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## **ВЫПУСКНАЯ КВАЛИФИКАЦИОННАЯ РАБОТА**

на тему: Детерминанты наступления экономических кризисов и их глубины

(Determinants of Occurrence and Depth of Economic Crises)

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### Краткое содержание.

Данная работа посвящена определению ключевых факторов, объясняющих вероятность наступления кризиса и его глубины. Вклад в существующие исследования основывается на том, что для решения поставленной задачи используется кластерный анализ рассматриваемых государств в целях получения классификации, позволяющей оценить специфические детерминанты возникновения кризиса и глубины кризисного спада. Также в данном контексте рассматривается роль участия стран в торговых, валютных и таможенных союзах.

Результаты исследования указывают на заметные различия между оценкой объясняющих моделей для совокупной выборки и каждого кластера в отдельности. Среди общих черт возникающих кризисов выделяется отрицательное влияние накопления совокупного государственного долга на экономическую устойчивость государств, а также снижение вероятности наступления кризиса на фоне положительной динамики рынка акций. Исследование показало, что степень влияния финансового сектора на вероятность возникновения кризиса и его глубину увеличивается с уровнем экономического развития государства, в то время как торговый канал уходит на второй план. Среди важных выводов следует также отметить существенное увеличение вероятности наступления кризиса в экономически развитых странах, связанное со вступлением в валютный союз. Влияние регионального распространения кризисов отмечено как значимое для наименее развитых, развивающихся и развитых стран.

National Research University -  
Higher School of Economics

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**Graduation Thesis**

Determinants of Occurrence and Depth of Economic Crises

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## **Abstract**

This paper is devoted to determination of major factors explaining the probability of crisis occurrence and depth. The paper contributes to the existing research by applying cluster analysis to country grouping and explaining cluster-specific determinants of crisis occurrence and incidence, explicit analysis of the role of economic integration in crisis emergence and inclusion of data for the year 2011. The results of the research suggest that analysis of cluster-specific factors indeed differs from the whole-sample parameters interpretation. Common features of crisis patterns in the international perspective include the adverse effect of government gross debt accumulation on economic stability, and the negative relationship between stock market movements and probability of a crisis. The role of financial sector in crisis probability and depth determination increases with the degree of a country's economic development, whereas the trading sector becomes relatively less important. Important findings also include large positive effect of currency union membership on the probability of crisis taking place for developed countries, and importance of regional contagion for crisis patterns in the least developed, developing and developed economies.

**Keywords:** economic crisis, probability of a crisis, crisis depth, country clustering

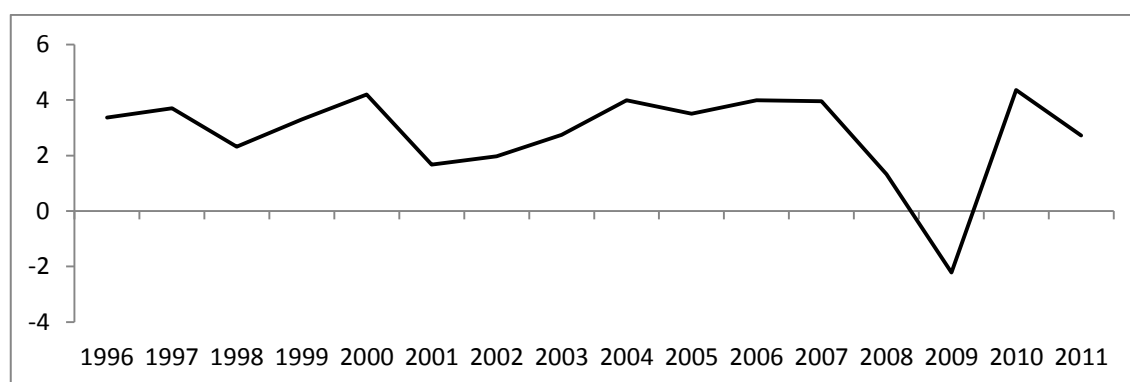
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## 1. Introduction

The topic of economic crises has been worrying the international society for centuries. The wish to avoid significant loss of economic welfare caused by local, regional and global crises gives rise to the questions related to the roots of crisis emergence and to the measures that can be taken to reduce the economy's vulnerability to shocks.

Several globally significant crises took place during the 1997-2011 period: the Asian crisis of 1997-1998, default on debt in Russian Federation in 1998, the Dotcom crisis of 2000-2001, the Global financial crisis of 2007-2009 and the continuing European sovereign debt crisis. The dynamics of world real GDP reflect the impact of these crises on global real economic growth.



Picture 1: real growth rate of world GDP; source: the World Bank

The importance of the subject has attracted a considerable amount of studies.

At the start it is crucial to develop the criteria of crisis occurrence – in other words, to define the start of a crisis. According to the Business Cycle theory (started by J. C. L. de Sismondi (1819), C. Dunoyer (1825)), a crisis follows economic slowdown – it refers to the lowest point of ‘downside’ GDP movement. A broader view on the question states that an economic recession is accompanied by a crisis, which can take various forms: financial crisis, banking crisis, debt crisis, etc. Nevertheless, crises have some common features: there is a sharp fall in economic growth, unemployment rises and it takes considerable time for the economy to recover when a crisis takes place.

Reinhart (2011) outlines three major types of crises which occurred during 1800-2009. Currency, inflation or hyperinflation crises form the first type; a currency crisis was registered when devaluation of a country's currency equaled at least 15 percent per annum, an inflation crisis referred to the case of annual inflation exceeding 20 percent. In most cases these crises

took place simultaneously. The second category includes debt crises, which appear in form either of a default on external debt payment, of external debt restructuring or of a domestic debt crisis – a failure of domestic institutions to service their debt obligations. Domestic debt crises normally occur under worse economic conditions compared to external defaults (Reinhart and Rogoff (2008)) and their endpoints are hard to determine since domestic debt crises may occur during banking or currency crises. The third major group of crises is banking crises – these can be driven by the liabilities side of the banking sector (withdrawals, bank runs) or by the assets side (bankruptcies, nonperforming loans).

This historical study provides evidence on the cyclical nature of banking and sovereign debt crises; also, the hypothesis about banking crises raising probability of sovereign debt default was affirmed.

Kaminsky and Reinhart (1999) construct a currency crisis index based on exchange rate devaluation and loss of official international reserves held by central banks of countries involved in 1990-s currency crises. The index involves a weighting scheme where exchange rates are assigned positive weights and reserves enter with a negative sign, and the crisis manifests if the index' value is three standard deviations greater than its mean.

Another important notion is a 'twin' crisis – the case when currency and banking crises take place simultaneously (Kaminsky and Reinhart (2000); Glick and Hutchinson (1999)). Among 16 indicators examined by Kaminsky and Reinhart (2009) (the sample contained data on banking and currency crises in 20 industrial and developed countries within the period 1970-1995), the ratio of public sector to GDP, real exchange rate and stock prices were the leading factors explaining crises occurrence. Cecchetti, Kohler and Upper (2009) provided evidence that such 'twin' crises are more costly for the economy than banking crises accompanied by sovereign debt defaults in terms of output loss.

The global financial crisis of 2007-2009 stirred interest in systemic banking crises. Laeven and Valencia (2008) describe a systemic banking crisis by a sharp increase in non-performing loans and almost exhausted capital of the banking sector. During systemic banking crises there may be a slowdown or even a reversal in capital flows, drops in asset prices (especially after a pre-crisis run-ups) and sharp increases in real interest rates.

Currency crises of 1990-s and their regional and global effects attracted great attention to crisis transmission channels – the process of contagion gained large importance. Eichengreen et al. (1996) defined contagion as increasing probability of a crisis at home conditional on the

presence of a crisis elsewhere abroad. Kaminsky and Reinhart (1999) used this definition to reveal the major triggers of currency crises contagion in developing countries during 1970-1998. Major emphasis was placed on fundamentals-based contagion and the role of financial sector. They revealed that ‘... contagion is more regional than global’<sup>1</sup>. Bilateral trade and common creditors were the factors explaining contagion patterns during the considered period.

M. Fratzscher (2003) examined the 1990-s currency crises and associated contagion effects for emerging economies using non-linear Markov-switching VAR models. The results of this investigation indicate that developing countries are vulnerable to contagion if they are engaged in strong competition and trade with the countries already experiencing crises; financial interdependence in capital markets and banking sectors also played one of the leading roles.

In the study of the Global Financial crisis effects on economies of Sub-Saharan Africa Sin Yu Ho (2009) also distinguishes between real and financial channels of crisis transmission. Despite financial sector development level is heterogeneous among the countries under consideration, financial channel does not lose its importance. The major real factors of transmission were change in terms of trade and commodity prices, workers’ remittances and slowdown in largest trading partners, economic aid providers and foreign investors (India and China).

C. Calderon and T. Didier (2009) have examined the sources of countries’ vulnerability to the Global Financial crisis. According to the paper, countries with greater trade openness and less resilient financial markets had larger output drops during the crisis years; also, vulnerability to international imbalances increased with external liabilities leverage (bias towards debt instruments rather than equity). To a lesser extent, economic contraction of countries with improved macroeconomic environment was also comparatively larger.

Overall, there are several important factors to be considered when a crisis is to be determined: level of economic integration, value of government debt, interest rates (lending, discount, treasury, etc.), inflation, exchange rates, changes in international reserves of the central bank, asset prices, and capital market fluctuations. Surely, it is crucial to analyze output dynamics, since crises ought to have real effects on the economy.

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<sup>1</sup> C. Reinhart, G. Kaminsky, 1998. “On Crises, Contagion and Confusion”. University of Maryland, College Park, Department of Economics, p. 5



The literature devoted to the probability of crisis occurrence contains models of early warning systems. Lund-Jensen (2012) constructs a dynamic binary-response model aimed at monitoring conditional probability of a systemic banking crisis. Systemic risk estimates formed on a basis of 11 variables, which include dynamics of the real exchange rate, equity prices, credit-to-GDP ratio, leverage of the banking sector, banks' lending premia and interconnectedness in the financial sector, could be interpreted as systemic banking crisis signals.

Matijù et al. (2011) build two models – discrete and continuous – that form an early warning system. The Crisis Occurrence Index is the dependent variable in the discrete model, formed on the basis of research related to crises definition and registration (Kaminsky and Reinhart, 1999; Caprio and Klingebiel, 2003; Kaminsky, 2006; Reinhart and Rogoff, 2008; Laeven and Valencia, 2008 and 2010). The Crisis Incidence Index is a dynamic dependent variable – it is an average of standardized variables, such as gaps of real GDP, government budget surplus and unemployment rate. The paper provides evidence that housing prices and global factors (dynamics of world output and credit) are substantial sources of risk considering both discrete and continuous approaches to early warning indicators.

These papers suggest that it is vital to have a well-developed crisis definition: it is important to compare and contrast several possible crisis indicators in order to have a sensible panel of crisis occurrence index.

Since almost all crises have real effects, it is natural to measure the economic cost of crises on the basis of GDP dynamics (as in Barro (2001) or Bordo et al (2001)). Cecchetti, Kohler and Upper (2009) define the length of a crisis as the time needed for the economy to recover to its pre-crisis level and the associated output cost is the percentage decline in GDP – from the peak (GDP value within one year either side from the crisis date) to the lowest point within the crisis period. The findings of the paper relate to the length and depth of different types of economic crises. Banking crises accompanied by currency crises last on average more than five quarters longer and corresponding output costs are on average larger by 6 percentage points. Banking crises accompanied by sovereign debt defaults are found to be less costly: it takes on average two years less to recover and output drop is smaller on average by 7 percentage points of pre-crisis GDP.

Gurvich and Prilepskiy (2010) use the difference between actual average GDP growth and IMF forecast prior to the active phase of the 2007-2009 crisis. The research involved differentiation between developed and developing countries, and energy exporters were

examined separately; the model included both external and internal macroeconomic parameters. The results show that the most influential factor for crisis depth during 2007-2009 was private external debt, growth of trading partners and increase in credit.

The analysis of literature devoted to measuring the depth of an economic crisis leads to the following criteria that the dependent variable should satisfy: it should reflect the real effect of the crisis, taking into account the 'potential' GDP dynamics (expressed in terms of forecasts, historical evidence, etc.). Also, in face of regional or global crises the pre-crisis stage of business cycle should also be considered.

