate of nominal effective exchange rate (from 100,25% to 97,04%), the level of real external and internal interest rate (from -13,5 to -16,23), the level of money multiplier (from 5,01 to 4,90) and the growth rate of the money supply (from 6,51% to -6,46); and also the increase of the following variables as the total external debt in respect to GDP (from 117% to 215%), short term external debt in respect to GDP (from 27% to 215%) and the CPI (from 7,94 to 9,62%). The indexes of the gross accumulation and consumption of the capital assets show the tendencies of the capital distribution.

During the after crisis period one can see the resumption of the level of previously mentioned variables and indexes.

For the index that shows the ratio of international reservs to GDP the situation is atypical. During the crisis period the group of countries that suffered sufficiently from the crisis are characterized by the much higher level of the index(87%) than the countries that were influenced little by the crisis (52%). The same is the comparison of the index of two groups of countries during the before-crisis period (62% for those that were damaged significantly and 57% for those the opposite) and after-crisis period (92% for those that were damaged significantly and 54% for those the opposite).

Conclusions to Part 1

In the first part of the paper we have examined in detail the overall tendencies of the world financial crisis development of 2007-2009 years. We have distinguished among them the development of securitization, appearing of the "shadow banking system", the rise of the market of credit-default swaps, the increase of the demand for the raw materials etc.

Different theoretical approaches to identification and development of the three types of financial crisis were investigated: banking, currency crises and the crises of financial markets (including state finance). On the basis of the conducted research dome tendencies that characterize crisis situation were noted. As a result of the investigation the list of main indexes was formed. Those variables reveal crisis tendencies of the world economies according to the following groups: real sector, debt burden, trade balance, international variables, financial liberalization, and fiscal variables. The groups of the indexes, their compositions and description are provided in Table 1.

Using the methodology of the index that shows the pressure on the currency market, the analyses of 239 countries was conducted and the periods of crises were defined. With the aim of the further analyses countries were grouped in two sets with 10 countries each: "countries that were damaged significantly by the crisis" (Table 6). and "countries that were damaged insignificantly by the crisis" (Table 7). The characteristics of the economies' peculiarities were provided.

On the basis of the chosen indexes and countries the comparative statistical analyses of the dynamics of macroeconomic variables of the world economies during the periods of before, during and after crisis was carried out (table 10-37). In the result the main tendencies were shown apparent.

So, as a result of the conducted comparative analysis of the dynamics of macroeconomic variables of the world economies during the periods of before, during and after crisis one may conclude that among the variables that foresee the crisis development best (other words may be considered as sign indicators) are the following 9with pointing out the group they belong to): the growth rate of the real

GDP, gross accumulation of current assets and the consumption of current assets (real sector); gross external and short term external debt (debt burden); trade balance; current account trade balance, the growth rate of real effective exchange rate and the growth rate of nominal effective exchange rate (balance of payments); the ratio of real internal to real external interest rates (international variables); money multiplier (financial liberalization), CPI and the growth rate of money supply (other financial variables).

Part 2. Analysis and quantitative estimation of the precondition of the economy shift to a crisis state

2.1. Methods that determine main indexes and their values as a proof of a possible crisis arising

To determine the main leading indicators and their values that indicate the possible onset of economic crisis the "signals approach", which was developed by G. Kaminsky and C. Reinhart for predicting financial crises, was used [27].

In order to utilise the “signals approach” it is necessary to determine the list of indicators to be tested, considering whether they predict financial instability or not. The list of such indicators was defined in chapter 1.2. It should be noted that not every proposed indicator was analyzed because the statistics on some of them is not available.

The methodology of the "signals approach” is based on the concept of "signal". The idicator issues a signal if it deviates from its historical mean by an amount greater than specific critical value. It is said that the indicator X_t^j gives a signal about the crisis in period *t*, if its value in this period exceeds the threshold value X_{cr}^j.

Formal definition of the signal is as follows:

$$\{S_t^j = 1\} = \{S_t^j, \left|X_t^j - \overline{X}^j\right| > \left|X_{cr}^j\right|\}, \tag{2.1}$$

where S_t^j is signal of indicator *j* in period *t*, X_t^j is the value of the indicator *j* in period *t*, $\overline{X}^j$ – mean of the indicator *j*, X_{cr}^j – threshold value of the indicator *j*.

Respectively, lack of signal is defined as follows:

$$\{S_t^j = 0\} = \{S_t^j, \left|X_t^j - \overline{X}^j\right| < \left|X_{cr}^j\right|\}. \tag{2.2}$$

The equations are given in absolute values, as some indicators of future crises issue signals by declining and other by growing. By using the absolute values it is possible to take into account deviations from the mean to both sides.

If the indicator issues a signal during some reasonable time before the crisis (the so-called “signaling window”), this indicator is labeled as accurate. If the indicator gives a signal and the crisis never occurs within given timeframe, the alarm is labeled as false alarm. In this research the signaling window of 4 quarters before

the crisis is used. In other words, it is assumed that the negative trends that can lead to financial crisis can be detected one year before the actual emergence of the crisis.

To obtain a set of country-specific "optimal" threshold values of each indicator the following procedure was used. Threshold values are defined in percentiles of distribution of each parameter. For example, possible set of country-specific thresholds for the growth rate of imports could be a set of growth rates (one per country) that would leave 10% of observations of growth rates of imports above threshold for each country. Notice that threshold in percentiles of distribution is the same for all countries, whereas the corresponding country-specific thresholds for each country are different. For example, the optimal threshold value is 5 pecentiles of distribution of an indicator. Then the actual threshold value for each country leaves only 5 percentage of the distribution of this indicator above this value.

Threshold values are chosen by exhaustive search of possible thresholds in percentiles in order to both minimize the number of false alarms, and predict the maximum number of crises. The criterion which allows to do this is the minimizing of the ratio of "noise" to "signal" for each of the indicators. To explain this criterion it is useful to divide all indicator values into four groups as in Table. 2.2.1.

Table 2.1. ***Possible values of indicators***

	Crisis (within 4 quarters)	***No crisis (within 4 quarters)***
Signal was issued	A	B
No signal was issued	C	D

It is clear that in case of an ideal indicator its values will fall only in cells A and D. When choosing the threshold values the ratio of "noise" to "signal" has to be minimized:

$$[B/(B+D)]/[A/(A+C)] \quad (2.3)$$

Additional criteria are also used. The unconditional probability of financial crisis' occurrence for each indicator is defined as the ratio of observations after which within the signaling window the financial crisis ocurred to all observations:

$$P(C) = (A+C)/(A+B+C+D) \quad (2.4)$$

If the indicator issues a large number of "accurate" signals, one can expect that the probability of occurrence of the crisis after the signal P(C|S) (conditional probability) is greater than the unconditional probability P(C). Conditional probability is defined as:

$$P(C|S) = A/(A+B) \quad (2.5)$$

Therefore, for effective indicators is the following inequality must hold:

$$P(C|S) > P(C) \quad (2.6)$$

The validity of this condition is necessary for the threshlod to be optimal.

Thus, all possible thresholds for each indicator (for the maximum possible period of time) were considered, and those indicator-specific thresholds in percentiles which minimized the "noise" to "signal" ratio were chosen as optimal. The values in percentiles were then transformed into the actual country-specific threshold values of indicators.

Application of methodology of "signals approach" for ten pre-selected crisis countries using the economic data between the I quarter of 2002 to II quarter of 2010 allowed to obtain the results presented in Table. 2.2. Specific crisis periods for each country were specified in the previous sections.

Indicators in Table 2.2 are sorted ascending by the ratio of "noise" to "signal". That is the most effective indicators by this criterion are listed first. Also the table provides data on the number of crises which were accurately predicted (local crisis in

selected countries, and hence the maximum is 10 crises). It should be noted that most indicators accurately forecast 5 or more local crises.

The fifth column in the table shows the ratio of accurate signals issued to all possible accurate signals. 100% in this column would mean that the indicator gives a signal in each of the 4 quarters preceding the crisis period. **According to this criterion, the most effective indicator is the ratio of government credit to GDP, which gave 72.97% accurate signals of all possible accurate signals.**

The sixth column shows the ratio of false alarms issued to all possible false alarms. The best indicator according to this criterion is the **proportion of short-term debt in the structure of foreign debt, which provided only 0.98% of all possible false signals.**

The eighth column is an alternative to the seventh; it shows the probability of a crisis conditioned on the presence of the signal. The results according to this criterion correspond to the results received with the help of "noise" to "signal" ratio.

The next column shows the difference between the conditional and the unconditional probabilities of crisis for each indicator. The better indicator, the greater the likelihood of financial crisis after the signal is given and, therefore, the higher is the difference between conditional and unconditional probabilities of crisis, since the unconditional probability does not depend on the choice of threshold. Different values of the unconditional probability of the indicators depend only on the availability of data.

Table 2.3 contains the threshold values of indicators for each of the analyzed countries. **Thresholds are provided in the form of deviation from the mean.**

Let’s illustrate the proposed methodology on the example of ratio of the trade balance to GDP. For clarity consider the indicators of two countries: Ukraine and the Republic of Korea.

Figure 2.1 shows the dynamics of the deviation of the ratio of trade balance to GDP from its mean for the period from the I quarter of 2002 to IV quarter of 2009 for Ukraine. The mean ratio is -0.0035. Upper and lower threshold deviations from the mean, which were defined by the beforementioned methodologie are -0.0945 and 0.0945 respectively (see Table. 2.3).

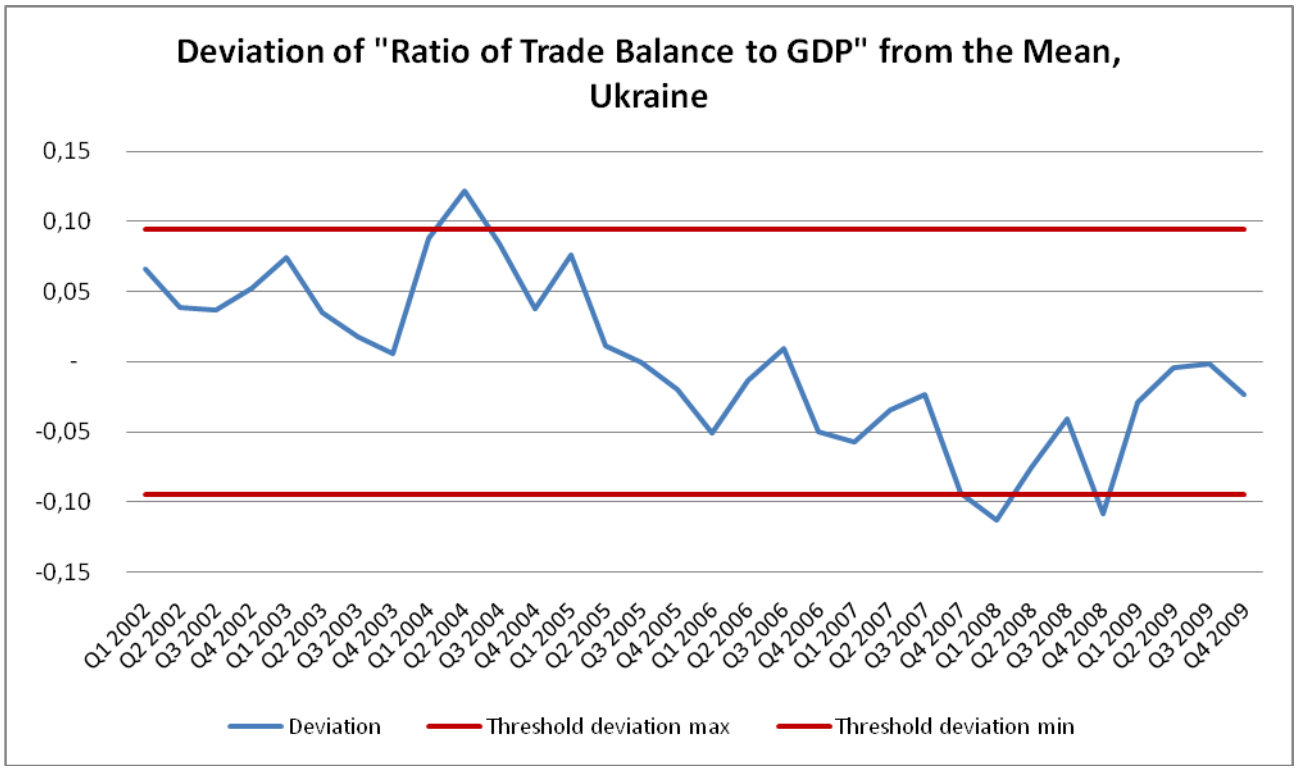


Figure 2.1 Deviation of "Ratio of Trade Balance to GDP" from the Mean, Ukraine

The figure 2.2 shows deviation of the trade balance to GDP ratio from its mean for the period from I quarter of 2002 to IV quarter of 2009 for Korea, which is 0.0178. Upper and lower threshold deviations from an average are -0.0347 and 0.0347 respectively (see Table. 2.3).

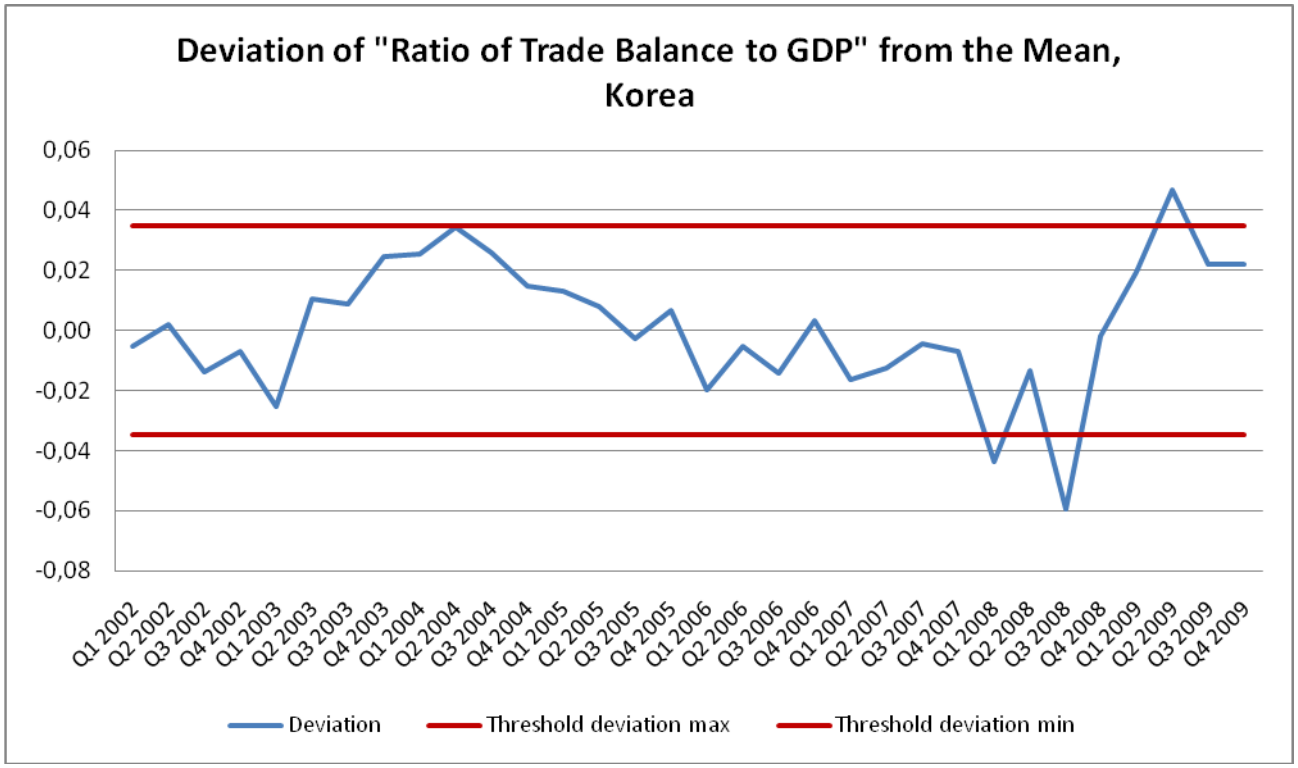


Figure 2.2 Deviation of "Ratio of Trade Balance to GDP" from the Mean, Korea

Signal is a situation when the deviation from the mean exceeds the threshold value (deviation from the mean crosses the critical limits). As one can see, the indicator for Ukraine gives three signals, namely in II quarter of 2004, in I quarter of 2008 and in IV quarter of 2008. First signal is a false alarm because no crisis occurs within the signal window after the signal. Two other signals are correct as they correctly forecast crisis in advance (within a signaling window of 4 quarters). For the Republic of Korea figure also shows three signals, two of which are accurate i.e. occurred within 4 quarters before the crisis.

Similarly, we can consider the actual value of the indicator, rather than its deviation from the average. In this case the signal is given when the actual value is outside the range which is defined as the mean ± threshold (see Fig. 2.3 and 2.4).

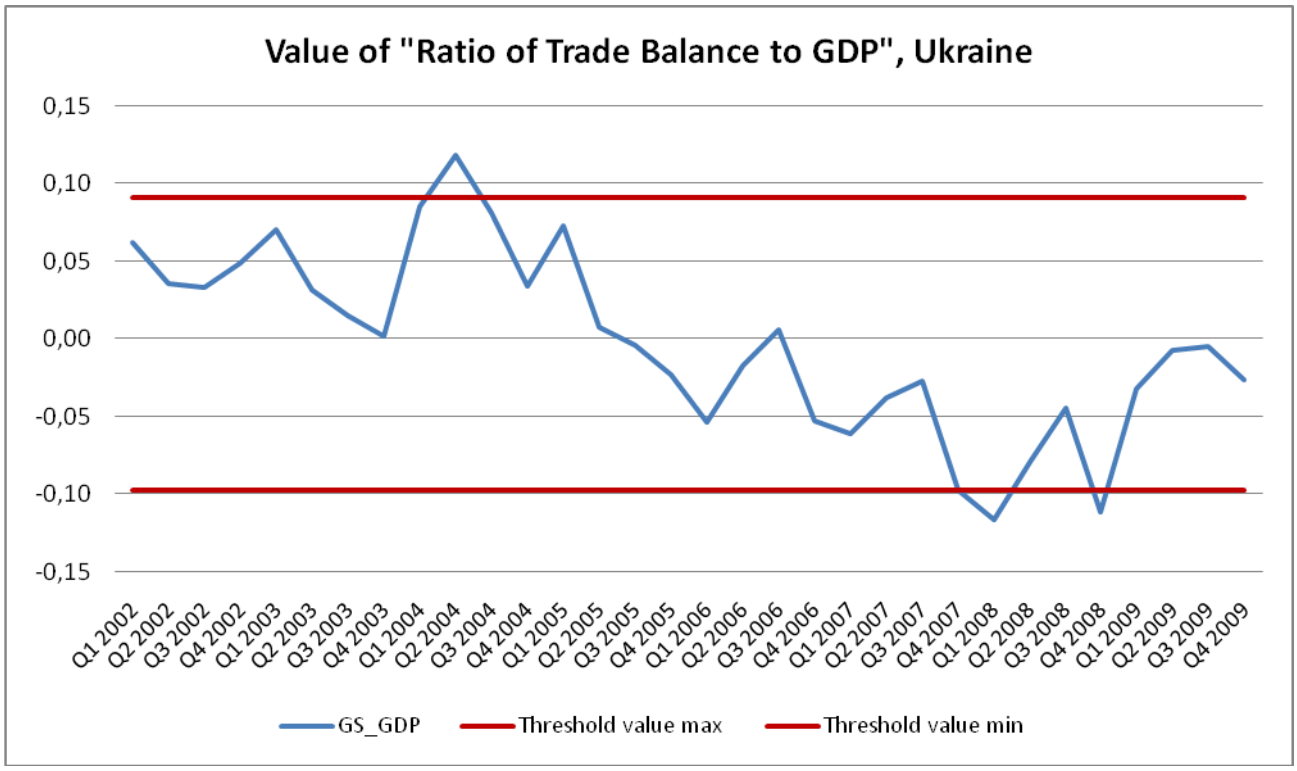


Figure 2.3 Value of the "Ratio of Trade Balance to GDP", Ukraine

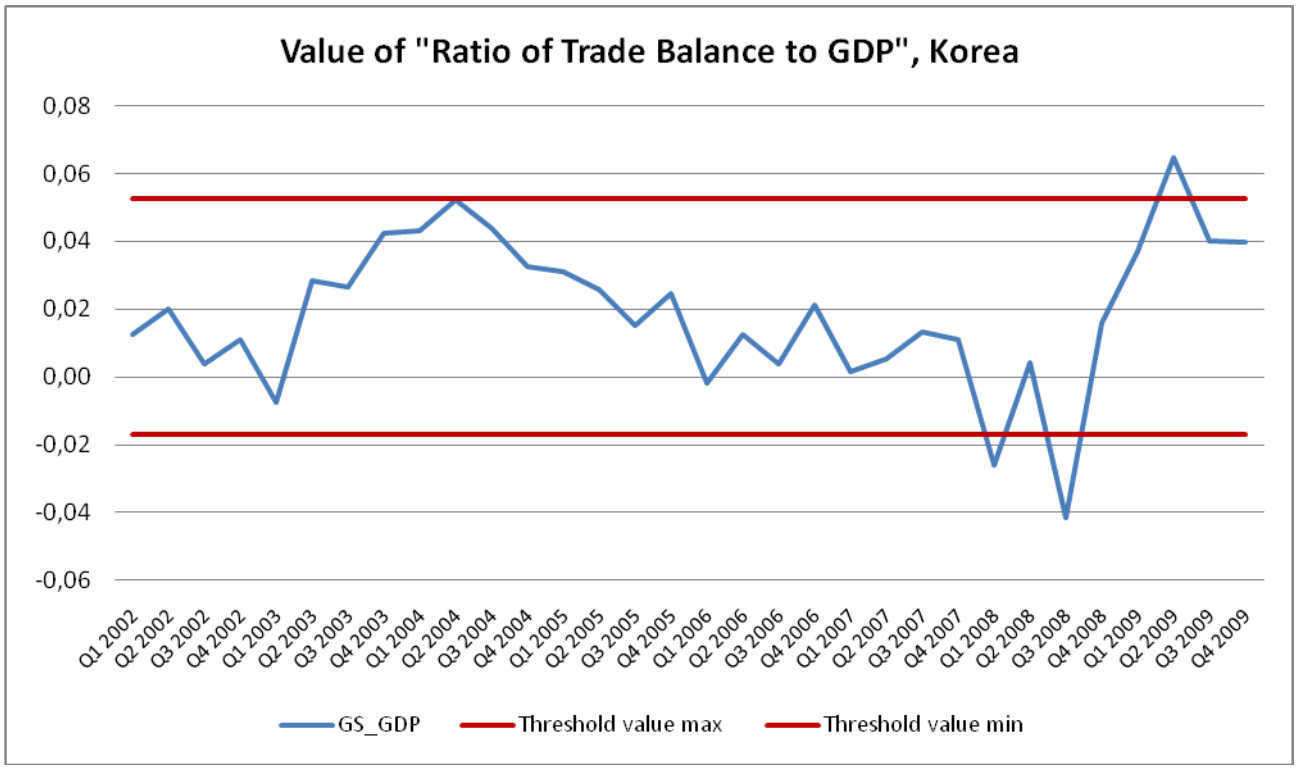


Figure 2.4 Value of the "Ratio of Trade Balance to GDP", Ukraine

Table 2.4 summarizes the average values of indicators for all countries simultaneously and average threshold deviations for each of the indicators. Deviations from the average value greater than the threshold deviation may be regarded as a signal of the increasing risk of financial crisis. However, countries differ strongly enough in the amplitude of the indicators, so the average value and the threshold deviation from the mean for each indicator give only a general idea of acceptable limits of indicators, and can not be readily used for forecasting. For this purpose, for a given indicator of a new counrty, which took no part in the analysis, the most appropriate is to calculate the actual threshold values using the threshold of this indicator expressed in precentiles (see Table. 2.4).

