THE EVALUATION OF ECONOMIC RECESSION MAGNITUDE: INTRODUCTION AND APPLICATION

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Abstract:

We propose a new quantitative *recession magnitude scale* for measuring recessions' magnitudes ('strength') derived from GDP growth rates during a recession and its duration. Furthermore, we introduce a qualitative scale with four recession categories: *minor*, *major*, *severe* and *ultra*, where the categories are defined by the magnitude scale. We use both scales to evaluate several well known economic recessions of the 20th and the 21st centuries. We have found that the Great Depression in 1929-1933 and recessions in Russia and Ukraine in the 1990s belong to ultra recessions, while the recent 2007-2009 financial crisis falls mainly into major (EU and Japan) and severe (USA) category.

Keywords: business cycle, financial crisis, recession, recession classification, recession magnitude.

JEL Classification: B49, E32, O57

1. Introduction

Fluctuations in production or in national economic activity around a long-term growth rate are called business cycles. Business cycle lasts from several months to several years. Inside the business cycle, there are four significant periods – the period of economic expansion, followed by the period of recession, contraction and economic revival (West, 1990). The most discussed part of the business cycle is a recession.

There are many definitions of recession in literature such as that of the National Bureau of Economic Research (NBER, 2010):

(Recession is) "...a significant decline in the economic activity spread across the country, lasting more than a few months, normally visible in real gross domestic product (GDP) growth, real personal income, employment (non-farm payrolls), industrial production, and wholesale-retail sales."

In practice another simple and quantitative 'technical' definition of a recession is used:[1] a recession is a period of time when a nation's GDP declines for at least two consecutive

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1   We use this technical definition of a recession as it is more convenient to our approach.

quarters in a quarter-to-quarter comparison. Moreover, other factors such as real personal income, employment, industrial production and wholesale and retail sales are used to determine whether an economy is in a recession or not (Rachlin, 2009). A deep recession influencing more than one country and lasting for a long time is called a depression. Hence, depression is defined as a sustained, long-term downturn in economic activity in one or more economies.

The measurement and indication of business cycles dates back to the 19th century and the work of French economist Charles Juglar, who was the first to identify cycle presence. Since then, the economic cycles have been studied by many economists. For example Pervushin (1928) studied Russian consumption, agricultural and manufacturing indicators in Russia through 1869-1926. As the economic indicators he took prices of production goods, industrial commodities and raw materials as well as the year-to-year fluctuations in crop yields in Russia. He discovered several periods of economic recession and expansion, and found correlations between world and Russian business cycles.

The classic definition of business cycles comes from Burns and Mitchell (1946). The history and evolution of the theory of business cycles can be found in Fels (1952). Fluctuations of main economic indicators are studied from the statistical point of view (Clark, 1987 and Harding and Pagan, 2002), as well as from the economic point of view (Kim and Nelson, 1999). Coe (2002) showed the Great Depression (1929-1933) had a character of a financial crisis, while Romer (1990) described the low consumption spending because of the uncertainty of consumers about their future income. On the other hand, Olney (1999) argued that before the Great Depression, the decrease in consumption spending was caused by high cost of credit default. After the Great Depression, more than ten recessions occurred, for their brief review see *e.g.* Barufaldi (2008). Other than US recessions are described, for example, in Miniaci and Weber (1999), Western and Healy (1999), Glassman (2001) or Newson (2009).

Economic recessions are often studied from three perspectives. The first concentrates on recession causes, the second examines its consequences and the last focuses on recession predictions. The first approach is used by West (1990) who has shown that the cost shocks are predominant sources of variability in GNP; Blanchard (1993) investigated effects of consumption on recession genesis and Wilson (1985) explored possible effects of tax and monetary regulations on a recession rise. The second approach focuses on sociologic and economic consequences of recessions on human life. Cummings (1987) studied influence of recessions on females and minorities; Edgell and Duke (1986) described the radicalism in the Great Britain in the 1980s and its connection with recessions. Recessions impacts on families and human well-being are depicted in Moen (1979) and Taussig and Fenwick (1999). As for the last approach, the study of economic indicators with emphasis on a recession prediction can be found in Camacho and Perez-Quiros (2002) or Western and Healy (1999). Examining recession causes, characteristic features and consequences naturally draw attention to their comparison.

Recessions are usually compared by various macroeconomic indicators such as GDP decline, duration, unemployment, fall of industrial production, downturn of stock market

indices, decrease in trade volumes or real personal income and many others (Moore, 1967; Barufaldi, 2008; Gascon, 2009; or Eichengreen and O´Rourke, 2010). However, when many indicators are involved, a direct comparison of recessions' strength is in general inconclusive (and thus impossible): one recession may be evaluated worse by one indicator but better by another. Moreover, recessions are usually described qualitatively using vague terms such as 'mild' or 'severe'. For example Gascon (2009, p. 2), who compared six recessions with four indicators, concludes:

> "Based on these indicators, the current recession has been worse than average; however, the declines are not unprecedented... Main recession indicators tend to support the claim that this recession could be the most severe in the past 40 years. However, we are still far from another Great Depression."

But one may ask: "What is an average recession?" because with no measure of recession magnitude, there is no average as well, or "Which recession is severe and which is not?" when the term 'severe' is not defined.

We propound a solution to the problem of a recession comparison: we propose a recession magnitude scale, which allows direct comparison and classification of recessions. In our approach we were inspired by another phenomenon outside economics that was successfully reduced to a single measure – an earthquake intensity.

Earthquakes are usually described by a broad range of their consequences including number of casualties, demolished buildings or overall damage in terms of money, but only Richter's logarithmic scale, which expresses amount of energy released by an earthquake, allows comparison of earthquakes' magnitudes through time and space.

The goal of this paper is to introduce a new quantitative *recession magnitude scale*, which assigns each recession only one value – its magnitude ('strength'). The scale allows measuring recessions' magnitudes and enables their direct comparison. Furthermore, we propose a new qualitative (ordinal) scale with four recession categories: *minor*, *major*, *severe* and *ultra*, where the categories are defined by the magnitude scale. To illustrate the application of our scale, we evaluate magnitudes of some well known economic recessions of the 20th and 21st centuries, and provide their comparison and classification in the empirical part of the paper.

The paper is organized as follows: in Section 2 the recession magnitude scale is introduced, Section 3 provides recession classification and Section 4 is devoted to the scale application – the evaluation of selected recessions. Summary of results and Conclusions close the article.