Overall, analysis of crisis occurrence and depth should involve the following. Crisis triggers may be found in both external and internal imbalances: changes in global economic and financial environment, growth of trading partners, policy imperfections, lack of investors' confidence, capital markets booms and crashes, etc. There should be strict criteria of crisis occurrence and duration in order to obtain precise results. Among the factors explaining crisis occurrence and depth it is important to outline the dynamics of public sector finance, banking sector, financial markets and trade patterns. Also, it is crucial to evaluate the role of membership in international unions (currency, customs or trade unions and organizations) because economic integration is one of the reasons underlying crisis transmission and contagion. Membership in such unions imposes certain policy restrictions that can affect economic stabilization mechanisms and may lead to moral hazard issues, but trade creation and decrease in counterparty risks are certain benefits that should be accounted for.

This paper contributes to the existing research in the following ways. Firstly, countries are grouped on the basis of cluster analysis, and this helps to reveal crisis patterns attributable to specific types of economies. Secondly, the role of membership in free trade agreements, currency or customs unions and WTO is examined explicitly. Lastly, the research contains data for 2011, which helps to look more closely at the current sovereign debt crisis in European countries.

The paper is structured as follows. Section 2 is devoted to data description and methodology of dependent variables construction. Section 3 provides description of county cluster analysis. Section 4 shows model specification and estimation results for the probability of crisis taking place. Section 5 describes the methodology of estimation and analysis of the key determinants of crisis depth. Section 6 presents the general conclusion of the paper.

## **2. Description of Data and Variables**

The main data sample includes macroeconomic variables for 170 countries within the 1997-2011 period. This time span includes several important regional and global crises, such as the Asian currency crisis of 1997-1998, Russian crisis of 1998, Dotcom crisis of 2001 in the USA and Western Europe, the Global Financial crisis of 2007-2009 and the European sovereign debt crisis which started in early 2010.

For crisis emergence criteria both annual and quarterly data is used, if the latter is available for a given country.

Annual data is used for estimation of equations for the whole samples and clusters I-IV, and for USA crises analysis quarterly data is used.

Data sources: the World Bank, IMF World Economic Outlook (WEO), International Financial Statistics (IFS), St. Louis Federal Reserve Economic Data (St. Louis FRED)

### **2.1. Data used for cluster analysis**

The sample includes dynamic annual macroeconomic data for 170 countries within the 1997-2011 period.

Clustering criteria include real GDP, real GDP per capita, current account balance to GDP ratio and value of oil net exports to GDP ratio. Real GDP helps to measure the relative size of the economy; also, such parameters as the country's share in international trade and financial flows strongly correlate with the size of the economy. Real GDP per capita reflects the country's economic development and average wealth of its citizens; this is the leading classification criterion that distinguishes developing economies from developed according to the World Bank. Current account balance to GDP ratio's sign shows whether the country is a debtor or a creditor, thus revealing the signature and magnitude of external shocks – trade or financial – that have greater effect on the economy (e.g. a global recession will affect Russia (net exporter) through a fall in demand for commodities whereas Belarus (net importer) will be worse-off due to greater cost of international borrowing). Finally, value of oil net exports to GDP helps to distinguish the specific group of countries for which oil exports is the leading economic driver among the factors considered.

The initial data set for cluster analysis can be described as follows.

Variable	Real GDP, USD billion	Real GDP per capita, USD	Current account balance to GDP, %	Value of oil net exports to GDP, %
Number of Observations	2,464	2,464	2,464	2,464
Mean	301.40	11,415.041	-2.84	2.04
Standard Deviation	1,157.37	20,991.24	11.13	16.82

Table 1: descriptive statistics for variables used in cluster analysis; source: own calculations

## 2.2. Dependent variables

To measure the probability of crisis occurrence and the depth of the downturn three dependent variables were created. There are two binary and one continuous dependent variable.

*Crisis index - binary variable (CI)*

Initially, it is crucial to determine the exact time when a crisis started and the period it lasted. There is no unified set of criteria for crisis detection, so we develop the criteria of crisis occurrence and duration on the basis of macroeconomic variables and existing research. Since qualitative definitions of crises are inappropriate for quantitative research, it is important to include quantitative criteria in the criteria set.

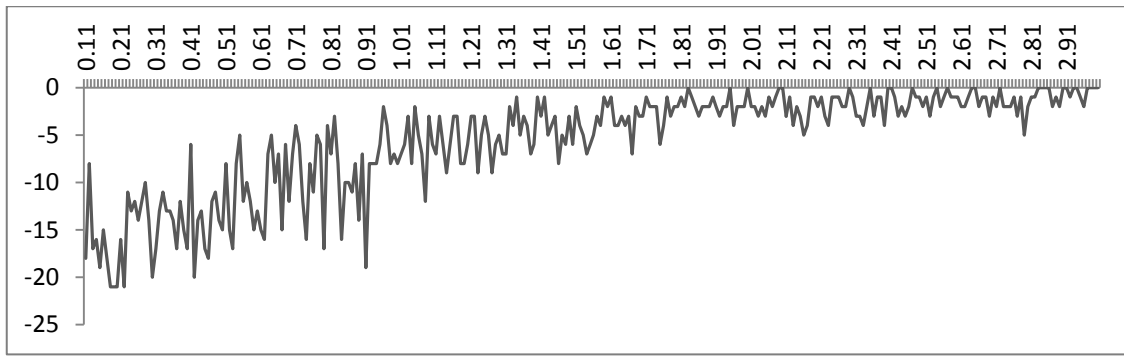
### 1) Sharp drops in quarterly real GDP growth

Crises are in most cases associated with economic slowdowns. In case deseasonalized quarterly real GDP falls dramatically in either quarter from 1997Q1-2011Q4, a crisis is registered. The crisis indicator takes the form:

$$growth_t = \left( \frac{GDP_t^{real}}{GDP_{t-1}^{real}} - 1 \right) \times 100\%$$

$$Crisis_t = \begin{cases} 1, & growth_t < \overline{growth} - \alpha \times StDev(growth) \\ 0, & otherwise \end{cases}$$

In order to determine the optimal number of standard deviations from the mean growth, we check the change of the number of registered crises at values of alpha varying from 0.1 to 3 with 0.01 step. The following plot was obtained:



Picture 2: change in the number of crises detected based on quarterly growth data; source: own calculations

Largest drops in the number of crises are observed when alpha is smaller than 1.1; the graph almost fully stabilizes at large values of alpha starting from 1.8. The optimal parameter is chosen to be 1.2 – this value belongs to the interval with relatively narrow range of function values and the resulting crisis pattern is consistent with existing knowledge of most important local, regional and global crises.

The quarterly index is transferred into annual format according to the following criteria:

- The crisis should last at least two quarters (in order not to capture small temporary shocks)
- If in a given year the crisis was present at least in one quarter (either started or ended), the crisis is registered

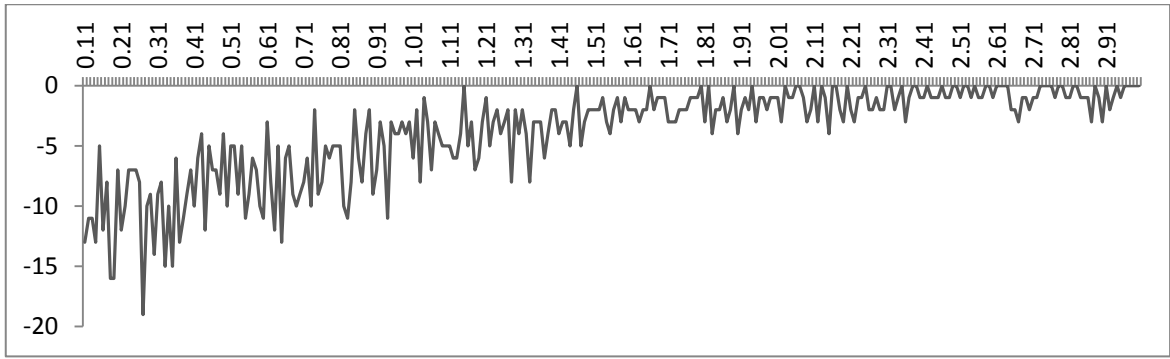
Quarterly real growth could be calculated only for a subsample of 74 countries, so for the whole sample the same logic was applied to annual real growth.

2) Sharp drops in annual real GDP growth.

The procedure of crisis registration was similar to that of quarterly real growth:

$$growth_t = \left( \frac{GDP_t^{real}}{GDP_{t-1}^{real}} - 1 \right) \times 100\%$$

$$Crisis_t = \begin{cases} 1, & growth_t < \overline{growth} - \alpha \times StDev(growth) \\ 0, & otherwise \end{cases}$$



Picture 3: change in the number of crises detected based on annual growth data; source: own calculations

The optimal value of alpha is chosen to be 0.75: at this value there are no sharp drops in the number of detected crises, and the crises registered are consistent with existing knowledge. Alpha for annual data is smaller than for quarterly, because annual data is characterized by smoother series.

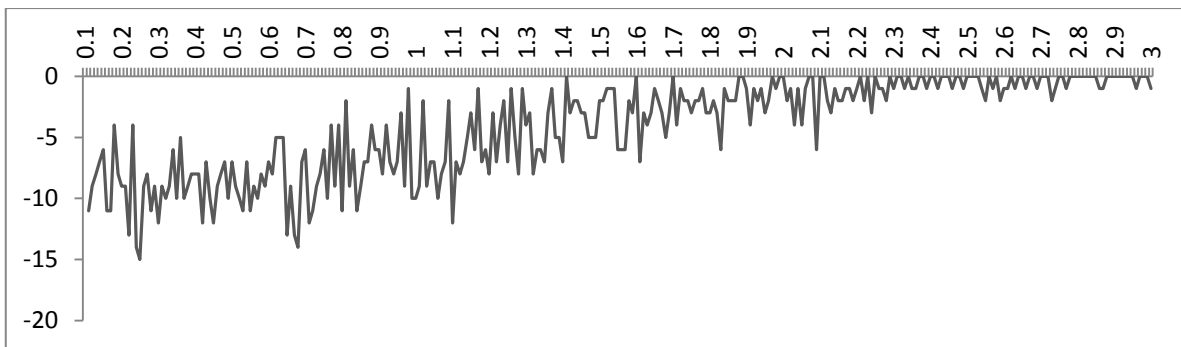
The crisis index obtained from annual real growth data is consistent with the quarterly growth-based index values where data was available for both panels.

### 3) Sharp drops in current account to GDP

Large drops in current account to GDP ratio may signal about currency crises. The logic of crisis registration is similar to the one described above; the optimal parameter for current account crises is 1.4.

$$\Delta \frac{CA_t}{GDP_t} = \left( \frac{CA_t/GDP_t}{CA_{t-1}/GDP_{t-1}} - 1 \right) \times 100\%$$

$$Crisis_t = \begin{cases} 1, & \Delta \frac{CA_t}{GDP_t} < \overline{\Delta \frac{CA}{GDP}} - \alpha \times StDev(\Delta \frac{CA_t}{GDP_t}) \\ 0, & otherwise \end{cases}$$



Picture 4: change in the number of crises detected based on annual current account balance and GDP data; source: own calculations

#### 4) Losses of official international reserves held by central banks.

In case domestic currency is pegged against foreign currency, the central bank has to intervene in the FOREX market by trading domestic and foreign currency in order to maintain the peg. Currency crises are usually associated with a break of the peg – either devaluation or free-float regime result from such crises. According to the first- and second-generation models of currency crises a sharp fall in reserves is a sign of the crisis.

The index of crisis registration is constructed as follows:

- 25-50% drop – ‘moderate’ (index = 0.4)
- 50-75% drop – ‘large’ (index = 0.7)
- 75-100% drop – ‘dramatic’ (index = 1)

Index values are based on the relative size of the drop and its effect on economic stability; furthermore, currency crises involve both changes in reserves and interest rates – therefore these two factors combined may signal about crisis emergence if their sum equals one (e.g. a ‘moderate’ in reserves combined with ‘large’ rise in the discount rate register a crisis). Any ‘dramatic’ events guarantee that deep imbalances take place, so their value is at least one.

#### 5) Sharp rise in the discount rate

Discount rate represents the cost of borrowing from the central bank. A sharp rise in the discount rate may signal that financial risks in the economy have dramatically risen, and financial institutions require larger interest on credit – this is applicable to both borrowing from the central bank and interbank lending. This can signal about a financial crisis taking place.

- 1-5% rise – ‘moderate’ (index = 0.4)
- 5-10% rise – ‘large’ (index = 0.7)
- 10-30% rise – ‘dramatic’ (index = 1)
- 30-100% rise – ‘gigantic’ (index = 1.5)
- >100% rise – ‘unbelievable’ (index = 2)

Rising risks in the country are also reflected by the changes in government bond prices and corresponding rates. Imbalances can manifest themselves through the combination of attacks on reserves and rising rates.