Table 2.2. Effectiveness of indicators according to "signals approach"

	Indicator	Identifier	Crises predict-ed	Accurate signals as a percentage of all possible accurate signals	False signals as a percentage of all possible false signals	Noise/ Signal	Probability of a crisis conditioned on the presence of the signal	Difference of conditional and uncon-ditional pro-babilities
1	The share of short-term debt in the structure of ext. debt	ST_DEBT_SHARE	3	15,15%	0,98%	0,0645	62,50%	52,79%
2	The ratio of current account to GDP	CURACC_GDP	6	18,18%	1,30%	0,0717	60,00%	50,29%
3	CPI growth rate,%	CPI_CHNG	4	12,12%	1,95%	0,1612	40,00%	30,29%
4	Money multiplier	MM	4	11,76%	1,96%	0,1667	40,00%	30,00%
5	The ratio of M2 to international reserves	M2_RES	3	9,09%	1,95%	0,2150	33,33%	23,63%
6	The real interest rate on loans	RLENDRATE	3	9,09%	1,95%	0,2150	33,33%	23,63%
7	REER growth rate,%	REERI	7	33,33%	8,14%	0,2443	30,56%	20,85%
8	The ratio of trade balance to GDP	GS_GDP	6	27,27%	6,84%	0,2508	30,00%	20,29%
9	Investment, share in GDP	GFCF	2	6,06%	1,63%	0,2687	28,57%	18,87%
10	Growth of exports,%	EXPI	5	22,86%	7,21%	0,3156	26,67%	16,37%
11	Real rate on deposits	RDEPRATE	5	26,47%	10,13%	0,3827	22,50%	12,50%
12	Growth of imports,%	IMPI	10	58,54%	28,76%	0,4914	21,82%	9,76%
13	The difference between the real rates on loans and on deposits	RATE_MARGIN	6	41,67%	21,38%	0,5132	18,75%	8,16%
14	The ratio of Int. reserves to imports	RES_IMP	5	30,30%	17,59%	0,5805	15,63%	5,92%
15	Consumption, share in GDP	CONS_TOTAL	9	35,29%	22,22%	0,6296	15,00%	5,00%
16	M2 growth rate,%	DM2	8	30,56%	19,41%	0,6352	15,71%	5,13%
17	The ratio of Int. reserves to export	RES_EXP	3	12,12%	7,82%	0,6450	14,29%	4,58%
18	Ratio of government loans to GDP,%	GVT_CLAIMS_GDP	9	72,97%	49,50%	0,6784	15,25%	4,37%
19	Difference between LIBOR rates and rates on domestic loans	DRATES	5	27,78%	19,74%	0,7105	14,29%	3,70%
20	The ratio of international reserves to GDP	RES_GDP	7	41,67%	34,54%	0,8289	12,50%	1,91%
21	The nominal effective exchange rate	NEER	10	67,50%	57,67%	0,8543	13,50%	1,74%

Table 2.3. Mean and threshold values of indicators for individual countries

	CPI_CHNG		DM2		M2_RES		GVT_CLAIMS_GDP		RATE_MARGIN	
	CPI growth rate,%		M2 growth rate,%		The ratio of M2 to international reserves		Ratio of government loans to GDP,%		Difference between the real rates on loans and on deposits	
Country	mean	threshold deviation	mean	threshold deviation	mean	threshold deviation	mean	threshold deviation	mean	threshold deviation
Armenia	4,3368	± 6,38	5,9308	± 16,33	1,0507	± 0,89	0,0120	± 0,01	0,1119	± 0,02
Chile	3,2743	± 5,62	2,6951	± 4,10	5,1915	± 3,66	0,1718	± 0,13	0,0362	± 0,01
Costa Rica	10,5697	± 5,00	4,5124	± 5,72	3,1043	± 0,44	0,0363	± 0,01	0,1144	± 0,03
Georgia	6,6862	± 6,31	5,6558	± 10,33	1,5029	± 0,60	0,2584	± 0,08	0,1497	± 0,08
Iceland	6,4257	± 10,64	7,3761	± 15,93	4,9852	± 4,99	0,1157	± 0,12	0,0244	± 0,04
Republic of Korea	3,0804	± 1,71	2,0648	± 1,72	7,4084	± 1,32	0,0215	± 0,02	0,0170	± 0,00
Moldova	9,7690	± 10,71	5,8465	± 7,70	1,9640	± 0,54	0,2472	± 0,08	0,0553	± 0,03
Romania	10,1317	± 14,19	5,9856	± 6,00	2,3490	± 0,39	0,0020	± 0,00	0,0927	± 0,04
Russian Federation	11,8658	± 5,95	7,4908	± 7,91	1,8307	± 0,38	0,0791	± 0,04	0,0635	± 0,02
Ukraine	11,3660	± 14,49	7,5472	± 6,29	3,6294	± 0,70	0,1715	± 0,09	0,0816	± 0,03
Mean	7,7506	± 8,10	5,5105	± 8,20	3,3016	± 1,39	0,1116	± 0,06	0,0747	± 0,03

Table 2.3. Mean and threshold values of indicators for individual countries

	MM		IMPI		EXPI		REERI		DRATES	
	Money multiplier.		Growth of imports,%		Growth of exports,%		REER growth rate,%		Difference between LIBOR rates and rates on domestic loans	
Country	mean	threshold deviation	mean	threshold deviation	mean	threshold deviation	mean	threshold deviation	mean	threshold deviation
Armenia	1,1398	± 0,27	6,3563	± 17,84	4,4877	± 32,50	0,6023	± 7,21	-15,9664	± 3,83
Chile	3,9953	± 1,30	4,2485	± 5,49	4,3153	± 15,89	0,1717	± 6,35	-4,9932	± 2,31
Costa Rica	1,2404	± 0,28	2,3508	± 5,74	2,1993	± 11,23	0,3269	± 4,40	-18,4507	± 7,37
Georgia	1,0666	± 0,23	7,0063	± 17,75	9,1924	± 40,57	0,6294	± 5,16	-22,6685	± 8,71
Iceland	6,4604	± 6,46	2,6218	± 10,51	3,4243	± 23,24	-0,3816	± 7,67	-12,2134	± 4,30
Republic of Korea	24,5980	± 2,59	3,8053	± 5,38	4,0637	± 14,98	0,0000	± 0,00	-3,5552	± 2,18
Moldova	1,7418	± 0,38	6,0493	± 18,37	4,3623	± 25,78	0,9446	± 7,37	-17,3693	± 4,00
Romania	3,9352	± 0,90	5,1985	± 13,65	4,5381	± 9,87	0,4273	± 5,84	-17,7239	± 9,48
Russian Federation	2,1785	± 0,64	6,3073	± 17,88	5,4800	± 16,04	1,3493	± 3,13	-9,6924	± 4,84
Ukraine	2,4716	± 0,54	5,2710	± 12,35	4,7064	± 20,65	-0,1673	± 5,73	-15,3326	± 6,37
Mean	4,8828	± 1,36	4,9215	± 12,50	4,6770	± 21,07	0,3903	± 5,29	-13,7966	± 5,34

Table 2.3. Mean and threshold values of indicators for individual countries

	GS_GDP		CURACC_GDP		RES_GDP		ST_DEBT_SHARE		RLENDRATE	
	The ratio of trade balance to GDP		The ratio of current account to GDP		The ratio of international reserves to GDP		Share of short-term debt in the str. of ext. debt		The real interest rate on loans	
Country	mean	threshold deviation	Mean	threshold deviation	mean	threshold deviation	mean	threshold deviation	mean	threshold deviation
Armenia	-0,2082	± 0,13	-0,0756	± 0,13	0,4509	± 0,17	0,1415	± 0,14	0,1380	± 0,09
Chile	0,0765	± 0,10	0,0133	± 0,08	0,3984	± 0,14	0,1643	± 0,16	0,0423	± 0,03
Costa Rica	-0,0386	± 0,06	-0,0485	± 0,07	0,2989	± 0,05	0,2390	± 0,24	0,0956	± 0,08
Georgia	-0,1881	± 0,14	-0,1309	± 0,15	0,2218	± 0,09	0,0706	± 0,13	0,1764	± 0,13
Iceland	-0,0425	± 0,15	-0,1159	± 0,25	0,3357	± 0,20	0,1792	± 0,70	0,0878	± 0,09
Republic of Korea	0,0178	± 0,03	0,0167	± 0,05	0,6493	± 0,06	0,3829	± 0,07	0,0303	± 0,01
Moldova	-0,3779	± 0,24	-0,0836	± 0,15	0,4989	± 0,15	0,2978	± 0,30	0,0958	± 0,11
Romania	-0,0948	± 0,05	-0,0813	± 0,08	0,4984	± 0,13	0,0648	± 0,26	0,0927	± 0,04
Russian Federation	0,1052	± 0,05	0,0786	± 0,07	0,5910	± 0,21	0,1579	± 0,16	0,0045	± 0,05
Ukraine	-0,0034	± 0,09	0,0159	± 0,13	0,4304	± 0,11	0,2238	± 0,22	0,0641	± 0,19
Mean	-0,2082	± 0,13	-0,0756	± 0,13	0,4509	± 0,17	0,1415	± 0,14	0,1380	± 0,09

Table 2.3. Mean and threshold values of indicators for individual countries

	RDEPRATE		RES_EXP		RES_IMP		NEER		GFCF		CONS_TOTAL	
	Real rate on deposits		The ratio of Int. reserves to export		The ratio of Int. reserves to imports.		The nominal effective exchange rate		Investment, share in GDP		Consumption, share in GDP	
Country	mean	threshold deviation	mean	threshold deviation	mean	threshold deviation	mean	threshold deviation	mean	threshold deviation	mean	threshold deviation
Armenia	0,0261	± 0,06	3,0661	± 3,04	1,0809	± 0,23	107,2471	± 14,21	26,8480	± 21,62	90,7999	± 21,79
Chile	0,0061	± 0,02	1,2952	± 1,06	1,5591	± 0,78	97,5338	± 2,99	19,5936	± 19,59	66,5117	± 7,83
Costa Rica	-0,0188	± 0,05	0,9572	± 0,23	0,6962	± 0,13	101,7497	± 12,81	18,9444	± 18,94	76,7416	± 9,37
Georgia	0,0267	± 0,05	2,1781	± 1,90	0,6428	± 0,24	102,6481	± 3,74	22,7605	± 22,76	87,2961	± 14,30
Iceland	0,0085	± 0,02	1,2506	± 0,93	1,1347	± 0,84	80,2827	± 9,76	23,0853	± 12,48	81,1542	± 3,92
Republic of Korea	0,0133	± 0,01	1,8437	± 0,44	1,9761	± 0,31	93,4707	± 5,43	28,1485	± 4,94	66,4721	± 3,74
Moldova	0,0405	± 0,07	1,6483	± 1,65	0,6388	± 0,64	103,0138	± 4,46	22,4329	± 23,45	105,0430	± 13,56
Romania	0,0000	± 0,05	1,7899	± 0,74	1,2269	± 0,45	99,6724	± 4,30	24,2122	± 11,74	85,1969	± 10,33
Russian Federation	-0,0590	± 0,04	2,1628	± 1,05	3,3951	± 1,43	99,1751	± 1,89	18,3383	± 11,48	66,3388	± 5,32
Ukraine	-0,0175	± 0,09	1,1557	± 0,55	1,0415	± 0,37	93,3736	± 6,70	21,5924	± 7,96	75,7473	± 6,67
Mean	0,0026	± 0,05	1,7348	± 1,16	1,3392	± 0,54	97,8167	± 6,63	22,5956	± 15,5	80,1302	± 9,68

Table 2.4. Mean and threshold values of indicators average across all countries

	Indicator	Identifier	Mean	Threshold deviation, %	Threshold deviation
1	The share of short-term debt in the structure of ext. debt	ST_DEBT_SHARE	0,1922	6	± 0,24
2	The ratio of current account to GDP	CURACC_GDP	-0,0411	3	± 0,12
3	CPI growth rate,%	CPI_CHNG	7,7506	3	± 8,10
4	Money multiplier	MM	4,8828	3	± 1,36
5	The ratio of M2 to international reserves	M2_RES	3,3016	3	± 1,39
6	The real interest rate on loans	RLENDRATE	0,0827	3	± 0,08
7	REER growth rate,%	REERI	0,3903	12	± 5,29
8	The ratio of trade balance to GDP	GS_GDP	-0,0754	9	± 0,10
9	Investment, share in GDP	GFCF	22,5956	3	± 15,50
10	Growth of exports,%	EXPI	4,6770	9	± 21,07
11	Real rate on deposits	RDEPRATE	0,0026	12	± 0,05
12	Growth of imports,%	IMPI	4,9215	31	± 12,50
13	The difference between the real rates on loans and on deposits	RATE_MARGIN	0,0747	22	± 0,03
14	The ratio of Int. reserves to imports	RES_IMP	1,3392	20	± 0,54
15	Consumption, share in GDP	CONS_TOTAL	80,1302	24	± 9,68
16	M2 growth rate,%	DM2	5,5105	20	± 8,20
17	The ratio of Int. reserves to export	RES_EXP	1,7348	9	± 1,16
18	Ratio of government loans to GDP,%	GVT_CLAIMS_GDP	0,1116	55	± 0,06
19	Difference between LIBOR rates and rates on domestic loans	DRATES	-13,7966	21	± 5,34
20	The ratio of international reserves to GDP	RES_GDP	0,4374	35	± 0,13
21	The nominal effective exchange rate	NEER	97,8167	60	± 6,63

2.2. Practical usage of the indexes for crisis phenomena diagnostics

Practical implementation of the “signals approach” to diagnose the crisis requires consistent application of specific steps that can be represented schematically as a flowchart, see Figure 2.2.1. Further, we analyze the characteristics of each step of diagnosis.

Step 1. Definition of crisis countries and crisis periods with the help of index of currency market pressure.

At the first step, it is necessary to select a set of countries for the diagnosis. Then, by constructing an index of currency market pressure countries that have experienced significant currency crisis are determined (those that experienced significant currency depreciation and/or significant losses of foreign reserves).

For a given set of countries specific crisis periods for each country are determined. Detailed methods of calculation are described in chapter 1.3. Next, step 2 is conducted: leading indicators of financial crises are chosen and their values are calculated according to the "signals approach" (note that a prerequisite of using this approach is the existence of specific crisis periods for all the countries).

Step 2. Calculation of indicators’ values for each country for the whole period.

In the previous chapters, based on the analysis of theoretical and empirical research of Ukrainian and Western economists, a number of indexes that can be considered signal indicators for predicting the occurrence of financial crises have been proposed and justified (see Chapter 1.2). In step 2, the indicators are calculated based on available statistical information. At this step, some indicators may be rejected, since data on them may not be available for all previously selected countries. Therefore, the initial information for the step 2 is a database of statistical values of the final set of indicators.

Step 3. Application of optimization procedure to calculate the threshold values of crisis indicators.

At this step, threshold values of the indicators that were selected during the previous phase are calculated. Note that the calculations are made for each indicator simultaneously for all countries. Next, we illustrate how we calculate the threshold

values for the CPI growth rate for 10 selected countries that have suffered significantly from the financial crises (see Chapter 2.1).

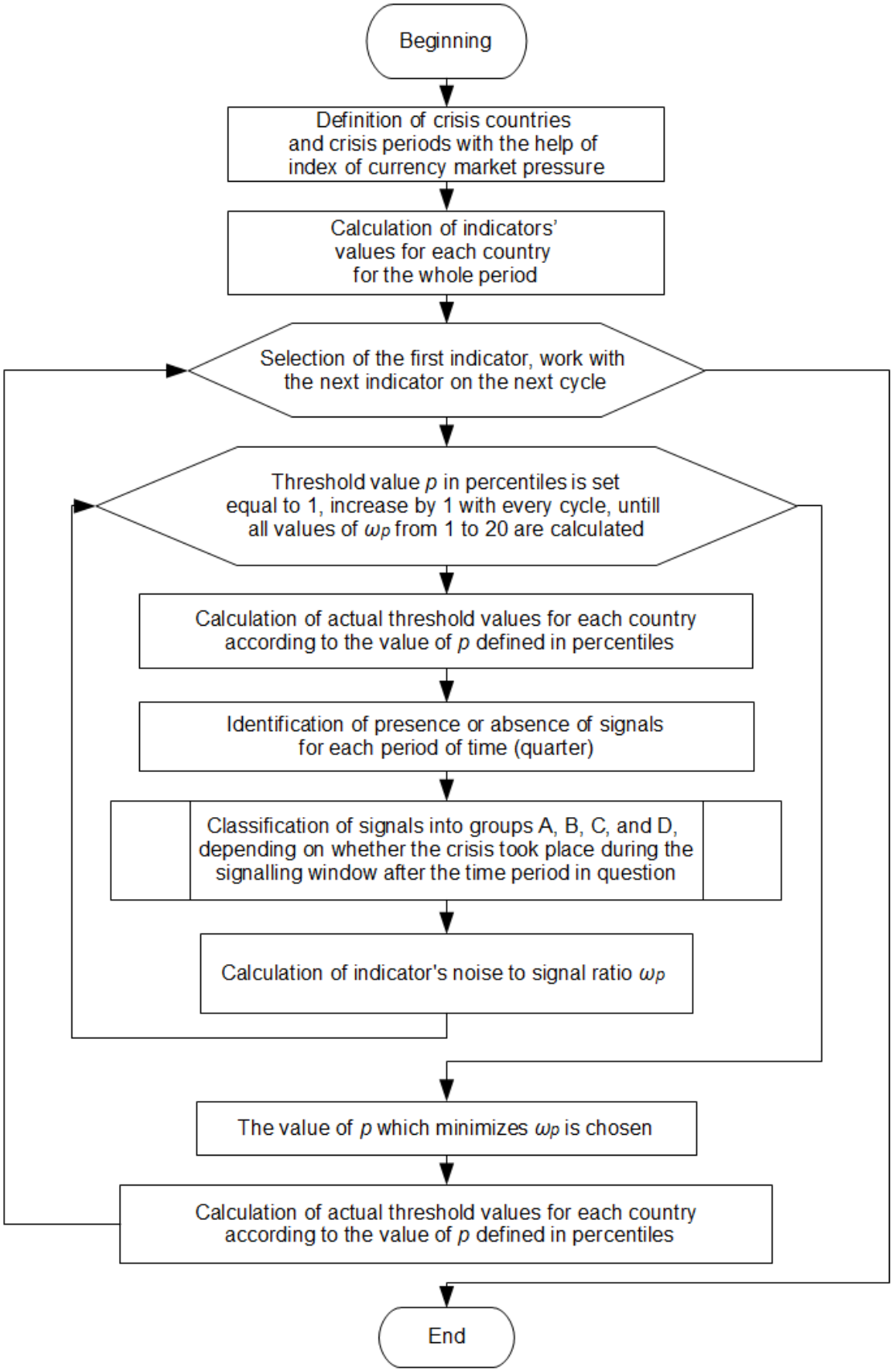


Figure 2.2.1 General flow chart of indicators' threshold values estimation

Available data on the rates of CPI for the 10 crisis countries is presented in Table 2.2.1.

Table 2.2.1. Dynamics of CPI growth rate in the selected crisis countries

Country	Q1 2002	Q2 2002	Q3 2002	Q4 2002	Q1 2003	Q2 2003	Q3 2003	Q4 2003	Q1 2004	Q2 2004	Q3 2004	Q4 2004
Armenia	0,43	3,04	-0,17	0,88	3,36	3,01	5,13	7,53	7,87	7,32	8,39	4,31
Chile	2,44	2,20	2,36	2,94	3,78	3,72	2,73	1,07	0,01	0,46	1,48	2,27
Costa Rica	9,80	7,81	9,18	9,86	9,39	10,22	8,83	9,37	11,30	11,54	13,09	13,24
Georgia	5,22	6,60	5,14	5,31	4,30	3,04	5,10	6,78	5,84	4,86	5,53	6,46
Iceland	9,05	6,05	3,46	2,42	1,72	2,09	1,95	2,50	2,14	3,15	3,57	3,76
Republic of Korea	2,53	2,69	2,58	3,25	4,08	3,37	3,17	3,52	3,28	3,38	4,31	3,40
Moldova	6,10	6,15	4,55	4,41	6,76	8,20	15,30	16,78	14,57	13,00	11,07	11,63
Romania	26,94	24,29	21,35	18,42	16,66	14,78	14,96	14,80	13,56	12,29	11,88	9,96
Russian Federation	17,81	15,54	14,97	15,01	14,63	14,02	13,54	12,55	10,66	10,18	10,99	11,64
Ukraine	3,71	0,76	-0,91	-0,47	2,22	4,52	6,44	7,72	7,47	7,33	9,59	11,81

Table 2.2.1. Dynamics of CPI growth rate in the selected crisis countries, continued

Country	Q1 2005	Q2 2005	Q3 2005	Q4 2005	Q1 2006	Q2 2006	Q3 2006	Q4 2006	Q1 2007	Q2 2007	Q3 2007	Q4 2007
Armenia	4,40	0,20	-1,83	-0,26	-2,04	1,73	6,64	5,69	4,84	4,26	2,16	6,38
Chile	2,29	2,77	3,32	3,81	4,06	3,81	3,49	2,25	2,69	2,86	4,79	7,24
Costa Rica	13,41	13,96	13,73	14,07	12,79	11,97	11,62	9,64	9,01	9,22	8,92	10,25
Georgia	9,45	9,49	7,03	7,27	5,01	9,12	12,99	9,62	10,42	7,56	7,76	11,25
Iceland	4,37	3,33	3,92	4,32	4,31	7,04	8,19	7,16	6,70	4,62	3,81	5,16
Republic of Korea	3,28	2,94	2,37	2,43	2,01	2,30	2,49	2,19	2,07	2,45	2,33	3,31
Moldova	13,07	13,58	11,02	10,30	10,81	11,81	14,19	14,23	11,84	10,60	13,23	13,70
Romania	8,85	9,84	8,81	8,48	8,61	7,14	5,95	4,77	3,82	3,80	4,99	6,69
Russian Federation	13,09	13,75	12,68	11,29	10,85	9,43	9,42	9,07	7,72	7,94	8,89	11,39
Ukraine	13,55	14,54	14,56	11,55	9,65	7,19	7,94	11,39	10,16	11,41	14,09	15,54

Table 2.2.1. Dynamics of CPI growth rate in the selected crisis countries, continued

Country	Q1 2008	Q2 2008	Q3 2008	Q4 2008	Q1 2009	Q2 2009	Q3 2009	Q4 2009	Q1 2010	Q2 2010
Armenia	7,89	10,06	11,16	6,79	2,00	3,34	3,40	4,87	8,39	6,30
Chile	8,01	8,89	9,34	8,61	5,62	3,11	-0,60	-1,86	0,23	1,16
Costa Rica	11,00	11,89	15,11	15,49	12,86	9,80	5,81	3,54	5,59	6,03
Georgia	11,26	11,55	11,08	6,25	2,70	2,17	-0,87	2,98	4,69	4,37
Iceland	7,14	12,27	14,04	17,06	17,08	11,91	11,01	8,60	7,44	7,14
Republic of Korea	3,77	4,78	5,51	4,53	3,91	2,83	1,98	2,44	2,69	2,57

Moldova	14,88	16,32	11,91	8,42	3,12	-0,93	-1,71	-0,60	5,85	7,98
Romania	7,95	8,56	8,11	6,81	6,77	6,09	4,99	4,56	4,63	4,36
Russian Federation	12,86	14,87	14,94	13,74	13,74	12,43	11,44	9,21	7,21	5,92
Ukraine	22,51	30,16	25,81	22,61	20,39	15,04	15,27	13,34	11,24	8,34

First, for the indicator under consideration threshold defined in percentiles which minimizes the noise to signal ratio (one for all countries) is calculated.

The indicator issues a signal if it deviates from its historical mean by an amount greater than specific critical value. Formal definition of the signal is as follows:

$$\{S_t^j = 1\} = \{S_t^j, \left|X_t^j - \overline{X}^j\right| > \left|X_{cr}^j\right|\}, \quad (2.2.1)$$

where S_t^j is signal of indicator *j* in period *t*, X_t^j is the value of the indicator *j* in period *t*, $\overline{X}^j$ – mean of the indicator *j*, X_{cr}^j – threshold value of the indicator *j*. Respectively, lack of signal is defined as follows:

$$\{S_t^j = 0\} = \{S_t^j, \left|X_t^j - \overline{X}^j\right| < \left|X_{cr}^j\right|\}. \quad (2.2.2)$$

For the purpose of following calculations all the values of an indicator of the specific country have to be converted to deviations from indicator's average over a chosen period. For example, the average rate of growth of CPI in Armenia for the period from I quarter of 2002 to II quarter of 2010 is 4.34. Deviation from average for I quarter of 2002 will, therefore, be: 0.43 - 4.34 = -3.91. The calculated values of deviations of CPI growth rate from its average value for the respective country are presented in Table 2.2.2.

Table 2.2.2. CPI growth rate (deviation from the mean)

Country	Q1 2002	Q2 2002	Q3 2002	Q4 2002	Q1 2003	Q2 2003	Q3 2003	Q4 2003	Q1 2004	Q2 2004	Q3 2004	Q4 2004
Armenia	-3,91	-1,30	-4,51	-3,46	-0,98	-1,33	0,79	3,19	3,53	2,98	4,05	-0,03
Chile	-0,83	-1,07	-0,91	-0,33	0,51	0,45	-0,54	-2,20	-3,26	-2,81	-1,79	-1,00
Costa Rica	-0,77	-2,76	-1,39	-0,71	-1,18	-0,35	-1,74	-1,20	0,73	0,97	2,52	2,67
Georgia	-1,47	-0,09	-1,55	-1,38	-2,39	-3,65	-1,59	0,09	-0,85	-1,83	-1,16	-0,23
Iceland	2,62	-0,38	-2,97	-4,01	-4,71	-4,34	-4,48	-3,93	-4,29	-3,28	-2,86	-2,67
Republic of Korea	-0,55	-0,39	-0,50	0,17	1,00	0,29	0,09	0,44	0,20	0,30	1,23	0,32
Moldova	-3,67	-3,62	-5,22	-5,36	-3,01	-1,57	5,53	7,01	4,80	3,23	1,30	1,86
Romania	16,81	14,16	11,22	8,29	6,53	4,65	4,83	4,67	3,43	2,16	1,75	-0,17
Russian Federation	5,94	3,67	3,10	3,14	2,76	2,15	1,67	0,68	-1,21	-1,69	-0,88	-0,23

Ukraine	-7,66	-10,61	-12,28	-11,84	-9,15	-6,85	-4,93	-3,65	-3,90	-4,04	-1,78	0,44

Table 2.2.2. CPI growth rate (deviation from the mean), continued

Country	Q1 2005	Q2 2005	Q3 2005	Q4 2005	Q1 2006	Q2 2006	Q3 2006	Q4 2006	Q1 2007	Q2 2007	Q3 2007	Q4 2007
Armenia	0,06	-4,14	-6,17	-4,60	-6,38	-2,61	2,30	1,35	0,50	-0,08	-2,18	2,04
Chile	-0,98	-0,50	0,05	0,54	0,79	0,54	0,22	-1,02	-0,58	-0,41	1,52	3,97
Costa Rica	2,84	3,39	3,16	3,50	2,22	1,40	1,05	-0,93	-1,56	-1,35	-1,65	-0,32
Georgia	2,76	2,80	0,34	0,58	-1,68	2,43	6,30	2,93	3,73	0,87	1,07	4,56
Iceland	-2,06	-3,10	-2,51	-2,11	-2,12	0,61	1,76	0,73	0,27	-1,81	-2,62	-1,27
Republic of Korea	0,20	-0,14	-0,71	-0,65	-1,07	-0,78	-0,59	-0,89	-1,01	-0,63	-0,75	0,23
Moldova	3,30	3,81	1,25	0,53	1,04	2,04	4,42	4,46	2,07	0,83	3,46	3,93
Romania	-1,28	-0,29	-1,32	-1,65	-1,52	-2,99	-4,18	-5,36	-6,31	-6,33	-5,14	-3,44
Russian Federation	1,22	1,88	0,81	-0,58	-1,02	-2,44	-2,45	-2,80	-4,15	-3,93	-2,98	-0,48
Ukraine	2,18	3,17	3,19	0,18	-1,72	-4,18	-3,43	0,02	-1,21	0,04	2,72	4,17

Table 2.2.2. CPI growth rate (deviation from the mean), continued

Country	Q1 2008	Q2 2008	Q3 2008	Q4 2008	Q1 2009	Q2 2009	Q3 2009	Q4 2009	Q1 2010	Q2 2010
Armenia	3,55	5,72	6,82	2,45	-2,34	-1,00	-0,94	0,53	4,05	1,96
Chile	4,74	5,62	6,07	5,34	2,35	-0,16	-3,87	-5,13	-3,04	-2,11
Costa Rica	0,43	1,32	4,54	4,92	2,29	-0,77	-4,76	-7,03	-4,98	-4,54
Georgia	4,57	4,86	4,39	-0,44	-3,99	-4,52	-7,56	-3,71	-2,00	-2,32
Iceland	0,71	5,84	7,61	10,63	10,65	5,48	4,58	2,17	1,01	0,71
Republic of Korea	0,69	1,70	2,43	1,45	0,83	-0,25	-1,10	-0,64	-0,39	-0,51
Moldova	5,11	6,55	2,14	-1,35	-6,65	-10,70	-11,48	-10,37	-3,92	-1,79
Romania	-2,18	-1,57	-2,02	-3,32	-3,36	-4,04	-5,14	-5,57	-5,50	-5,77
Russian Federation	0,99	3,00	3,07	1,87	1,87	0,56	-0,43	-2,66	-4,66	-5,95
Ukraine	11,14	18,79	14,44	11,24	9,02	3,67	3,90	1,97	-0,13	-3,03

The original paper by G. Kaminsky suggests calculating all threshold values in percentiles from 1 to 20 to select optimal threshold [27]. Note that if the threshold is defined as 5 percentiles, it means that 5 percent of extreme values of the indicator's distribution are considered to be over the threshold. Thus, previous assumptions about the distribution law of the indicator are not required. Moreover, the methodology assumes that some indicators may signal crisis by declining, and some, on contrast, by growing, which creates the necessity of using absolute values of deviations while determining the signals. Therefore, the task of determining, for example, 5% of the most extreme values of indicators is equal to determining the largest deviations in absolute values from the mean value of this indicator. So, next

step requires converting indicator deviations from the mean (given in Table 2.2.2) to their absolute values. The calculated absolute values of deviations of CPI growth rate from their respective mean values are presented in Table 2.2.3.