2. The Recession Magnitude Scale

2. 1 The recession magnitude scale introduction and definition

Usually, recessions are compared by more than one economic indicator. A recession is stronger than another one if it has worse evaluation at least in one indicator and it is not

evaluated better in any of the other indicators. If it is not the case, recessions cannot be compared. Hence the use of multiple indicators leads to inconclusive results in many instances. The problem can be solved by an introduction of a scale that assigns each recession only one value corresponding to its magnitude.

This can be done by two ways: by picking only one, the most important, macroeconomic indicator relevant to a recession magnitude, or by choosing multiple indicators and aggregating them into one. With the latter approach many difficulties arise, *e.g.*: How many and which indicators to choose? How to aggregate them into one? Will the comparison relation change by adding or eliminating some indicators?

We prefer the first approach; though we do not dismiss the latter approach absolutely (see Section 4.9 where we provide one simple example of a combined measure of a recession magnitude). From the set of all relevant macroeconomic indicators related to a recession magnitude we have chosen only one indicator, namely a mean decline of real quarterly GDP growth rates during a recession along with its duration.[2] Main arguments supporting this choice are as follows:

i.   A recession itself is defined by GDP declining for at least two consecutive quarters from the preceding period. Hence GDP decline and recession duration are explicitly mentioned in the definition of a recession.
ii. We regard recession deepness and length to be the most important features concerning recession magnitude. In our approach an average deepness of a recession is expressed by the mean decline of GDP growth rates during a recession, while a recession length is given by its duration in quarters.
iii. Both declines in GDP growth rates and recession duration are among the most cited indicators relevant to a recession magnitude.
iv. Choosing only one macroeconomic indicator makes computation easy and interpretation clear.

DEFINITION: Let D be the number of consecutive quarters with negative quarterly changes in real GDP. Let p_1, p_2, ..., p_D be (negative) percentage changes from the preceding period in real GDP for the respective D quarters, $|p_i| < 100$. Let the mean percentage decline G of real GDP for the respective D quarters be given as:[3]

$$G = 100 - \sqrt[D]{\prod_{i=1}^{D}(100 + p_i)} \qquad (1)$$

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2   Gascon (2009, p. 1) states: "In a recession, the severity of the decline is just as relevant as the duration of the recession... A prolonged, but shallow recession may have an aggregate impact similar to short but deep recession." We agree absolutely with this idea and our proposed measure of recession's magnitude is constructed so that a long and shallow recession may have indeed the same magnitude as a short and deep recession.

3   If decimal numbers p_i are used then the formulae (1) is: $G = 1 - \sqrt[D]{\prod_{i=1}^{D}(1 + p_i)}$. But in (2) G must be in (%).

Then the recession magnitude M is given as:

$$M = \log_2(10DG) = \frac{\log(10DG)}{\log 2} = \frac{\log D + \log G + 1}{\log 2}, \qquad (2)$$

$$\text{where } D \geq 2 \text{ and } G \geq 0.1 \qquad (3)$$

Relation (2) defines a mapping from the set of recessions represented as pairs (D, G) to the magnitude scale $M: (D,G) \to M$.

Constraints (3) result directly from the definition of recession and from the convention of using one decimal place in GDP growth rates values. Factor of 10 in equation (2) is a scaling factor so that for the lowest values of D and G (the smallest recession) the magnitude recession is equal to 1. Further, (2) implies that when D doubles and G isn't changed, or *vice versa*, the M increases by 1 point ('one order of magnitude'). A recession with the magnitude $M = 5$ is twice as strong as a recession with the magnitude $M = 4$.

The mapping $(D,G) \to M$ enables recession comparison: we say that a recession r is bigger (smaller) than a recession s if and only if the magnitude of the recession r is higher (lower) than the magnitude of a recession r. More formally, for every pair of recessions r and s we introduce a comparison binary relation " $\prec$ " ("is smaller or equal to") such that:

$$r \prec s \text{ if } M(r) \leq M(s) \qquad (4)$$

Relation (4) is reflexive and transitive (these properties follow directly from reflexivity and transitivity of real numbers), but it is not antisymmetric, as some different recession pairs from R may have the same magnitude M; therefore relation (4) provides preorder (quasiorder) on R. More precisely it is a total preorder, as every pair of elements from R is comparable.

If only yearly GDP growth rates are available, relations (1) to (3) can be easily modified so that a duration D of a recession is given in years and G is equal to the geometric mean of annual GDP growth rates; $D \geq 2$ and $G \geq 0.1$ However, we recommend using the quarterly GDP data where possible, as a period of a recession given in years may not describe its actual duration accurately.

We use strictly quarterly GDP growth rates through the paper with two exceptions in Sections 4.3 and 4.8, where yearly GDP growth rates were used because quarterly GDP data were not available.

2.2 The scale's elementary mathematical properties

Basic properties of the function M given by the relation (2):

i. M is the real function of two positive and discrete variables D and G;
ii. The range of the function M is in the interval $[1, \infty)$.
iii. The function M is subadditive; division of a recession's time period C into two

recession's time periods A and B such as $A \cup B = C \wedge A \cap B = \varnothing$ results in the following inequalities for recessions' magnitudes:

$$[M(A \cup B) \leq M(A) + M(B)] \text{ and } [M(A \cup B) \geq M(A) \text{ and } M(A \cup B) \geq M(B)] \quad (5)$$

Relations (5) follow immediately from the subadditivity of a logarithmic function for arguments equal or larger than 1.

iv. The function M is monotonic (strictly increasing) in both arguments D and G. When a new quarter (even with the lowest GDP decline of 0.1%) is added, the magnitude M increases as well.

2.3 Benefits of the scale

i. *Measuring*: each recession with quarterly or yearly GDP growth rates can be assigned its magnitude and this measure provides recession's objective and exact evaluation.

ii. *Comparison*: recessions from different time and different places can be compared and put into new perspective.

iii. *Classification*: the magnitude scale allows introduction and precise definition of recession categories. For the proposed recession classification see Section 3.

iv. *Modeling*: economic models, which aspire to predict evolution of GDP in time, can be used to predict expected recessions' magnitudes too.

v. *Extensions*: one of the most straightforward extensions of our approach is a possibility to evaluate economic booms or the whole economic cycle.