#### 6) Sharp rise in the treasury interest rate

A sharp rise in the interest rate paid on government bonds reflects the increase in the default risk of the country's debt. This may serve as a signal of a debt crisis. The classification is the same as the one applied to the discount rate:

- 1-5% rise – 'moderate' (index = 0.4)
- 5-10% rise – 'large' (index = 0.7)
- 10-30% rise – 'dramatic' (index = 1)
- 30-100% rise – 'gigantic' (index = 1.5)
- >100% rise – 'unbelievable' (index = 2)

#### 7) Sharp fall in market capitalization

Financial crises are often triggered by dramatic drops in the stock market. The crisis registration index takes the value of one if in a given year market capitalization falls by more than 7% - this value is revealed from empirical evidence on crises accompanied by falling stock markets (e.g. Dotcom or the recent global financial crisis).

#### 8) Use of IMF Stand-By Arrangement (SBA)

SBA is a form of IMF credit given to countries experiencing crises. So, if a country received an SBA in a particular year, the crisis was registered regardless of any other criteria.

#### 9) Systemic banking crises specified by Reinhart and Rogoff (2010) – weight = 2

#### 10) Crises specified by Kaminsky (2006) – weight = 2

The general crisis registration procedure implies that the sum of all individual registration indices should be at least 3 (except for the cases when SBA is used). The resulting crisis index includes 364 crises, 108 of which take place during 2007-2009.

The crisis index (CI) is the resulting dependent binary variable. The model explaining this variable can be used to determine the probability of a crisis in a given year.



*Crisis occurrence index – binary variable (COI)*

This index is based on the values of CI and it shows crisis start dates. This index is created as follows:

$$COI_t = \begin{cases} 1, & \text{if } CI_t = 1 \cap CI_{t-1} = 0 \\ 0, & \text{if } CI_t = CI_{t-1} \end{cases}$$

The equation for COI can help to evaluate the probability of crisis occurrence under certain macroeconomic conditions. More specifically, this is the probability of current economic events provoking a crisis in a particular country.

*Crisis depth – continuous variable (Depth)*

Crisis depth is measured in terms of loss of economic growth during the crisis and the recovery period, which is defined as the time needed for the country to reach the 15 year-average non-crisis real growth rate. The variable equals:

$$Depth_t = \begin{cases} \overline{growth_{no\ crisis}} - growth_t, & t = t(CI_t = 1) \\ \overline{growth_{no\ crisis}} - growth_t, & t > t(CI_t = 1) \cap growth_t < \overline{growth_{no\ crisis}} \end{cases}$$

Comparing growth during (post-) crisis period with the no-crisis average growth level is a superior technique to the one frequently used – comparing (post-) crisis growth with pre-crisis growth pace. Crises may cause structural economic changes which make potential economic growth in the medium-run lower than prior to the crisis; therefore, pre-crisis rates of growth are hardly reached. The average no-crisis growth assigns some weight to the post-crisis real growth rate so that recovery takes reasonable time.

Some crises are characterized by no loss of real growth at their start; however, in most cases significant drops in real growth rate take place in the following periods. Such phenomena are also included in the sample; however, further research of this type of crises is desirable.

The equation explaining crisis depth is helpful in determining the factors which have the greatest impact on the size of real growth loss and to decide on the policy measures that can be used in order to decrease negative effect caused by the crisis.

### 2.3. Independent variables

19 independent variables were analyzed within the whole sample and each country cluster. These variables can be divided in the following groups by their role in a country's economy.

#### I. Economic growth

*Past real economic growth* measures the previous-period stage of business cycle for a given economy. This variable is calculated as the year-to-year percent change in GDP measured at constant prices:

$$growth_{t-1} = \left( \frac{GDP_{t-1}^{real}}{GDP_{t-2}^{real}} - 1 \right) \times 100\%$$

#### II. Trade

Variables of this group represent the patterns and conditions of international trade for a given country. *Current account balance to GDP ratio* shows whether the country is a net exporter or importer, and the magnitude of this variable points at the size of trade imbalance. *Value of oil net exports to GDP ratio* helps to distinguish between oil exporters and importers and to measure the degree of a country's economic dependence on the international demand for oil. *Changes of real effective exchange rate (REER change)* (year-to-year basis) measured as the weighted average real value of domestic currency in terms of foreign currencies (usually trade partners' currencies and currencies with largest trade volumes on FOREX are considered) affect the demand for a country's exports and domestic demand for imports, thus changing current account structure. Since current account to GDP ratio changes when either current account or GDP change (or both), REER change allows to control for current account dynamics only. *Terms of trade change* shows the changes in relative price of domestic exports; this variable is calculated as the ratio of unit value of exports index and unit value of imports index (both year-to-year). The relative price of domestic exports affects the country's competitiveness in international goods markets: the overall effect of this variable on current account depends on demand elasticity for domestic exports and imports.

#### III. Financial markets

Variables of this group represent the dynamics of capital markets, domestic interest rates and credit. *Change in market capitalization* of traded companies measured as the total value of stocks traded on the domestic stock exchange shows the stock market dynamics; booms and

busts appear as dramatic changes of this variable. *Discount rate* reflects the cost of interbank borrowing: large values of this variable stimulate banks to employ relatively strong risk-management; however, they may also undermine the strength of the whole banking system by making banks' assets less resilient in the face of temporary liquidity issues. *Interest rate spread* measured as the difference between borrowing and lending rates reflects the lending risk in the economy: under turbulent economic conditions greater counterparty risk raises banks' lending rates and reduces borrowing rates since banks' assets become more risky and the expected terms of repayment are harmed. *Real interest rate* calculated as the deflated lending rate represents the real value of rent; the greater is its value, the more reluctant are domestic agents to invest, but the greater are flows of foreign capital. *Change in domestic credit to GDP ratio* reflects the change of credit to private sector share in the economy. Increasing levels of this factor have stimulating effect on the economy; however, this may lead to bubbles in capital markets (like the mortgage boom in the USA).

Annual data on interest rates is registered at its end-of-period value due to the issues related to availability of data with higher frequency. Change in market capitalization and domestic credit is calculated on the basis of end-of-period annual data.

#### IV. Monetary data

*Deflator* (year-to-year) measures annual inflation in a given country; increasing inflation indicates growth, but rapid growth in prices deteriorates agents' wealth and real returns on investments. *Change in money supply (M2 change)* reflects the central bank's policy nature, either stimulating or contractionary.

#### V. Government finance

Variables of this group are responsible for changes in government saving and debt. *Government budget balance to GDP ratio* shows the signature and relative size of budget deficit (surplus). Large deficits lead to accumulation of *gross debt to GDP* and negatively affect current account balance according to the twin deficits hypothesis (otherwise private investment is depressed and savings rise).

#### VI. Economic integration

This group of dummy variables is responsible for membership in international unions and common areas. *WTO* reflects membership in WTO; *FTA* takes the value of one if the country enters and remains in a free-trade area; *customs* shows membership dates in customs unions

and *currency* – in formal currency unions. These dummies were based on the data on 8 free trade areas, 5 currency unions, 6 customs unions and WTO member-states.

## VII. Regional contagion

Number of crises in the region shows the number of countries experiencing an economic crisis in a given year (quarter) except for the given country. If this variable is statistically significant, one may deduct that the crisis was transmitted from abroad.

The following regional classification is used:

- Asia (20 countries)
- Australia and Oceania (6 countries)
- Central America and the Caribbean (19 countries)
- Europe (43 countries)
- Middle East, North East Africa and Greater Arabia (21 countries)
- North America (3 countries)
- South America (12 countries)
- Sub-Saharan Africa (46 countries)

### Descriptive statistics of independent variables

Variable	Budget balance to GDP, %	Currency	Current account balance to GDP, %	Customs	Deflator change, %	Discount rate, %
N	2379	2550	2526	2550	2519	1755
Mean	-1.62	0.21	-2.87	0.23	1.09	12.08
Standard deviation	6.95	0.41	11.07	0.42	0.31	33.04

Variable	Domestic credit to GDP change, %	FTA	Government gross debt to GDP change, %	Interest rate spread	M2 change, %	Market capitalization change, %
N	2247	2550	2070	1925	2239	1495
Mean	-0.64	0.32	-0.28	9.31	131.56	58.86
Standard Deviation	248.06	0.46	26.28	15.69	3798.46	1283.34

Variable	Number of crises in the region	Real effective exchange rate change, %	Real growth, %	Real interest rate	Terms of trade change, %	Value of oil net exports to GDP, %	WTO
N	2550	1364	2353	1982	2501	2528	2550
Mean	4.45	1.05	4.21	8.25	3.81	1.94	0.80
Standard Deviation	5.50	15.36	5.86	21.99	58.42	16.65	0.40

Table 2: descriptive statistics for independent variables data; source: own calculations

## 2.4. Tests and modifications

In order not to get spurious regressions, all series are tested for stationarity. Panel data unit root tests refer to the Fisher-type group, for time series data the Augmented Dickey-Fuller test is performed. All panels and series are stationary in first differences, and those that are found to be level non-stationary are transformed into change-type variables, e.g.

$$GDP_{change_t} = (GDP_t / GDP_{t-1} - 1) \times 100\%$$

$$Discount\ rate_{change_t} = Discount\ rate_t - Discount\ rate_{t-1}$$

The transformed panels and series are stationary.

Quarterly data is subject to seasonality, so deseasonalized values are obtained using the following procedure.

The series is regressed on a constant, 3 ‘season’ dummies (takes value of 1 for the corresponding season, e.g. first quarter, and 0 otherwise) and ‘trend’ – variable that takes the value of the place of a particular quarter in time, i.e. 1 for the first quarter of 1997, 5 for the first quarter of 1998, 60 for the fourth quarter of 2011, etc.:

$$Series_t = \beta_0 + \beta_1 SEAS_{1,t} + \beta_2 SEAS_{2,t} + \beta_3 SEAS_{3,t} + \beta_4 TREND_t + \varepsilon_t$$

If any of the dummies or trend is significant, it is extracted from the series with the corresponding coefficient, e.g.:

$$Series_t^{deseasonalized} = Series_t - \widehat{\beta}_1 SEAS_1 - \widehat{\beta}_4 TREND \mathbf{1}_{p\text{-value}(SEAS_1) \leq 0.1; p\text{-value}(TREND) \leq 0.1}$$

In time series model estimation Huber/White standard errors were used in order to eliminate error heteroscedasticity. ARMA effects in time series equations were accounted for. For panel data models estimation, the tradeoff between fixed-effects model and the random-effects model is resolved by Hausman test; if the difference between estimates provided by the

models is statistically insignificant at 5% level, random-effect model is used because in such case it provides consistent and efficient estimates.

The endogeneity issues, i.e. correlation between independent variables and the error term, frequently arise in panel data and time series models due to omitted variables, measurement errors or autocorrelated errors; also, this problem is related to the simultaneous equations case where dependent and independent variables are interrelated. In order to avoid this issue, equations for crisis depth estimation are obtained using instrumental variables (IV) techniques.

Panel data models for crisis depth are estimated using the Generalized Two-Stage Least Squares Instrumental Variables (G2SLS IV) (fixed-) random-effect regression which resolves the problem of right-hand side covariates' endogeneity – this method is described in Baltagi (2005). For time-series crisis depth estimation simultaneous equations are used; the estimation technique is Full Information Maximum Likelihood (FIML). This method implies maximization of the likelihood function under the assumption of joint normal distribution of contemporaneous errors. In order to check for errors' normality, Jarque-Bera test is used – according to the test, FIML produces efficient estimates for the depth equation. The benefit of this approach is that it allows for randomly missing data – in our case, several data points are missing due to stationarity-related transformation of variables.

### **3. Approaches to country grouping.**

In order to reveal specific features of economic crises within the international perspective, it is useful to divide countries into groups based on particular criteria: regional, economic, political or social aspects can be taken into account. Country grouping helps to identify crisis occurrence and depth patterns specific to particular category of countries, thus reducing generality of the whole-sample results.

There are two most widely used approaches to classifying economies. The first one is regional grouping – this method is based on the logic that within a particular region countries are more interrelated due to certain economic similarities, hence, there will be specific channels of crisis spreading (e.g. C. Caldron and T. Didier (2009)).