Table 2.2.3. CPI growth rate, absolute values of deviations from the mean

Country	Q1 2002	Q2 2002	Q3 2002	Q4 2002	Q1 2003	Q2 2003	Q3 2003	Q4 2003	Q1 2004	Q2 2004	Q3 2004	Q4 2004
Armenia	3,91	1,30	4,51	3,46	0,98	1,33	0,79	3,19	3,53	2,98	4,05	0,03
Chile	0,83	1,07	0,91	0,33	0,51	0,45	0,54	2,20	3,26	2,81	1,79	1,00
Costa Rica	0,77	2,76	1,39	0,71	1,18	0,35	1,74	1,20	0,73	0,97	2,52	2,67
Georgia	1,47	0,09	1,55	1,38	2,39	3,65	1,59	0,09	0,85	1,83	1,16	0,23
Iceland	2,62	0,38	2,97	4,01	4,71	4,34	4,48	3,93	4,29	3,28	2,86	2,67
Republic of Korea	0,55	0,39	0,50	0,17	1,00	0,29	0,09	0,44	0,20	0,30	1,23	0,32
Moldova	3,67	3,62	5,22	5,36	3,01	1,57	5,53	7,01	4,80	3,23	1,30	1,86
Romania	16,81	14,16	11,22	8,29	6,53	4,65	4,83	4,67	3,43	2,16	1,75	0,17
Russian Federation	5,94	3,67	3,10	3,14	2,76	2,15	1,67	0,68	1,21	1,69	0,88	0,23
Ukraine	7,66	10,61	12,28	11,84	9,15	6,85	4,93	3,65	3,90	4,04	1,78	0,44

Table 2.2.3. CPI growth rate, absolute values of deviations from the mean, continued

Country	Q1 2005	Q2 2005	Q3 2005	Q4 2005	Q1 2006	Q2 2006	Q3 2006	Q4 2006	Q1 2007	Q2 2007	Q3 2007	Q4 2007
Armenia	0,06	4,14	6,17	4,60	6,38	2,61	2,30	1,35	0,50	0,08	2,18	2,04
Chile	0,98	0,50	0,05	0,54	0,79	0,54	0,22	1,02	0,58	0,41	1,52	3,97
Costa Rica	2,84	3,39	3,16	3,50	2,22	1,40	1,05	0,93	1,56	1,35	1,65	0,32
Georgia	2,76	2,80	0,34	0,58	1,68	2,43	6,30	2,93	3,73	0,87	1,07	4,56
Iceland	2,06	3,10	2,51	2,11	2,12	0,61	1,76	0,73	0,27	1,81	2,62	1,27
Republic of Korea	0,20	0,14	0,71	0,65	1,07	0,78	0,59	0,89	1,01	0,63	0,75	0,23
Moldova	3,30	3,81	1,25	0,53	1,04	2,04	4,42	4,46	2,07	0,83	3,46	3,93
Romania	1,28	0,29	1,32	1,65	1,52	2,99	4,18	5,36	6,31	6,33	5,14	3,44
Russian Federation	1,22	1,88	0,81	0,58	1,02	2,44	2,45	2,80	4,15	3,93	2,98	0,48
Ukraine	2,18	3,17	3,19	0,18	1,72	4,18	3,43	0,02	1,21	0,04	2,72	4,17

Table 2.2.3. CPI growth rate, absolute values of deviations from the mean, continued

Country	Q1 2008	Q2 2008	Q3 2008	Q4 2008	Q1 2009	Q2 2009	Q3 2009	Q4 2009	Q1 2010	Q2 2010
Armenia	3,55	5,72	6,82	2,45	2,34	1,00	0,94	0,53	4,05	1,96
Chile	4,74	5,62	6,07	5,34	2,35	0,16	3,87	5,13	3,04	2,11
Costa Rica	0,43	1,32	4,54	4,92	2,29	0,77	4,76	7,03	4,98	4,54
Georgia	4,57	4,86	4,39	0,44	3,99	4,52	7,56	3,71	2,00	2,32
Iceland	0,71	5,84	7,61	10,63	10,65	5,48	4,58	2,17	1,01	0,71
Republic of Korea	0,69	1,70	2,43	1,45	0,83	0,25	1,10	0,64	0,39	0,51
Moldova	5,11	6,55	2,14	1,35	6,65	10,70	11,48	10,37	3,92	1,79
Romania	2,18	1,57	2,02	3,32	3,36	4,04	5,14	5,57	5,50	5,77
Russian Federation	0,99	3,00	3,07	1,87	1,87	0,56	0,43	2,66	4,66	5,95
Ukraine	11,14	18,79	14,44	11,24	9,02	3,67	3,90	1,97	0,13	3,03

After calculating absolute values of deviations from the mean for a particular indicator, the thresholds in percentiles are calculated. As it has been previously stated, a percentile is a value of a variable below which certain percent of observations fall. For example 5th percentile is a value of a variable, below which 5% of observations of this variable fall. So, to determine, for example, 5% of the most extreme values, one may calculate 95th percentile of the variable, and then all the values greater in absolute terms than the found value are considered such that exceed the critical limit.

Next, we illustrate the described procedure for 99th percentile of the CPI growth rate. Note that all calculations on real data were conducted using Microsoft Excel, in which this methodology was implemented in practice.

To estimate the value v_p, of the P-th percentile of N ordered values (arranged from least to greatest) with values $v_1 \leq v_2 \leq \cdots \leq v_n$, the rank of P-th percentile is calculated:

$$n = \frac{P}{100}(N-1)+1$$

Then the value is split into its integer component k and decimal component d, such that $n = k + d$. Then v_p is calculated as:

$$v_p = \begin{cases} v_1, & k = 0 \\ v_N, & k = N \\ v_k + d(v_{k+1} - v_k), & 0 < k < N \end{cases}$$

Next, we calculate actual threshold values for all countries for the 99th percentile of the absolute values of deviations of CPI growth rate from its respective averages. We illustrate this calculation on the example of Ukraine:

$$n = \frac{P}{100}(N-1) + 1 = \frac{99}{100}(34-1) = 33{,}67$$

$$n = k + d = 33 + 0{,}67$$

$$v_p = v_k + d(v_{k+1} - v_k) = v_{33} + 0{,}67(v_{34} - v_{33}) = 14{,}44 + 0{,}67(18{,}79 - 14{,}44) = 17{,}36$$

Thus, if the deviation of Ukraine's CPI growth rate is higher than the 17.36 (in absolute value), the indicator has crossed the threshold and therefore has given a warning signal of future crisis. Similarly, the actual values of threshold deviations for all other countries are calculated. For illustration purposes table 2.2.4 presents calculated critical values of the CPI growth rate for all countries for percentiles from 1st to 20th.

Table 2.2.4. CPI growth rate, threshold values for deviations from the mean

Percentile / Country	1	2	3	4	5	6	7	8	9	10
Armenia	6,67	6,53	6,38	6,31	6,24	6,17	6,03	5,88	5,74	5,38
Chile	5,91	5,77	5,62	5,52	5,43	5,34	5,27	5,21	5,14	5,02
Costa Rica	6,36	5,68	5,00	4,96	4,94	4,92	4,87	4,82	4,77	4,70
Georgia	7,14	6,73	6,31	5,84	5,37	4,89	4,77	4,68	4,58	4,57
Iceland	10,65	10,64	10,64	9,67	8,67	7,67	7,06	6,48	5,89	5,73
Republic of Korea	2,19	1,95	1,71	1,62	1,54	1,45	1,38	1,31	1,23	1,19
Moldova	11,22	10,96	10,71	10,59	10,48	10,37	9,33	8,22	7,11	6,90
Romania	15,94	15,06	14,19	13,22	12,25	11,28	10,31	9,34	8,37	7,76
Russian Federation	5,95	5,95	5,95	5,53	5,11	4,68	4,50	4,33	4,16	4,08
Ukraine	17,36	15,92	14,49	13,75	13,03	12,32	12,14	12,00	11,85	11,66

Table 2.2.4. CPI growth rate, threshold values for deviations from the mean, continued

Country \ Percentile	11	12	13	14	15	16	17	18	19	20
Armenia	5,01	4,64	4,57	4,54	4,51	4,40	4,28	4,16	4,12	4,09
Chile	4,89	4,75	4,51	4,26	4,00	3,94	3,91	3,88	3,71	3,51
Costa Rica	4,62	4,55	4,54	4,54	4,54	4,25	3,90	3,56	3,47	3,43
Georgia	4,57	4,57	4,55	4,53	4,52	4,48	4,44	4,40	4,28	4,15
Iceland	5,62	5,50	5,26	5,00	4,75	4,67	4,63	4,59	4,55	4,52
Republic of Korea	1,15	1,11	1,09	1,08	1,07	1,05	1,03	1,01	1,01	1,00
Moldova	6,78	6,66	6,62	6,59	6,55	6,26	5,93	5,59	5,48	5,42
Romania	7,18	6,60	6,47	6,41	6,34	6,33	6,32	6,31	6,16	5,99
Russian Federation	4,01	3,93	3,85	3,77	3,69	3,53	3,35	3,18	3,14	3,12
Ukraine	11,46	11,27	11,21	11,18	11,14	10,99	10,81	10,64	10,21	9,73

After calculating threshold values for the CPI growth rate, we may determine in which periods of time CPI growth rate crosses the country's specific threshold, and thus signals of the possibility of financial crisis in the future.

Next, we graphically illustrate the signal using the Ukraine's CPI growth rate and the 5th percentile threshold (i.e. 5% of extreme values of its distribution are considered to be abnormal) (see Figure.2.2.2).

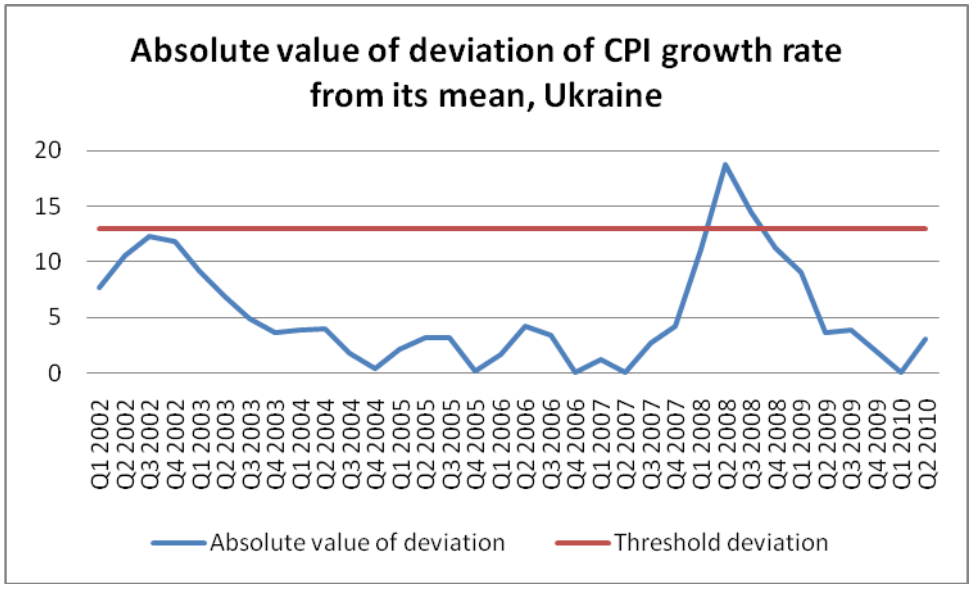


Figure 2.2.2. Absolute value of deviation of CPI growth rate from its mean, Ukraine

As seen from Figure 2.2.2, Ukraine's CPI growth rate with the threshold of 5 percentiles signals twice: in II and III quarters of 2008.

Similarly, the described procedure is performed for all countries and all values of thresholds in percentiles from 1st to 20th. As a result, a table of indicator's signals is formed for each percentile (signal is labeled as 1 and absence of signal as 0). For example, a set of signals for the CPI growth rate with the threshold of 1 percentile is presented in Table 2.2.5.

Table 2.2.5. CPI growth rate signals, threshold of 1 percentile

Country	Q1 2002	Q2 2002	Q3 2002	Q4 2002	Q1 2003	Q2 2003	Q3 2003	Q4 2003	Q1 2004	Q2 2004	Q3 2004	Q4 2004
Armenia	0	0	0	0	0	0	0	0	0	0	0	0
Chile	0	0	0	0	0	0	0	0	0	0	0	0
Costa Rica	0	0	0	0	0	0	0	0	0	0	0	0
Georgia	0	0	0	0	0	0	0	0	0	0	0	0
Iceland	0	0	0	0	0	0	0	0	0	0	0	0
Republic of Korea	0	0	0	0	0	0	0	0	0	0	0	0
Moldova	0	0	0	0	0	0	0	0	0	0	0	0
Romania	1	0	0	0	0	0	0	0	0	0	0	0
Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0
Ukraine	0	0	0	0	0	0	0	0	0	0	0	0

Table 2.2.5. CPI growth rate signals, threshold of 1 percentile, continued

Country	Q1 2005	Q2 2005	Q3 2005	Q4 2005	Q1 2006	Q2 2006	Q3 2006	Q4 2006	Q1 2007	Q2 2007	Q3 2007	Q4 2007
Armenia	0	0	0	0	0	0	0	0	0	0	0	0
Chile	0	0	0	0	0	0	0	0	0	0	0	0
Costa Rica	0	0	0	0	0	0	0	0	0	0	0	0
Georgia	0	0	0	0	0	0	0	0	0	0	0	0
Iceland	0	0	0	0	0	0	0	0	0	0	0	0
Republic of Korea	0	0	0	0	0	0	0	0	0	0	0	0
Moldova	0	0	0	0	0	0	0	0	0	0	0	0
Romania	0	0	0	0	0	0	0	0	0	0	0	0
Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0
Ukraine	0	0	0	0	0	0	0	0	0	0	0	0

Table 2.2.5. CPI growth rate signals, threshold of 1 percentile, continued

Country	Q1 2008	Q2 2008	Q3 2008	Q4 2008	Q1 2009	Q2 2009	Q3 2009	Q4 2009	Q1 2010	Q2 2010
Armenia	0	0	1	0	0	0	0	0	0	0
Chile	0	0	1	0	0	0	0	0	0	0
Costa Rica	0	0	0	0	0	0	0	1	0	0
Georgia	0	0	0	0	0	0	1	0	0	0
Iceland	0	0	0	0	1	0	0	0	0	0
Republic of Korea	0	0	1	0	0	0	0	0	0	0

Moldova	0	0	0	0	0	0	1	0	0	0
Romania	0	0	0	0	0	0	0	0	0	0
Russian Federation	0	0	0	0	0	0	0	0	0	1
Ukraine	0	1	0	0	0	0	0	0	0	0

Based on the table of signals the noise to signal ratio for the indicator "CPI growth rate" with the threshold of 1 percentile can be calculated. To complete this, it is necessary to classify all signals into four possible types according to Table 2.2.6.

Table 2.2.6. Possible values of indicators

	Crisis (within 4 quarters)	***No crisis (within 4 quarters)***
Signal was issued	A	B
No signal was issued	C	D

In the process, data about specific crisis periods identified by the index of currency market pressure in chapter 1.3 is used. The crisis periods for the countries in question are given in Table 2.2.7.

Table 2.2.7. Crisis periods for the countries in question

Country	Q1 2008	Q2 2008	Q3 2008	Q4 2008	Q1 2009	Q2 2009	Q3 2009	Q4 2009	Q1 2010	Q2 2010
Armenia	0	0	0	0	1	0	0	0	0	0
Chile	0	0	0	1	0	0	0	0	0	0
Costa Rica	0	0	1	0	0	0	0	0	0	0
Georgia	0	0	0	1	0	0	0	0	0	0
Iceland	0	0	1	0	0	0	0	0	0	0
Republic of Korea	0	0	1	1	0	0	0	0	0	0
Moldova	0	0	0	0	1	0	0	0	0	0
Romania	0	0	0	1	0	0	0	0	0	0
Russian Federation	0	0	0	1	1	0	0	0	0	0
Ukraine	0	0	0	1	1	0	0	0	0	0

Each signal in Table 2.2.5 should be classified as a signal of type A, B, C or D, according to Table 2.2.6. Note that the signaling window in our study is 4 quarters. The following Table 2.2.8 lists signals issued by the indicator “CPI growth rate” with the threshold of 1 percentile.

Table 2.2.8. Classification of CPI growth rate signals

Country	Q1 2002	Q2 2002	Q3 2002	Q4 2002	Q1 2003	Q2 2003	Q3 2003	Q4 2003	Q1 2004	Q2 2004	Q3 2004	Q4 2004
Armenia	D	D	D	D	D	D	D	D	D	D	D	D
Chile	D	D	D	D	D	D	D	D	D	D	D	D
Costa Rica	D	D	D	D	D	D	D	D	D	D	D	D
Georgia	D	D	D	D	D	D	D	D	D	D	D	D
Iceland	D	D	D	D	D	D	D	D	D	D	D	D
Republic of Korea	D	D	D	D	D	D	D	D	D	D	D	D
Moldova	D	D	D	D	D	D	D	D	D	D	D	D
Romania	B	D	D	D	D	D	D	D	D	D	D	D
Russian Federation	D	D	D	D	D	D	D	D	D	D	D	D
Ukraine	D	D	D	D	D	D	D	D	D	D	D	D

Table 2.2.8. Classification of CPI growth rate signals, continued

Country	Q1 2005	Q2 2005	Q3 2005	Q4 2005	Q1 2006	Q2 2006	Q3 2006	Q4 2006	Q1 2007	Q2 2007	Q3 2007	Q4 2007
Armenia	D	D	D	D	D	D	D	D	D	D	D	D
Chile	D	D	D	D	D	D	D	D	D	D	D	D
Costa Rica	D	D	D	D	D	D	D	D	D	D	D	C
Georgia	D	D	D	D	D	D	D	D	D	D	D	D
Iceland	D	D	D	D	D	D	D	D	D	D	D	C
Republic of Korea	D	D	D	D	D	D	D	D	D	D	D	C
Moldova	D	D	D	D	D	D	D	D	D	D	D	D
Romania	D	D	D	D	D	D	D	D	D	D	D	D
Russian Federation	D	D	D	D	D	D	D	D	D	D	D	D
Ukraine	D	D	D	D	D	D	D	D	D	D	D	D

Table 2.2.8. Classification of CPI growth rate signals, continued

Country	Q1 2008	Q2 2008	Q3 2008	Q4 2008	Q1 2009	Q2 2009	Q3 2009	Q4 2009	Q1 2010	Q2 2010
Armenia	D	C	A	C	D	D	D	D	D	D
Chile	C	C	A	D	D	D	D	D	D	D
Costa Rica	C	C	D	D	D	D	D	B	D	D
Georgia	C	C	C	D	D	D	B	D	D	D
Iceland	C	C	D	D	B	D	D	D	D	D
Republic of Korea	C	C	A	D	D	D	D	D	D	D
Moldova	D	C	C	C	D	D	B	D	D	D
Romania	C	C	C	D	D	D	D	D	D	D
Russian Federation	C	C	C	C	D	D	D	D	D	B
Ukraine	C	A	C	C	D	D	D	D	D	D

Based on the obtained information, the noise to signal ratio of the indicator (for the chosen threshold deviation) is calculated according to the following general formula:

$$\omega_p = \frac{B/(B+D)}{A/(A+C)}, \quad (2.2.5)$$

where ω_p – noise to signal ratio of the indicator with the threshold value corresponding to *P*-th percentile, A, B, C, D – the total number of signals of the respective type.

Calculated quantities of each type of signals for the indicator "CPI growth rate" with the threshold of 1 percentile are given in Table 2.2.9.

Table 2.2.9. Quantity of signals of each type of the indicator "CPI growth rate"

Type of signal	A	B	C	D
Quantity of signals	4	6	29	301

Consequently, the noise to signal ratio of the CPI growth rate can be calculated:

$$\omega_p = \frac{B/(B+D)}{A/(A+C)} = \frac{6/(6+301)}{4/(4+29)} = 0{,}1612$$

Calculated noise to signal ratio of the CPI growth rate with a threshold of 1 percentile equals 0.1612.

This procedure is then repeated for all threshold values in percentiles, from 1st to 20th, and the threshold value that minimizes the noise to signal ratio is selected. For example, the minimum noise to signal ratio of the indicator "CPI growth rate" in this research is observed at a thresholds of 1st, 2nd or 3rd percentile. For these threshold values respective noise to signal ratios are the same, so the largest possible range is selected, i.e. 3% of the indicator's distribution.

Thus, for the indicator "CPI growth rate" the optimal threshold of 3 percentiles was determined (which is the same for all countries), and the corresponding actual value of threshold for each country was calculated.

The described procedure of calculating threshold values is conducted for all indicators that were selected for analysis. In the result, a set of actual threshold values of indicators for each country is determined (see Table 2.1.3 Chapter 2.1).

The calculated threshold values are used for further in-depth analysis. For example, the CPI growth rate at the chosen threshold deviation accurately signals about 4 out of 10 crises in our sample, namely the crisis in Armenia, Chile, South Korea and Ukraine. To illustrate this point the dynamics of the absolute value of deviations of CPI growth rate from its mean is presented in Figures 2.2.3, 2.2.4, 2.2.5, and 2.2.6.

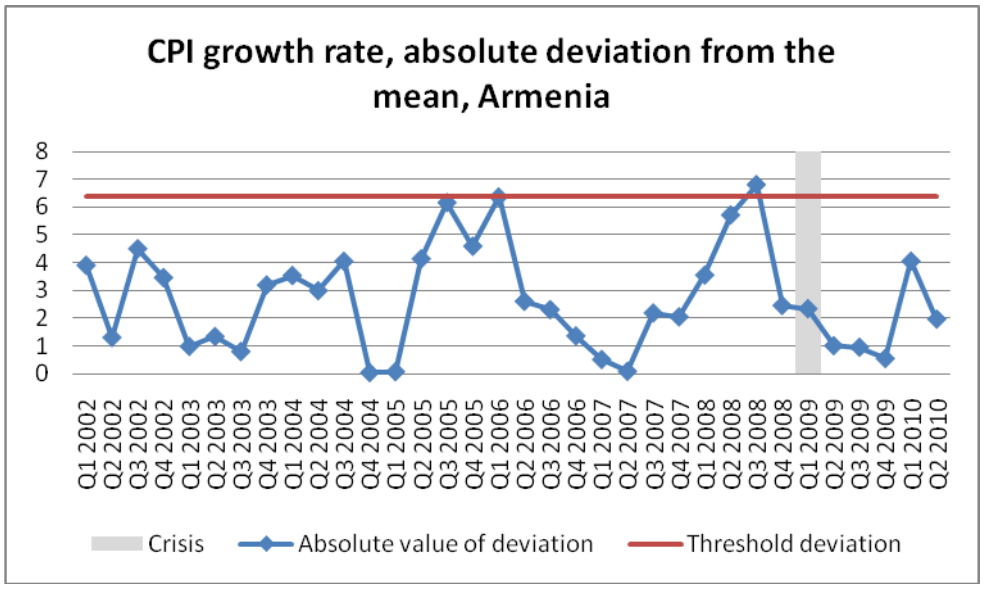


Figure 2.2.3 A CPI growth rate, absolute deviation from the mean, Armenia

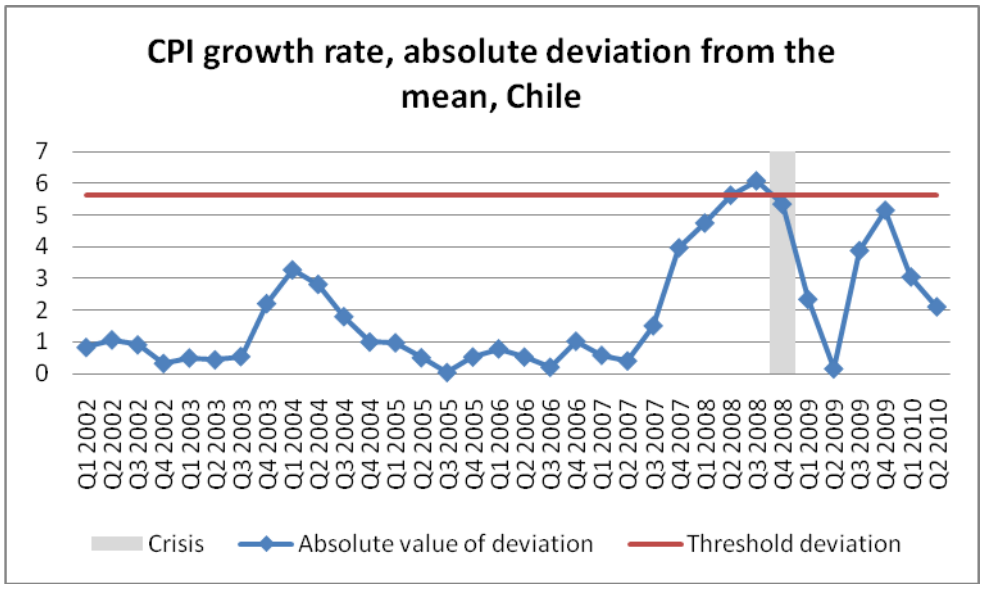


Figure 2.2.4 CPI growth rate, absolute deviation from the mean, Chile

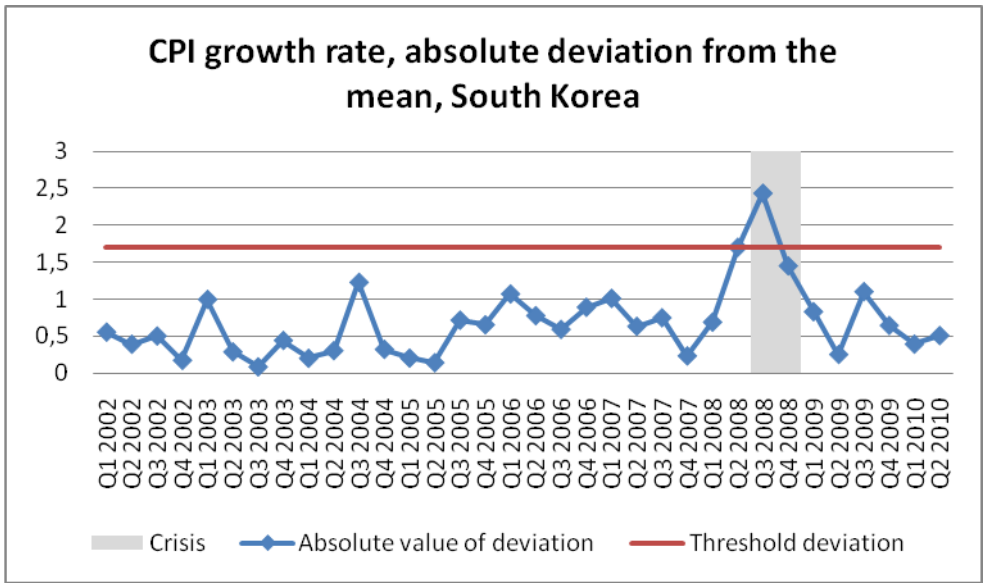


Figure 2.2.5 CPI growth rate, absolute deviation from the mean, South Korea

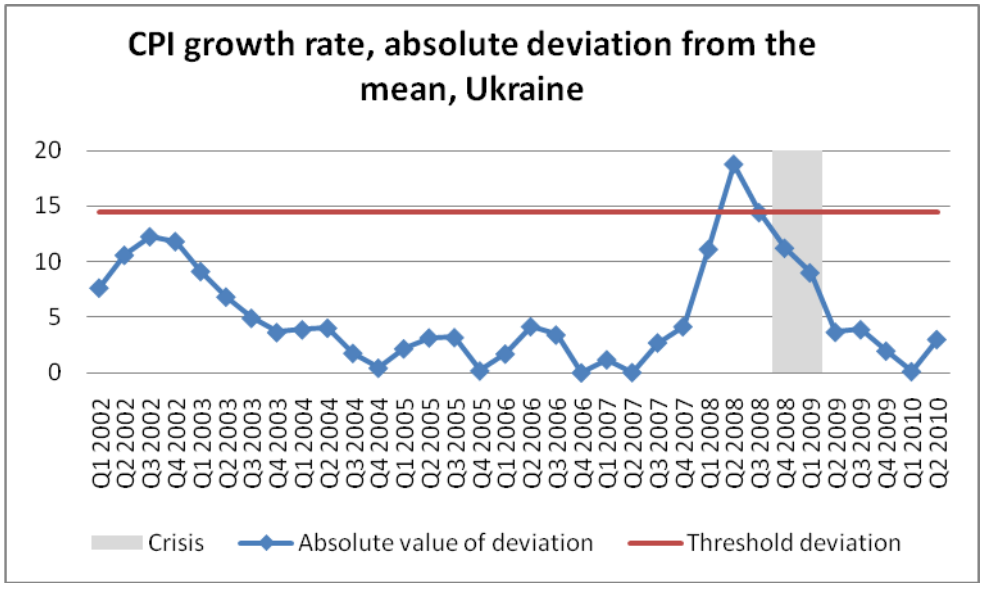


Figure 2.2.6 CPI growth rate, absolute deviation from the mean, Ukraine

The above figures show that abnormal behavior of indicator "CPI growth rate" indeed signals in advance about the financial crisis for these countries. On the contrast, for six other analyzed countries with a chosen threshold the indicator does not signal about a crisis in advance. The dynamics of the absolute value of deviations of CPI growth rate from its mean for Costa Rica, Georgia, Iceland, Moldova, Romania and the Russian Federation is presented in Figures 2.2.7, 2.2.8, 2.2.9, 2.2.10, 2.2.11, and 2.2.12.