2.4 Limitations of the scale

i. The magnitude scale takes into account only one macroeconomic indicator, namely GDP, which we consider to be the most fundamental for recession evaluation. Naturally, using other macroeconomic indicators, *e.g.* unemployment growth or decline of industrial production, one can get different results in recession comparison.[4] However, when more than one indicator is used for comparison, ambiguity begins to occur.

ii. As the GDP growth rates are the only economic input of a magnitude evaluation, *availability*, *reliability* and *accuracy* of the data is crucial. GDP time series from mainly developing countries are available only for the last few years or decades;

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4   Eichengreen and O´Rourke (2010) compare the recent financial crisis with the Great Depression by a variety of indicators such as global output or world trade, with the concluding statement: "The world is currently undergoing an economic shock every bit as big as the Great Depression shock of 1929-30."

reliability and accuracy of some countries' data is under question as well.[5] Another problem constitutes potential later GDP revisions (usually by a few tenths of percent up or down) that might influence a recession's magnitude slightly.

iii. In the case of W-shaped recessions, we recommend to evaluate both partial recessions separately (see Section 4.5 for explanation).

2.5 Modifications of the scale

Whereas the product of D and G is approximately equal to an absolute value of a cumulative decline (C) of GDP (in %) during a recession, it is possible to use C instead of $D \cdot G$. Another (integral) approach for magnitude evaluation can use a logarithm of an area between the time axis and (by parts linear) plot of (negative) GDP growth rates during a recession.

3. Recession Classification

Recessions are often described by adjectives such as 'strong', 'big' or 'severe' with rather unclear meaning of these words and distinction between them in particular. The existence of the proposed recession magnitude scale allows us to define several classes of recessions with respect to their magnitudes. We propose a new logarithmic scale of a recession magnitude derived from the relation (2) with the following four categories: *minor*, *major, severe* and *ultra*.

The categories are defined and briefly described[6] in Sections 3.1-3.4. Moreover, we propose using the term 'depression' for the two highest categories – severe and ultra – while minor and major recessions can be labeled briefly as 'recessions'.

Because the magnitude scale assigns each recession the number from 1 to cca 10 we have chosen four categories of recessions.[7] Categories' boundaries are integer numbers as integers are easier to remember. We set the boundaries of the first category from 1 to 5 because we have found that recessions with magnitudes lower than 3 are rather rare. Magnitudes of the next two categories range from 5 to 7 (from 7 to 9 respectively), so they are of the same length. The lower boundary ($M = 9$) of the highest category was selected so that the Great Depression would belong into this category. This last category

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5   According to Curtis (1996) some western experts question accuracy of GDP data of the Soviet and the post-Soviet era, as the former data are likely to be overestimated and the latter data underestimated. Also questionable might be the data from New EU Members from the early 1990s. But GDP data of both old and New EU Member States used in the empirical part of this paper for the evaluation of the recent financial crisis are not under question in terms of their reliability or accuracy. Older US data (from the 1930s and the 1960s) are based on BEA (Bureau of Economic Analysis) statistics; therefore we expect their consistency and accuracy.

6   Categories are defined by recession magnitudes. Categories' short description in terms of recessions' socio-economic consequences is only illustrative and its purpose is to provide a broader picture of these events.

7   As there are 10 degrees of recession magnitudes (from 1 to about 10), Sturges rule suggests they should be divided into 4 groups.

is not bounded from above. Finally, we emphasize that the presented concept of the classification scale is a proposal opened to a discussion.

3.1 Minor recession (1 ≤ *M* < 5)

The first class refers to the mildest (hence *minor*) recessions with magnitudes smaller than 5. Recessions of this category typically last for only two or three quarters and mean quarterly GDP decline is up to about 1.5 %. The recovery of an economy is swift, macroeconomic indicators return to a pre-recession level in one or two years.

Examples:
- Sweden 2008; ($G = 0.60$, $D = 2$ quarters, $M = 3.6$)
- USA 1969-1970; ($G = 0.85$, $D = 2$ quarters, $M = 4.1$)
- Japan 2001; ($G = 0.88$, $D = 2$ quarters, $M = 4.1$).

3.2 Major recession (5 ≤ *M* < 7)

The second class of recessions – major recessions – is defined by its magnitude value between 5 and 7. Recessions of this class are major economic events, often on the global scale. They last from 2 to 4 quarters with mean quarterly GDP growth rates decline between 1 % and 3 %. Usually, governments and central banks intervene to fight economic consequences of a recession through increased government investment and export supports, and also through decreased government spending on social services. This type of a recession has an impact on lowering living standards of inhabitants; demonstrations and strikes are its common consequences.

Examples:
- France 2008-2009; ($G = 1.0$, $D = 4$ quarters, $M = 5.3$)
- Germany 2008-2009; ($G = 1.7$, $D = 4$ quarters, $M = 6.1$)
- South Korea 1998; ($G = 2.8$, $D = 3$ quarters, $M = 6.4$)
- Japan 2008-2009; ($G = 2.3$, $D = 4$ quarters, $M = 6.5$).

3.3 Severe recession (7 ≤ *M* < 9)

The third class refers to the recessions that constitute a large-scale economic downturn, event not seen in many decades. The term *severe* is already used in the literature[8] for deep recessions. Severe recessions typically last for 1-2 years with mean quarterly GDP growth rates decline from 3 % to 5 %. Severe recessions are associated with a fall of living standards of the majority of the population. Protest marches and strikes often overgrow to violent riots in the streets, criminality increases. The currency is devalued; country's economy is on the brink of a breakdown.

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8   See Gascon (2009) or IMF Survey Magazine (2010).

Examples:

- Thailand 1997-1998; ($G = 3.1$, $D = 3$ quarters, $M = 7.2$)
- Argentina 2001-2002; ($G = 4.0$, $D = 4$ quarters, $M = 7.3$)
- USA 2008-2009; ($G = 4.1$, $D = 4$ quarters, $M = 7.4$)
- Latvia 2008-2009 ($G = 3.56$, $D = 8$ quarters, $M = 8.2$).

3.4 Ultra recession ($9 \leq M$)

For the fourth category of recession scope we propose the term *ultra*. This extreme recession category is defined by recession's magnitude $M \geq 9$. Ultra recessions last several years (about 4 years during the Great Depression, about 6 years in Russia during 1990s and about 9 years in Ukraine during 1990s) and GDP growth rates can decline as much as 20-25 % annually. During an ultra recession, GDP falls by 30 % or more when compared to GDP levels prior to a recession. The recovery from a recession may last a decade or longer. During an ultra recession the majority of population plunges into poverty, industrial production and agriculture is subdued and some industrial branches might even cease to exist. Population suffers from hunger, breakdown of social and medical services, high inflation, criminality and emigration. People lose their trust in economy, government and politics in general.