Another way to group economies is to use a popular differentiation of countries – developed and developing economies. This classification is based on the GNI per capita figures (World Bank), however, there are a number of parameters that are attributable to almost all countries within these categories – for instance, developing countries are normally characterized by faster economic growth, smaller share of services sector in GDP and higher interest rates compared to developed countries. There can also be some extensions: E. Gurvich and I. Prilepskiy (2010) involved differentiation between developed and developing countries, but energy exporters were examined separately.

In this paper we analyze specific crisis patterns using country clustering.

Cluster analysis is a statistical procedure that measures the similarity of objects with respect to the given criteria and creates groups with smallest within-group dissimilarity. Here Ward's minimum variance method of clustering is used. This is a hierarchical clustering procedure which was initially introduced as agglomerative clustering, i.e. at each consecutive step groups merged.

The main intuition underlying this clustering method lies in minimization of the loss incurred in case multivariate data is represented by the whole-group statistic (e.g. mean) rather than each unit is examined separately. The objective function introduced by Joe H. Ward, Jr. (1963) reflected the value of this 'information loss' as the error sum of squares (ESS). If initially the data was grouped in either way, the 'information loss' value from such grouping was the sum of each original group's ESS. The goal of cluster agglomeration is the stepwise merger of groups such that the increase of the objective function is minimized.

In order to perform divisive clustering based on Ward's method, a recursive algorithm should be used. The metric used to measure within-group dissimilarity in terms of distance between means is the squared Euclidean distance:

$$DIST_{ij} = \|X_i - X_j\|^2$$

Since cluster analysis takes into account the scale of variables, in order to avoid bias towards either variable associated with the differences in measurement, standardization may be used:

$$X_{i,t}^{standardized} = \frac{X_{i,t} - \bar{X}_i}{\sqrt{\frac{1}{n-1} \sum_{t=1}^T (X_{i,t} - \bar{X}_i)^2}}$$

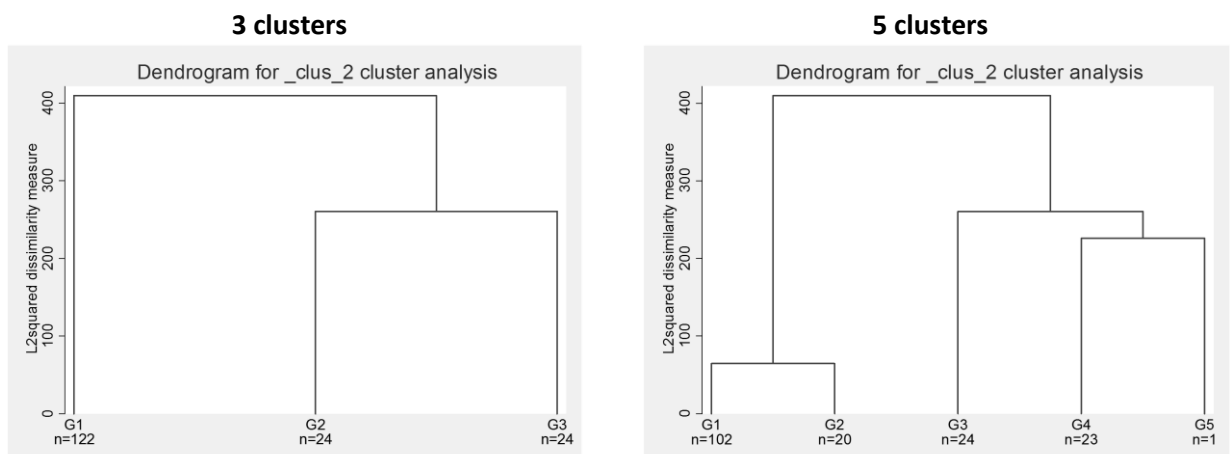
At each stage clusters are split so that within-cluster variance is minimized.

Cluster analysis helps to group data so that each group has similar elements in terms of stated criteria and within-group dissimilarity is minimized. In contrast to existing approaches to country classification, cluster analysis helps to be more specific about each particular economy, enabling one to judge on the basis of selected criteria (e.g. size of the economy, GDP per capita, size of financial markets, etc.).

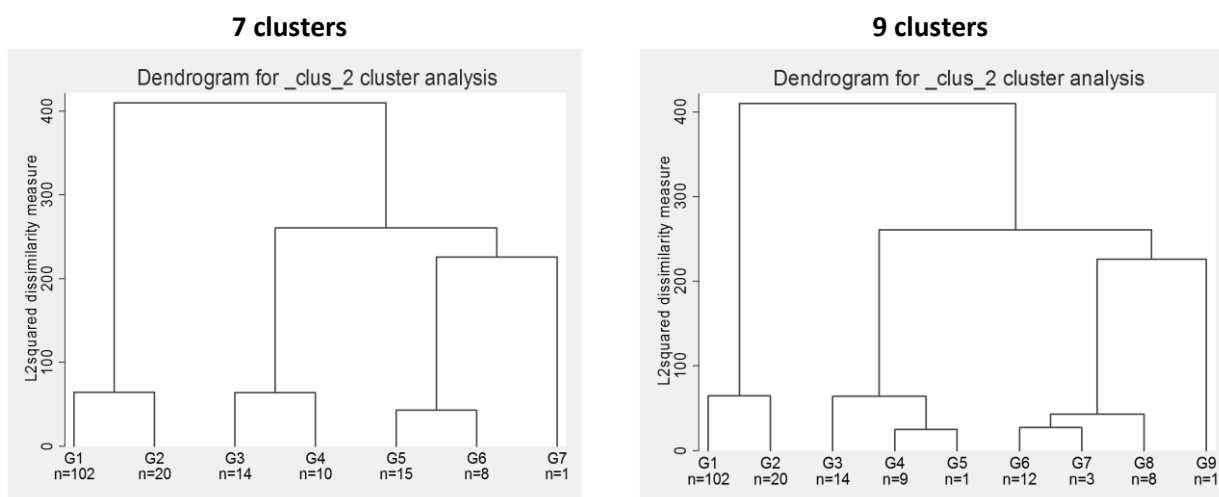
### 3.1. Country clusters

The clusters are created on the basis of standardized data for each year – since cluster analysis is based on measuring distance, scaling should be the same for all variables; otherwise some factors play the leading role and others lose significance.

Cluster analysis is performed for each year separately. The number of clusters was chosen between three and ten, and the optimal number of clusters was chosen on the basis of splitting patterns. Below there are sample dendrograms for 2005:







Picture 5: dendrograms for 2005; source: own calculations

It is seen that country classification in 3 clusters is too general compared to five clusters; when the number of clusters exceeds five, the largest cluster remains unchanged whereas there is excessive splitting of other clusters. Therefore, in all years except for 2002 five clusters are distinguished. In 2002 an additional cluster is required because, unlike the results for other years, USA is added to the developed countries group – this could have led to sampling bias caused by the US advanced economic parameters.

The resulting clusters follow the same logic for each year

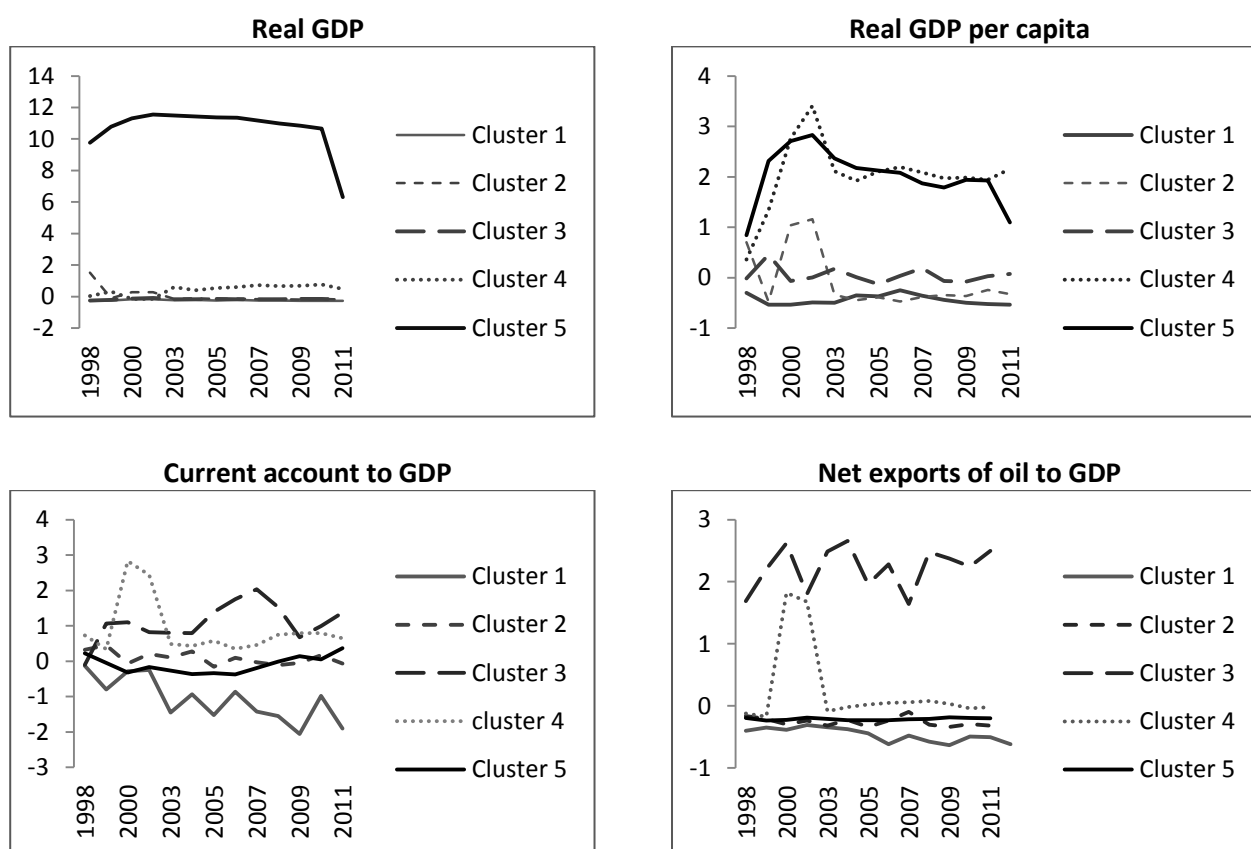
- Cluster I – least developed countries
- Cluster II – developing countries
- Cluster III – economies driven mostly by oil exports
- Cluster IV – Developed countries
- Cluster V – USA only (only in 2011 cluster V was comprised of USA, China and Japan; in all other cases USA was unique)

The table below provides average characteristics of countries belonging to each particular cluster.

Cluster	Real GDP	2010, USD billion	Real GDP per capita	2010 USD	CA balance to GDP	2010 %	Net exports of oil to GDP	2010 %
I	Small	5.83	Small	3,527.6	Large negative	-15.7	Negative	-8
II	Medium	182.9	Medium	6,295.4	Small	-3.9	Negative	-3
III	Medium	107.4	Medium	10,600.3	Large positive	7.3	Large positive	41.4
IV	Large	1,081.4	Large	48,726.9	Positive	4.7	Positive	2.6
V	Very large	13,876.4	Large	44,801	Negative	-3	Negative	-1.9

Table 3: characteristics of clusters; source: own calculations

The dynamics of cluster characteristics suggest that groups are significantly different in most aspects – the difference is seen from the distance between individual graphs. Lines in bold indicate that the given factor was significant for a particular cluster.



Picture 6: mean values of standardized real GDP, real GDP per capita, current account to GDP ratio, value of oil net exports to GDP ratio for 5 clusters; source: own calculations

Since most of the countries belong to the same cluster in each considered year, a general cross-section of clusters is created. In case a country moves from one cluster to the other, it is assigned its group on the basis of the corresponding series mode (the cluster to which this country belongs more than 9 years). The resulting cluster structure is the following: cluster I includes 30 countries, cluster II – 99 countries, cluster III – 18 countries, cluster IV – 22 countries and cluster V is represented by USA only. USA is considered as a special case because its economic characteristics are unique among the considered economies; if USA were added to the cluster of developed countries, this would have caused certain calculation bias since the US economic development outstrips that of Western European countries, Canada, Japan and Qatar.

Overall, the logic of clustering is clear and stable for each year. Such classification is consistent with the World Bank definitions of developing and developed countries, but it is

more specific about the degree of overall economic development and it pays special attention to countries heavily dependent on oil exports.

## 4. Estimation Results

### 4.1. Crisis and crisis occurrence

#### 4.1.1. Model specification

For panel data model specification depends on whether fixed- or random-effect models provide consistent and efficient parameter estimates – the decision on model specification was based on Hausman test. If the difference between fixed- and random-effect estimates was insignificant at 5% level, random-effect model was used.