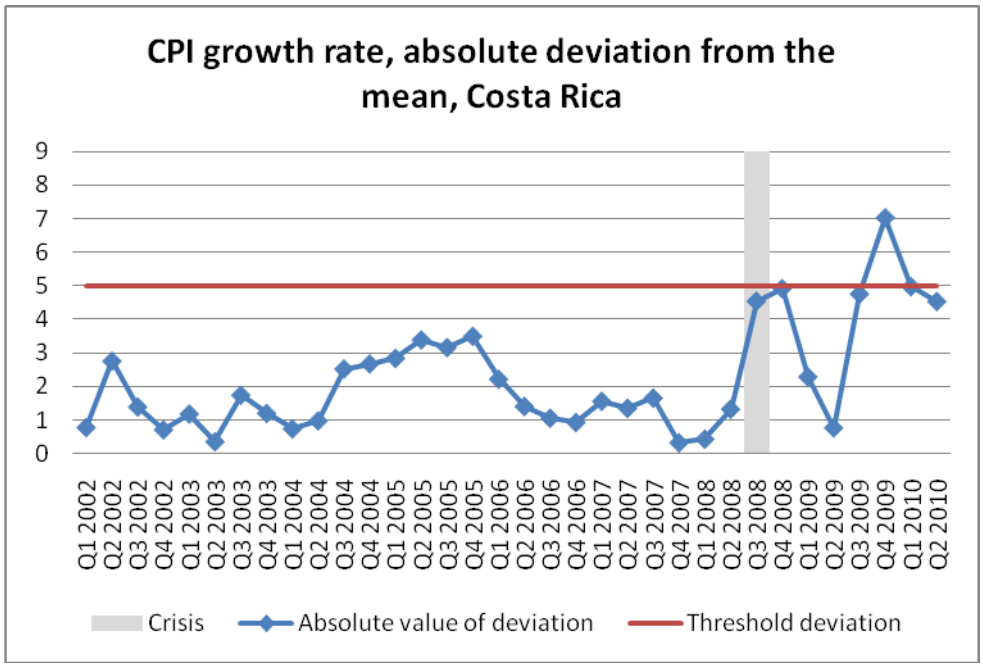


Figure 2.2.7 CPI growth rate, absolute deviation from the mean, Costa Rica

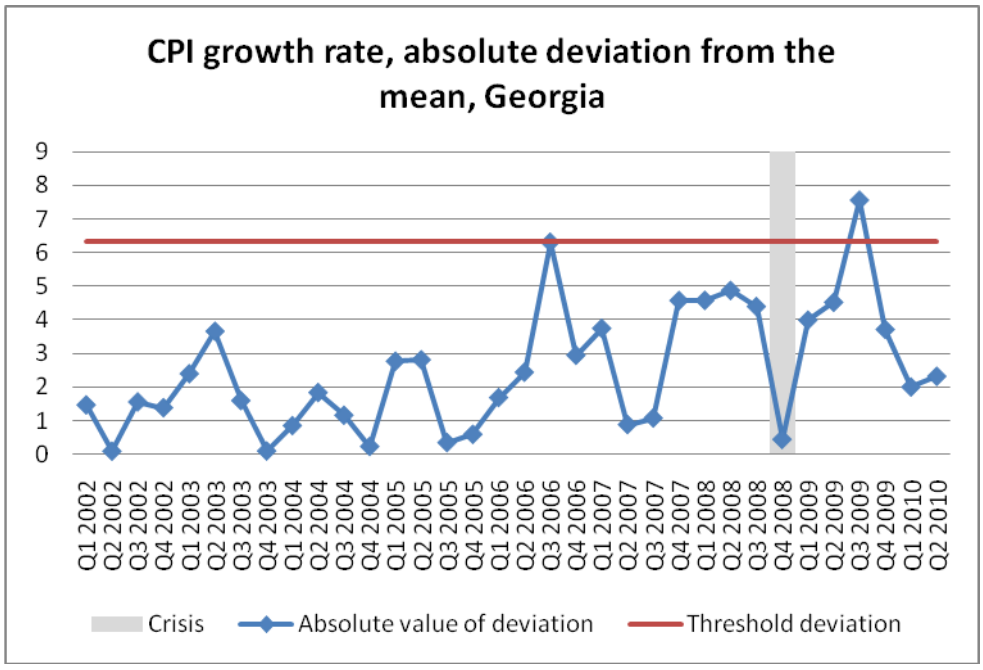


Figure 2.2.8 CPI growth rate, absolute deviation from the mean, Georgia

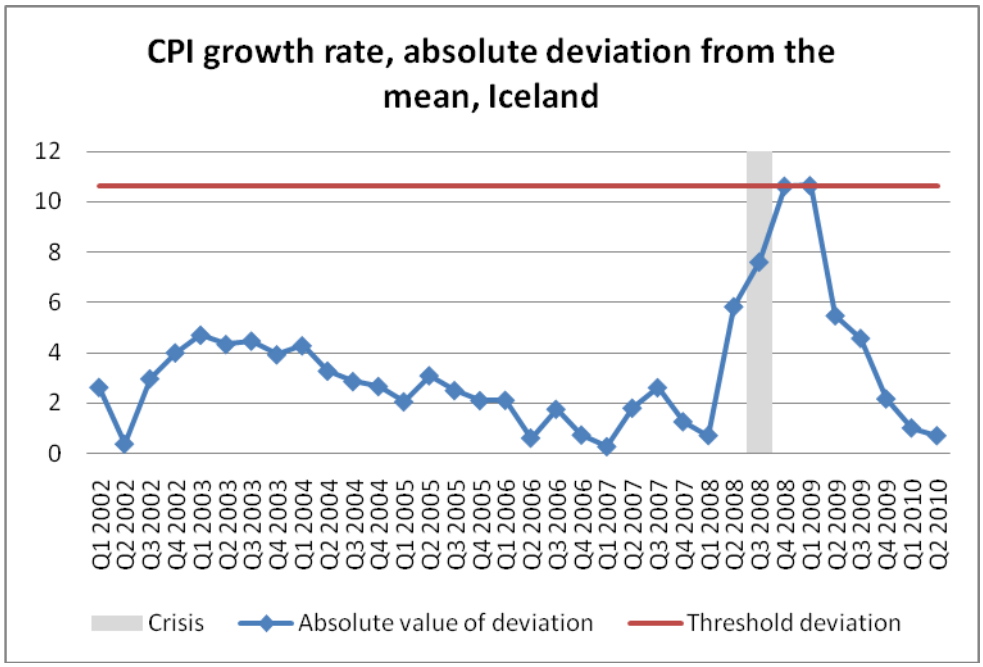


Figure 2.2.9 CPI growth rate, absolute deviation from the mean, Iceland

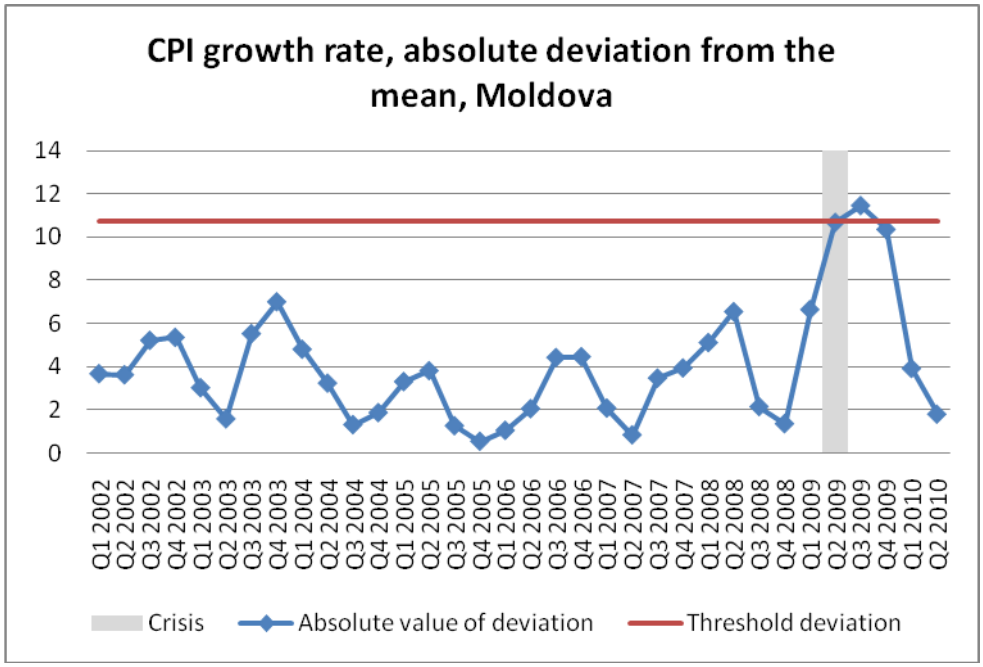


Figure 2.2.10 CPI growth rate, absolute deviation from the mean, Moldova

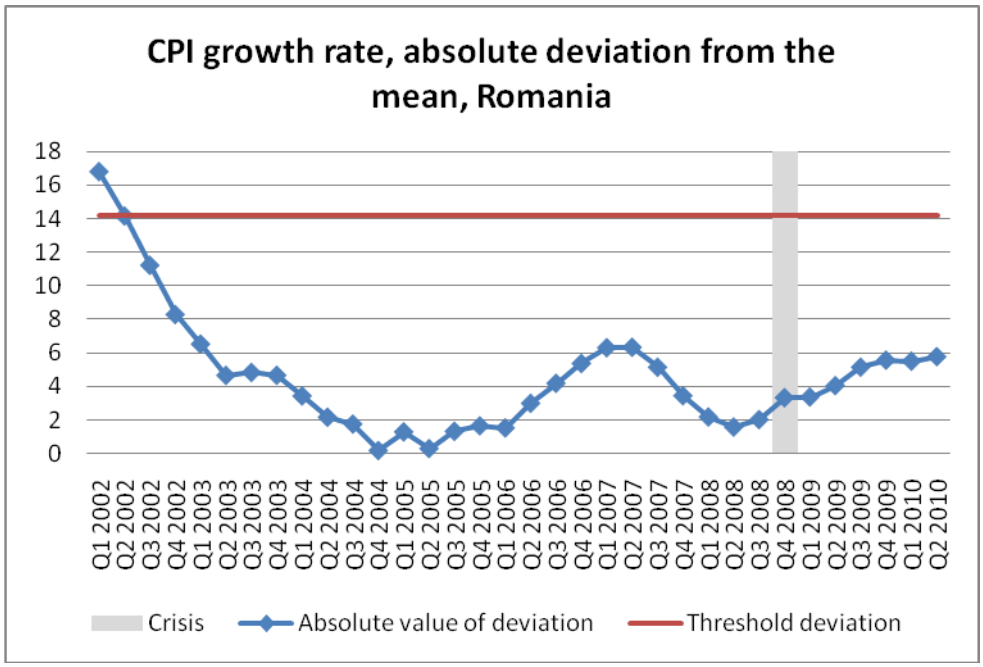


Figure 2.2.11 CPI growth rate, absolute deviation from the mean, Romania

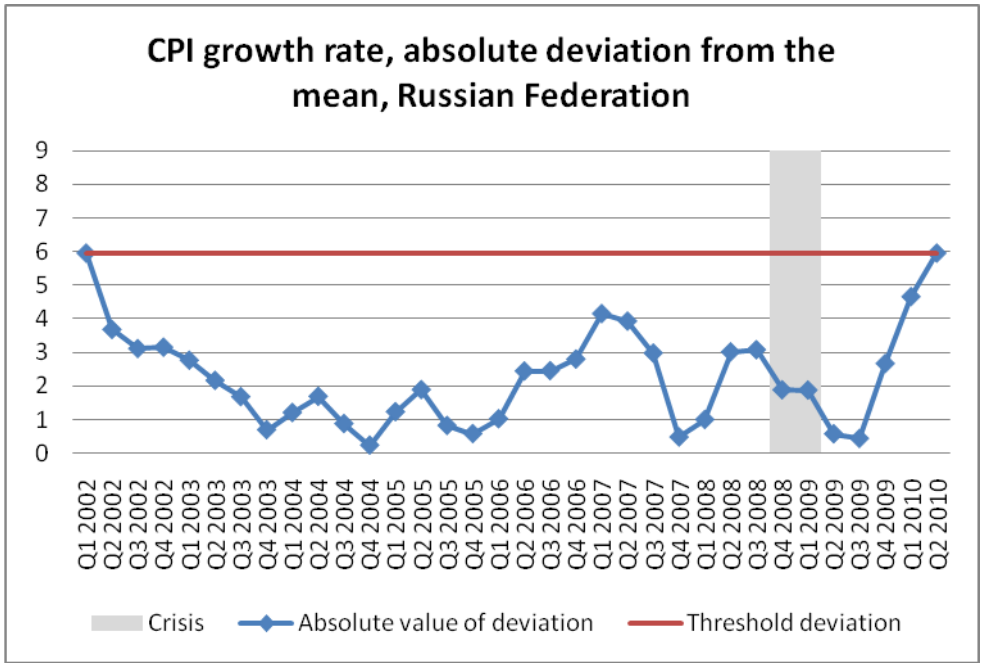


Figure 2.2.12 CPI growth rate, absolute deviation from the mean, Russian Federation

The growth of CPI in some cases does not show abnormal dynamics for 4 quarters preceding the crisis (as in cases of Costa Rica, Romania, and Russian Federation), and in some cases a significant increase in this indicator in the pre-crisis period is not crossing the threshold (an example of this is the trend before the crisis in Moldova, Iceland, and Georgia).

This example shows that every crisis is a unique phenomenon, so one cannot expect that all countries will show the same dynamics of macroeconomic variables before the crisis. Therefore, while diagnosing financial crises, only a simultaneous analysis of signals from the entire set of leading indicators can take into account individual characteristics of countries and forecast crises with decent probability.

After the analysis of the entire array of parameters several important conclusions can be formulated.

Firstly, one can clearly distinguish the group of indicators that signal in advance of a crisis for at least seven countries (see Table 2.2). These are the following indicators: growth rate of imports (IMPI), the nominal effective exchange rate (NEER), consumption share in GDP (CONS_TOTAL), the ratio of government loans to GDP (GVT_CLAIMS_GDP), M2 growth rate (DM2), REER growth rate (REERI), the ratio of international reserves to GDP (RES_GDP). It can be said that this set of indicators describes general trends in the global crisis, or those that are common to most countries. For example, five of the seven named indicators signaled about the crisis in advance in the case of Ukraine and Iceland, 6 in the case of Chile, Costa Rica, South Korea, Romania, and Russian Federation, and all 7 indicators issued timely signals about the future crises in Armenia, Georgia and Moldova.

Secondly, each country has its specific set of indicators that signal about the approaching financial crisis in advance. For Ukraine, such indicators are: CPI growth rate (CPI_CHNG), ratio of government loans to GDP (GVT_CLAIMS_GDP), the difference between the real rates on loans and on deposits (RATE_MARGIN), growth rate of imports (IMPI), growth rate of exports (EXPI), REER growth rate (REERI), ratio of trade balance to GDP (GS_GDP) ratio of international reserves to GDP (RES_GDP), real rate on deposits (RDEPRATE), nominal effective exchange rate (NEER), consumption share in GDP (CONS_TOTAL). Therefore, Ukraine should pay particular attention to these indicators for early prediction of financial crises.

29. Kaminsky G., Lizondo S., Reinhart C. Leading Indicators of Currency Crises // IMF Staff Papers. 1998. Vol. 45 (March)

Conclusions to Part 2

Therefore, the indexes that were proposed as leading indicators of crisis were analyzed with the help of "signals approach".

Following indicators successfully predicted the largest number of crises in the sample: growth of imports, the nominal effective exchange rate, the ratio of government loans to GDP, the share of consumption in GDP, growth rate of money supply, the ratio of international reserves to GDP, growth rate of REER, the ratio of current account to GDP, ratio of trade balance to GDP, the difference between the real rates on loans and on deposits. However, most of these indicators also issued significant levels of signals labeled as "false alarms". Rate of growth of imports gave 28.76% of all possible "false alarms", nominal effective exchange rate issued 57.67% "false signals" possible, the ratio of government loans to GDP had 49.5% "false alarms", the share of consumption in GDP had 22.22% "false alarms", money supply growth issued 19.74% "false alarms", ratio of international reserves to GDP had 34.54% "false alarms", and the difference between the real rates on loans and on deposits issued 21.38% of all possible "false alarms". Given the large number of inaccurately issued signals these indicators are not the best predictors of crises. Only a small number of mentioned indicators have low percentage of "false alarms": REER growth rate gives 8.14% of all possible "false alarms", the ratio of current account to GDP issues 18.18% false signals possible, and the ratio of trade balance to GDP gives only 6.84% of all possible "false alarms".

On the other hand, the following indicators provided the highest percentage of all possible accurate signals: ratio of government loans to GDP – 72.97%, the nominal effective exchange rate – 67.50%, growth of imports – 58.54%, the ratio of international reserves to GDP – 41.67%, the difference between the real rates on loans and on deposits – 41.67%, share of consumption in GDP – 35.29%, growth rate of REER – 33.33%, M2 growth rate – 30.56%, the ratio of international reserves to imports – 30.30%, difference between LIBOR rates and rates on domestic loans –

27.78%, the ratio of trade balance to GDP – 27.27%. However, among these indicators, only the trade balance ratio to GDP, growth rate of REER, the ratio of international reserves to imports, and growth rate of M2 issued an acceptable level of "false alarms".

Therefore, to select the most effective indicators (which would both predict a significant portion of crises, and have low levels of "false alarms") minimization of a noise to signal ratio was used as a criterion for determining the threshold values of indicators. The most effective indicators according to this criteria were the following: the share of short-term debt in structure of external debt, the ratio of current account to GDP, growth rate of CPI, money multiplier, the ratio of M2 to international reserves, the real interest rate on loans, the growth rate of REER, the ratio of trade balance to GDP, investment share in GDP, and growth rate of exports. For these indicators noise to signal ratio is less than 32%. All figures that characterize the effectiveness of indicators are presented in Table 2.2.

For each country and for each indicator the critical value of the maximum deviation from the mean was identified. Using these values, one can easily build “safe” limits of actual index. If the indicator crosses the defined threshold values, it signals about the threat of financial crisis over the next 4 quarters. Threshold deviations for each country are given in Table 2.3.

Average threshold deviations of indicators are presented in Table 2.4. These values provide information on the values of each indicator that may indicate the threat of financial crisis in specific countries.

PART 3. Estimation of the optimal bank reserves Modeling.

3.1. Model of the optimal bank reserves on the basis of exogenous estimation of crisis arising probability.

During the 90s of the last century scientists and policymakers used the ratio of official reserves to amount of money necessary to finance the import of goods and services, as a rule, during the three months so as to evaluate the risks related with the balance of payments account. However, since 2001 such approach has been considered as too artificial and incomplete since it does not take into account the balance of borrowing and lending in terms of their amounts and maturities.

In "General approaches to the foreign reserves management", approved by the IMF Council of Directors in March 2001, the rule of three-months-of-import-coverage is questioning and further the documents states that for the countries with limited access to the capital markets reserves were continued considering in terms of import volume since this procedures is universally accessible and easy to account. Despite this fact in reality more broaden criteria should be considered for reserves holding determination instead of three-months of imports criterion and for the reserves management using the short term debt accounting.

In October 2001 IFM published the analysis of potential opportunities for the adequacy of monetary reserves based on the capital flows. The ratio of international reserves to short-term debt was stated as one of the most useful indicator for adequacy reserves evaluation in emerging countries. Also the following conclusion was made: the countries with weak economic positions (Ukraine belongs to this group) such as, for example, with unstable macroeconomic base (high budget deficit), with high level of domestic short-term debt (especially in the economies where the mechanism for capital controls is absent), with developing immature banking system, which cannot reach high level of capital turnover, require the presence of high

reserves level, which should be much higher than the level of reserves suggested by the three-months-of-import rule[2].

Regardless of the transitions from the three-months-of-import-coverage to the coverage of short-term debt, the problem of reserves optimization still remains open due to the artificial nature of both approaches. In addition, they do rely on serious theoretical background.

That is why in this chapter we are developing and analyzing the model which allows for optimal reserves calculation that are necessary to preclude negative consequences which can appear during the sudden stop. The approach is based on deeper modeling of economic agent behavior in contrast to the mentioned classical rules. Proposed model is relatively simple with small number of equations. The important peculiarity of the model is the exogenous probability of the sudden stop, which taken as given, not derived within the model itself.

The model for optimal reserves calculation is based on the approaches, offered by Jeanne and Rancière[26]. It was selected because of the following reasons:

1. The work of authors has been started since 2006 and was published in the IMF Working papers. Taking into account the close cooperation of Ukrainian government with the IMF and IMF own requirements to the reserves amount, it would be useful to take into account the IFM approaches.
2. The model is developed for the optimal reserves calculation for small open emerging economies. Ukraine can be classified to this group of countries.
3. The reserves are calculated with the insurance goal to protect the economy in case of the sudden stop of capital inflows, which was observed in many countries during the financial and economic crisis of 2008-2009.
4. The approach itself is based on the modeling of economic agents behavior and has serious theoretical background in contrast to the widely spread alternative models (vector autoregressive, etc., where the links between variables are set atheoretically).

[2] Expository letter to the Draft Law of Ukraine on Introducing the changes to some Laws of Ukraine in order to improve the balance of payments positions in Ukraine in terms of word financial crises by 19.11.2008, The Supreme Court of Ukraine.

It is worth noticing that developed model does not require including the large number of variables and concentrates mainly on the insurance against sudden stop of capital inflows, neglecting other aspects of economic system. As a result, the model calibration does not require large statistical data sets and can be considered as standard approach to the optimal level of reserves calculation.

The analysis of the model, its assumptions and the results of optimization

The formal model is derived based on the exogenous probability of the sudden stop by aggregating the behavior of separate economic agents (consumers) in before and after crisis conditions. It is assumed that representative consumer has the following budget constraint:

$$C_t = Y_t + L_t - (1+r)L_{t-1} + Z_t, \quad (3.1)$$

where C_t is the level of consumption, Y_t is the GDP, L_t is the foreign debt, Z_t is the transfer which is granted by the government from the reserves. Before the sudden stop[3] of capital inflows (before the crisis) the transfer is negative, that is, the government is taxing consumers in order to repay the loan to the creditor (e.g., to IMF). This volume is proportional to the sum of the risk premium and the probability of the sudden stop. During the period of the crisis the transfer is positive; the government is helping to the representative consumer to repay the foreign debt which by assumption is not extended.

In such circumstances the consumer can smooth its consumption during the normal periods and the periods of the crises using the "insurance contract" or reserves. During the normal periods the contract establishes the payments to the foreign investor in the volume of:

$$Z_{t+1}^n = -x_t R_t, \qquad (3.2)$$

and during the crises consumer receives:

$$Z_{t+1}^s = (1-x_t)R_t, \qquad (3.3)$$

[3] This is a sudden stop of capital inflows to the country, which is related first of all with the crises episodes as in the country, as well as in the word.

where n denotes normal before and after crisis period, while s denotes the period of the sudden stop.

This assumption corresponds to the current situation in Ukraine, where IMF is supporting Ukrainian economy during the crisis using such form of help as reserves increase and Ukraine repay the loans and interests during the period of economic stability.

Potential GDP is assumed to be increasing with the constant rate in such a way that in normal situation (before and after the crisis) it is:

$$Y_t^n = (1+g)^t Y_0 . \qquad (3.4)$$

During the sudden stop of foreign capital GDP is decreasing by γ% and constitutes:

$$Y_t^s = (1-\gamma) Y_t^n . \qquad (3.5)$$

To finalize the model we should set up intertemporal preferences of consumers – the population of Ukraine:

$$U_t = E_t \left(\sum_{i=0}^{\infty} (1+r)^{-i} u(C_{t+i}) \right), \qquad (3.6)$$

where utility function has constant risk-aversion $\sigma \geq 0$, $u(C) = \frac{C^{1-\sigma}}{1-\sigma}$ if $\sigma \neq 1$, and $u(C) = log(C)$ if $\sigma = 1$, C is the level of consumption, E is the operator for mathematical expectations.

The optimal level of reserves maximizes the following function, which represents the expectations of the population welfare in Ukraine as during the sudden stop periods as well before and after the crisis periods:

$$R_t = argmax((1-\pi_t) u\left(C_{t+1}^n\right) + \pi_t u(C_{t+1}^s)), \quad (3.7)$$

where π_t is the probability of the crises in $t+1$ year.