Examples:

- USA, the Great Depression 1929-1933; ($G = 14.1$, $D = 4$ years, $M = 9.1$)
- Russia 1991-1996; ($G = 9.9$, $D = 6$ years, $M = 9.2$)
- Ukraine 1991-1999; ($G = 9.5$, $D = 9$ years, $M = 9.7$).

4. The Evaluation of Selected Recessions' Magnitudes in the 20[Th] and the 21[St] Centuries

4.1 The scope of the evaluation

The aim of this section is to evaluate magnitudes of selected recessions. We focused on developed (mainly OECD) countries and the most famous recessions such as the Great Depression of 1930s in the USA or recent global financial crisis.

4.2 The data and data sources

For the evaluation quarterly or yearly GDP growth rates series adjusted for inflation and seasonality were used. The data sources include: *Eurostat* for EU countries*, Bureau of Economic Analysis* (*BEA*) for the USA, *International Monetary Fund* (*IMF*) for the Russian Federation, *National Bank of Ukraine* (*NBU*) for Ukraine and *TradingEconomics* for the rest of the world. Due to possible later GDP revisions we provide the data[9] along with the evaluation.

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9   For recessions' evaluation we use quarterly GDP growth rates published in September 2010
      at the latest.

4.3 The Great Depression, 1929-1933

The Great Depression officially began on the Black Tuesday of October 29, 1929 as a Wall Street stock market crash, when prices of stocks rapidly fell down. Despite the optimistic expectations the collapse started the huge economic downturn that influenced not only the economy of the USA but also the economy of almost all countries in the world for more than one decade. The Great Depression in the USA lasted for four years. The official end of the Great Depression was in 1934, when the so-called 'First New Deal' programs provided work to the unemployed and increased demand through increased government spending. However, the consequences of the Great Depression lasted till the World War II.

During the depression, the unemployment rate reached 25 % and industrial production fell by approximately 45 % (Bernanke, 2000). In 1930, real output of durable consumer goods, semidurable consumer goods, and perishable goods decreased by 32.4 %, 13.8 %, and 1.6 %, respectively (Romer, 1990). By 1933, the income of an average American family dropped by 40 %, social workers reported increased amount of children malnutrition. The situation even worsened by the so-called Dust Bowl – the period of dust storms in American prairie lands caused by drought and erosion as a consequence of extensive farming (1930-1936). The dust storms forced approximately 2.5 million people, mostly farmers and farm workers, to migrate out of affected areas seeking for a job. For more details and references see *e.g.* Smiley (2008).

As for the Great Depression evaluation, we had to use yearly GDP growth rates as quarterly data were not available, so results must be treated with some caution. Both the data and results are provided in Tables 1 and 2. The mean yearly decline of GDP growth rates was 14.1 %, duration 4 years and the respective magnitude $M = 9.14$. This value makes the Great Depression an ultra recession. Our results confirm the status of the Great Depression as the worst economic decline in the US history of the 20th century.

Table 1

Percentage Changes in Real GDP from the Preceding Period, USA, the Great Depression 1929-1933

Country/year	1929	1930	1931	1932	1933	1934
(1)	(2)	(3)	(4)	(5)	(6)	(7)
USA	6.4	-12.0	-16.1	-23.2	-3.9	17

Source: BEA (2010).

Table 2
Evaluation of the Great Depression, USA, 1929-1933

Country	Duration (years)	Mean Yearly Decline of GDP (%)	Magnitude
(1)	(2)	(3)	(4)
USA	4	14.08	9.14

Source: authors.

4.4 The global financial crisis, 2007-2009

The recent global financial crisis started in the USA during the summer 2007 by a liquidity shortfall in the US banking system. The trigger of the crisis was a collapse of a US housing boom that led to fall of large financial institutions or its bailout by national governments, and to large share drops around the world. This recession can be considered as a major recession in the EU ($M = 5.8$) and Japan ($M = 6.5$), and a severe recession in the USA ($M = 7.4$). The data and results are given in Tables 3 and 4.

In the EU 25 out of 27 countries experienced a recession (the only exceptions are Poland and Slovakia). Their magnitudes are provided in Table 11. The strongest recession took place in Latvia[10] ($M = 8.2$) and Estonia ($M = 7.8$), the weakest in Cyprus ($M = 4.9$), Malta ($M = 5.1$), and France ($M = 5.3$).

As can be seen from Table 3 and column (11), in the first quarter of 2010 all major economies returned to the growth.

However, after short recovery during 2010 and the first half of 2011, Eurozone slipped into a new recession in the first quarter of 2012. The latest Eurostat data on GDP (from the 2nd half of 2011) suggest that the most affected countries are small or medium sized: Greece, Ireland, Portugal, Slovenia or the Netherlands.

Table 3
Percentage Changes in Real GDP from the Preceding Period, Financial Crisis, 2007-2009, Selected Countries

Country/ quarter	2007Q4	2008Q1	2008Q2	2008Q3	2008Q4	2009Q1	2009Q2	2009Q3	2009Q4	2010Q1
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
EU	0.5	0.6	-0.3	-0.5	-1.9	-2.5	-0.3	0.3	0.2	0.3
Germany	0.2	1.4	-0.7	-0.4	-2.2	-3.4	0.5	0.7	0.3	0.5
France	0.2	0.5	-0.7	-0.2	-1.6	-1.5	0.1	0.3	0.6	0.2
Latvia	0.9	-3	-2.2	-1.1	-4.2	-11.6	-1.5	-3.2	-1.2	0.9
USA	2.9	-0.7	0.6	-4	-6.8	-4.9	-0.7	1.6	5	3.7
Japan	0.4	0.2	-0.7	-1.2	-2.7	-4.4	2.3	-0.1	0.9	1.2

Source: Eurostat (2010) for EU countries, BEA (2010) for USA and TradingEconomics (2010) for Japan.

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10   Paul Krugman (2008) wrote in The New York Times: "The most acute problems are on Europe's periphery, where many smaller economies are experiencing crisis strongly reminiscent of past crises in Latin America and Asia: Latvia is the new Argentina."
      The latest developments (in the beginning of 2012) indicate that the most affected countries of today (Greece, Ireland, Portugal or Slovenia) are still rather on Europe's periphery, but economic problems shifted from very small countries (Latvia, Lithuania) to small or medium sized countries.