*Conditional fixed-effect logistic model:*

Fixed-effect logistic model can be expressed as

$$\Pr(\text{crisis}_{i,t} = 1 | x_{i,t}) = F(\alpha_i + \beta x_{i,t})$$

$$F(z) = \frac{e^z}{1 + e^z}$$

where  $\alpha_i$  is the unobserved heterogeneity term.

Direct maximum likelihood estimation of this model leads to inconsistency in estimates for  $\alpha_i$  and  $\beta$ . The solution to the problem of inconsistency lies in estimation of conditional fixed effect logit:

$$k_{1,t} = \sum_{t=1}^{T_i} y_i$$

$$\Pr\left(y_i \mid \sum_{t=1}^{T_i} y_i = k_{1,t}\right) = \frac{e^{\beta x_{i,t} \sum_{t=1}^{T_i} y_i}}{\sum_{d_i \in S_i} e^{\beta x_{i,t} \sum_{t=1}^{T_i} d_i}} = \frac{e^{\beta x_{i,t} k_{1,t}}}{\sum_{d_i \in S_i} e^{\beta x_{i,t} k_{1,t}}}$$

Notations:

- $\beta$  – common parameter vector for all groups
- $x_{i,t}$  – vector of covariates
- $k_{1,t}$  – number of positive outcomes (1) for a given group i
- $d_i$  – binary variable taking values 0 and 1 so that  $\sum_{t=1}^{T_i} d_i = k_{1,i}$

$S_i$  – set of all possible combinations of quantities of zeroes and ones for group i

The main drawback of this model is that it gives no estimate for  $\alpha_i$  (whose value is not involved in model estimation), but it still provides consistent estimates for  $\beta$ .

Another difficulty associated with conditional fixed-effect logistic model is that it does not provide reliable marginal effects for either variable because they are based on the unknown estimate of  $\alpha_i$ .

‘Pseudo’ marginal effect for a given variable can be obtained from fixed-effect as follows:

$$\widehat{ME} = \hat{\beta} \times \frac{dF}{dz}(\hat{\beta}) = \hat{\beta} \times \hat{\pi} \times (1 - \hat{\pi})$$

where  $\hat{\pi}$  is the average probability predicted from the estimated equation.

Detailed discussion of this model derivation and application can be found in Chamberlain (1980), Greene (2008), Hosmer Jr. and Lemeshow (2000).

The *random-effect logistic model* assumes the random effect to follow zero-mean Normal distribution:

$$f(v_i) = \frac{1}{(2\pi\sigma_v)} e^{-\frac{1}{2}\left(\frac{v_i}{\sigma_i}\right)^2}$$

$$\Rightarrow \Pr(\text{crisis}_{i1}, \dots, \text{crisis}_{in_i} | x_{i1}, \dots, x_{in_i}) = \int_{-\infty}^{\infty} \frac{1}{(2\pi\sigma_v)} e^{-\frac{1}{2}\left(\frac{v_i}{\sigma_i}\right)^2} \times \left[ \prod_{t=1}^{n_i} F(\text{crisis}_{i,t}, z_{i,t}) \right] dv_i = \pi$$

$$z = \beta x_{i,t} + v_i$$

$$F(z) = \begin{cases} \frac{1}{1 + e^{-z}} & \text{if crisis} = 1 \\ \frac{1}{1 + e^z} & \text{if crisis} = 0 \end{cases}$$

This model requires strong assumptions:

- the unobserved heterogeneity term should be uncorrelated with explanatory variables;
- the unobserved heterogeneity term is taken randomly from a fixed distribution.

Marginal effects from the random-effect logistic model are obtained as follows:

$$\widehat{ME}_i = \hat{\beta} \times \frac{d\pi}{dz}(\hat{\beta}, \hat{v}_i)$$

The *logistic model for time series* used for estimation of crisis (occurrence) in the USA takes its general form:

$$Pr(crisis_t = 1 | x_{1,t}, \dots, x_{n,t}) = F(z_t)$$

$$z_t = \beta_0 + \sum \beta_i x_{i,t}$$

$$F(z_t) = \frac{1}{1 + e^{-z_t}}$$

The marginal effect is obtained by

$$\widehat{ME}_i = \frac{dF}{dx_i}(\widehat{\beta}_i) = \widehat{\beta}_i \times \frac{dF}{dz} = \widehat{\beta}_i \times \frac{e^{-z}}{(1 + e^{-z})^2} = \widehat{\beta}_i \times \widehat{F} \times (1 - \widehat{F})$$

Further discussion of the model specification and estimation can be found in Conway (1990), Neuhaus (1992) and Liu and Pierce (1994).

The marginal effects in the following sections are calculated at the mean values of variables comprising the estimation equation; in case of dummy variables their marginal effect is calculated at their values of one. Such estimation of marginal effects yields relatively low figures because predicted probability of crisis (occurrence) is in almost all cases low – below 15%. As it is known, in case of usual logistic models greatest marginal effects are attained at the function's inflection point where the probability of a positive outcome is 50%. Therefore, estimated marginal effects should rather be used to evaluate the direction and relative size of either factor's impact on crisis (occurrence) probability.

The importance and effect of either factor in dependent variable explanation is further evaluated on the basis of the size of corresponding marginal effect.

#### 4.1.2. Estimation results.

The table below represents estimated coefficients for the crisis occurrence and crisis models applied to the whole sample; corresponding marginal effects are also shown.

	Whole Sample			
	Crisis Occurrence		Crisis	
	Beta	ME	Beta	ME
Current account balance to GDP	-0.208**	-0.023	-0.293***	-0.032
Deflator, year to year	0.292**	0.032		
Discount rate	-0.30*	-0.031	0.019	0.002
Government gross debt to GDP change	0.019	0.002	0.050***	0.005
Interest rate spread	-0.118	-0.013	-0.187	-0.02
Market capitalization change (-1)	-0.042***	-0.005	-0.022***	-0.002
Number of crises in the region			0.179***	0.019
Real interest rate	0.337**	0.037	0.076	0.008
REER change	-0.013	-0.001	-0.042	-0.005
Value of oil net exports to GDP			0.427**	0.046
Log likelihood	-40.06		-58.27	

Table 4: coefficient estimates and corresponding marginal effects for crisis occurrence and crisis probability models; \*, \*\* and \*\*\* represent significance on 10%, 5% and 1% level respectively; source: own calculations

##### 1) Crisis occurrence

The crisis occurrence model shows the probability of facing a crisis conditional on no crisis present in the previous period. The resulting equation shows that deflator, discount rate and real interest rate have the greatest impact on crisis occurrence probability.

##### 2) Crisis

The crisis equation shows the probability of a crisis under particular macroeconomic conditions. Like the crisis occurrence equation, the resulting equation also contains current account balance to GDP ratio and past change in market capitalization as significant explanatory variables, however, relative impact size changes. The positive relationship between value of oil net exports and probability of crisis emergence reflects the predominance of oil-importing countries' loss from increasing oil prices over the gain of oil exporters.

The whole-sample equations indicate general crisis occurrence patterns: on average, growth in current account balance and in the stock market stabilizes the macroeconomic environment whereas risks of crisis taking place increase as the government runs systematic budget deficits or when there is a fall in consumption due to inflationary pressure or low feasibility of credit. The estimated general equations point out at several groups of variables that are important in crisis probability estimation: financial, monetary, government finance and trade.

Estimation results for cluster I (least developed countries).

	Cluster I			
	Crisis Occurrence		Crisis	
	Beta	ME	Beta	ME
<b>Current account balance to GDP</b>			-0.111***	-0.009
<b>Government gross debt to GDP change</b>	0.019	0.001	0.026*	0.002
<b>M2 change</b>	-0.046*	-0.002	-0.058***	-0.005
<b>Number of crises in the region</b>	0.147***	0.005	0.173***	0.014
<b>Real growth (-1)</b>			-0.112**	-0.009
<b>Real interest rate</b>	-0.086**	-0.003		
<b>TOT change</b>	-0.057***	-0.002		
<b>Const</b>	-2.11***			
<b>Log likelihood</b>	-39.71		-39.49	

Table 5: estimated coefficients and marginal effects for crisis occurrence and crisis equations based on cluster I data; \*, \*\* and \*\*\* represent significance on 10%, 5% and 1% level respectively; source: own calculations

1) Crisis occurrence

The results of crisis occurrence probability estimation show that for the least developed countries regional contagion is the most influential factor – the greater is the number of crises in the region, the greater is the probability of crisis occurrence for a given country. This can be explained either by tight trade interrelation between countries or by the fall in economic activity in large trading partners: for instance, this can be the case described by Sin Yu Ho (2009) – one of the crisis transmission channels for Sub-Saharan countries was the slowdown in India and China, their major trade partners and economic aid providers.

A very important factor to consider within this cluster is the change in terms of trade: the positive impact of this variable on economic stability indicates that the loss of competitiveness in international goods markets is outweighed by the growth of net exports value. Demand for domestic exports is likely to be relatively elastic taking into consideration



the quality of goods supplied; therefore, the revealed relationship can be plausibly explained by inelastic domestic demand for imports.

Rising real interest rates decrease the probability of crisis occurrence. This can be explained by the reduction of risky loans given out by banks – fragile banking systems are usually characterized by poor risk management, therefore centralized increase in borrowing costs helps to strengthen the banks' assets. Also, increasing real return attracts foreign capital. Overall, the positive effects from the rise in real interest rate outweigh the fall in domestic consumption and investment.

The fact that money supply growth decreases crisis occurrence probability shows that expansionary monetary policy has at least short-run positive impact on economic stability. However, the overall effect of increasing monetization is arguable since stimulation should have fundamental drivers in the first place; in case stability is reached only with monetary means, in the medium run strong inflation pressure can arise (e.g. hyperinflation in Zimbabwe). The negative impact of inflation caused by monetary expansion on economic stability may arise from market bubbles, money printing or the negative effect of inflation on real wages and rent. Market bubbles undermine financial sector stability, thus increasing the risk of a financial crisis occurrence when the bubble bursts. Money printing is usually associated with government budget financing – so, increasing inflation may point at poorly designed fiscal policy. The impact of inflation on real wages and rents is usually assumed to be omitted in the short run, however, deterioration of households' real wealth may lead to a fall in aggregate consumption.

## 2) Crisis

The equation for the probability of a crisis supports the leading role of regional contagion in crisis presence. Also, the role of trade channel remains significant – improvements in current account balance have the second largest marginal effect on crisis probability. The direction of monetary expansion impact on economic stability is the same as in the crisis occurrence equation.

One of the most influential variables is past real growth. The negative relationship between this factor and crisis probability leads to a conclusion that the countries belonging to the first cluster are likely to maintain positive macroeconomic environment if the economy is growing, all other things being equal.

Finally, the probability of a crisis rises as government debt is expanded. Accumulation of debt is associated with persisting government budget deficits, which may arise from inefficient fiscal policy. When debt levels are considerably high, the probability of default on government debt increases, thus increasing country risk. Inefficient fiscal policy and growing probability of default on debt are the major factors undermining economic stability in this case.

Overall, we conclude that least developed countries are subject to regional contagion processes. Trade channel is one of the most influential factors explaining crisis probability – improvements in current account have relatively large positive impact on economic stability.

#### Estimation results for cluster II (developing countries)

	Cluster II			
	Crisis Occurrence		Crisis	
	Beta	ME	Beta	ME
Discount rate	-0.062	-0.006	0.129***	0.012
Domestic credit to GDP change	0.004*	0.001	0.03	0.001
Government gross debt to GDP change	0.021*	0.002	0.027**	0.003
Interest rate spread	0.037	0.003	-0.170**	-0.016
Market capitalization change	-0.033***	-0.003	-0.009**	-0.001
Number of crises in the region			0.103***	0.01
Real growth (-1)			-0.087	-0.008
REER change	-0.027	-0.003	-0.045	-0.004
Log likelihood	-39.84		-58.85	

Table 6: estimated coefficients and marginal effects for crisis occurrence and crisis equations based on cluster II data; \*, \*\* and \*\*\* represent significance on 10%, 5% and 1% level respectively; source: own calculations

#### 1) Crisis occurrence

According to the estimated equation for crisis occurrence probability, changes in market capitalization play the leading role in crisis occurrence – a fall in stock market undermines macroeconomic stability. This reveals the importance of capital market dynamics for the economic environment in developing countries.

Increasing government gross debt raises the probability of crisis occurrence – explanation lies in persistent budget deficits and increasing default risks.