The goal of the optimization is to smooth the consumption of the population during the crisis in such a way that it becomes close to the consumption level during the non-crisis episodes. Solving the optimization problem (3.6) – (3.1), which consists of objective function and budget constraint, the first order condition can be set up:

$$\pi_t(1-x_t)u'\left(C_{t+1}^s\right)=(1-\pi_t)x_t u'\left(C_{t+1}^n\right), \qquad (3.8)$$

where $x=\delta+\pi$, π is the probability of the sudden stop, δ is the net risk premium (the difference between nominal interest rate and risk free rate).

Let set up the price of one unit of consumption during the normal times relative to the price of one unit of consumption during the crisis as:

$$p_t=\frac{u'(C_{t+1}^n)}{u'(C_{t+1}^s)}, \qquad (3.9)$$

If $p_t=1$, then consumption level will be always the same regardless of the fact whether the economy is in the crisis or not. If $p_t<1$, then the consumption level is smaller during the period of sudden stop.

If the level of reserves is set up optimally, then based on the (3.8) and (3.9) we can derive the following expression:

$$p_t=\frac{x_t^{-1}-1}{\pi_t^{-1}-1}. \quad (3.10)$$

Optimizing the consumer problem, the following ratio of optimal reserves to GDP can be derived:

$$\rho_t^*=\frac{\lambda+\gamma-\left(1-\frac{(r-g)\lambda}{1+g}\right)(1-p_t^{1/\sigma})}{1-x_t(1-p_t^{1/\sigma})}, \qquad (3.11)$$

where λ is the change of short-term debt to GDP during the sudden stop, r is the risk free rate, $x=\delta+\pi$, π is the probability of the sudden stop, δ is the net risk premium (the difference between nominal interest rate and risk free rate), γ is the level of real GDP drop, g is the growth rate of GDP, σ is the relative risk-aversion.

To take into account the national currency depreciation during the sudden stop, we should slightly transform described formulas but the algorithm of calculations remains the same. The formula for optimal reserves calculation will have the following form:

$$\rho_t^*=\frac{\lambda+\gamma-\left(1-\frac{(r-g)\lambda}{1+g}\right)\left(1-p_t^{1/\sigma}\right)+\frac{1+r}{1+g}\lambda\Delta Q}{1-x_t\left(1-p_t^{1/\sigma}\right)+(1-x_t)\Delta Q}, \quad (3.12)$$

$$p_t = \frac{x_t^{-1} - 1}{\pi_t^{-1} - 1}(1 + \Delta Q) \,. \quad (3.13)$$

Model parameters estimation

Let consider three variants of model calibration. The first one (table 3.2, column 3) is analogous to the calibration described in the work of Jeanne and Rancière (2009), which is based on the analysis of 34 countries with the average level of development, using the data for 1975-2003 period [26]. The second one (table 3.2, column 4) and the third one (table 3.2, column 5) are based on the data of Ukraine. This is done in order to accommodate the parameters values of the model closer to the Ukrainian conditions. The difference between the last two lies in the determination of the periods of the sudden stop. The second variant defines the period of the sudden stop if the ratio of short-term debt to GDP has decreased by more than 5% during the year. The third variant determines the periods of sudden stop using the expert analysis, regardless of the change of capital inflows. We selected 1999 and 2009 as crisis years since they are considered in such a way by the majority of economists (table 3.1).

Table 3.1. ***Periods of sudden stop and before and after crises periods***

Year	Sudden stop – 5% drop	Sudden stop – based on empirical analysis and expert assumptions
1997	0	0
1998	1	0
1999	1	1
2000	0	0
2001	0	0
2002	1	0
2003	1	0
2004	0	0
2005	0	0
2006	0	0

2007	0	0
2008	0	0
2009	0	1

Source: Jeanne and Rancière (2009), NBU data, own calculations.

The results of calibration are shown in the table 3.2 (more detailed calculations are shown in the appendix). The final calculations of reserves are conducted in three steps:

1. The following parameters are evaluated λ, π, γ, g, δ, r, σ, x, ΔQ based on the statistical data and other scientific investigations (see table 3.2 for parameters description).
2. Calculate p and p standard using (3.10) and (3.13).
3. Using the results of calculations at the previous two steps and formulas (3.11) and (3.12), we can determine the optimal level of reserves.

Table 3.2. ***Calibrated parameters and optimal level of reserves calculations***

Parameter	Name	Values from the Jeanne and Rancière, work – variant 1	The change of parameters for Ukraine – variant 2	The change of parameter for Ukraine – variant 3
1	2	3	4	5
λ	The the change of short-term debt to GDP, %	10%	10%	10%
π	Probability of the sudden stop, %	10%	10%	10%
γ	GDP drop during the first period of the sudden stop, %	6.5%	6.5%	7.6%
g	Potential GDP growth, %	3.3%	3.1%	3.1%
δ	Net risk premium, %	1.5%	1.5%	1.5%
r	Risk free rate, %	%	5%	5%
σ	Risk-aversion	2	2	2
x	Gross risk premium, %	11.5%	11.5%	11.5%
p	The price of one unit of currency during non-crisis period relative to the price of one unit of currency during the sudden stop without depreciation	0.86	0.86	0.86
p ΔQ	The price of 1 unit of currency during non-crises period	0.94	1.07	1.35

	relative to the price of one unit of currency during the sudden stop with depreciation			
ΔQ	Exchange rate depreciation, %	10%	25%	58%
ρ standard	Ratio of reserves to GDP without depreciation, %	9.1	9.0%	10.2%
p ΔQ	Ratio of reserves to GDP with depreciation, %	13.4%	18.3%	26.0%

Source: Jeanne and Rancière (2009), NBU data, own calculations.

Estimated level of reserves

The results of calculations assume that the probability of the sudden stop is 0.1 each year. The optimal level of reserves is also a fixed number and constitutes:

- **9.1% of GDP based on the parameters values of Jeanne and Rancière** (table 3.2, column 3, which are averages and are calculated based on the data of 34 countries with the average income level during the 1975-2003 period),
- **9.0% – based on the parameters values calculated for Ukraine for the period 1996-2009** (table 3.2, column 4)**,** assuming the periods of sudden stops shown in the second column of the table 3.1 (1998, 1999, 2002 and 2003 years) and
- **10.2% - for periods of sudden stop based on the third column of the table 3.1** (the crises of 1999 and 2009 years) using the parameters of table 3.2, column 5.

Potential usage of **depreciation significantly increases the level of optimal reserves:**

- **from 9.1% to 13.4%** using the data for 34 countries (table 3.2, column 3),
- **from 9.0% to 18.3%** –calibration based on the data for Ukraine with the sudden stops in 1998, 1999, 2002 and 2003 (table 3.2, column 4) and
- **from 10.2% to 26.0%** – with the sudden stop in 1999 and 2009 (table 3.2, column 5).

The comparison of current level of reserves volume with the recommended one by the model which takes into account depreciation is shown on the figure 3.1.

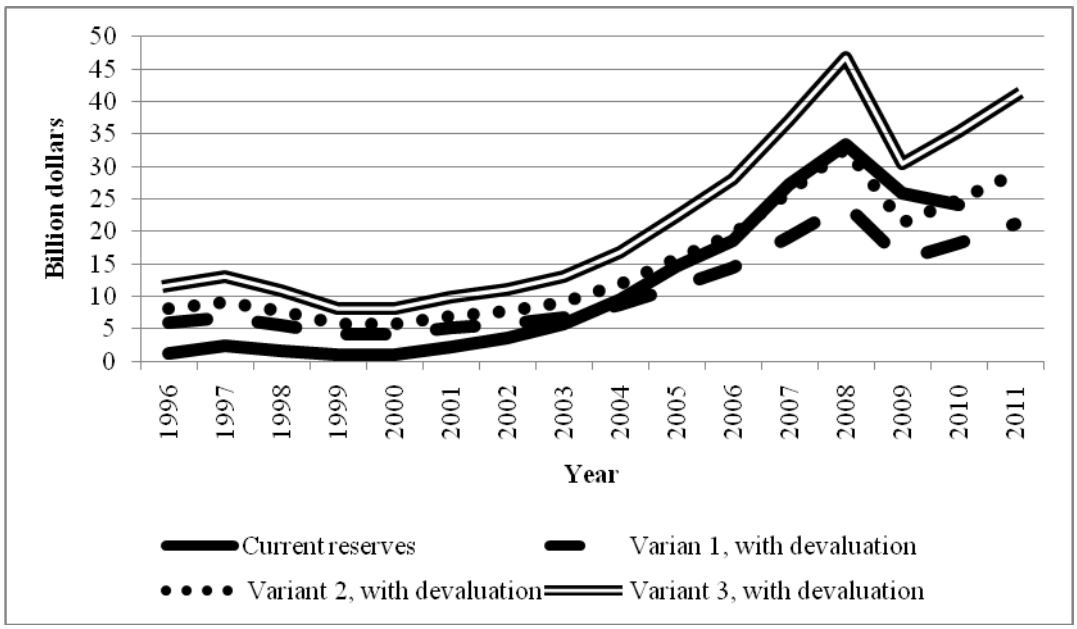


Figure 3.1. ***Optimal level of reserves calculation***

Source: NBU data, own calculations.

As we can see from the figure 3.1, the variant which is based on the sudden stops in 1999 and 2009 (table 3.2, column 5) always recommends larger volume of reserves in comparison to the current level. On the other hand, variant 1 which uses the parameters estimated based on the data for 34 countries (table 3.2, column 3) would recommend till 2004 larger volume of the reserves and to decrease it after 2005. Similar dynamics is observed based on the variant 2 (table 3.2, column 4) where the model would suggests increasing the level of reserves till 2006 and slightly decreasing after 2006 and, basically, keep the current level in 2010.

In 2011 variant 1 of the model recommends decreasing the level of reserves by 12%, variant 2 – increasing by 19% and variant 3 – increasing even by 70% in comparison to the existing level of reserves (by 2010).

Simulations and comparison with alternatives

The results of estimation of the developed model hardly depend on the values of the parameters. That is why an important element of the analysis of the model quality is stability check by changing parameters in comparison with their existing values. For such type of analysis the simulation principle is often used. We offer to determine for each value of the parameters (based on the variant 2 of the calibration, table 3.2, column 4) the optimal level of reserves and compare it with the current volume by 2010. It should be stated that for 2010 the current level of reserves and recommended one by the model in fact coincide.

In table 3.3 the initial values of the parameters are shown with the intervals of changes.

Table 3.3. ***Parameters values, which are used for the initial model estimation and their intervals for the next simulation***

Symbol	***Parameter***	***Value***	***Simulation interval***
π	Probability of the sudden stop, %	10.0%	1%-30%
g	Real GDP growth, %	3.1%	0%-10%

r	Risk free rate, %	7.8%	1%-10%
δ	Risk premium, %.	1.3%	0.0%-2.5%
γ	GDP decrease during the sudden stop, %	6.5%	0%-50%
ΔQ	Exchange rate depreciation, %	25%	0%-80%
σ	Risk-aversion	2.0	1.0-3.0

Source: NBU data, authors' assumptions.

Calculated optimal level of reserves is relatively sensitive to all parameters except the risk free rate.

As for the probability of the sudden stop this relation is positive and linear as can be seen from the figure 3.2. It should be noticed also that for each percent of the probability increase the model recommends increasing the level of reserves by 1.4 billion dollars.

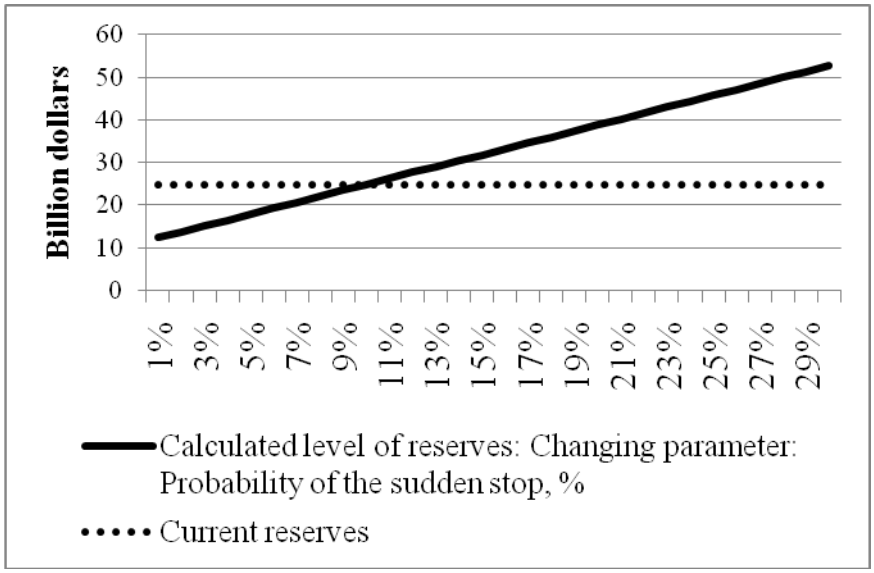


Figure 3.2. ***The optimal level of reserves sensitivity to the probability of the sudden stop***

Source: NBU data, own calculations.

The level of reserves positively depends on the potential GDP growth rate, as it is shown on the figure 3.3.

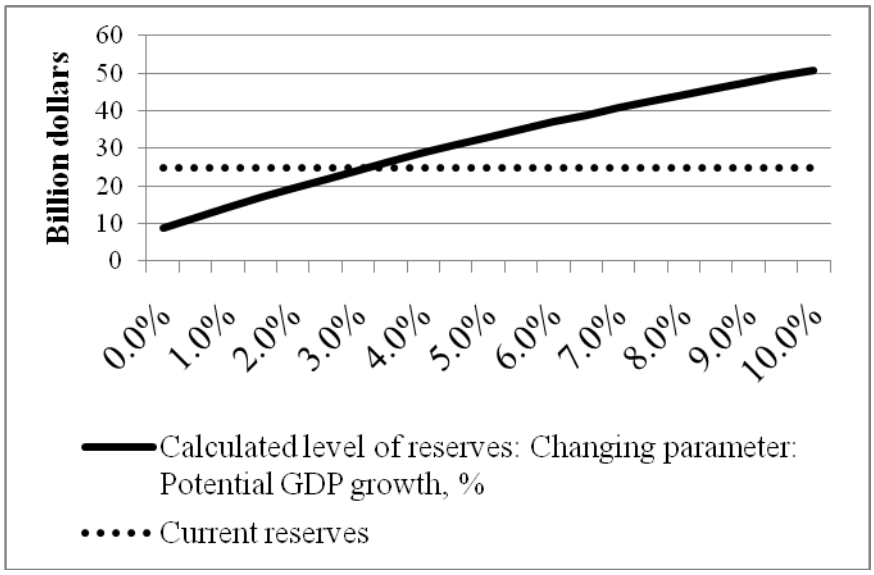


Figure 3.3. ***The optimal level of reserves sensitivity to the potential GDP growth rate***

Source: NBU data, own calculations.

With the change of the risk free rate the optimal level of reserves is almost not changing (figure 3.4).

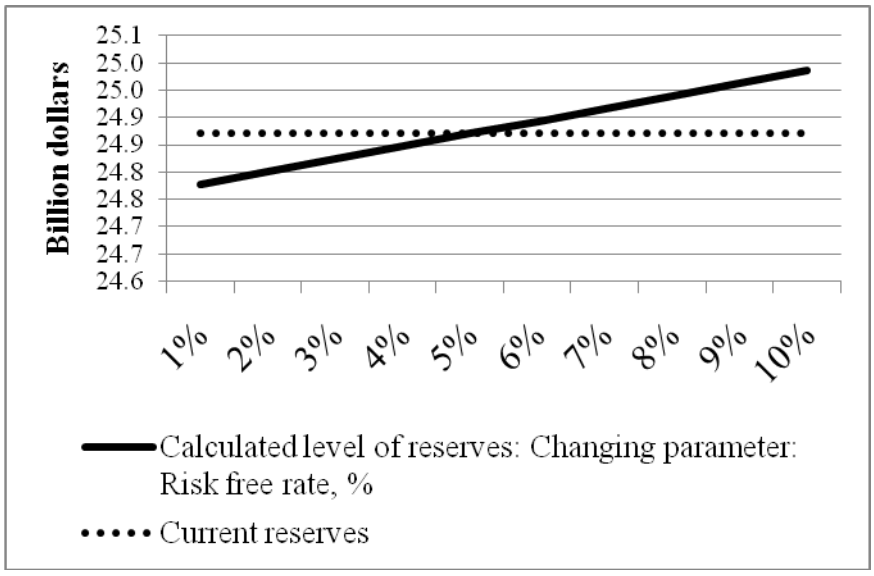


Figure 3.4. ***The optimal level of reserves sensitivity to the risk free rate***

Source: NBU data, own calculations.

Risk premium is negatively related to the level of reserves: as it is growing, the optimal level of reserves is decreasing, as shown on the figure 3.5.

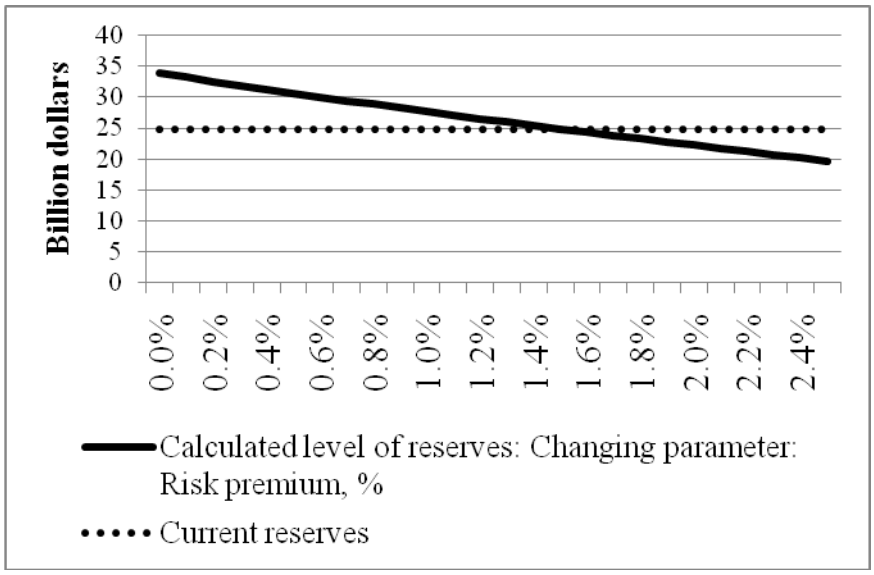


Figure 3.5. ***The optimal level of reserves sensitivity to risk premium***

Source: NBU data, own calculations.

The higher the level of expected GDP decrease during the sudden stop, the larger is the recommended by the model level of reserves. This dependence is shown on the figure 3.6 and it is linear. Each expected percentage of GDP drop requires increasing the level of reserves by 2.2 billion dollars.

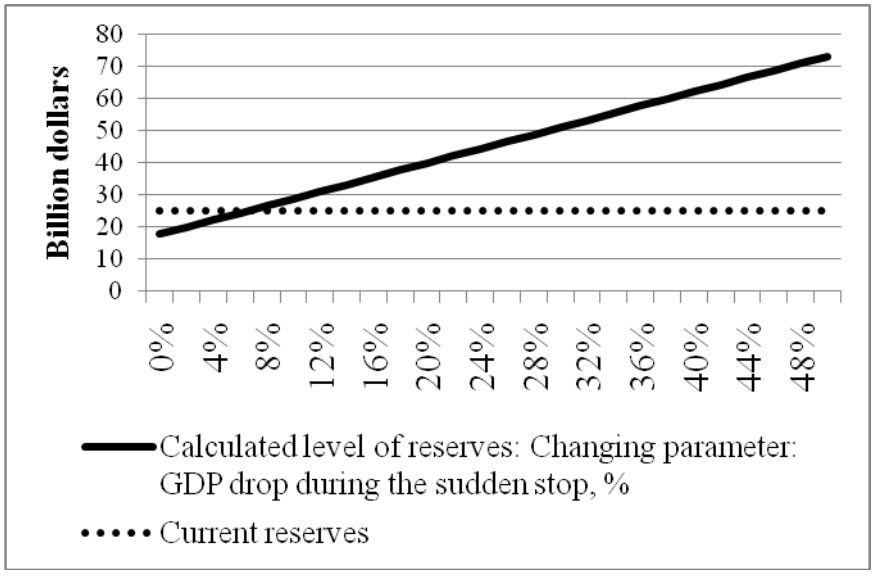


Figure 3.6. ***The optimal level of reserves sensitivity to the GDP drop during the sudden stop***
Source: NBU data, own calculations.

Expected significant exchange rate depreciation requires accumulating larger level of reserves to combat the negative consequences of potential crisis (figure 3.7). This dependency is linear. If the expected percentage of exchange rate depreciation

increases by 10%, then the model recommends increasing the level of reserves on average by 6 billion dollars.

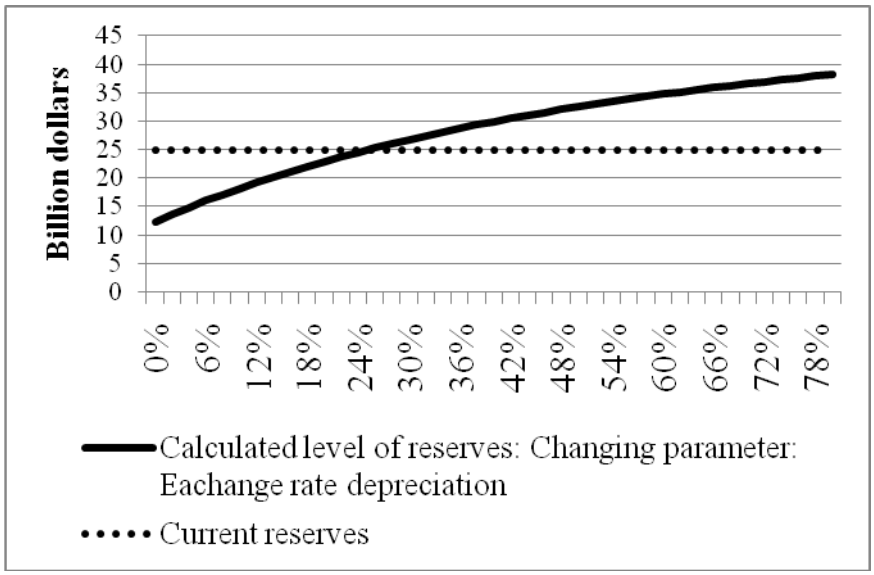


Figure 3.7. ***The optimal level of reserves sensitivity to the exchange rate change***
Source: NBU data, own calculations.

The level of risk aversion is negatively related to the recommended level of reserves (figure 3.8). However, this relation is not very strict. In this context, we should also remember than we can face the famous Lukas critique. Its essence means that some classical models assume the stability of parameters as the time changes, specifically during monetary and fiscal regulations. In reality this situations may be the opposite one. Let take as an example the level of risk aversion. At the first glance it is expected to be relatively stable. But in fact the situation may be significantly indeterminant. The level of risk aversion characterizes the degree of riskiness of economic agents, including investors. During many year economists argue that liquidity can be explained though the analysis of monetary aggregates. But the problems at the mortgage market in the USA and the corresponding world crises showed that liquidity (or its absence) has more and more in common with the appetites to the risk from the sides of borrowers and creditors than with the monetary aggregates. Simply speaking this is the decrease of the riskiness of economic agents and their desire to invest into the projects which were acceptable before the crisis *ceteris paribus*. That is why we should remember that risk aversion during the crisis periods can change a lot, which will require the corresponding change of the level of reserves served as an insurance instrument.

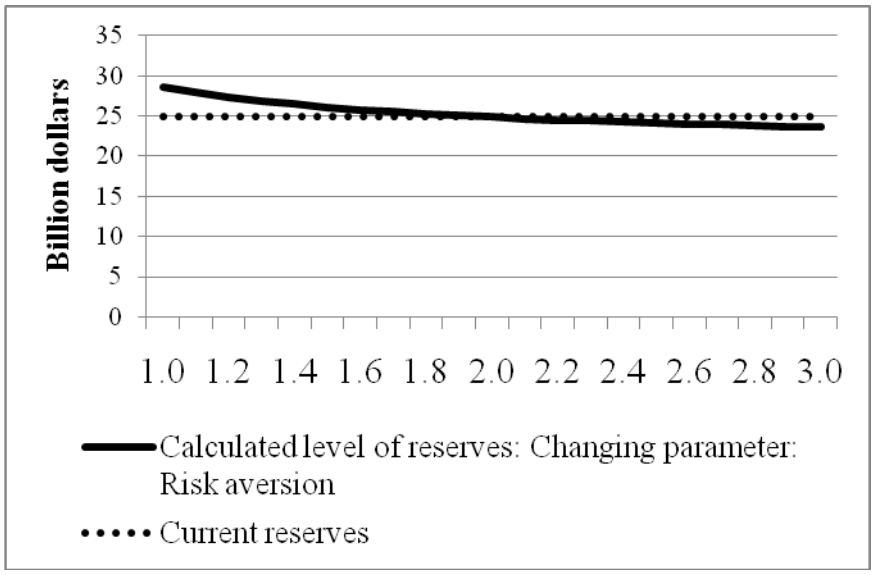


Figure 3.8. ***The optimal level of reserves sensitivity to the risk aversion***
Source: NBU data, own calculations.

In addition, to compare the results of modeling with existing practical rules for reserves calculation, we can compare the level of current reserves of Ukraine with the recommended level, which are calculated based on the model and also with the levels of results which can be calculated based on two classical rules:

1) Greenspan-Guidotti rule and
2) three-months-of-import-coverage rule.

Greenspan-Guidotti rule[4] states that the level of reserves should be equal to the short-term debt, and, as a result, the ratio of reserves to the short-term debt will be equal to unity. This rule is derived from the fact that countries should possess with the recourses necessary to protect them from the massive foreign capital outflows[5].

Three-months-of-import-coverage rule allows to finance the import of goods and services during the specified periods without additional capital inflows.

[4] The rule is named after Pablo Guidotti – the former Argentinean Deputy Minister of Finance and Alan Greenspan - the former Head of Federal Reserve of USA. Initially Guidotti formed the rule during the G33 summit in 1999, and Greenspan widely spreaded it in his speech during the meeting at the World Bank. Gusman Kalafel and Padilia del Boske (2002) showed that the ratio of reserves to the short-term debt is the leading indicator of external crises.

[5] http://en.wikipedia.org/wiki/Guidotti%E2%80%93Greenspan_rule.