Table 4
Evaluation of the Financial Crisis, 2007-2009, Selected Countries

Country (Union)	Duration (quarters)	Mean decline of GDP (%)	Magnitude
(1)	(2)	(3)	(4)
Latvia	8	3.56	8.15
USA	4	4.13	7.37
Japan	4	2.26	6.50
Germany	4	1.68	6.07
E.U.	5	1.10	5.79
France	4	1.00	5.32

Source: authors.

4.5 W-shaped recessions

A W-shaped recession, or 'double dip' recession, occurs when an economy is in a recession, the period of a recession is interrupted by a short period of growth, and after short recovery (one or two quarters) an economy gets back into the recession. A typical example of this type of recession comes from the USA, 1980-1981, and from Japan during the Asian financial crisis, 1997-1998.

Figure 1 illustrates the case of Japan, where the GDP growth rate curve has a form of W-letter. Periods before and after the peak can be regarded as two separate recessions (A and B recessions) lasting for two quarters or one overall recession (recession C) lasting for five quarters. From the first perspective, the magnitudes of two recessions A and B are $M(A) = 3.70$ and $M(B) = 4.53$ respectively. From the second point of view the overall magnitude $M(C) = 5.05$. Hence, the recession magnitude for the overall period is larger than both magnitudes $M(A)$ and $M(B)$, but smaller than its sum.

The question is whether to use the former or the latter approach. Usually, the time period between two separate recessions of W-type recession is too short for economic recovery from the first recession and both recessions have the same macroeconomic causes. Nevertheless, we advocate the former approach on two grounds. To begin with, (overall) W recession does not satisfy the 'technical' definition of a recession we use in the paper. Secondly, in some (not so unrealistic) cases absurd results might occur.[11]

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11   Let's have a W recession with the following quarterly GDP growth rates (in %): -0.1, -0.1, 1, -0.1, -0.1. Then the recession's duration $D = 5$ quarters and from (1) we get $G = -0.12$. The negative value of G implies mean *increase* of GDP during the recession (!).

Figure 1
Example of W-shaped Recession in Japan, 1997-1998
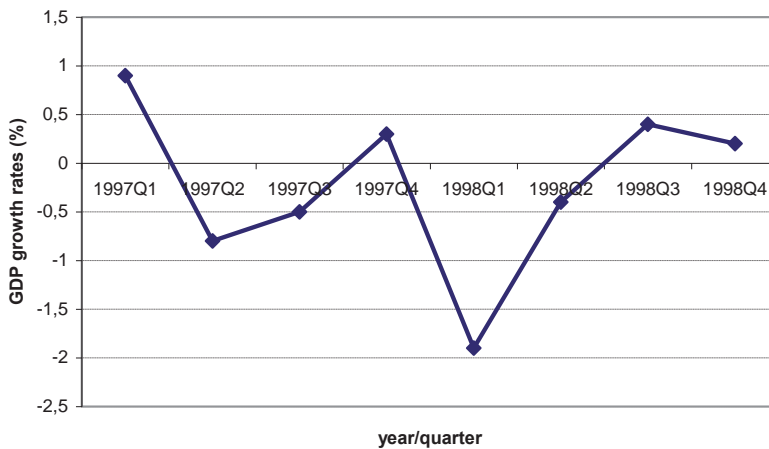
Note: This figure illustrates the W-shaped recession with a central positive 'peak' in the 4th quarter of 1997.

Source: TradingEconomics (2010).

4.6 The Asian financial crisis, 1997-1999

The Asian financial crisis ended the so-called 'Asian economic miracle'. The crisis began in July 1997 in Thailand by the collapsing of Thai currency, and it spread soon around Southeast Asia and Japan, with Thailand, Indonesia and South Korea being the most affected countries. According to Goldstein (1998), the causes of the crisis were financial-sector weaknesses in Asian emerging economies with easy global liquidity conditions and mounting concerns about external-sector problems. For a recession magnitude evaluation, Thailand, South Korea and Japan were selected (the data and results are provided in Tables 5 and 6). Thailand's recession was the deepest ($G = 3.0$) and also the longest (5 quarters), with the magnitude $M = 7.2$. Japan experienced two short recessions with magnitudes $M = 3.7$ and $M = 4.5$ respectively. The recession in South Korea stands between those of Thailand and Japan with the magnitude $M = 6.4$. Recessions in Japan were minor, South Korean recession falls into major category and the recession in Thailand belongs to severe category.

Table 5
Percentage Changes in Real GDP from the Preceding Period, Asian Financial Crisis, 1997-1998

Country/ quarter	1997Q1	1997Q2	1997Q3	1997Q4	1998Q1	1998Q2	1998Q3	1998Q4	1999Q1
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
South Korea	0.7	2.9	1	-0.4	-7	-1	1.3	2.5	3
Thailand	-1.9	2.2	-1	-3.5	-5.1	-4.7	-0.8	2.7	2
Japan	0.9	-0.8	-0.5	0.3	-1.9	-0.4	0.4	0.2	-0.7

Source: TradingEconomics (2010).

Table 6
Evaluation of Asian Financial Crisis, 1998-1999, Selected Countries

Country	Duration (quarters)	Mean decline of GDP (%)	Magnitude
(1)	(2)	(3)	(4)
Thailand	5	3.04	7.25
South Korea	3	2.85	6.42
Japan, 1998	2	1.15	4.52
Japan, 1997	2	0.65	3.70

Source: authors.

4.7 The Argentinean crisis, 2001-2002

The Argentinean recession 2001-2002 was one of the largest economic declines in the modern economic history. The GDP dropped by 10.9 % in one year, the recession magnitude was equal to 7.3, a number corresponding to the severe recession (the data and results are given in Tables 7 and 8). Unemployment rate peaked at 21.5 %; total consumption decreased by 12.9 %. Investment and imports dropped by 36.1 % and 49.7 %, respectively (*Informe Economico Trimestral*, 2002). The Argentinean crisis was accompanied by violent demonstrations, confrontations between the police and citizens, destructions of properties owned by banks and foreign companies, and fires set in the Buenos Aires avenues. As for the cause of the crisis, *Informe Economico Trimestral* (2002, p. 1-2) describes it in the following manner:

"Both domestic and foreign reasons conform a vicious circle characterized by the increasing need of loans, fall of product and overvaluation of real exchange rates. These elements in turn grew due to the absence of appropriate policies attacking the problems as a whole, whereas the trap in which the economy was immersed closed and the cost of finding a way out grew exponentially."