Rising share of domestic credit in the economy has negative effect on economic stability. The most evident explanation is the increase in credit risks in the banking system – larger credit availability is associated with decreasing average quality of borrowers.

## 2) Crisis

The resulting equation for probability of a crisis delegates the leading role to the interest rate spread in the economy, i.e. the difference between borrowing and lending rates. Increasing spread may signal about increasing financial risks – banks are more reluctant to lend and increased credit risk makes them lower deposit rates. Therefore, financial crisis is more likely to occur if interest rate spread widens.

Increasing discount rate undermines economic stability. It should be noted that high levels of discount rate create a threat of multiple bank defaults in case public expectations about future economic stability worsen – even if the number of withdrawn deposits is seemingly moderate, small banks can face liquidity problems being unable to borrow sufficient funds from the central bank. Since an increase in the discount rate negatively affects economic stability, it may be concluded that on average the positive effect of decreasing risks taken by banks cannot outweigh the negative effect from rising fragility in presence of negative changes in agents' expectations.

The crisis equation supports the negative economic impact of increasing government gross debt – as in the case with crisis occurrence probability estimation, rising debt implies greater chance of facing a crisis.

As in the crisis occurrence model, changes in stock market capitalization are inversely related to the probability of a crisis.

Lastly, regional contagion is a significant factor to be considered: developing countries are more likely to experience a crisis if the number of crises in the region grows. The reason underlying this finding is strong competition in regional goods markets and tight financial and trading links.

In contrast to the first cluster, the countries belonging to the second cluster are affected by financial sector dynamics, and changes in trade patterns do not play leading roles. Nevertheless, it should be noted that this cluster is comprised of a large number of countries which may differ in some aspects, so the equations should be used to reveal the most influential general features of developing countries.

Estimation results for cluster III (economies driven mostly by oil exports).

	Cluster III			
	Crisis Occurrence		Crisis	
	Beta	ME	Beta	ME
<b>Domestic credit to GDP change</b>			-0.054*	-0.004
<b>Market capitalization change</b>	-0.05*	-0.003	-0.032*	-0.002
<b>Real growth (-1)</b>	0.323*	0.022		
<b>REER change</b>			-0.145**	-0.01
<b>Value of oil net exports to GDP</b>	-0.303*	-0.021	-0.376**	-0.027
<b>Log likelihood</b>	-6.2		-6.22	

Table 7: estimated coefficients and marginal effects for crisis occurrence and crisis equations based on cluster III data; \*, \*\* and \*\*\* represent significance on 10%, 5% and 1% level respectively; source: own calculations

1) Crisis occurrence

The equation for crisis occurrence probability estimation shows that value of oil net exports to GDP ratio is the most influential factor. Surely, macroeconomic conditions in such countries heavily depend on oil exports, so a drop in the value of oil net exports worsens the economic environment within the third cluster.

Increased real growth in the past period increases the crisis occurrence probability. Since economic growth of the countries considered is to a great extent driven by oil production and export, overall growth is attributable mostly to the oil production sector. The negative impact of past real growth on economic stability can be referred to the concept of immiserizing growth (Bhagwati, 1958): if the country is large, i.e. if it affects world relative supply and demand, export-biased growth worsens the country's terms of trade, thus worsening the macroeconomic environment within the country.

Lastly, as in earlier equations, market capitalization growth reduces the probability of a crisis.

2) Crisis

As in the crisis occurrence model, value of net oil exports to GDP is the leading factor determining the probability of a crisis.

Positive changes in the real effective exchange rate contribute to macroeconomic stability within the third cluster: domestic exports become more competitive in international markets, and the positive economic effect is significant since large oil exporters' economies are largely affected by current account dynamics.

Change in domestic credit to GDP ratio is inversely related to the probability of crisis – this can be explained that the economy gains more from greater availability of credit than loses from increased credit risk.

Finally, change in market capitalization has the lowest marginal effect as in the crisis occurrence model.

The analysis of economies heavily dependent on oil exports suggests that a crisis is most likely to occur if there is a fall in international demand for oil. Unlike the developing countries cluster, this cluster experiences positive effect from expanding credit. Financial market movements also contribute significantly to the estimation of crisis probability; however, their impact is not as large as that of oil exports or domestic credit growth.

#### Estimation results for cluster IV (developed countries)

	Cluster IV			
	Crisis Occurrence		Crisis	
	Beta	ME	Beta	ME
<b>Central government budget balance to GDP</b>	0.364***	0.002	-0.246***	-0.061
<b>Currency union</b>			3.369***	0.437
<b>Current account balance to GDP</b>	-0.281**	-0.001		
<b>Discount rate</b>	-0.341*	-0.002	0.455***	0.113
<b>Government gross debt to GDP change</b>			0.020**	0.005
<b>Interest rate spread</b>			-0.527	-0.131
<b>M2 change</b>			-0.008	-0.002
<b>Market capitalization change</b>	-0.107***	-0.001	-0.041***	-0.01
<b>Number of crises in the region</b>			0.270***	0.067
<b>Const</b>	-1.653*		-2.696***	
<b>Log likelihood</b>	-27.5		-29.02	

Table 8: estimated coefficients and marginal effects for crisis occurrence and crisis equations based on cluster IV data; \*, \*\* and \*\*\* represent significance on 10%, 5% and 1% level respectively; source: own calculations

#### 1) Crisis occurrence

The model for crisis occurrence suggests that increasing government budget balance to GDP has the greatest positive effect on the probability of crisis occurrence. It is most likely that such effect arises from policies aimed at lowering budget deficit. Most Western European countries that comprise the greatest part of cluster IV systematically run government budget deficits due to the high level of economic support provided to citizens (high pensions, unemployment benefits, etc.). This leads to accumulation of gross debt, which in turn raises default risk – this issue is especially important considering the sovereign debt crisis in Western Europe. One of the solutions to the problem is raising taxes and decreasing

government expenditure, but these measures have contractionary effect on aggregate output. So, here the link between the budget deficit and probability of crisis occurrence may lie not in the consequences of debt accumulation, but in the policy aimed at debt reduction.

Changes in discount rate play the second most important role in estimating crisis occurrence probability. Since cluster IV countries are characterized by resilient well-developed banking systems, greater cost of interbank borrowing has net positive effect on financial system stability – stronger risk-management is beneficial for developed countries.

The trade channel works in expected direction: improvement in current account reduces economic instability.

Finally, increasing market capitalization reduces the probability of crisis occurrence whereas adverse shocks in capital markets are likely to raise the risk of financial crisis emergence.

## 2) Crisis

The largest booster of crisis probability is the membership in currency union according to estimation results. The reason lies in the absence of independent monetary policy in currency union member-states which makes state control over economic fluctuations less flexible. Also, the correlation of financial risks of currency union member-states is higher: an adverse shock in a country's productivity may affect all other member-states because, to some extent, negative investors' expectations are transmitted to all member-states through the unified currency.

The hypothesis of rising risks in a currency union is supported by the significance of regional contagion within the cluster of developed countries; the importance of this factor can also be addressed to developed financial systems that are subject to greater dependence on other developed countries' market fluctuations.

The effect of rising discount rate has a reversed sign compared to the crisis occurrence equation: since the crisis index reflects not only crises start dates, but also the time of their presence, it can be deduced that in the presence of a crisis banking sector requires more flexibility. This is especially important in the face of financial crises characterized by large number of defaults in the banking sector – in the face in increased risks, larger deposit withdrawals increase the need in additional liquidity.

In the presence of significant positive impact of debt accumulation on crisis probability, the effect of decreasing budget deficit changes its signature. Negative relationship between the

probability of a crisis and changes in government budget surplus is explained by the adverse consequences of debt accumulation on economic stability.

Finally, as in all cases considered before, drops in the stock market raise the probability of a downturn.

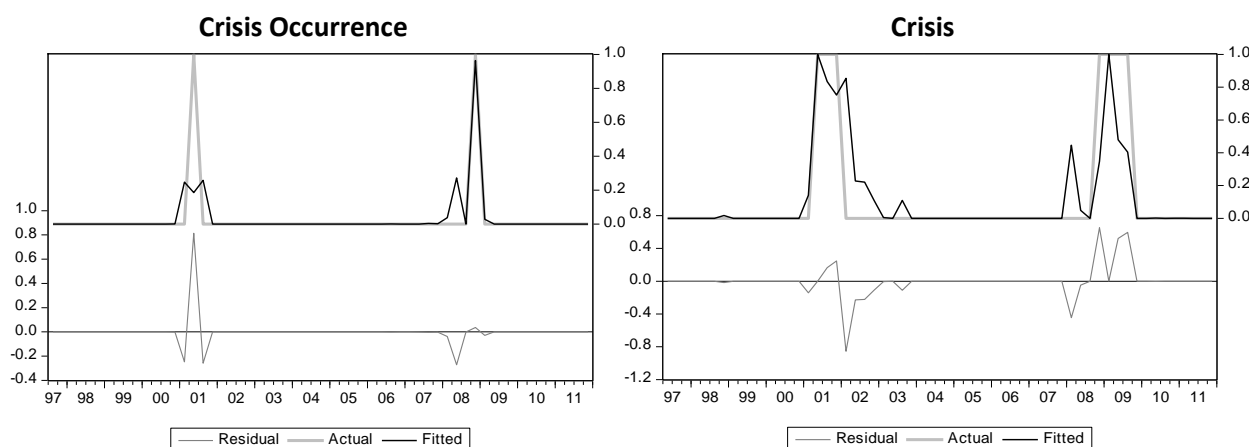
Overall, the developed country cluster can be characterized by a large extent of dependence on the financial sector and government finance. There are more individual aspects to be taken into account compared to the least developed and developing country clusters: economic phenomena and their interpretation are more complicated within the fourth cluster.

Remarkably, the leading role of currency union membership in raising probability of a crisis points at the drawbacks of currency unions: smaller set of feasible policy tools and transfer of risks undermine economic stability of currency union member-states.

#### Estimation results for cluster V – the USA

	Cluster V			
	Crisis Occurrence		Crisis	
	Beta	ME	Beta	ME
Domestic credit to GDP change			-2.678*	-0.0005
Discount rate			-2.396*	-0.0004
Discount rate (-1)	3.970***	4.46E-08		
Interest rate spread change (-1)	9.904***	1.11E-07	8.889*	0.0016
Market capitalization change	-0.579***	-6.5E-09	-0.405*	-7.5E-05
Market capitalization change (-1)	-0.317**	-3.6E-09	-0.252	-4.7E-05
Real effective exchange rate change (-1)	0.714***	8.03E-09		
Constant	-38.983***	-4.4E-07	6.735	0.0012
Mcfadden R-squared	0.690		0.691	

Table 9: estimation results of crisis occurrence and crisis equations for the USA; \*, \*\* and \*\*\* represent significance on 10%, 5% and 1% level respectively; source: own calculations



Picture 7: actual, fitted, residual plots for crisis occurrence and crisis equations; source: own calculations

## 1) Crisis occurrence

The model for estimation of crisis occurrence in the USA suggests that the most influential factor is the change in interest rate spread which reflects growing credit and liquidity risks in the banking sector.

Increasing discount rate that serves as a contractionary factor for banks' assets raises the probability of crisis occurrence – this relationship can be explained by lower availability of credit which cools down the economy. The sign of the effect indicates that the loss from interbank borrowing flexibility exceeds the benefit of stricter risk management.

Rising real effective exchange rate also undermines economic stability in the USA. The interpretation of this relationship lies not only in the trade channel, but also in the special role of US dollar in international economy – as the most popular reserve currency – and strong dependence of financial markets (including FOREX) on macroeconomic news from the USA.

Increasing real effective exchange rate serves as a signal of growing imbalances within the economy. If such increase takes place, internal demand decreases, thus causing slowdown in economic growth.

Financial sector is affected by increasing risk premia required by investors – interest rates tend to rise when imbalances reveal themselves through currency depreciation. This imposes downward pressure on domestic consumption and investment. Also, if assets in the banking sector are not hedged against currency risk, decrease in asset value leads to certain liquidity issues.

At last, large trading volumes and deep international integration that are attributable to developed financial markets deepen the imbalances through investors' switching to other assets.

As in previous equations, stock market capitalization dynamics are significant for crisis occurrence probability estimation: drops in stock indices are likely to provoke a crisis.

## 2) Crisis depth

As in the crisis occurrence equation, widening interest spread has the largest marginal effect on the probability of a crisis.

The effect of rising discount rate changed its sign in the presence of stabilizing effect from rising domestic credit. This can be interpreted as the fall in domestic credit availability in the



start of the crisis below its optimal level, which therefore raises the need for lower lending rates for private sector. However, the probability of crisis is reduced if and only if the banks' assets are not subject to large counterparty risk – this is why interbank borrowing should be less flexible.