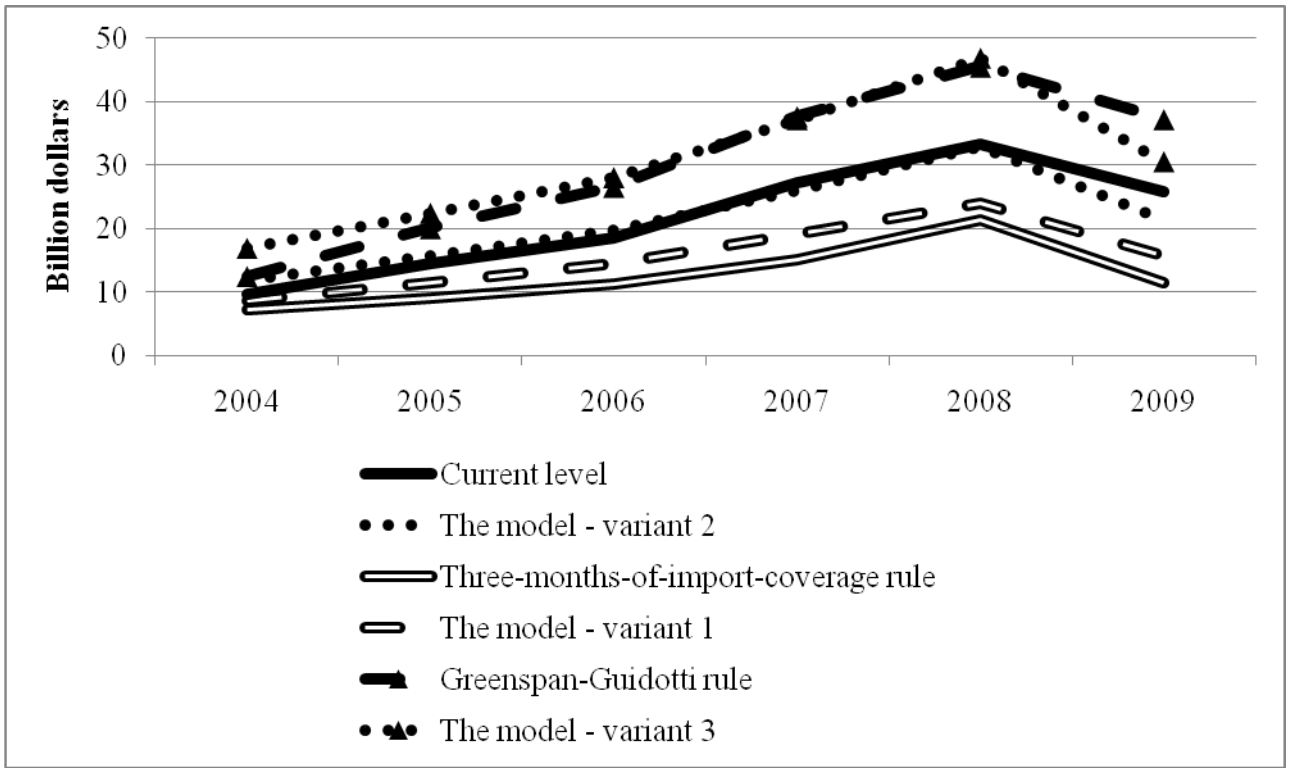


Figure 3.9. ***Comparison of the current level of reserves, model prediction and reserves recommended by the classical rules***
Source: NBU data, own calculations.

As shown on the figure 3.9, the optimal level of reserves based on the three-months-of-import-coverage rule during 2008-2009 approximately is two times lower than the current level. Similar to this rule recommendation provides variant 1 of the model (table 3.2, column 3). On the other hand, Greenspan-Guidotti rule recommends increasing significantly the level of reserves – by 40-60% – in order to combat possible negative tendencies related with the massive capital outflows from the country. Similar prediction is received based on the variant 3 of the model (table 3.2, column 5). Variant 2 of the model (table 3.2, column 4) almost coincides with the current level of reserves, which lies between two rules.

3.2. Model of the optimal bank reserves with probability calculations of the sudden stop on the basis of macroeconomic data

Instead of determining the parameter of the sudden stop based on the expert estimation, we can estimate it on the existing macroeconomic data. This estimate can be obtained using the probability models like probit or logit, which are based on the

assumption that the distribution of such indicator as probability of the sudden stop is normal or logistic, respectively, and the dependent variable is a dummy.

In general there are three classical approaches to the probability of the sudden stop modeling with the usage of dummy variable as dependent one: linear probability model (LPM), probit and logit. Dependent variable in each of these models is the binary value, which takes 0 (event did not occur) and 1 (even occurred). [58,61]

Linear probability model (LPM) is a classical regression of binary variable on other explanatory variables and has the following form:

$$\boldsymbol{Y} = \boldsymbol{X\beta} + \boldsymbol{e}, \quad (3.14)$$

where $\boldsymbol{Y}$ is Nx1 vector of values of dependent variable, $\boldsymbol{X}$ is Nxk matrix of k explanatory variables (including the constant), $\boldsymbol{\beta}$ is kx1 vector of regression parameters, $\boldsymbol{e}$ is Nx1 vector of residuals of the regression.

The usage of this method on practice is related with the following problems:

1. Residuals of such type of regression are not normally distributed. It means that hypothesis testing and confidence intervals building for the estimated parameters based on the small sample will be not correct.
2. Heteroscedasticity of the residuals leads to the violation of one of the classical assumption of ordinary linear regression, which also can lead to the incorrect conclusion in terms of modeling.
3. The possibility of predicted probability lying outside (0, 1) interval, which contradicts to the definition of the probability and complicates the usage of the received results on practice.
4. The coefficient of determination will be underevaluated (R-squared) since all values of the dependent variables are lying on the lines $y = 0$ and $y = 1$, and the model forms the line which intersects them.

The first problem can be addressed by increasing the sample size, the second one by using the weighted least squares method, problem 4 – by introducing other analogous indicators of goodness of fit measure (for example, using pseudo-R-square, that is, Mc Fadden R-square[6]). So the main remaining problem is the

[6] The indicator is named after 2000 Nobel laureate in Economics Daniel McFadden.

distribution of estimated probability outside (0, 1) interval. It can be addressed by using the nonlinear methods of probability estimation such as probit and logit, which have the following form:

$$P(y_t = 1|x_t) = F(x_t\boldsymbol{\beta}) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x_t\boldsymbol{\beta}} e^{-\frac{z^2}{2}} dz, \qquad (3.15)$$

$$P(y_t = 1|x_t) = L(x_t\boldsymbol{\beta}) = \frac{1}{1+e^{-x_t\boldsymbol{\beta}}}, \qquad (3.16)$$

where y_t is the values of the dependent variable at the period t, $t = \overline{1,N}$, x_t is the 1xk vector of k explanatory variables (including the constant) during the period t, $t = \overline{1,N}$, x_t is the t row of the matrix $\boldsymbol{X} = \begin{bmatrix} x_1 \\ \dots \\ x_t \\ \dots \\ x_N \end{bmatrix}$, $\boldsymbol{\beta}$ is the kx1 vector of regression parameters, $F(\cdot)$ is the standardized normal cumulative distribution function., $L(\cdot)$ is the logistic function.

Estimation of these models is conducted by maximum likelihood estimator. The parameters of them are not treated in a classical way, that is, as x_{it} changes by unity the probability $P(y_t = 1|x_t)$ will not change by β_i as in the case of LPM. With the change of x_{it} by unity in the probit model (3.15) the probability will change approximately by $\beta_i f(x_t\boldsymbol{\beta})$[7], in the logit model (3.16) – by $\beta_i P(y_t = 1|x_t)(1 - P(y_t = 1|x_t))$. The coefficient β_i is called partial regression coefficient, and the change of the probability caused by x_{it} is called a marginal effect (see Appendix 9).

We should notice that probit and logit models are close and there are no strict criteria in favor of any of them. In the models of this class pseudo-R-squared or McFadden R-squared is used to estimate the coefficient of determination. It can be calculated using the following formula:

---

[7] $f(\cdot)$ – marginal standard normal probability distribution function.

$$R^2_{McF} = 1 - \frac{l(\hat{\beta})}{l(\tilde{\beta})}, \qquad (3.17)$$

where $l(\hat{\beta})$ is the optimal log-likelihood of the estimating model,

$l(\tilde{\beta})$ is the optimal log-likelihood of the restricted model, when all coefficients, except the constant, equals to zero.

In order to calculate the probability of the crisis in 1999 and 2009 we used general probit models (3.15) in two modifications. Parallel computations based on the logit models (3.16) produced analogous results.

To formalize probit model and run it on real data we assume that during the period of 1996-2010 the crises happened in 1999 and 2009. It is assumed that the probability of the crisis depends on the following factors: deviation of exchange rate from its long-term trend, which is estimated by Hodrick-Prescott filter (detailed algorithm for using this filter is given in appendix 8), ratio of short-term debt to GDP, ratio of current account to GDP.

Two versions (3.18) and (3.19) of probit models were estimated[8] to calculate the probabilities of sudden stops in 1999 and 2009. They differ one from another in the numbers of lags variables and have the following form:

Probit 1:

$$y_t = F\left(\beta_1\left(erate_{t-1} - erate\_hp_{t-1}\right) + \beta_2\left(st\_to\_gdp_{t-1} - st\_to\_gdp_{t-2}\right) + \beta_3\left(ca\_to\_gdp_{t-1}\right)^2 + \varepsilon_{1t}\right) =$$

$$\frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\beta_1\left(erate_{t-1} - erate\_hp_{t-1}\right) + \beta_2\left(st\_to\_gdp_{t-1} - st\_to\_gdp_{t-2}\right) + \beta_3\left(ca\_to\_gdp_{t-1}\right)^2 + \varepsilon_{1t}} e^{-\frac{z^2}{2}} dz, \quad (3.18)$$

Probit 2:

$$y_t = F\left(\beta_4\left(erate_{t-1} - erate\_hp_{t-1}\right) + \beta_5 st\_to\_gdp_{t-2} + \varepsilon_{2t}\right) =$$

$$\frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\beta_4\left(erate_{t-1} - erate\_hp_{t-1}\right) + \beta_5 st\_to\_gdp_{t-2} + \varepsilon_{2t}} e^{-\frac{z^2}{2}} dz, \qquad (3.19)$$

where y_t is the values of dependent variable in period t, $t = \overline{1, N}$, $y_{t \in \{1999, 2009\}} = 1$, $y_{t \notin \{1999, 2009\}} = 0$, $erate_t$ is the exchange rate, $erate\_hp_t$ is the long-term exchange rate,

[8] In order to estimate the probit models in Eviews **Object/New object…/Equation** should be selected, then the equations should be entered and the type of estimation **BINARY – Binary Choice (Logit, Probit, Extreme Value)** should be chosen.

$st\_to\_gdp_t$ is the ratio of short-term debt to GDP, $ca\_to\_gdp_t$ is the ratio of current account to GDP, β_1, β_2, β_3, β_4, β_5 are regression coefficients, ε_{1t} and ε_{2t} are residuals, $F(\cdot)$ is the standardized cumulative density function.

The results of estimation of unknown parameters of the models on the 1996-2009 data are shown in the tables 3.4 and 3.5.

Table 3.4. The results of estimation of the probability of the sudden stop based on the Probit 1 (3.18)

Explanatory variable	Valiable	Coefficient	p-statistics[9]
Exchange rate$_{t-1}$-Long-term exchange rate$_{t-1}$	$erate_{t-1} - erate\_hp_{t-1}$	-1.145484	0.2037
Ratio of short-term debt to GDP$_{t-1}$-Ratio of short-term debt to GDP$_{t-2}$	$st\_to\_gdp_{t-1} - st\_to\_gdp_{t-2}$	-45.74402	0.1198
Ration of current account to GDP$_{t-1}^2$	$(ca\_to\_gdp_{t-1})^2$	-246.6334	0.1944

Source: NBU data, own calculations.

Table 3.5. The results of estimation of the probability of the sudden stop based on the Probit 2 (3.19)

Explanatory variable	Variable	Coefficient	p-statistics
Exchange rate$_{t-1}$-Long-term exchange rate$_{t-1}$	$erate_{t-1} - erate\_hp_{t-1}$	-1.278222	0.0973
Ratio of short-term debt to GDP$_{t-2}$	$st\_to\_gdp_{t-2}$	-6.994474	0.0358

Source: NBU data, own calculations.

The resulting values of McFadden R-square for the models (3.18) and (3.19) based on the formula (3.17) is:

$$R^2_{McF1} = 1 - \frac{-5,056}{-5,742} = 0.119, \quad (3.20)$$

$$R^2_{2McF2} = 1 - \frac{-4,809}{-5,742} = 0.162. \quad (3.21)$$

As we can see from the resulting calculations shown in the tables 3.4 and 3.5, estimated coefficients of the model probit 1 (3.18) are marginally significant (that is, they lie on the margin or close to the 10% significance level), and for the model probit 2 the coefficients are significant with lower p-statistics. The increase of each factor (explanatory variable) negatively influences the probability of the sudden stop.

[9] p-statistics shows the probability of the so called Type I error, which is the rejection of true hypothesis that the coefficient is equal to zero. This is a minimum significance level at which the hypothesis of equality of the coefficient to zero can be rejected. The smaller the p-statistics, the lower the probability of rejection of true hypothesis that the coefficient is equal to zero.

In order to get the marginal effects for probit models, which show the change of the probability caused by the change in x_{it} by some value, additional calculations should be conducted. More specifically, probability density functions should be evaluated and multiplied by the partial coefficients (see attachment 3.3). The resulting calculations of marginal effects are shown in the table 3.6.

Table 3.6. The change of the probability caused by changes in the explanatory variables

Year	Probit 1			Probit 2	
	Exchange $rate_{t-1}$-Long-term exchange $rate_{t-1}$. The change of this variable by 1.00	Ratio of short-term debt to GDP_{t-1} - Ratio of short-term debt to GDP_{t-2}. The change of this variable by 0.01	Ratio of current account to GDP_{t-1}^2. The change of this variable by 0.01	Exchange $rate_{t-1}$-Long-term exchange $rate_{t-1}$. The change of this variable by 1.00	Ratio of short-term debt to GDP_{t-2}. The change of this variable by 0.10
1996	N/A	N/A	N/A	N/A	N/A
1997	N/A	N/A	N/A	N/A	N/A
1998	-0.42	-0.17	-0.91	-0.32	-0.18
1999	-0.23	-0.09	-0.49	-0.35	-0.19
2000	-0.22	-0.09	-0.47	-0.43	-0.23
2001	-0.03	-0.01	-0.07	-0.11	-0.06
2002	0.00	0.00	0.00	-0.23	-0.13
2003	-0.44	-0.18	-0.95	-0.04	-0.02
2004	-0.34	-0.13	-0.73	-0.09	-0.05
2005	-0.06	-0.02	-0.12	-0.23	-0.13
2006	-0.17	-0.07	-0.37	-0.36	-0.20
2007	-0.45	-0.18	-0.97	-0.35	-0.19
2008	-0.39	-0.15	-0.83	-0.43	-0.24
2009	-0.46	-0.18	-0.98	-0.40	-0.22

Source: NBU data, own calculations.

As we can see from the table 3.6, the results of modeling are least sensitive to the changes of factors in 2001, 2002 and 2005, where marginal effects for estimated coefficients have the lowest values. During before crisis years sensitivity of models sharply increased. It means that instability of economic system raised and small changes of factors (explanatory variables) lead to relatively significant changes in the probability of the sudden stop. For example, analyzing the model probit 1 (3.18), only based on the changes of ratio of short-term debt to GDP during the period of 2006-2008, the conclusion about the sharp increase of probability of the sudden stop of capital inflows can be made, which constitutes +0.53.

Graphical results of estimated probabilities of sudden stop for two probit models are shown on the figure 3.10.

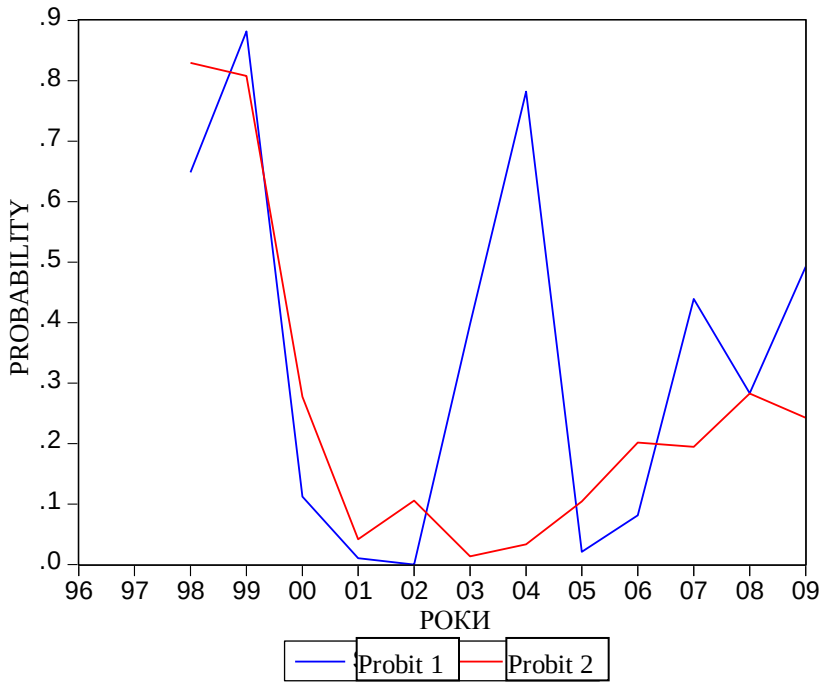


Figure 3.10. Estimated probabilities of sudden stop for probit 1 and probit 2 models

Source: NBU data, own calculations.

As we can see from the figure, the principal difference between the models is that probit 1 shows very high probability of sudden stop in 2004.

Estimated values of the probabilities of both probit 1 and probit 2 can be used as input parameters to the next calculations of optimal reserves level based on the formula (3.12) which takes into account depreciation and parameters are represented by variant 3 (probability of the sudden stop influences on x – see (3.8) – and on p_t directly and through x – see (3.13), that is we should change constant probability π in the formulas for x (3.8) and p_t (3.13) for the probabilities that are calculated for each year based on the probit models and use the new values in the final formula (3.12). The values of parameters for the variant 3 of the model for optimal reserves calculations are shown in table 3.2 in the column 5.

Graphical results of the optimal level of reserves calculations based on the annual data for the period of 1996-2009 with the probabilities from the probit models

are shown on the figure 3.11 (analytical results of calculations are shown in the appendix 4).

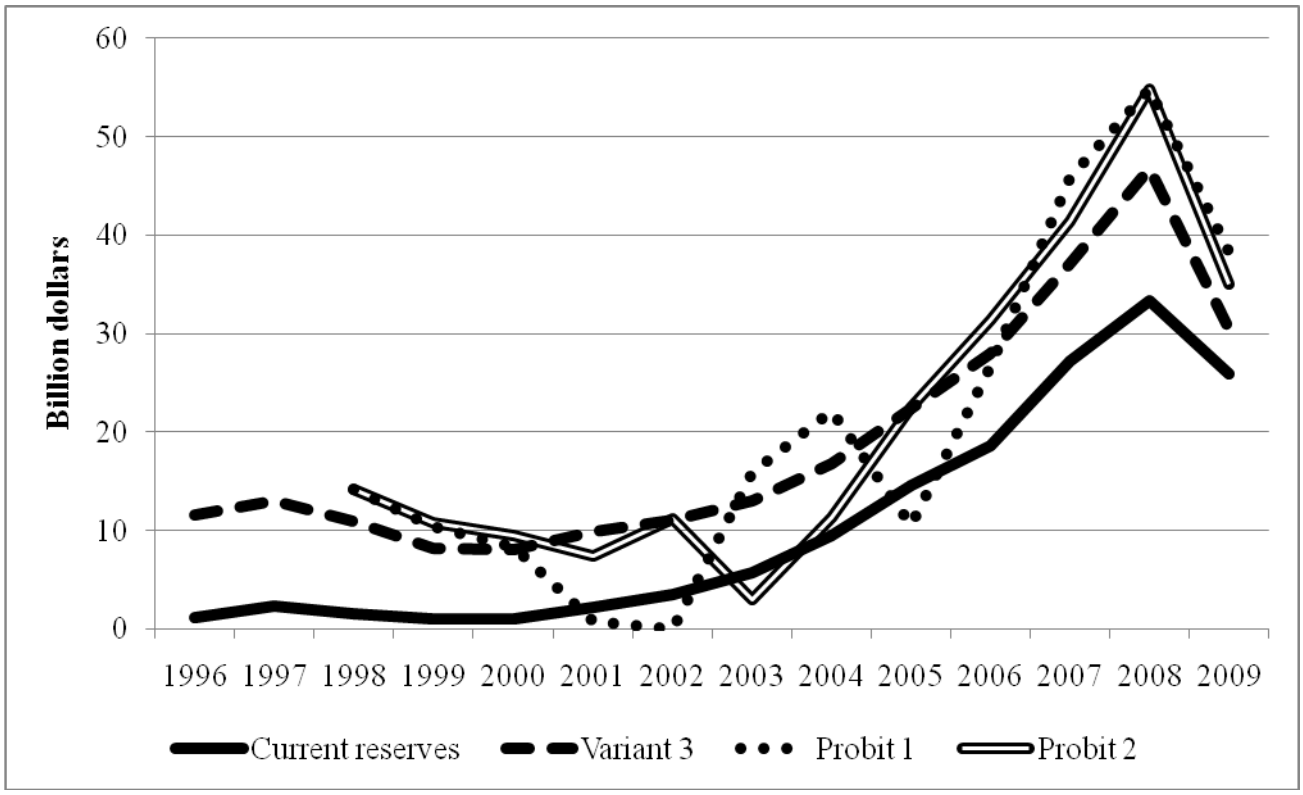


Figure 3.11. Calculated level of reserves using the probabilities of the sudden stop from the probit 1 and probit 2.

Source: NBU data, own calculations.

As we can see from the figure, due to the large fluctuations of the probability of the sudden stop, the optimal level of reserves is also very volatile in contrast to the current level and reserves predicted by the variant 3 with constant probability of the sudden stop. The model results with the probabilities from the probit 1 are more volatile than the results of the model with probabilities from probit 2. Nevertheless, both models show close reserves volumes after 2006. These calculated volumes are higher than recommended levels of reserves recommended by the variant 3, since the probability of the sudden stop in the variant 3 during 2007-2009 is stable and equals to 0.1, but for the probit models during this period it practically does not decline below 0.2. As a result, received optimal level of reserves which fluctuates a lot cannot be considered as realistic ones since NBU and other Central Banks have no practical possibility to change sharply the volume of reserves since it is very costly operation (this conclusion is especially actual for the model which uses the

probability from the probit 1). One of the possible variants of solving this problem may be the introduction of transaction costs for the change of reserves, which can help smoothing recommended level of reserves as the probability of the sudden stop changes.

Conclusions to Part 3

Conducted analysis of the change of macroeconomic dynamics during, before and after crisis periods showed that before crisis periods the clear trend of reserves accumulation could be observed. The results of calculations based on all models of optimal reserves calculations allow analyzing these tendencies in different ways. Moreover, the variants of the model are significantly different, which may require additional investigations, improvements, analysis and modeling of influence of different factors which influences the volume of reserves and calculations of their optimal value.

Such two standard tests, which determines the adequacy of reserves volume as Greenspan-Guidotti rule (reserves should cover completely short-term liabilities if the state) and three-months-of-import-coverage rule (the reserves should be equal to the import volume for the last three months), as it was shown by Krznar (2009)[10], has several drawbacks:

1) They are not based on optimization criteria. Because of this the excess of the reserves above optimal level can lead to the alternative costs increase, which can be decreased by using reserved for other goals. At the same time insufficient reserves volume can put under the risk economy of Ukraine before potential crisis;
2) They do not take into account the high level of economy dollarization since the rules were to the large extent developed for the US for which the term dollarization is not actual;
3) These standard rules cannot be relevant in new financial conductions, especially after the world crisis of 2008-2009.

At the current moment, we think that the results that can describe the Ukrainian reality the most adequately can be represented by the variant 2 of the model for

[10] Ivo Krznar, Essays in International Economics, A dissertation for the degree Doctor of Philosophy.

optimal level of reserves calculation with depreciation taken into account. In this case current reserves of 2010 almost coincide with the recommended by the model volume (current reserves are recommended to increase by 3.1% in 2010). As for the next 2011, the results of modeling recommend to accumulate by 19.3% more reserves in comparison with the 2010 volume.

As for the probability of the sudden stop calculation based on the macroeconomic data, the low flexibility of reserves changing should be taken into account. It can be done by expanding the model introducing into it transaction or other costs of reserves changing. The more stable reserves volume can be formed, less sensitive to the fluctuations of the probability of the sudden stop. It should be noticed that there is a necessity in increasing the sample size, which can be achieved by modeling the probability of the sudden stop based on the data for a group of countries.

Besides it, we should notice that the following problems may require attention in the future research:

1. There is a necessity in developing the modified version of the proposed model for optimal level of reserves calculation by taking into account more detailed aspects of the Ukrainian economy. It will help to achieve three important results:

1.1. More deeper to understand the influence of different factors on the optimal and current level of reserves, which can allow the NBU to determine the most effective instruments for achieving the optimal level of reserves.

1.2. The realization of more detailed and elaborated model, which will include more descriptive equations in comparison to the model analyzed in this chapter, will allow improving the stability of the parameters of the model itself. It is very important in the crisis conditions, which are characterized by fast changes and large and frequent domestic and foreign shocks.

1.3. To conduct the endogenization of the several model assumptions, which means that the values of several parameters will be determined within the model itself and not given exogenously. As a result, NBU can receive the answers to the conjugate to the optimal level of reserves calculation questions like the probability of the sudden stop, etc.

2. It is important to widen the optimization problem, for example, to consider the optimization by several instruments of the monetary and fiscal policy of NBU. It may be useful to consider the simultaneous optimization of the level of reserves with other variables – debt, inflation, GDP growth, etc., which may to rise the efficiency of not only of the monetary policy but also fiscal one.

In addition, the perspective direction for future research is the improving of the core task of the model, which is the insurance of the sudden stop of capital inflows motive by including other goals for reserves accumulations.

CONCLUSIONS

1. The global financial crisis of 2007-2009, the beginning of which has been provoked by the issues at the USD mortgage market, is one of the most powerful financial crises since the Great Depression.

Capital flows and foreign trade belong to the key transmission channels of the crisis from the developed countries to developing ones. Thus, countries that have been significantly affected by the crisis, suffered almost immediate withdrawal of capital. Consequently, these countries experienced high levels of repayment for loans and bonds of private issue, as well as difficulties in refinancing them in terms of global reduction in interbank lending and the suspension of new bonds issues. In addition, the capital reduction of the largest hedge funds and mutual funds, along with termination of their strategy of "carry-trade", caused additional pressure on the currency depreciation in these countries. The financial collapse of 2008 and further decline in lending and global demand caused a sharp fall in international trade volumes and commodity prices, which in turn strengthened the crisis for developing countries, affecting their external debt and balance of payments.

2. Certain macroeconomic indicators appear to be helpful for diagnosing the occurrence of the global economic crises. Generalization and comparison of macroeconomic indicators, selected on the basis of theoretical and empirical research, allowed forming a basic set of 71 proactive indicators in order to develop methods of

diagnosing the onset of recession in the economy of Ukraine. Since not all of them can be used in practice due to the absence or inaccessibility of information, it was necessary to conduct additional analysis of availability and completeness of the original information.

3. Analysis of availability and completeness of the initial information based on three-dimensional model of data helped to reduce possible sample of countries from 239 to 60, and a list of indicators - from 71 to 60. Thus, the analysis took into account forty-one indicator for which sufficient information was available in all countries and all time periods, and also nineteen variables (stock indexes) that have global effect and need just one time series .

4. In order to group countries according to the level of involvement into the global crisis of recent years the exchange market pressure index (EMP) has been used. Based on the calculations of this index based on 2002-2010 years quarterly data the countries had been divided into two groups: the ones most and the ones least affected by the crisis of 2008-2009. Moreover, countries of each group were additionally ranked by time of occurrence and duration of the crisis. The detailed analysis of peculiarities of the economic situation in each country from the first and the second group accounting for their territorial proximity to Ukraine, similarity of economies type and the need of representing most of the Earth continents finally allowed to set up two pools of 10 countries each, comprising that were significantly and slightly affected by the crisis, respectively.