The Argentinean crisis lasted for 4 quarters, the mean decline of GDP growth rates was 4.04 % and recession's magnitude $M = 7.34$. The recession belongs to severe category.

Table 7

Percentage Changes in Real GDP from the Preceding Period, Argentinean Crisis, 2001-2002

Country/quarter	2000Q4	2001Q1	2001Q2	2001Q3	2001Q4	2002Q1	2002Q2	2002Q3	2002Q4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Argentina	0.3	0.2	-0.8	-4.7	-5.7	-4.9	0.5	0	1

Source: TradingEconomics (2010).

Table 8

Evaluation of Argentinean Crisis, 2001-2002

Country	Duration (quarters)	Mean decline of GDP (%)	Magnitude
(1)	(2)	(3)	(4)
Argentina	4	4.04	7.34

Source: authors

4.8 The economic collapse of post-Soviet Republics in the 1990s

In 1991 the Soviet Union split-up into 15 independent countries. The breakup was accompanied by democratization and transition from centrally planned economies to free market economies. During the transition former USSR republics experienced economic collapse of magnitude rarely seen in the developed world. To evaluate the magnitude of the event, we focused on the two major economies: Russian and Ukrainian economies.

According to IMF Stuff Country Report No. 99/100 (1999), recession in Russia lasted for six years from 1991 to 1996. During that period, GDP fell by more than 50 %, with declines mainly in military-industrial complex production and heavy industry production. Moreover, as inefficient companies were closed, other economic sectors as well as agricultural sector suffered as well (Curtis, 1996). Surprisingly, official unemployment rates were low, up to 2-3 % (Boutenko and Razlogov, 1997).

Ukraine experienced even worse economic breakdown lasting from 1991 to 1999 (NBU, 2010). Implementations of structural reforms were slow and obstructed within the government and by a large part of population. Ukraine's government continued to subsidy state-run industry and agriculture by uncovered monetary emissions, which resulted in a record-breaking hyperinflation in 1993 and lead to introduction of a new currency, Hryvnia, in 1996. The recession in Ukraine lasted for nine years, with GDP in 1999 being only 40 % of GDP in 1991. Majority of population slipped into poverty, and people survived by growing their own groceries, taking two or more jobs and exchanging goods in barter economy.

Events in Russia and Ukraine were not 'pure' recessions in a sense that their causes were not a contraction of a standard economic cycle. However, the disruption of the

Soviet Union followed by political changes and transition to free market economics touched the economy of the country as well as it influenced life of inhabitants.

We had to use yearly GDP growth rates as quarterly data were not available, so results must be treated with some caution. We derived magnitudes of Russian and Ukrainian recessions to be 9.2 and 9.7 respectively (the data and results are provided in Tables 9 and 10). Recessions in both countries were classified as ultra recessions.

Table 9

Percentage Changes in Real GDP from the Preceding Period, Russia and Ukraine in the 1990s

Country/year	1991	1992	1993	1994	1995	1996	1997	1998	1999
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Russia	-5.5	-19.4	-10.4	-11.6	-4.8	-6.7	1	-3.8	6.3
Ukraine	-8.7	-9.9	-14.2	-22.9	-12.2	-10	-3	-1.9	-0.2

Source: IMF (2010), NBU (2010).

Table 10

Evaluation of Russian and Ukrainian Economic Collapse in the 1990s

Country	Duration (years)	Mean yearly decline of GDP (%)	Magnitude
(1)	(2)	(3)	(4)
Ukraine	9	9.47	9.74
Russia	6	9.88	9.21

Source: authors.

4.9 A combined measure of a recession magnitude based on quarterly GDP growth rates and unemployment rates

In this section we provide a simple combined measure of a recession magnitude based on both GDP growth rates and unemployment rates. The aim of this section is to show how such a measure can be constructed and to examine whether (or how much) can a recession magnitude change when unemployment rates are considered along with GDP growth rates.

Generally, a recession magnitude obtained from an aggregation of macroeconomic indicators can be defined as a function $M' = M'(I, w, f)$, where I denotes a set of indicators used for the evaluation, w denotes the vector of weights (or scaling factors) of indicators, and finally f is an aggregation function or operator.

We are going to demonstrate a simple case, where the set of indicators consists of unemployment rates (U) and GDP growth rates (G) during a recession with the same

weights, while the aggregation function is the arithmetic mean. For our purposes we define quantities U and G as follows[12]:

- G is given as a cumulative decline of nation's GDP during a recession (in %), where time of a recession consists of consecutive quarters of declining GDP growth rates in quarter-to-quarter comparisons.
- U is given as a difference $U = U_2 - U_1$ (in %), where U_1 is the monthly unemployment rate in a turning point T_1 (a local minimum prior to a recession) and U_2 is the monthly unemployment rate in a turning point T_2 (a local maximum immediately following the local minimum T_1).

In such a case a combined recession magnitude M' can be defined as follows:

$$M' = \log_2 5(G + U) \qquad (6)$$

Using formulae (6) we evaluated recession magnitudes M' of EU countries during the financial crisis 2007-2009. The data for all countries (G, U_1 and U_2) were taken from monthly *Eurostat newsrelease euroindicators* (2008-2011).

Results – combined recessions' magnitudes – are shown in the column (7) of Table 12. Recession magnitudes based solely on GDP by the relation (2) are provided in the column (2) of Table 12 for a comparison. Generally, magnitudes M' were slightly smaller than M, but the ranking of countries was very similar as can be checked via Pearson's correlation coefficient r or Spearman's rank correlation coefficient: $r = 0.93$, $\rho = 0.88$, which are statistically significant at 0.05 level.

In this section we demonstrated the use of one simple combined measure (6) of a recession magnitude, and results were similar to magnitudes obtained by the relation (2) based solely on GDP. Nevertheless, we still regard the use of combined measures problematic. Unemployment might not be suitable for the evaluation of recession magnitudes because recessions are not always accompanied by a significant increase of unemployment rates, see Section 4.8 on post-Soviet Republics. Also, the 'natural' level of unemployment is different across countries (in Spain unemployment rates are close to 20%, while in Germany they reach only 4-7 %). Hence, the use of unemployment rates would require some non-trivial 'scaling' or transformation of values (in Table 12 the ranking of Spain according to M and M' is so different just due to its high unemployment rates). And finally, unemployment rates can be significantly influenced (reduced) by government interventions involving an increase of part-time jobs, community service, *etc*, while GDP growth is not so sensitive to public policy.