Again, falling market capitalization leads to greater probability of crisis in the given period whereas index recovery reduced economic instability.

Overall, it can be concluded that the US economy is subject to risks associated with financial sector dynamics. The main issue for policy makers is control of risk-management techniques applied by commercial and investment banks – failure to evaluate credit risks leads to rising uncertainty in banks' assets and undermines the banking sector stability. Private sector borrowing is one of the main drivers of the US economy, and this implies that certain measures should be taken in order to maintain the optimal high level of credit availability together with applied high-quality risk management techniques.

Also, it is important to consider the link between the real effective exchange rate of US dollar and demand for domestic consumption, credit and assets.

The analysis of the whole-sample and individual cluster probability of crisis occurrence and persistence leads to the following conclusions:

- in contrast to the general whole-sample equation, each cluster's crisis probability is represented by models that include smaller ranges of factors; this finding emphasizes the role of individual features of each cluster representative countries in crisis emergence;
- the degree of financial sector influence on crisis occurrence and persistence grows with the level of economic development; at the same time, the trade channel takes the back seat;
- the more developed the economy is, the more complex are the links between external and internal imbalances;
- regional contagion is an important factor to be considered for both developing and developed countries;
- for developed countries that are strongly integrated in international goods and financial markets membership in a currency union increases the probability of a crisis.

## 4.2. Crisis depth

### 4.2.1. Model specification

*Panel data model* for crisis depth (general form):

$$Depth_{i,t} = \beta_0 + \sum \beta_j x_{ji,t} + \alpha_i + \delta t + \varepsilon_{i,t}$$

where  $\alpha_i$  is the unobserved heterogeneity term and  $\delta t$  allows for dynamic intercept.

The choice of fixed- or random-effect specification is based on the results of Hausman test; if the difference in estimated coefficient is significant at 5% level, fixed-effect model is used since it provides consistent and efficient estimated in such case; otherwise random-effect model was applied.

The equations are estimated using the G2SLS procedure (Baltagi (2005)) with instrumental variables. Instruments are chosen so that their correlation with the explanatory variable is considerably high and there is no strong evidence of their correlation with the disturbance term.

*Time series model* for crisis depth (general form):

$$Depth_t = \beta_0 + \sum \beta_i x_i + ARMA(p, q) + \varepsilon_t$$

In order to avoid distortions caused by autocorrelated errors, ARMA terms are included. The equation is estimated using the simultaneous equations technique based on full information maximum likelihood estimation procedure. This enables one to capture all significant effects when some data is missing (in our case first values of change-type variables are missing).

#### 4.2.2. Estimation results.

##### Estimation results for the whole sample

	Whole Sample
Government gross debt to GDP change	0.076***
Market capitalization change (-1)	0.013***
Number of crises in the region	0.102***
TOT change	0.082***
Const	1.423***
R squared	0.41

Table 10: estimation results for crisis depth equation for the whole sample; \*, \*\* and \*\*\* represent significance on 10%, 5% and 1% level respectively; source: own calculations

According to estimation results, the greatest role in determining the size of the downturn is played by regional contagion. If the number of crises in the region increases, expectations of domestic crisis rise, demand for domestic exports falls and there is a large chance of transmitting the crisis from the financial sector. This finding is consistent with regional crises emergence increasing the probability of domestic crises.

Positive changes in the terms of trade deepen the crisis as well – this can be explained by falling international competitiveness of domestic exports which leads to smaller export volumes; this effect outweighs the upward pressure from increased relative price of exports on current account balance.

Gross debt accumulation increases the size of real growth loss, and this is consistent with the positive relationship between gross debt changes and probability of a crisis revealed by the models estimating crisis probability.

Interestingly, past growth in market capitalization deepens the recession. Most likely, individuals and firms form their expectations of crises on the basis of stock market movements; however, if a crisis takes place due to the reasons not associated with capital markets, positive expectations influenced by rising stock indices make agents less prepared for an adverse shock. Also, the revealed relationship may arise from the fact that largest financial crises that took place during the 2001-2009 period were triggered by stock market bubbles.

The general equation suggests that regional contagion, trade, government finance and financial markets affect the depth of a crisis to the greatest extent.

### Estimation results for cluster I (least developed countries)

	<b>Cluster I</b>
<b>Deflator, year to year</b>	-0.307**
<b>Discount rate</b>	0.008**
<b>Government gross debt to GDP change</b>	0.142***
<b>TOT change</b>	-0.064*
<b>Const</b>	34.517***
<b>R squared</b>	0.66

Table 11: estimation output of depth equation for cluster I; \*, \*\* and \*\*\* represent significance on 10%, 5% and 1% level respectively; source: own calculations

The most important role in crisis depth determination is delegated to inflation level. As in the models estimating the probability of crisis emergence, this finding supports the conclusion that monetary expansion has positive effect on economic stability at least in the short run.

Increasing government gross debt depresses real growth during the crisis and recovery period. This is the consequence of increasing default risk and persistent budget deficits that are attributable to the least developed countries. This finding is consistent with the positive impact of growing debt on the probability of crisis.

Increasing discount rate during the period of recession has an additional contractionary effect on the economy, thus deepening the effects of the crisis.

Finally, increase in the relative price of domestic exports benefits the economy. As discussed in the section of crisis probability estimation, relatively low elasticity of domestic demand for imports makes positive changes in terms of trade increase the current account balance.

Again, trade conditions, government finance and monetary policy are the three most crucial factors to consider when evaluating crisis patterns in the first cluster.

### Estimation results for cluster II (developing countries)

	<b>Cluster II</b>
<b>Government gross debt to GDP change</b>	0.069***
<b>Market capitalization change (-1)</b>	0.014***
<b>Number of crises in the region</b>	0.132***
<b>REER change</b>	-0.098***
<b>Const</b>	1.326***
<b>R squared</b>	0.41

Table 12: estimation results of crisis depth equation for cluster II; \*, \*\* and \*\*\* represent significance on 10%, 5% and 1% level respectively; source: own calculations

The results of estimation show that regional contagion is the leading factor explaining the depth of crises in developing countries. This finding corresponds to the general equation fit – crises faced by trading partners and financial crisis transmission deepen the effects of domestic crises.

As expected, debt accumulation increases the real growth loss during the crisis and post-crisis periods. As well as in the general equation, agents’ misperception of crisis probability based on stock market dynamics deepens the recession.

Increase in the real effective exchange rate improves the macroeconomic environment for developing countries. This result is consistent with the findings related to the probability of crises.

Here we conclude that trade conditions, government finance and financial sector statistics are the leading factors affecting the depth of crises. Remarkably, the number of financial sector variables in the estimated equation is smaller compared to crisis occurrence. This indicates that changes in interest rates trigger the crisis, but their role in within- and post-crisis growth is insignificant compared to the factors discussed above. From this we conclude that financial fundamentals serve as transmission channels or triggers, whereas the sources of countries’ vulnerability lie in the trading and policy sectors.

Estimation results for cluster III (economies driven mostly by oil exports)

	<b>Cluster III</b>
<b>Discount rate</b>	-0.301***
<b>Interest rate spread</b>	1.390*
<b>Market capitalization change (-1)</b>	-0.249***
<b>TOT change</b>	0.130***
<b>Const</b>	-0.555
<b>R squared</b>	0.73

Table 13: estimation output for crisis depth equation in cluster III; \*, \*\* and \*\*\* represent significance on 10%, 5% and 1% level respectively; source: own calculations

The greatest impact on the depth of a crisis in the third cluster refers to growth in the interest rate spread; this may signal about the growing concern about crisis persistence and the corresponding rise in financial risks in the economy.

Increasing cost of interbank borrowing reduces crisis incidence – this finding shows that constraints on lending improve the stability of the banking sector.

Interestingly, increasing terms of trade raise the loss of real growth during the crisis and recovery period. One of the explanations to this phenomenon is the reluctance of government

to control the imbalances not associated with the oil sector when the crisis has non-oil-exports roots. Another explanation could be the increase in the value of imports due to falling unit import values, but it is unlikely that demand for imports in the countries belonging to the third cluster is elastic – since the main emphasis is placed on oil production, import substitution is unlikely to be feasible.

Finally, stock market growth in the previous period reduces the negative deviation of real growth from its average non-crisis level. All other things being equal, larger equity value reduces leverage of listed companies, therefore reducing default risks. Another way to look at this relationship is the good quality of stock market movements as signals of upcoming crisis. Probably, the reason for this is that most large companies are state-owned oil producers and exporters.

The overall conclusion on cluster III crisis depth is that financial sector fragility is the major source of deepening crisis incidence. Reliance on the oil production sector implies smaller control for other sectors' vulnerability to shocks and associated imbalances.

Estimation results for cluster IV (developed countries)

	<b>Cluster IV</b>
<b>Government gross debt to GDP change</b>	0.045***
<b>Market capitalization change (-1)</b>	-0.046***
<b>Number of crises in the region</b>	0.071
<b>REER change</b>	0.121***
<b>Const</b>	1.753***
<b>R squared</b>	0.6

Table 14: estimation results for crisis depth equation in cluster IV; \*, \*\* and \*\*\* represent significance on 10%, 5% and 1% level respectively; source: own calculations

The most influential determinant of crisis depth for developed countries is the change in real effective exchange rate. As in the analysis of crisis occurrence probability in the USA, high liquidity of financial markets, decrease in internal demand and currency risk faced by banks and corporations lie behind this relationship.

The growth of gross debt deepens crisis incidence, and this is consistent with the findings of crisis probability models.

Developed capital markets are more efficient in information absorption, so their dynamics make agents more aware about the upcoming macroeconomic fluctuations; also, the larger is

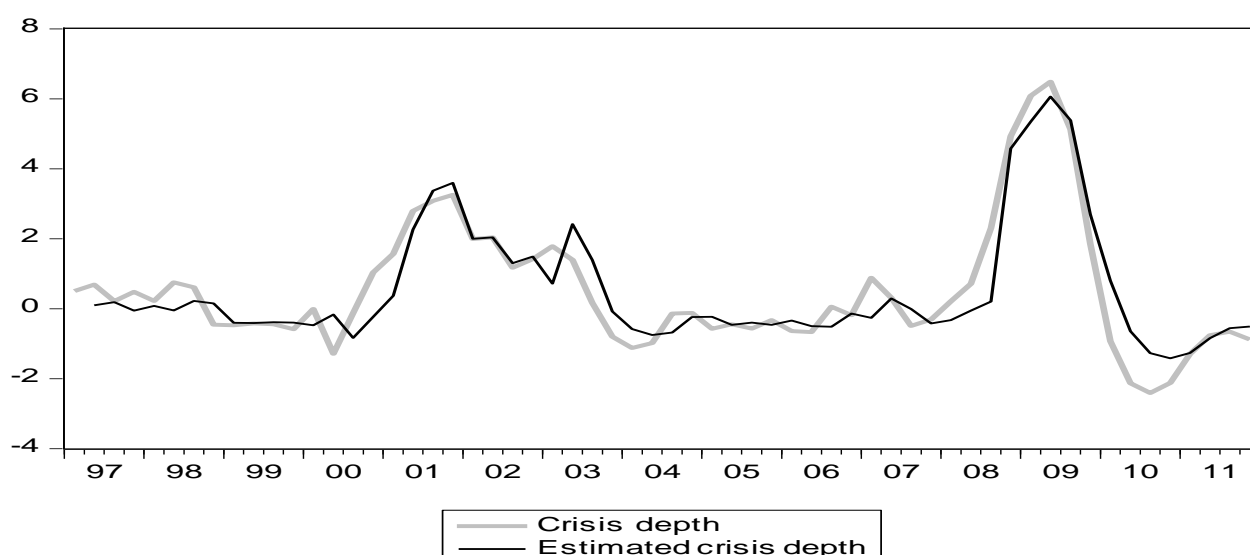
the fall in stock market, the deeper is crisis incidence – this relationship emphasizes the leading role of financial sector dynamics for developed countries.

Overall, the sensitivity of domestic economy to crises is almost fully determined by the financial sector dynamics and their consequences.