5. The comparative statistical analysis of the macroeconomic dynamics in the economies of selected countries during the pre-crisis, crisis and post-crisis periods has shown that for countries that have been significantly affected by the crisis, crisis period was associated with relatively deeper recession of following indicators: real GDP growth rate, trade balance, current account surplus, the growth rate of nominal effective exchange rate, the level of real domestic and foreign interest rates, money growth rate etc. However, for this particular group the values of real effective exchange rate and the level of money multiplier growth rates decreased much less.

6. As a result of the comparative analysis of the economies' macroeconomic dynamics in the pre-crisis, crisis and post-crisis periods the general conclusion was made that among the indexes that provide best prediction of the onset of the crisis and thus can be user as the indicators of approaching crisis the following indexes can be named (with the group to which they belong in brackets): real GDP, gross fixed capital formation and fixed capital consumption (real sector), total foreign debt and short-term external debt (debt burden), trade balance, current account balance, the growth rate of real effective exchange rate and pace of nominal effective exchange rate growth (the balance of payments), the ratio of real domestic and foreign interest rates (international variables) money multiplier (financial liberalization), the consumer price index and growth rate of money supply (other financial variables).

7. In order to calculate the threshold values for proactive indicators of possible occurrence of economic crisis, the "signal approach" has been used. This approach is based on the notion of "signal", which is specified as a deviation of some indicator from its average value by an amount greater than a certain critical value. This critical value had been identified separately for each combination of country and indicator as the maximum deviation from the mean through, so that "safe" range of actual index values can be built. The event of index intersecting the defined threshold values is assumed to be the indicator's signal of the financial crisis threat within the next 4 quarters.

8. By using the "signal approach" technique the analysis of indicators proposed as proactive indicators of crisis has been conducted. The most effective indicators judging by "noise" to "signal" ratio criterion were the following (in brackets we give the average value and threshold deviations for Ukraine): the share of short-term debt in foreign debt, in ratio units (0,2238 ± 0,22); current account ratio to GDP, rat.un. (0,0159 ± 0,13); growth rate of CPI,% (11,3660 ± 14,49); money multiplier, rat.un. (2,4716 ± 0,54), ratio of M2 to international reserves, rat.un. (3,6294 ± 0,70), the real loan interest rate, rat.un. (0,0641 ± 0,19), growth rate of REER,% (-0,1673 ± 5,73); trade balance to GDP ratio, rat.un. (-0,0034 ± 0,09); investment as a share of GDP,% (21,5924 ± 7,96); exports growth rate,% (4,7064 ± 20,65).

9. Preliminary assessment of the reserves volume sufficient to prevent the negative consequences during the crisis periods has been obtained based on the modified model of Jeanne and Rancière, which originally was designed to determine the amount of reserves for small open developing economies. According to the model, reserves are specified as means of insurance against sudden outflows of capital investments in Ukraine's economy, which had been observed during the financial crisis of 2008-2009. The model is based on modeling the behavior of economic agents. Calculations on real data sample were conducted for 3 possible options for model's calibration. Moreover, the difference between the latter two lies in the way of identifying the periods of sudden stop either based on the fall of the short-term debt to GDP ratio more than 5% in a given year, or based on the expert estimates periods instantaneous stop without respect to the magnitude of change in capital inflows. Comparison of the calculated optimal levels of reserves and their actual volumes at different times showed an insignificant difference. Accordingly, the model can be used as a basis of estimating the optimal size of reserves in the policy decision making.

10. The model for determining optimal size of reserves, based on the likelihood of occurrence of exogenous crisis can be improved by the introducing more factors into the model. It is also important to develop and evaluate version of the model that simultaneously determines the optimal amount of reserves and the probability of crisis occurrence. An important direction for further research is also to develop models for simultaneous optimization of size of reserves and debt. In addition, it is important to identify and analyze key factors that influence the formation of reserves in different groups of countries based on vector autoregressive models and their derivatives.

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Appendixes

Appendix 1

Detailed comments for Matlab application for processing the initial data

Stage 1. Importing data for analysis.

Note that in current the data for analysis is stored in the Exel-file in the following structure (column headings):

- Units,
- Scale,
- Country name,
- Database
- Indicator code in the database,
- Description of indicator
- Variable name
- Index period (Q1 2002 ... Q2 2010)

Importing data is performed by the following command sequence:

```
importts ('raw_data_save.xls');

dimensions = {'COUNTRYNAME', 'VARNAME'};

data_start_col = 8;

data_start_row = 2;

mddi = MDDataImport (data, textdata, dimensions, data_start_col, data_start_row);
```

The result of the procedures above is MDDataImport object, which contains all the information of the input Excel-table, and procedure for its transformation into a more convenient form for analysis.

Step 2. Creating a three-dimensional matrix of initial information, indexed by country, indicator and time.

Creating of a three-dimensional matrix is initialized by the command:

```
md_data = mddi.recursive_reshape ();
```

The result of the command is a creation of the three-dimensional data matrix and codes vectors named «md_data», which correspond to the sets of values for each of the dimensions - the country names, variable names and time periods identifiers.

Step 3. Sort countries and indicators by the number of missing values:

Sort countries and indicators by the number of missing values is done by the instruction set:

```
[Dd vi] = sort (count_nans_dim (md_data, 'VARNAME'));

[Dt ci] = sort (count_nans_dim (md_data, 'COUNTRYNAME'));
```

The result of the code is a set of two vectors named “dd” and “dt”, containing data for respective indicators and countries, ordered according to increase the number of missing observations.

Step 4. Charting obtained data decay functions:

Diagram of indicators according to the missing values number growth is drawn by:

```
plot (dd, 'DisplayName', 'dd', 'YDataSource', 'dd');
```

The result of this command is displaying a graph of data decay by indicator in all countries and time periods.

The following command plots countries in the ascending order of missing observations amount:

```
plot (dt, 'DisplayName', 'dt', 'YDataSource', 'dt');
```

The result of this command is a graph of data decay by country on all indicators in all time periods.

PS Note that the list of indicators includes some variables that do not bind to a specific country, but are used in calculations as variables of global economy. These include **gold prices, and stock indexes.** For such variables the field "country" is set to "Global".

Step 5. Forming the final sample of countries and indicators on which there is greatest completeness of data.

In order to minimize the number of missing observations in the sample, we select the countries and variables as follows: initial 54 selected indicators with the lowest values of unavailability of data, and 15 price and stock indices that reflect the global economic environment and are put at the end of the sorted series. Among the countries 60 countries that have the highest data availability were selected. This was performed by the instructions:

```
cutoff.VARNAME = md_data.dimtags.VARNAME (vi ([1:54 56: end]));

cutoff.COUNTRYNAME = md_data.dimtags.COUNTRYNAME (ci (1:60));
```

The result of implementation of these commands is the list of variable names and countries, according to which a data sub-sample will be formed. Lists stored in the structure named “cutoff” with the field names VARNAME and COUNTRYNAME respectively.

Formation of the final sub-sample from the already existing database is done with a sequence of commands:

```
desc.dims = cutoff;

desc.timespan = 1: length (md_data.ts_indices);

new_slice_countries = md_data.get_slice (desc);
```

The result of implementation of these commands is the final selection of indicators (69 indicators) and the (60 +1) in the data object named new_slice_countries.

Step 6 **Sorting countries and indicators of the final sample according to the data decay rate:**

Sorting countries and indicators of the final sample according to the data decay rate is done with:

```
[Dd vi] = sort (count_nans_dim (new_slice_countries, 'VARNAME'));

[Dt ci] = sort (count_nans_dim (new_slice_countries, 'COUNTRYNAME'));
```

The result of the commands is a set of two vectors with the names of “dd” and “dt”, which contain data of the final selection of indicators and countries sorted according to increase the number of missing observations.

Step 7. Charting the completeness of data for the final selection of countries and indicators:

Diagram of indicators and countries included in the final sample is done by a sequence of commands:

```
figure

plot (dd, 'DisplayName', 'dd', 'YDataSource', 'dd');

set (gca, 'XTickLabel', new_slice_countries.dimtags.VARNAME, 'XTick', 1: length
(...

new_slice_countries.dimtags.VARNAME))

rotateticklabel (gca, 90)

figure

plot (dt, 'DisplayName', 'dt', 'YDataSource', 'dt');

set (gca, 'XTickLabel', new_slice_countries.dimtags.COUNTRYNAME, 'XTick', 1: ...
```

```
length (new_slice_countries.dimtags.COUNTRYNAME))

rotateticklabel (gca, 90)
```

The result of implementation of these instructions is to build and display graphically the lack of data on each indicator, which is included in the final sample, for all countries included in the final sample in all time periods, as well as construction and display graphics lack of data on each country on all indicators in all time periods.

Note that the list of names and designations of indicators and countries included in the final sample is presented in Appendix 2

Appendix 2

List of primary variables and the countries included in the final sample

Table 1. List of variables in the final sample used for analysis

Number	Variable name	Explanation variable
1	RMG	International reserves excluding gold, million SDR
2	INTERN_RESERVES	International reserves, million SDR
3	ER	The official or market exchange rate in national currency per $ 1. USD
4	CPI_CHNG	Percentage change in CPI compared with the previous quarter
5	DEPRATE	Average market rate on deposits
6	GOLD_OUNC	Gold stock, oz.
7	BRMONEY	Aggregate growth rate of broad money aggregate, pp.
8	LENDRATE	Average market rate on loans
9	IMPORT	Imports, mln. USD
10	EXPORT	Exports, mln. USD
11	GVT_CLAIMS	Loans to government, mln. national currency
12	DEP_TRANS	Volume transitional deposits, mln. national currency
13	DEP_OTH	Other deposits included in the monetary aggregate BROAD MONEY, mln. national currency
14	M2	Monetary aggregate M2, millions of national currency
15	DEP_EXCL	Deposits not included in the monetary aggregate BROAD MONEY, mln. national currency
16	BOP_CURACC	Current account balance, mln. USD
17	BOP_GS	The balance of trade in goods and services, mln. USD
18	BOP_GSI	The balance of trade in goods and services taking into account income transfers, million USD
19	BOP_TR_BAL	The balance of trade balance, mln. USD
20	MBASE	Monetary base, mln. national currency

21	BOP_CAPACC	Capital account balance, mln. national currency
22	NEER	NEER,%
23	LOANS	The volume of loans, mln. national currency
24	REER	REER, %
25	SPI	Stock Price Index
26	GDP_VOL_CHNG	Volume change in real GDP,%
27	GDP_DEFL_CHNG	Change of GDP deflator,%
28	CONS_H	Household consumption, million national currency
29	GFCF	Gross fixed capital, mln. national currency
30	CONS_GOV	Consumption of state, mln. national currency
31	NGDP	Nominal GDP, mln. national currency
32	M3	Monetary aggregate M3, mln. national currency
33	EXPORT_UNT_PRICES	Unit Price export, USD
34	FD_CB	External debt of commercial banks, mln. USD
35	FD_GG	External government debt, mln. USD
36	FD_MA	External debt of the central bank, mln. USD
37	FD_OS	External debt of other sectors, million USD
38	GEDP	Gross external debt position, million USD
39	GDP_VOL_2005	Real GDP, 2005 = 100%
40	FD_CB_ST	Short-term external debt of commercial banks, million $. USD
41	FD_GG_ST	Short-term external debt of the government million. USD
42	FD_MA_ST	Short-term external debt of the central bank mln. USD
43	FD_OS_ST	Short-term external debt of other sectors million. USD
44	GDP_DEFL_2005	GDP deflator, base by 2005, %
45	IMPORT_UNT_PRICES	Unit price of imports, USD
46	GNI	Gross national income, mln. national currency
47	GNDI	Gross national disposable income, mln. national currency
48	GDP_VOL_2000	GDP in prices of 2000, million national currency
49	FD_FC	External debt in foreign currency, million USD
50	FD_DC	External debt in local currency, million. USD
51	FD_FC_LT	Long-term external debt in foreign currency, million USD
52	FD_FC_ST	Short-term external debt in foreign currency, million. USD
53	FD_DC_LT	Long-term external debt in local currency, million. USD
54	FD_DC_ST	Short-term external debt in local currency, million. USD
55	GOLD_IMF	Stocks of gold, acc. to IMF
56	WIG20	WIG20, period average
57	WIG20EP	WIG20, end of period
58	FTSE100	FTSE100
59	GOLD_LOND	The price of gold in London.
60	GOLD_SDR_OUNC	The price of gold, SDRs per ounce
61	AMEX	AMEX
62	NASDAQ	NASDAQ
63	SP_IND	S & P industrials

64	USD_SDR	rate USD / SDR
65	GOLD_MARKET	The market price of gold
66	GOLD_SDR	Collect gold, SDRs
67	LIBOR	LIBOR
68	RTS	RTS
69	MICEX	MICEX

Table 2. List of countries in the final sample for analysis

Number	**Name Country**	**Number**	**Name Country**	**Number**	**Name Country**
1	Hungary	21	Germany	41	Romania
2	KoreaRepublicof	22	RussianFederation	42	Norway
3	Colombia	23	Ukraine	43	Slovenia
4	Turkey	24	Iceland	44	Austria
5	Chile	25	Lithuania	45	Peru
6	UnitedStates	26	Belarus	46	Italy
7	SouthAfrica	27	Estonia	47	Spain
8	Thailand	28	Argentina	48	France
9	Sweden	29	Canada	49	Portugal
10	Croatia	30	SlovakRepublic	50	Uruguay
11	Denmark	31	Finland	51	Armenia
12	CostaRica	32	Greece	52	Kazakhstan
13	Brazil	33	Indonesia	53	Netherlands
14	Bulgaria	34	Moldova	54	Australia
15	CzechRepublic	35	Ireland	55	Philippines
16	Malaysia	36	Belgium	56	KyrgyzRepublic
17	Poland	37	Georgia	57	UnitedKingdom
18	Switzerland	38	Bolivia	58	Paraguay
19	Japan	39	Mexico	59	Mauritius
20	Latvia	40	Israel	60	Egypt
	61	Global			

Appendix 3

Detailed comments on the Matlab application for calculating the exchange market pressure index based on precision weighting approach

Matlab application is to calculate the index of exchange market pressure following general formula:

$$ER = \omega_{ER}\Delta logER + \omega_{IR}\Delta \log IR - \omega_{RES}\frac{\Delta(\frac{M2}{M0}INTERN\_RESERVES)}{M2_{t-1}/ER_{t-1}} \quad (1)$$

where ER-official or market exchange rate $\Delta logER$- the difference of logarithms of current and previous values of ER, $\Delta \log IR$- the difference of logarithms of current and previous interest rate on loans, $\frac{M2}{M0}$- approximation of money multiplier, $INTERN\_RESERVES$- the volume of international reserves, in special drawing rights (SDR), $M2_{t-1} / ER_{t-1}$- approximation of money supply, expressed in dollars, for the preceding period. $\omega_{ER}, \omega_{IR}, \omega_{RES}$ -corresponding weights of index components that for the precision weighting approach are equal to unit divided by the standard deviation of each component.

The calculation of the formula (1) is conducted in three successive steps.

Step 1. At the first stage the individual components of (1) are computed, namely the variables

$$\begin{aligned} MM &= \frac{M2}{M0} \\ LOGER &= \log ER \\ LOGIR &= \log IR \end{aligned} \quad (2)$$

are calculated with the following instruction sequence:

```
d = new_slice_countries;

p = d.md_eval (['MM = {d2: M2 {}}./{ d2: MBASE {}}' ...

    'LOGER = log ({d2: ER {}})' ...

    'LOGIR = log ({d2: LENDRATE {}})' ...

    'RES_USD = {d2: INTERN_RESERVES {}}.*{ d2: USD_SDR, d1: Global {}}' ...

    'M2 = {d2: M2 {}}' ...

    'ER = {d2: ER {}}' ...

], 'VARNAME', 'VARNAME');
```

The result of consecutive commands is a calculated set of time series: LOGER - logarithm of nominal exchange rate, **LOGIR** - logarithm of nominal interest rate, **RES_USD** - international reserves in million USD, **M2** - the money supply, mln. USD, **ER** - nominal exchange rate, national. curr. per USD.

Step 2. In the second stage on the basis of values, calculated at the first stage, DER, DIR, DRES indices are calculated:

$$\begin{aligned} DER &= LOGER_t - LOGER_{t-1} \\ DIR &= LOGIR_t - LOGIR_{t-1} \\ DRES &= \frac{MM_t INTERN\_RESERVES_t - MM_{t-1} INTERN\_RESERVES_{t-1}}{M2_{t-1} ER_{t-1}} \end{aligned} \quad (3)$$

by the sequence of the following commands:

```
r = p.md_eval (['DER = ({d2: LOGER {}}-{ d2: LOGER {-1}})' ...

     'DIR = ({d2: LOGIR {}}-{ d2: LOGIR {-1}})' ...

     'DRES = ({d2: MM {}}.*{ d2: RES_USD {}}-{ d2: MM {-1 }}.*{ d2: RES_USD {-1
}}).//({ d2: M2 { -1 }}./{ d2: ER {-1}}) ' ...

], 'VARNAME', 'VARNAME');
```

The result of consecutive commands is a set of time series that contain the components of the formula (1), namely **DER** - a difference of logarithms of nominal exchange rate, **DIR** - a difference of logarithms of nominal market interest rate, **DRES** - index changes in international reserves.

Step 3. The stage of weighing and calculating the index of exchange market pressure.

For the examined approach, namely the precision weighting, weights are defined as the inverse standard deviation of each of the components of the **DER, DIR, DRES, and the EMP index** is calculated according to the formula:

$$EMP = \frac{DER}{\sigma_{DER}} + \frac{DIR}{\sigma_{DIR}} - \frac{DRES}{\sigma_{DRES}} \quad (4)$$

by the following sequence of commands:

```
k = r.md_eval (['EMP = {d2: DER {}}./ stdi ({d2: DER {}}, 1) +' ...

    '{D2: DIR {}}./ stdi ({d2: DIR {}}, 1) - {d2: DRES {}}./ stdi ({d2: DRES
{}}, 1)'], 'VARNAME' , 'VARNAME');
```

Note that stdi function computes standard deviation, ignoring missing observations.

Next, we remove the singleton dimension (as computational results contain only one indicator, EMP, and the need for indexing data by variable name disappears), bringing the results to the matrix Time-Country:

k = squeeze (k.md_data);

The result of command is the index of exchange market pressure (index EMP) based on precision weighting approach.

Appendix 4

Detailed comments on the Matlab application for calculating the exchange market pressure index based on equal weighting approach

Matlab application is to calculate the index of exchange market pressure following general formula:

$$ER = \omega_{ER}\Delta logER + \omega_{IR}\Delta \log IR - \omega_{RES}\frac{\Delta(\frac{M2}{M0}INTERN\_RESERVES)}{M2_{t-1}/ER_{t-1}} \quad (1)$$

where ER-official or market exchange rate $\Delta logER$- the difference of logarithms of current and previous values of ER, $\Delta \log IR$- the difference of logarithms of current and previous interest rate on loans, $\frac{M2}{M0}$- approximation of money multiplier, $INTERN\_RESERVES$- the volume of international reserves, in special drawing rights (SDR), $M2_{t-1}/ER_{t-1}$- approximation of money supply, expressed in dollars, for the preceding period. $\omega_{ER}, \omega_{IR}, \omega_{RES}$ -corresponding weights of index components that for the precision weighting approach are equal to unit.

The calculation of the formula (1) conducted in three successive phases.

Step 1. At the first stage the individual components of (1) are computed, namely the variables

$$MM = \frac{M2}{M0}$$
$$LOGER = \log ER \quad (2)$$
$$LOGIR = \log IR$$

are calculated with the following instruction sequence:

```
d = new_slice_countries;

p = d.md_eval (['MM = {d2: M2 {}}./{ d2: MBASE {}}' ...

    'LOGER = log ({d2: ER {}})' ...

    'LOGIR = log ({d2: LENDRATE {}})' ...

    'RES_USD = {d2: INTERN_RESERVES {}}.*{ d2: USD_SDR, d1: Global {}}' ...

    'M2 = {d2: M2 {}}' ...

    'ER = {d2: ER {}}' ...

], 'VARNAME', 'VARNAME');
```

The result of consecutive commands is a calculated set of time series: LOGER - logarithm of nominal exchange rate, **LOGIR** - logarithm of nominal interest rate, **RES_USD** - international reserves in million USD, **M2** - the money supply, mln. USD, **ER** - nominal exchange rate, national. curr. per USD.

Step 2. In the second stage on the basis of values, calculated at the first stage, DER, DIR, DRES indices are calculated:

$$DER = LOGER_t - LOGER_{t-1}$$
$$DIR = LOGIR_t - LOGIR_{t-1} \quad (3)$$
$$DRES = \frac{MM_t INTERN\_RESERVES_t - MM_{t-1} INTERN\_RESERVES_{t-1}}{M2_{t-1} ER_{t-1}}$$

by the sequence of the following commands:

```
r = p.md_eval (['DER = ({d2: LOGER {}}-{ d2: LOGER {-1}})' ...

     'DIR = ({d2: LOGIR {}}-{ d2: LOGIR {-1}})' ...

     'DRES = ({d2: MM {}}.*{ d2: RES_USD {}}-{ d2: MM {-1 }}.*{ d2: RES_USD {-1
}})./({ d2: M2 { -1 }}./{ d2: ER {-1}}) ' ...

], 'VARNAME', 'VARNAME');
```

The result of consecutive commands is a set of time series that contain the components of the formula (1), namely **DER** - a difference of logarithms of nominal exchange rate, **DIR** - a difference of logarithms of nominal market interest rate, **DRES** - index changes in international reserves.

Step 3. The stage of weighing and calculating the index of exchange market pressure.

For the examined approach, namely the equal weighting, weights are defined as the inverse standard deviation of each of the components of the **DER, DIR, DRES, and the EMP index** is calculated according to the formula:

$$EMP + DER + DIR + DRES \quad (4)$$

by the following command:

ke = r.md_eval ('EMP = {d2: DER {}}+{ d2: DIR {}}-{ d2: DRES {}}', 'VARNAME', 'VARNAME');

Next, we remove the singleton dimension (as computational results contain only one indicator, EMP, and the need for indexing data by variable name disappears), bringing the results to the matrix Time-Country:

ke = squeeze (ke.md_data);

The result of consecutive commands is the index of exchange market pressure (index EMP), based on equal weighting approach.

Appendix 5

Detailed description of the Matlab program ranking countries by the time of crisis occurrence and the construction of schedules-maps "periods and countries", according to the EMP (calculated by precision and equal weighting methods) at different threshold values.

5.1. Program in Matlab environment for ranking countries by the onset time of the crisis **according to the EMP index, calculated on the basis of precision weighting method** and charting of the results is to implement the following steps:

Step 1. Calculation of the EMP index deviation index from its average value over threshold.

For a given threshold (e.g. $\pm\sigma_{EMP}$, $\pm 2\sigma_{EMP}$ etc.), we determine a fact of EMP deviating beyond its trust region using the command:

detect_dev (matrix, nsigma),

where the *matrix* - matrix of EMP values computed in time for the countries and *nsigma* - number of standard deviations (the threshold given).

The result of this operation is the matrix in which 1 denotes depreciation pressure on the market, -1 - appreciation pressure, and 0 - absence of significant pressure according to the chosen threshold.

Step 2. Sorting countries by the time of crisis onset.

To ease the analysis of current crises in the countries, results are sorted by time of onset of the crisis, starting with the 3-rd quarter of 2007 (23-rd observation time series).

Frstpositive function sorts the countries according to the time of onset of the depreciation pressure on the market.

```
bins = detect_dev (k, 1);

bins = bins (23: end,:);

[sm si] = frstpositive (bins);

countries_sorted = p.dimtags.COUNTRYNAME (si);
```

The result of this operation and the list of countries ranked according to time of occurrence depreciation pressure on the market.

Step 3. Calculating and plotting a "periods and countries" map for the countries having experienced a deep financial crisis (threshold: two standard deviation ($\pm 2\sigma_{EMP}$)).

Calculations for the graph and its plotting are made through the following sequence of commands:

```
figure

k2 = detect_dev (k, 2);

imagesc (k2 (:, si) ')

emp_prec_2std = k2 (:, si) ';

set (gca, 'XTick', [1: length (r.ts_indices)])

set (gca, 'XTickLabel', p.ts_indices)

set (gca, 'FontSize', 6)

set (gca, 'YTickLabel', countries_sorted)

set (gca, 'YTick', [1: length (countries_sorted)])
```

The result is a display of a graph in the form of map “countries and periods” for the threshold of two standard deviations ($\pm 2\sigma_{EMP}$)).

Step 4. Calculating and plotting a “periods and countries” map for the countries having experienced a deep financial crisis (threshold: two standard deviation ($\pm \sigma_{EMP}$)).

Calculations for the graph and its plotting are made through the following sequence of commands:

```
figure

k3 = detect_dev (k, 1);

imagesc (k3 (:, si) ')

emp_prec_1std = k3 (:, si) ';

set (gca, 'XTick', [1: length (r.ts_indices)])

set (gca, 'XTickLabel', p.ts_indices)

set (gca, 'FontSize', 6)

set (gca, 'YTickLabel', countries_sorted)

set (gca, 'YTick', [1: length (countries_sorted)])

cs1 = countries_sorted;
```

The result is a display of a graph in the form of map "countries and periods" for the threshold of two standard deviations ($\pm\sigma_{EMP}$)).

5.2. Program in Matlab environment for ranking countries by the onset time of the crisis **according to the EMP index, calculated on the basis of equal weighting method** and charting of the results is to implement the following steps:

Step 1. Calculation of the EMP index deviation index from its average value over threshold.

For a given threshold (e.g. $\pm\sigma_{EMP}, \pm 2\sigma_{EMP}$ etc.), we determine a fact of EMP deviating beyond its trust region using the command:

detect_dev (matrix, nsigma),

where the *matrix* - matrix of EMP values computed in time for the countries and *nsigma* - number of standard deviations (the threshold given).

The result of this operation is the matrix in which 1 denotes depreciation pressure on the market, -1 - appreciation pressure, and 0 - absence of significant pressure according to the chosen threshold.

Step 2. Sorting countries by the time of crisis onset.

To ease the analysis of current crises in the countries, results are sorted by time of onset of the crisis, starting with the 3-rd quarter of 2007 (23-rd observation time series).

Frstpositive function sorts the countries according to the time of onset of the depreciation pressure on the market.

```
bins = detect_dev (ke, 1);

bins = bins (23: end,:);

[sm si] = frstpositive (bins);

countries_sorted = p.dimtags.COUNTRYNAME (si);
```

The result of this operation and the list of countries ranked according to time of occurrence depreciation pressure on the market.

Step 3. Calculating and plotting a "periods and countries" map for the countries having experienced a deep financial crisis (threshold: two standard deviation ($\pm 2\sigma_{EMP}$)).