Our main and general objection against the use of a combined measure of a recession magnitude is that it excludes the existence of one universal classification scale such as in Section 3, because different measures yield generally different results (recession magnitudes).

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12   The following definitions of G, U and M' were chosen from a wide range of other possible definitions mostly for their simplicity and easy data (G and U) accessibility from Eurostat databases.

4.10 Summary of results

The magnitude of the recent 2007-2009 global recession in the European Union was 5.8, which falls into the major recession category. The biggest recession among EU countries took place in Latvia ($M = 8.2$), that is almost 'three orders of magnitude' more than a recession in France ($M = 5.3$), which experienced the second smallest recession in the EU after Cyprus ($M = 4.9$). The Greek recession with the magnitude 5.9 was still in progress during the second half of 2010 and 2011, so it will be 'upgraded' after the end of the recession. The US recession ($M = 7.4$) was bigger than recessions in Japan ($M = 6.5$) and the EU ($M = 5.8$), and was classified as a severe recession.

After short recovery during 2010 and the first half of 2011, Eurozone was heading for another recession in 2012; hence many EU countries are going to experience the W-shaped recession.

By examining several historical recessions we have found out that the magnitude of the Great Depression in the 1930s was 9.1, which constitutes the biggest recession in the US history in the past 80 years. Recessions of Russian and Ukrainian economies after collapse of the Soviet Union in 1991 are fully comparable with the severity of the Great Depression, as its magnitudes were 9.2 and 9.7, respectively[13]. The recession in the USA during 1980 had the highest mean quarterly decline in GDP growth rates ($G = 5.65$ %), while Ukrainian recession lasting for 9 years was the longest. Other recessions with large magnitudes include the famous Argentinean crisis that led to the state bankruptcy in 2001 ($M = 7.3$) and Thai recession of 1997-1998 ($M = 7.2$), which triggered the Asian financial crisis. Both events were classified as severe recessions.

A graphical comparison of selected recessions is provided in Figures 2 and 3. Table 11 summarizes magnitudes of selected recessions evaluated in this study in the descending order of magnitude.

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13 All three estimations are based on yearly GDP growth rates, as quarterly GDP growth rates were not available.

Table 11
Magnitudes of Selected Recessions

| Country (Union)	Period	Duration (quarters)	Mean GDP decline (%)	Magnitude
(1)	(2)	(3)	(4)	(5)
Ukraine	1991-1999	36	2.29	9.7
Russia	1991-1996	24	2.38	9.2
USA	1929-1933	16	3.34	9.1
Latvia	2008-2009	8	3.56	8.2
Estonia	2008-2009	7	3.20	7.8
Lithuania	2008-2009	4	4.44	7.5
Argentina	2001-2002	4	4.04	7.3
Ireland	2008-2009	8	1.91	7.3
Thailand	1997-1998	5	3.04	7.2
USA	1980	2	5.65	6.8
Finland	2008-2009	4	2.55	6.7
Slovenia	2008-2009	3	3.36	6.7
Japan	2008-2009	4	2.26	6.5
Luxembourg	2008-2009	5	1.78	6.5
South Korea	1997-1998	3	2.85	6.4
USA	1981-1982	2	4.18	6.4
Romania	2008-2009	4	2.06	6.4
Hungary	2008-2009	6	1.35	6.3
Denmark	2008-2009	4	1.78	6.2
Italy	2008-2009	5	1.40	6.1
Germany	2008-2009	4	1.68	6.1
United Kingdom	2008-2009	6	1.10	6.0
Sweden	2008-2009	2	3.30	6.0
Greece*	2008-2010	7	0.84	5.9
EU	2008-2009	5	1.10	5.8
Netherlands	2008-2009	5	1.08	5.8
Austria	2008-2009	4	1.30	5.7
Spain	2008-2009	6	0.85	5.7
Czech Republic	2008-2009	3	1.68	5.7
Belgium	2008-2009	3	1.44	5.4
Portugal	2008-2009	4	1.00	5.3
France	2008-2009	4	1.00	5.3
Malta	2008-2009	3	1.14	5.1
Japan	1997-1998	5	0.66	5.1
Cyprus	2008-2009	5	0.58	4.9
Japan	1998	2	1.15	4.5
Japan	2001	2	0.88	4.1
USA	1969-1970	2	0.85	4.1
Japan	1997	2	0.65	3.7
Sweden	2008	2	0.60	3.6

Source: authors

Notes: In this table duration of a recession D is given in quarters and G is a mean quarterly decline of GDP growth rates during a recession.

*The recession in Greece continued through the 2nd half of 2010 and 2011, so its magnitude is going to be increased after the end of the recession. Horizontal lines in the table provide a division among recessions' categories from ultra at the top to minor at the bottom.

Figure 2
A Comparison of Selected Recessions.
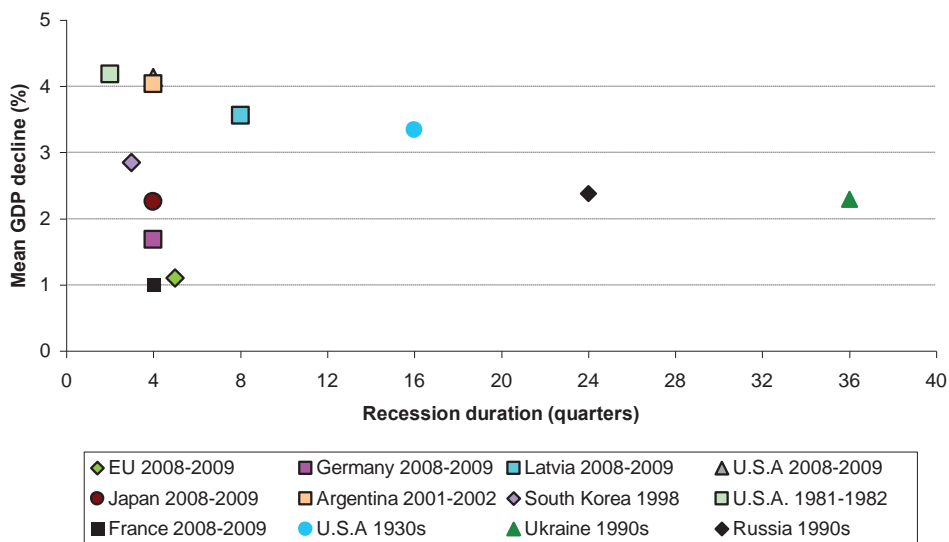
Note: This figure presents the distribution of selected recessions with regard to its deepness (G) and duration (D). Points identifying US 2008-2009 and Argentinean 2001-2002 recessions coincide in the figure, as both recessions are almost identical. Three 'outliers' on the right-hand side of the figure represent ultra recessions.