Estimation results for cluster V (USA)

	<b>Cluster V</b>
Discount rate	0.305***
Interest rate spread change	1.2*
Government gross debt change	0.41***
Crisis depth (-1)	0.519***
Constant	-0.167
R squared	0.86

Table 15: estimation results of crisis depth equation for cluster V; \*, \*\* and \*\*\* represent significance on 10%, 5% and 1% level respectively; source: own calculations



Picture 8: actual and fitted crisis depth; note that for the US the whole series of real growth deviation from non-crisis average is used in order not to lose observations; despite the generality of the approach, the resulting equation explains the crisis patterns (2001, 2008-2009) well. Source: own calculations

As in the equations estimating the probability of crisis occurrence and persistence in the USA, the leading factor determining the depth of crisis incidence is the interest rate spread, particularly, its change over the period. Smaller credit availability and lower deposit rates show that agents are aware of increased credit and liquidity risks in the banking sector. Widened spread has contractionary effect on economic activity.

Increasing discount rate also increases the loss of real growth, and this is consistent with the results of crisis occurrence model. Increasing government gross debt and its consequences expectedly depress real economic growth during the crisis and recovery periods.

Overall, financial sector dynamics and government borrowing are the leading factors explaining the depth of crises in the USA. Unlike the crisis occurrence and crisis models, the depth model does not point out at the change in domestic credit's significance, so we conclude that increasing credit serves as a trigger for the crisis rather than guarantees its persistence.

The analysis of crisis depth leads to the following general conclusions:

- growth in government gross debt increases the real growth loss regardless of the cluster we consider
- again, the importance of financial sector grows with the level of economic development
- the degree of capital market development and its structure affect the quality of agents' expectations of crisis occurrence and persistence
- regional contagion is especially influencing for developing countries



## 5. Conclusion

Revealed determinants of crisis occurrence and depth have highlighted several important features of crises in the international perspective.

Application of cluster analysis to countries helps to obtain logical cluster structure of countries, and therefore to grasp crisis patterns attributable to particular country categories. Indeed, several differences in crisis emergence that cannot be explicitly inferred from general sample equations are revealed. Noticeably, the USA comprises a separate cluster – taking into consideration the uniqueness of its role in international economy, the decision to distinguish between the developed countries' cluster and the US helps to avoid bias in determination of crisis emergence and depth sources.

A positive relationship is found between the role of financial sector and degree of economic development: macroeconomic environment in the least developed countries with less resilient financial systems is to a greater extent dependent on the trade sector compared to developing and developed countries, whereas financial fundamentals are less important. The positive impact of improved terms of trade on economic stability in the first and in the second clusters is consistent with the results of the model fitted for developing countries by Gurvich and Prilepskiy (2010).

Implicitly, the level of capital market's development is found to affect the depth of the downturn through its ability to absorb agents' beliefs about the current and future macroeconomic stability – countries with less developed stock markets are characterized by an inverse relationship between past market growth and crisis depth. Surely, this can also be explained by speculative rather than fundamentals-based upward movements in the market, but judging from the opposite relationship between market capitalization changes and crisis depth in developed countries (where bubble troubles are more likely to happen), agents' misperception of future events is still a plausible explanation in case of fragile financial sector.

The results of the investigation show that monetary expansion helps to maintain economic stability at least in the short run within the cluster of least developed countries. Together with persistent budget deficits, this can partly explain why regulating authorities rely on money printing despite the medium-run effects from inflationary pressure on the economy.

As expected, changes in the value of oil net exports serve as a leading factor determining macroeconomic stability in countries characterized by heavy dependence on oil exports. In contrast to the findings of Gurvich and Prilepskiy (2010), improvement in terms of trade deepens crisis incidence within the third cluster – this is interpreted as government’s reluctance to control for imbalances in other sectors of the economy when revenues from oil exports are still high.

A very valuable finding is the leading role of currency union membership in crisis emergence probability explanation for developed countries. It supports the hypothesis of certain economic inefficiencies of unions such as the Eurozone – lack of policy flexibility, fast transmission of negative market trends and moral hazard issues increase the risk of crisis emergence.

Secondly, several common features of economic crises occurrence and depth are found.

Accumulation of government gross debt is found to worsen macroeconomic stability for all considered clusters. The reasons underlying this finding are suboptimal fiscal policy and increasing default risks. This relationship is especially important in presence of the European sovereign debt crisis. The role of debt accumulation in crisis emergence and depth we find is consistent with the conclusions made by Calderon and Didier (2009).

Changes in market capitalization are negatively related to the probability of crisis taking place (except for the first cluster where this factor is insignificant). The significance of this relationship supports the hypothesis of tight relationship between the real and financial sectors. Also, this can partly explain why agents rely on stock market movements when they form expectations of future macroeconomic fluctuations.

Regional contagion is attributable to clusters I, II and IV. This is the sign of economic integration and globalization serving as a booster for economic risk transmission – this is emphasized by Kaminsky and Reinhart (1999), Fratzscher (2002) and Sin Yu Ho (2009).

Despite this paper attempts to take a closer look to specific patterns of crisis occurrence and incidence, several aspects require further research.

The investigation highlights the need for a model describing agents’ expectations of future economic fluctuations to be included in analysis of crisis patterns. Building a system of simultaneous equations which would include both parameter dynamics and agents’ expectations would shed more light on the nature of crises in various country groups.

The links between the real and financial sectors should be studied in more detail; the resulting relationships should also be included into the 'whole picture' system.

Overall, this study provides certain policy implications for international regulating authorities. While the least developed countries and developing economies require guidance in economic policy improvement (fiscal and monetary measures should be reviewed so that the effect from debt accumulation is reduced) and financial market efficiency enhancing, developed countries require innovation in risk-measurement techniques in order to better control for financial sector dynamics' impact on the real sector.

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## 6. Appendix

### 6.1. Countries by cluster

Cluster	Country
I	Antigua and Barbuda, Armenia, Burkina Faso, Burundi, Cape Verde, Djibouti, Dominica, Georgia, Grenada, Guyana, Jamaica, Jordan, Lao P.D.R., Lebanon, Liberia, Madagascar, Maldives, Mauritania, Montenegro, Mozambique, Nicaragua, Niger, São Tomé and Príncipe, Serbia, Seychelles, Solomon Islands, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Zimbabwe
II	Albania, Argentina, Barbados, Belarus, Belize, Benin, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Cambodia, Cameroon, Central African Republic, Chile, China, Colombia, Comoros, Costa Rica, Côte d'Ivoire, Croatia, Cyprus, Czech Republic, Democratic Republic of Congo, Dominican Republic, Ecuador, Egypt, El Salvador, Eritrea, Estonia, Ethiopia, FYR Macedonia, Ghana, Greece, Guatemala, Guinea, Guinea-Bissau, Haiti, Honduras, Hong Kong, Hungary, India, Indonesia, Israel, Kenya, Kiribati, Korea, Latvia, Lesotho, Lithuania, Malawi, Malaysia, Mali, Malta, Mauritius, Mexico, Moldova, Mongolia, Morocco, Namibia, Nepal, New Zealand, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russia, Rwanda, Senegal, Sierra Leone, Slovak Republic, Slovenia, South Africa, Sri Lanka, Sudan, Suriname, Swaziland, Syria, Tajikistan, Tanzania, Thailand, The Bahamas, The Gambia, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, Uruguay, Vanuatu, Vietnam, Yemen, Zambia
III	Algeria, Angola, Bahrain, Brunei Darussalam, Chad, Equatorial Guinea, Gabon, Iraq, Islamic Republic of Iran, Kazakhstan, Kuwait, Libya, Nigeria, Oman, Republic of Congo, Saudi Arabia, Turkmenistan, Venezuela
IV	Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Qatar, Singapore, Spain, Sweden, Switzerland, United Arab Emirates, the United Kingdom
V	The United States of America

## 6.2. Revealed crises

Country	Year	Country	Year	Country	Year
			1997, 2000-2001, 2008-2009		
Albania	1997	Ghana		Norway	1998-1999, 2008
Angola	1997-2000, 2009	Greece	2008-2011	Pakistan	1998, 2008
Antigua and Barbuda	2010	Grenada	2010	Papua New Guinea	1997-1999
Argentina	2001-2003	Guatemala	2001	Paraguay	1997-1999, 2002
Armenia	1997-1998, 2009-2010	Guinea-Bissau	2010	Peru	1998-1999
Australia	2008-2011	Haiti	2010	Philippines	1997-2001, 2008
Austria	2009	Honduras	1999, 2010	Poland	1999, 2001, 2011
Barbados	2006	Honduras	2010	Portugal	2003, 2008-2011
Belarus	1999-2000, 2002, 2009, 2011	Hong Kong SAR	1998, 2001, 2009	Republic of Congo	1998, 2003, 2008
Belgium	2001, 2008-2009	Hungary	2008-2009	Romania	1997-1999, 2008, 2011
Belize	2005	Iceland	2000, 2006, 2008-2010	Russia	1997-1998, 2008-2009
Benin	2010	India	1997-1998, 2001	São Tomé and Príncipe	1997, 2009
Bolivia	1999-2003	Indonesia	1997-1998, 2000-2001	Saudi Arabia	1998
Bosnia and Herzegovina	2009	Iraq	2010	Serbia	2008, 2010
Botswana	2000, 2008-2009	Ireland	2007-2010	Seychelles	2008-2009
Brazil	1997-1999, 2001, 2003, 2008	Islamic Republic of Iran	1998-1999, 2008	Sierra Leone	1998-1999, 2010
Brunei Darussalam	1997-1998	Israel	1998, 2002	Singapore	1997-1998, 2000-2001, 2008
Bulgaria	1997, 2009	Italy	2008-2009	Singapore	1998
Burkina Faso	2010	Jamaica	1997-1998, 2008-2010	Slovak Republic	2009
Burundi	1997, 2001, 2008	Japan	1997-1998, 2000-2001, 2008	Slovenia	2007, 2011
Canada	2008-2009	Jordan	1998	Solomon Islands	2010
Cape Verde	1997-1998	Kenya	1997, 1999-2000, 2011	South Africa	1998
Chile	1998-1999	Korea	1997-1998, 2000, 2009	Spain	2008-2010
China	1998-1999, 2001	Latvia	2008-2009	Sri Lanka	2000, 2008-2009
Colombia	1997-1999, 2010	Lebanon	1997	Sudan	2011
Comoros	2009	Lesotho	1998, 2010	Suriname	1999-2000
Costa Rica	2002, 2008-2009	Liberia	2003, 2008	Swaziland	1998
Côte d'Ivoire	2000, 2009	Luxembourg	2008	Sweden	2008

Croatia	1999, 2011	Malawi	1998, 2000-2003, 2010	Switzerland	2002, 2008-2009
Cyprus	2008-2009, 2011	Malaysia	1997-1998, 2000-2001	Tajikistan	1997, 1999, 2007, 2009
Czech Republic	1997-1998	Maldives	2009	Tanzania	1997-1999, 2005-2006, 2011
Democratic Republic of the Congo	2008-2009	Mali	2008	Thailand	1997-1998, 2000
Denmark	2008-2009	Malta	2001, 2008-2009	The Gambia	2002-2003
Djibouti	2008	Mauritania	2005, 2010	Tunisia	2002, 2011
Dominican Republic	2003, 2009	Mexico	1998	Turkey	2000-2001, 2008, 2011
Ecuador	1998-2001, 2009	Mexico	2000, 2002, 2011	Turkmenistan	1998
Egypt	2008, 2011	Moldova	1998, 2003, 2009-2010	Uganda	2000, 2010
El Salvador	2010	Mongolia	1998-1999, 2002-2004, 2008	Ukraine	1997-1998, 2008-2010
Equatorial Guinea	1998	Montenegro	2008	United Kingdom	2008-2009
Eritrea	1998, 2000, 2003	Morocco	1999	United States	2001, 2008-2009
Estonia	2008, 2011	Namibia	1998	Uruguay	1999, 2001-2002
Finland	2008-2009	Nepal	2010	Venezuela	1998, 2002
France	2008-2010	Netherlands	2002, 2008-2009	Vietnam	2008, 2011
FYR Macedonia	2011	New Zealand	1997-1998, 2008	Yemen	2010
Gabon	1998-1999	Nicaragua	2002, 2007	Zambia	1998-2002, 2004
Georgia	2008	Niger	2008	Zambia	1999
Germany	2008-2009	Nigeria	1997-1999, 2011	Zimbabwe	1997-2008

### 6.3. Currency and customs unions, and FTA

**Formal currency unions:** Eurozone, CFA Franc Zone, OECS, South African Rand Zone, Brunei/Singapore dollar

**Customs unions:** European Union, Customs Union (Russia, Belarus, Kazakhstan), MERCOSUR, CAN, EAC, SACU

**FTA:** NAFTA, ASEAN, TPP, CEFTA, G3, GAFTA, SAFTA, COMESA