Calculations for the graph and its plotting are made through the following sequence of commands:

```
figure
```

```
ke2 = detect_dev (ke, 2);

imagesc (ke2 (:, si) ')

emp_prec_2std = ke2 (:, si) ';

set (gca, 'XTick', [1: length (r.ts_indices)])

set (gca, 'XTickLabel', p.ts_indices)

set (gca, 'FontSize', 6)

set (gca, 'YTickLabel', countries_sorted)

set (gca, 'YTick', [1: length (countries_sorted)])
```

The result is a display of a graph in the form of map “countries and periods” for the threshold of two standard deviations ($\pm 2\sigma_{EMP}$)).

Step 4. Calculating and plotting a “periods and countries” map for the countries having experienced a deep financial crisis (threshold: two standard deviation ($\pm \sigma_{EMP}$)).

Calculations for the graph and its plotting are made through the following sequence of commands:

```
figure

ke3 = detect_dev (ke, 1);

imagesc (ke3 (:, si) ')

emp_prec_1std = ke3 (:, si) ';

set (gca, 'XTick', [1: length (r.ts_indices)])

set (gca, 'XTickLabel', p.ts_indices)

set (gca, 'FontSize', 6)

set (gca, 'YTickLabel', countries_sorted)

set (gca, 'YTick', [1: length (countries_sorted)])

cs2 = countries_sorted;
```

The result is a display of a graph in the form of map “countries and periods” for the threshold of two standard deviations ($\pm \sigma_{EMP}$)).

Appendix 6

Description of the application in Matlab environment for calculating leading indicators of the crisis based on the initial variables' values

For the program, the working space of MATLAB interpreter should contain loaded MDData objects under the names md_data and new_slice_countries, that provide information on the initial variables' values and a list of countries selected for analysis.

Step 0. Forming a list of countries that were selected for analysis is based on the sequence of commands:

```
countr_crisis = {'Ukraine' 'KoreaRepublicof' 'RussianFederation' 'Moldova'
'Armenia' 'Romania' 'Chile' 'CostaRica' 'Iceland' 'Georgia'} ';

countr_nocrisis = {'Canada' 'Sweden' 'Croatia' 'Poland' 'Germany' 'Argentina'
'SlovakRepublic' 'Norway' 'Kazakhstan' 'Australia'} ';

countr_select = [countr_crisis; countr_nocrisis; {'Global'}];
```

As a result of consecutive commands countr_select variable contains a list of countries severely affected and not affected by the crisis, based on which the average value of proactive indicators will be computed.

Step 1. Extraction of the selected countries' data.

```
desc.timespan = 1: length (new_slice_countries.ts_indices);

desc.dims = new_slice_countries.dimtags;

desc.dims.COUNTRYNAME = countr_select;

mainslice = md_data.get_slice (desc);
```

It should be noted that the data are taken from the object md_data, which contains all the information collected as soon as the subset new_slice_countries does not contain the data on Global.

The result of consecutive commands is creation of an object mainslice (of MDData type), containing a subset of the data have been analyzed for selected countries and indicators.

Step 2. Calculating the basic elements of proactive crises indicators

Some of the indicators of the crisis are not directly based on raw data, but calculated basedon some more complicated formulas. Therefore it is logical to calculate the indicators in two stages. In the first stage comprises estimation of variables that are the elements of leading indicators' formulas. These include:

```
comp_data = mainslice.md_eval (['RGDP_CHNG ={d2: GDP_VOL_CHNG {}}' ...

Change in real GDP compared to the previous period
```

```
    'RGDP2005 = {d2: NGDP {}}./{ d2: GDP_DEFL_2005 {}}' ...
```

Real GDP data based on nominal GDP and the deflator index with the base in 2005

```
    'RGDP_CHNG2000 = {d2: GDP_VOL_2000 {}}-{ d2: GDP_VOL_2000 {-1}}' ...
```

Change in real GDP calculated based on changes in GDP expressed 2000 prices

```
    'DSPI = {d2: SPI {}}-{ d2: SPI {-1}}' ...
```

Change of the stock market index

```
    'FD_TOT = {d2: FD_GG {}}+{ d2: FD_MA {}}+{ d2: FD_CB {}}+{ d2: FD_OS {}}'
...
```

Total external debt of the country as the amount of external government debt, central bank, commercial banks and other sectors

```
    'FD_TOT_ST = {d2: FD_GG_ST {}}+{ d2: FD_MA_ST {}}+{ d2: FD_CB_ST {}}+{ d2:
FD_OS_ST {}}' ...
```

Total short-term debt of the country as the sum of volumes of short-term external debt above the main categories of agents

```
    'FD_STATE = {d2: FD_GG {}}+{ d2: FD_MA {}}' ...
```

State debt, as the amount of debt the government and central bank

```
    'GS_GDP = {d2: BOP_GS {}}./({ d2: NGDP {}}./{ d2: ER {}})' ...
```

The ratio of trade balance in goods and services to GDP expressed in million USD

```
    'CURACC_GDP = {d2: BOP_CURACC {}}./({ d2: NGDP {}}./{ d2: ER {}})' ...
```

The ratio of current account balance to GDP expressed in mln. USD

```
    'RES_GDP = ({d2: INTERN_RESERVES {}} .* {d2: USD_SDR, d1: Global {}}
).//({ D2: NGDP {}}./{ d2: ER {}}) ' ...
```

The ratio of international reserves denominated in mln. USD to GDP expressed in mln. USD

```
    'RES_EXP = ({d2: INTERN_RESERVES {}} .* {d2: USD_SDR, d1: Global {}}
). / {D2: EXPORT {}} ' ...
```

The ratio of international reserves denominated in mln. USD to exports volume

```
    'RES_IMP = ({d2: INTERN_RESERVES {}} .* {d2: USD_SDR, d1: Global {}}
). / {D2: IMPORT {}} ' ...
```

The ratio of international reserves denominated in mln. USD to imports volume

```
   'TOT = {d2: EXPORT_UNT_PRICES {}}./{ d2: IMPORT_UNT_PRICES {}}' ...
```

Terms of trade as the ratio of average export unit price to the average unit price of imports

```
    'EXPI = 100 .* {d2: EXPORT {}}./{ d2: EXPORT {-1}} -100' ...

Growth of exports, the percentage

    'IMPI = 100 .* {d2: IMPORT {}}./{ d2: IMPORT {-1}} -100' ...

Growth of imports, the percentage

    'REERI = {d2: REER {}}-{ d2: REER {-1}}' ...

REER change compared to previous month

    'DLIBOR = {d1: Global d2: LIBOR {}}-{ d1: Global d2: LIBOR {-1}}' ...

Change in LIBOR as an indicator of foreign lending rate compared to previous
month

    'LIBOR = {d2: LIBOR, d1: Global {}}' ...

LIBOR index as an indicator of the foreign lending rate

    'DRATES = {d2: LIBOR, d1: Global {}}-{ d2: LENDRATE {}}' ...

The difference between foreign and domestic lending rates

    'DOM_CREDIT_GDP = {d2: LOANS {}}./{ d2: NGDP {}}' ...

The size of loans to GDP ratio

    'DOM_CREDIT_CHNG = 100 .* {d2: LOANS {}}./{ d2: LOANS {-1}} -100' ...

Growth rates of domestic loans volume, as a percentage

    'MM = {d2: M2 {}}./{ d2: MBASE {}}' ...

Money multiplier

    'RDEPRATE = (100 + {d2: DEPRATE {}})./( 100 + {d2: CPI_CHNG {}})- 1' ...

Real deposit rate based on the nominal rate and CPI

    'RLENDRATE = (100 + {d2: LENDRATE {}})./( 100 + {d2: CPI_CHNG {}})- 1' ...

The real loans rate based on the nominal rate and CPI

    'DEPOSITS = {d2: DEP_TRANS {}}+{ d2: DEP_OTH {}}+{ d2: DEP_EXCL {}}' ...

The volume of deposits as the sum of the relevant articles of standard reporting
forms

    'CPI_CHNG = {d2: CPI_CHNG {}}' ...

CPI Change

    'DM2 = 100 .* {d2: M2 {}}./{ d2: M2 {-1}} -100' ...

Money growth rate in percent
```

```
    'M2_RES = {d2: M2 {}}./({ d2: INTERN_RESERVES {}} .* {d2: USD_SDR, d1:
Global {}}

.* {D2: ER {}}) ' ...

The ratio of money supply to international reserves, expressed in national
currency

    'ER = {d2: ER {}}' ...

Nominal exchange rate (official or market, depending on the mode of exchange
rates in the country)

    'NGDP = {d2: NGDP {}}' ...

Nominal GDP

    'NEER = {d2: NEER {}}' ...

NEER

    'GFCF = {d2: GFCF {}}' ...

Gross fixed capital formation (investment)

    'LOANS = {d2: LOANS {}}' ...

The volume of loans to the economy

    'CONS_TOTAL = {d2: CONS_GOV {}}+{ d2: CONS_H {}}' ...

The volume of domestic consumption as the sum of public and private consumption

    'GVT_CLAIMS = {d2: GVT_CLAIMS {}}' ...

The claims of the central bank to the government

    'GEDP = {d2: GEDP {}}' ...

Gross external debt position

    'EXPORT = {d2: EXPORT {}}' ...

Exports in mln. USD

    'IMPORT = {d2: IMPORT {}}' ...

Imports in mln. USD

], 'VARNAME', 'VARNAME');
```

Note that all code described is a one MATLAB command, so there should be no comments between the individual indices in order for the code to be executed.

As a result of the command object comp_data is created, which contains the calculated variables of the "first stage" for the selected countries.

Step 3. The final calculation of proactive crises indicators

```
comp_data = comp_data.md_eval (['RGDP_CHNG ={d2: RGDP_CHNG {}}' ...

Change in real GDP compared to the previous period

    'RGDP2005_CHNG = 100 .* {d2: RGDP2005 {}}./{ d2: RGDP2005 {-1}}' ...

Real GDP index calculated based on the nominal GDP  and deflator index with the
base in 2005 over the previous period

    'RGDP_CHNG2000 = {d2: RGDP_CHNG2000 {}}' ...

Change in real GDP was calculated based on changes in GDP in 2000 prices

    'DSPI = {d2: DSPI {}}' ...

Change of the stock market index

    'NGDP = {d2: NGDP {}}' ...

Nominal GDP

    'FD_TOT_GDP = ({d2: ER {}}.*{ d2: FD_TOT {}})./{ d2: NGDP {}}' ...

The ratio of total external debt denominated in national currency to nominal GDP

    'ST_DEBT_SHARE = {d2: FD_TOT_ST {}}./{ d2: FD_TOT {}}' ...

The ratio of short-term external debt to total external debt

    'FD_STATE_GDP = ({d2: ER {}}.*{ d2: FD_STATE {}})./{ d2: NGDP {}}' ...

The ratio of foreign debt, expressed in national currency to nominal GDP

    'FD_TOT = {d2: FD_TOT {}}' ...

Total external debt of the country

    'FD_EXP = 100 * {d2: FD_TOT {}}./{ d2: EXPORT {}}' ...

The ratio of total external debt to exports

    'FD_IMP = 100 * {d2: FD_TOT {}}./{ d2: IMPORT {}}' ...

The ratio of total external debt to total imports

    'GEDP = {d2: GEDP {}}' ...

Gross external debt position

    'FD_STATE = {d2: FD_STATE {}}' ...

State debt

    'GS_GDP = {d2: GS_GDP {}}' ...

The ratio of trade balance in goods and services to GDP

    'CURACC_GDP = {d2: CURACC_GDP {}}' ...
```

```
The ratio of current account balance to GDP

    'RES_GDP = {d2: RES_GDP {}}' ...

The ratio of international reserves to GDP

    'RES_EXP = {d2: RES_EXP {}}' ...

The ratio of international reserves to total exports

    'RES_IMP = {d2: RES_IMP {}}' ...

The ratio of international reserves to total imports

    'TOT = {d2: TOT {}}' ...

Terms of trade

    'EXPI = {d2: EXPI {}}' ...

Growth of exports, the percentage

    'IMPI = {d2: IMPI {}}' ...

Growth of imports, the percentage

    'REERI = {d2: REERI {}}' ...

REER change compared to previous month

    'DEPOSITS = {d2: DEPOSITS {}}' ...

The volume of deposits

    'LOANS = {d2: LOANS {}}' ...

The volume of loans to economy

    'DLIBOR = {d2: DLIBOR {}}' ...

Change in LIBOR as an expression of foreign lending rate

    'LIBOR = {d2: LIBOR {}}' ...

LIBOR index as an expression of the foreign lending rate

    'DRATES = {d2: DRATES {}}' ...

The difference between foreign and domestic lending rates

    'DOM_CREDIT_GDP = {d2: DOM_CREDIT_GDP {}}' ...

The size of loans to GDP

    'DOM_CREDIT_CHNG = {d2: DOM_CREDIT_CHNG {}}' ...

Growth rates of domestic loans, as a percentage

    'MM = {d2: MM {}}' ...
```

```
Money multiplier

    'RDEPRATE = {d2: RDEPRATE {}}' ...

Real deposit rate

    'RLENDRATE = {d2: RLENDRATE {}}' ...

The real rate on loans

    'RATE_MARGIN = {d2: RLENDRATE {}}-{ d2: RDEPRATE {}}' ...

The difference between real loan and deposit rates

    'DEBT_DEPOS = ({d2: ER {}}.*{ d2: FD_TOT {}})./{ d2: DEPOSITS {}}' ...

The ratio of total external debt denominated in national currency to the amount
of deposits

    'LOANS_TO_DEPS = 100 .* ({d2: LOANS {}}./{ d2: DEPOSITS {}})' ...

The ratio of loans to deposits, in percent

    'CPI_CHNG = {d2: CPI_CHNG {}}' ...

CPI Change

    'DM2 = {d2: DM2 {}}' ...

Money growth rate

    'M2_RES = {d2: M2_RES {}}' ...

The ratio of money supply to international reserves

    'GVT_CLAIMS = {d2: GVT_CLAIMS {}}' ...

The claims of the central bank to the government

    'NEER = {d2: NEER {}}' ...

NEER

    'GFCF = 100 * {d2: GFCF {}}./{ d2: NGDP {}}' ...

The ratio of gross investment to GDP, percent

    'CONS_TOTAL = 100 * {d2: CONS_TOTAL {}}./{ d2: NGDP {}}' ...

The ratio of gross consumption to GDP, percent

], 'VARNAME', 'VARNAME');
```

The result of this command is the object comp_data, which contains leading indicators calculated.

Appendix 7. Calibration of the model for optimal level o reserves calculation

Using the values of parameters from the table 3.2, formulas (3.10), (3.11), (3.12) and (3.13), we can calculate recommended optimal level of reserves.

If we do not take into account possible depreciation, then on the basis of (3.10)

$$p_t = \frac{x_t^{-1} - 1}{\pi_t^{-1} - 1} = \frac{0{,}115^{-1} - 1}{0{,}1^{-1} - 1} = 0{,}86 \qquad \text{(D.7.1)}$$

for all variants.

Taking into account depreciation and using (3.2.13):

$$p_t = \frac{x_t^{-1} - 1}{\pi_t^{-1} - 1}(1 + \Delta Q) = \frac{0{,}115^{-1} - 1}{0{,}1^{-1} - 1}(1 + 0{,}1) = 0{,}97 \quad \text{(D.7.2)}$$

for variant 1,

$$p_t = \frac{x_t^{-1} - 1}{\pi_t^{-1} - 1}(1 + \Delta Q) = \frac{0{,}115^{-1} - 1}{0{,}1^{-1} - 1}(1 + 0{,}25) = 1{,}04 \quad \text{(D.7.3)}$$

for variant 2,

$$p_t = \frac{x_t^{-1} - 1}{\pi_t^{-1} - 1}(1 + \Delta Q) = \frac{0{,}115^{-1} - 1}{0{,}1^{-1} - 1}(1 + 0{,}58) = 1{,}35 \quad \text{(D.7.4)}$$

for variant 3.

Using the formula (3.11) and the results of previous calculations we can receive the following results without depreciation:

$$\rho_t^* = \frac{\lambda + \gamma - \left(1 - \frac{(r - g)\lambda}{1 + g}\right)(1 - p_t^{1/\sigma})}{1 - x_t(1 - p_t^{1/\sigma})} =$$

$$\frac{0{,}1 + 0{,}065 - \left(1 - \frac{(0{,}05 - 0{,}033)0{,}1}{1 + 0{,}033}\right)(1 - 0{,}86^{1/2})}{1 - 0{,}115(1 - 0{,}86^{1/2})} = 0{,}091, \quad \text{(D.7.5)}$$

for variant 1,

$$\rho_t^* = \frac{\lambda + \gamma - \left(1 - \frac{(r - g)\lambda}{1 + g}\right)(1 - p_t^{1/\sigma})}{1 - x_t(1 - p_t^{1/\sigma})} =$$

$$\frac{0,1+0,065-\left(1-\frac{(0,05-0,031)0,1}{1+0,031}\right)(1-0,86^{1/2})}{1-0,115(1-0,86^{1/2})}=0,090\text{, (D.7.6)}$$

for variant 2,

$$\rho_t^*=\frac{\lambda+\gamma-\left(1-\frac{(r-g)\lambda}{1+g}\right)(1-p_t^{1/\sigma})}{1-x_t(1-p_t^{1/\sigma})}=$$

$$\frac{0,1+0,076-\left(1-\frac{(0,05-0,031)0,1}{1+0,031}\right)(1-0,86^{1/2})}{1-0,115(1-0,86^{1/2})}=0,102\text{, (D.7.7)}$$

for variant 3.

Taking into account depreciation, based on the formula (3.12) and using previous calculations:

$$\rho_t^*=\frac{\lambda+\gamma-\left(1-\frac{(r-g)\lambda}{1+g}\right)\left(1-p_t^{1/\sigma}\right)+\frac{1+r}{1+g}\lambda\Delta Q}{1-x_t\left(1-p_t^{1/\sigma}\right)+(1-x_t)\Delta Q}=$$

$$\frac{0,1+0,065-\left(1-\frac{(0,05-0,033)0,1}{1+0,033}\right)\left(1-0,86^{1/2}\right)+\frac{1+0,05}{1+0,033}0,1*0,1}{1-0,115(1-0,86^{1/2})+(1-0,115)0,1}=0,134\text{,}\quad\text{(D.7.8)}$$

for variant 1,

$$\rho_t^*=\frac{\lambda+\gamma-\left(1-\frac{(r-g)\lambda}{1+g}\right)\left(1-p_t^{1/\sigma}\right)+\frac{1+r}{1+g}\lambda\Delta Q}{1-x_t\left(1-p_t^{1/\sigma}\right)+(1-x_t)\Delta Q}=$$

$$\frac{0,1+0,065-\left(1-\frac{(0,05-0,031)0,1}{1+0,031}\right)(1-0,86^{1/2})+\frac{1+0,05}{1+0,031}0,1*0,25}{1-0,115(1-0,86^{1/2})+(1-0,115)0,25}=0,183\text{,}\quad\text{(D.7.9)}$$

for variant 2,

$$\rho_t^*=\frac{\lambda+\gamma-\left(1-\frac{(r-g)\lambda}{1+g}\right)\left(1-p_t^{1/\sigma}\right)+\frac{1+r}{1+g}\lambda\Delta Q}{1-x_t\left(1-p_t^{1/\sigma}\right)+(1-x_t)\Delta Q}=$$

$$\frac{0,1+0,076-\left(1-\frac{(0,05-0,031)0,1}{1+0,031}\right)(1-0,86^{1/2})+\frac{1+0,05}{1+0,031}0,1*0,58}{1-0,115(1-0,86^{1/2})+(1-0,115)0,58}=0,260\text{,}\quad\text{(D.7.10)}$$

for variant 3.

Appendix 8. Description of Hodrick-Prescott filter

During 80s economists often used in their working papers the method of smoothing long-term macroeconomic series with the goal of eliminating from them short-term fluctuations. Formally this method was published in 1997 by Robert Hodrick and 2004 Nobel prize winner in Economics Eward Prescott and received the name Hodrick-Prescott filter.

The idea of Hodrick-Prescott filter is to divide the variable, Y_t, on two components: long-term trend, Y_t^T, and short-term fluctuations, Y_t^C:

$$Y_t = Y_t^T + Y_t^C, \qquad \text{(D.8.1)}$$

where Y_t^T can be found by solving the following optimization problem:

$$\min_{\{Y_t^T\}_{t=1}^{Time}} \sum_{t=1}^{Time} (Y_t - Y_t^T)^2 + \lambda \sum_{t=2}^{Time-1} \left((Y_{t+1}^T - Y_t^T) - (Y_t^T - Y_{t-1}^T)\right)^2, \quad \text{(D.8.2)}$$

where $Time$ is the sample size, λ is the parameter, the values of which are recommended to be 100 for annual, 1600 – for quarterly and 14400 – for monthly data.

In Eviews the separation of long-term trend can be done with the menu element **Proc/Hodrick-Prescott Filter**. Short-term part can be found as difference of the values of the variable and separated long-term trend.

Appendix 9. Calculation of marginal effects for probit and logit

Let set up once more LPM, probit and logit:

$$P\left(y_t = 1|x_t\right) = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \ldots + \beta_k x_{kt} + \varepsilon_t, \quad \text{(D.9.1)}$$

$$P\left(y_t = 1|x_t\right) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\beta_0+\beta_1 x_{1t}+\beta_2 x_{2t}+\ldots+\beta_k x_{kt}+\varepsilon_t} e^{-\frac{z^2}{2}} dz, \quad \text{(D.9.2)}$$

$$P\left(y_t = 1|x_t\right) = \frac{1}{1+e^{-(\beta_0+\beta_1 x_{1t}+\beta_2 x_{2t}+\ldots+\beta_k x_{kt}+\varepsilon_t)}}, \quad \text{(D.9.3)}$$

where y_t is the dummy variable, which denote sudden stop, x_{it} is the i-th explanatory variable, β_i is the i-th regression parameter, ε_t is the regression residual.

In order to determine the influence of explanatory variable x_i during the period t on the probability of the sudden stop, we should calculate for each model $\frac{\partial P\left(y_t = 1|x_t\right)}{\partial x_{it}}$. So for the LPM, probit and logit we will have respectively:

$$\frac{\partial P\left(y_t = 1|x_t\right)}{\partial x_{it}} = \beta_i, \quad \text{(D.9.4)}$$

$$\frac{\partial P\left(y_t = 1|x_t\right)}{\partial x_{it}} = \left|\textit{за формулою Ньютона – Лейбніца}\right| =$$

$$\frac{F\left(\beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \ldots + \beta_k x_{kt} + \varepsilon_t\right) - F\left(-\infty\right)}{\partial x_{it}} = f\left(\beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \ldots + \beta_k x_{kt} + \varepsilon_t\right)\beta_i,$$

(D.9.5)

$$\frac{\partial P\left(y_t = 1|x_t\right)}{\partial x_{it}} = \frac{\partial \frac{1}{1+e^{-(\beta_0+\beta_1 x_{1t}+\beta_2 x_{2t}+\ldots+\beta_k x_{kt}+\varepsilon_t)}}}{\partial x_{it}} = \frac{e^{-(\beta_0+\beta_1 x_{1t}+\beta_2 x_{2t}+\ldots+\beta_k x_{kt}+\varepsilon_t)\beta_i}}{\left(1+e^{-(\beta_0+\beta_1 x_{1t}+\beta_2 x_{2t}+\ldots+\beta_k x_{kt}+\varepsilon_t)}\right)^2} =$$

$$P\left(y_t = 1|x_t\right)\left(1 - P\left(y_t = 1|x_t\right)\right)\beta_i, \quad \text{(D.9.6)}$$

So as we see from the equations (D.9.4), (D.9.5) and (D.9.6), marginal effect or the change in probability with the change of some explanatory variable is constant for LPM, but depends on the time period for models probit and logit.

In EViews package the algorithm for marginal effects calculation consists of three steps:

1. At the beginning the prediction for $x_t\boldsymbol{\beta}$ should be generated: **Proc/Forecast(Fitted Probability/ Index)** and choose *Index – where Prob=1-F(-Index).*
2. Then for the probit model $f(x_t\boldsymbol{\beta})$ shold be generated by inserting into the command line: series name = @dnorm(-nsme_xb_from_the_previous_prediction). For the logit model to generate $P(y_t = 1|x_t)$ name = @dlogistic(-name_xb_fomr_the_previous_prediction) should be used.
3. Multiply the results from step 2 by corresponding partial coefficients.

Appendix 10. Optimal level of reserves calculation based on the models Probit 1 and Probit 2

At the beginning based on the models Probit 1 and Probit 2, which are given by the formulas (3.18) and (3.19) and by the tables of coefficients (3.4) and (3.5), we calculate the probability of the sudden stop for each year. The results of calculations are shown in the table D.10.1.

Table D.10.1. Probability of the sudden stop.

Year	Probit 1	Probit 2
1998	0.65	0.83
1999	0.88	0.81
2000	0.11	0.28
2001	0.01	0.04
2002	0.00	0.11
2003	0.40	0.01
2004	0.78	0.03
2005	0.02	0.10
2006	0.08	0.20
2007	0.44	0.19
2008	0.28	0.28
2009	0.49	0.24

Source: NBU data, own calculations.

Using the values of the parameters from the table 3.2 (all except from the probability of the sudden stop, π), formulas (3.12) and (3.13), and identity

$$x = \delta + \pi, \qquad \text{(D.10.1)}$$

We can calculate recommended optimal reserves level.

The algorithm is completely analogous to the described in the Appendix 9., only in the formulas (D.10.1) and (3.13) instead of π we should use the values of the parameters from the table D.10.2, and into the formula (3.13) instead of x the value from (D.4.1). Then the results received from the formulas (D.10.1) and (3.13) we can substitute into the formula (3.12). Such calculations should be conducted for each model and for each year.

Final and intermediate results are shown in the table D.10.2.

Table D.10.2. Optimal level of reserves calculation.

Year	Probit 1				Probit 2			
	Probability of the sudden stop	Gross risk premium	The price of 1 unit of currency during non-crises period relative to the price of one unit of currency during the sudden stop with depreciation	Ratio of reserves to GDP with depreciation	Probability of the sudden stop	Gross risk premium	The price of 1 unit of currency during non-crises period relative to the price of one unit of currency during the sudden stop with depreciation	Ratio of reserves to GDP with depreciation
1998	0.65	0.66	1.48	0.34	0.83	0.84	1.42	0.34
1999	0.88	0.90	1.36	0.33	0.81	0.82	1.43	0.34
2000	0.11	0.13	1.37	0.27	0.28	0.29	1.47	0.30
2001	0.01	0.03	0.64	0.02	0.04	0.06	1.15	0.20
2002	0.00	0.02	-	-	0.11	0.12	1.36	0.26
2003	0.40	0.41	1.49	0.32	0.01	0.03	0.74	0.06
2004	0.78	0.80	1.45	0.34	0.03	0.05	1.07	0.17
2005	0.02	0.04	0.91	0.12	0.10	0.12	1.36	0.26
2006	0.08	0.10	1.31	0.25	0.20	0.22	1.45	0.29
2007	0.44	0.45	1.49	0.32	0.19	0.21	1.44	0.29
2008	0.28	0.30	1.47	0.30	0.28	0.30	1.47	0.30
2009	0.49	0.51	1.49	0.33	0.24	0.26	1.46	0.30

Source: NBU data, own calculations.