Figure 3
Magnitudes of Selected Recessions.
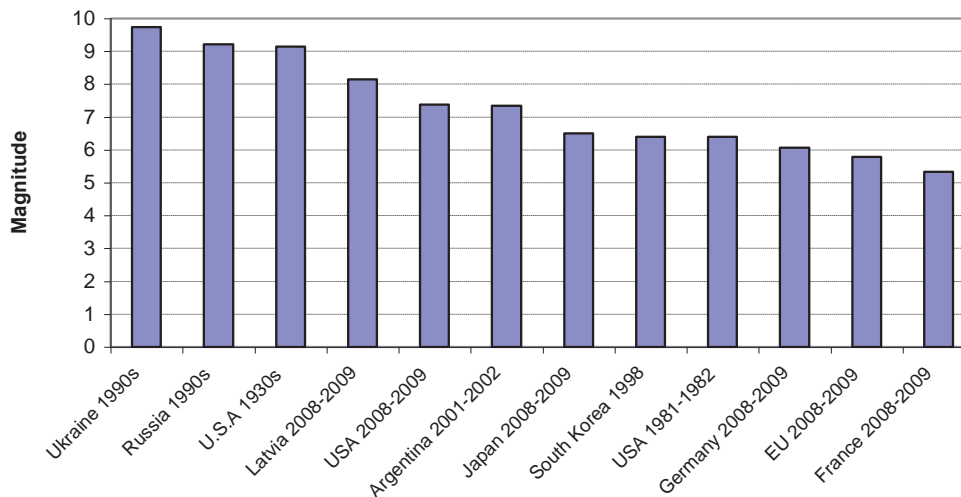
Note: This figure presents graphical comparison of selected recessions' magnitudes. As the magnitude scale is logarithmic, Ukrainian recession is in fact more than sixteen times bigger than recession in France.

Table 12

Combined (GDP + unemployment) Recession Magnitudes for EU Countries and 2007-2009 financial crisis

Country	M	G	U_1	U_2	U	M´
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Latvia	8.15	25.15	5.4	22.3	16.9	7.72
Estonia	7.81	20.37	3.7	19	15.3	7.48
Lithuania	7.47	16.6	4	17.4	13.4	7.23
Ireland	7.26	14.31	4.5	12.9	8.4	6.83
Finland	6.67	9.81	6.2	8.9	2.7	5.97
Slovenia	6.66	9.74	4.2	6.8	2.6	5.95
Luxembourg	6.48	8.6	4	6	2	5.73
Romania	6.36	7.99	5.7	7.6	1.9	5.63
Hungary	6.34	7.85	7.8	11.2	3.4	5.81
Sweden	6.28	7.52	5.6	8.9	3.3	5.76
Denmark	6.15	6.92	3.1	7.1	4	5.77
Italy	6.13	6.83	5.9	8.5	2.6	5.56
Germany	6.07	6.56	7.1	7.7	0.6	5.16
United Kingdom	6.05	6.44	5.1	7.9	2.8	5.53
Greece	5.88	5.76	7.5	11	3.5	5.53
Netherlands	5.76	5.3	2.7	4.3	1.6	5.11
Austria	5.70	5.11	3.6	5.6	2	5.15
Spain	5.67	4.9	7.9	19.4	11.5	6.36
Czech Republic	5.65	4.95	4.3	7.9	3.6	5.42
Belgium	5.43	4.25	6.6	8.6	2	4.97
Portugal	5.33	3.95	7.6	10.3	2.7	5.06
France	5.32	3.95	7.5	10	2.5	5.01
Malta	5.09	3.37	5.8	7.3	1.5	4.61
Cyprus	4.86	2.87	3.5	7.2	3.7	5.04

Source: authors.

5. Conclusions

The aim of the paper was to introduce a new recession magnitude scale derived from (negative) quarterly GDP growth rates during a recession and recession's duration. Using the magnitude scale, each recession can be characterized by a single value – its magnitude ('strength' or 'size'). This approach allows direct comparison of recessions' magnitudes in time and space. Furthermore, we proposed a recession classification based on our scale with the four categories of recession magnitude: minor, major, severe and ultra.

In the empirical part of the paper we evaluated some well-known recessions from the past. The US Great Depression in the 1930s and the recession following disruption of the former Soviet Union in 1990s were ultra recessions, while the Argentinean crisis in 2001-2002 and Thai financial crisis of 1997-1998 rank among severe recessions. The latest global financial crisis falls into severe category in the USA and into major category in the most of EU countries and Japan. Our findings confirm an exceptional status of the Great Depression in the US history as well as they reveal that the scope of the latest financial crisis is sometimes exaggerated in literature and media (see Eichengreen and O'Rourke, 2010), though the latest data suggest that EU is slipping into another recession in the beginning of 2012.

Further research may focus on the evaluation of 2012 EU recessions or on all post-war US recessions, and on recessions in developing countries, which were rather omitted in this paper.

We are well aware of the fact that construction of the magnitude scale from only one macroeconomic indicator, namely GDP, is too simplistic. One can take into account more parameters such as geographic scale, unemployment rates, decrease of stock indices, fall of industrial production or real income. However, when many parameters are used, ambiguity arises. Therefore, the simplicity of our scale is also its primary benefit: its definition is elementary, evaluation easy and interpretation clear.

Our scale opens new perspectives on comparison recessions' magnitudes of the past, it allows to assess recessions' magnitudes that are yet to come, and as for the present, it enables us to better recognize which country or region is affected by the recent economic downturn more than the other ones; thus, it can be supported and aided by an international community and international organizations. We would be pleased if the proposed measure was found useful, and we welcome further discussion as well as aspiration for its improvements, modifications or other applications.

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