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Banking Crises: Identification & Dating

Author: **Bc. Andrej Naščák**
Supervisor: **Mgr. Svatopluk Svoboda**
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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

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Prague, January 6, 2012 Signature

Abstract (in English)

The diploma thesis is devoted to the banking crises: their identification and dating. Theoretical part of the thesis contains two classifications of identification of banking crises. The first is the classification that distinguishes between event-method and index method, the second classifies the indexes in to the a) bottom-up approach, b) aggregate approach, and c) macroeconomic approach. The practical part of the thesis is, in its turn, divided into the parts dedicated to event-method, index-method, and results. Within "event-method" part there is presented compilation of banking crises periods for 11 selected countries, as found in the 4 four main databases. In the "index-method" I constructed two indexes for identification of banking sector crises, namely Banking Sector Fragility Index and Index of Money Pressure, for the same 11 countries. The thesis is concluded by the comparisons and discussion of the results, with the more attention paid to the case of Czech Republic. All indexes and tables with identified crises are presented in the appendix at the end of the thesis.

Abstrakt (in Slovak)

Diplomová práca je venovaná bankovým krízam, konkrétne problémom spojeným s ich identifikáciou a datovaním. V teoretickej časti sa zaoberá dvoma klasifikáciami prístupov ku identifikovaniu bankových kríz: Jedna rozlišuje medzi krízami identifikovanými na základe konkrétnych udalostí (takzvaný „prípadový" prístup) a krízami identifikovanými podľa indexov (takzvaný „indexový" prístup). Druhá klasifikácia rozdeľuje skupiny v rámci indexového prístupu (prezentované v 2. kapitole práce). Praktická časť diplomovej práce je venovaná bankovým krízam v jedenástich vybraných krajinách. Najprv je prezentovaná kompilácia bankových kríz v týchto krajinách, založená na 4 hlavných databázach bankových kríz (podľa „prípadového" prístupu). Následne sú konštruované 2 indexy s cieľom identifikovať (podľa nich) bankové krízy v týchto krajinách. Indexy sa volajú Banking Sector Fragility Index a Index of Money Pressure. Nakoniec sú výsledky oboch prístupov navzájom porovnané, a takisto sú navzájom porovnané výsledky oboch indexov. Bližšia diskusia je venovaná prípadu Českej republiky, kde indexy vykazujú lepšiu identifikáciu kríz než „prípadový" prístup. Tento fakt potvrdzujú aj akedmické štúdie českého bankovného sektoru. Indexy pre všetky krajiny aj s tabuľkami identifikovaných kríz sú priložené v prílohe na záver práce.

Used abbreviations

BSFI – Banking Sector Fragility Index

ICP – Index of Currency Pressure

IMP – Index of Money Pressure

SBM – Simple Banking Model

IMF – International Monetary Fund

BVI – Banking Vulnerability Index

BC – Banking Crisis

SC – Stressed Conditions

DSL – Distribution of Systemic Loss

PD – Probability of Default

LGD – Loss Given Default

DD – Distance to Default

D&D – Demirgüç-Kunt & Detragiache

L&V – Laeven & Valencia

H&D – Honnohan & Laeven

R&R – Reinhart & Rogoff

SIFI – Systematically Important Financial Institutions

FSC – Financial Supervision Commission

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Introduction

During the last 20 years banking crises swept through many emerging and transition economies; even developed countries were not left out, as the modern global crisis has shown:

The correct classification and dating of banking crises has become the important theoretical and practical issue. In the 1998 IMF and ECB officially started their own projects towards assessment of health of financial (not only banking) sectors. IMF also published its Yearly Outlook, which started the attempts of constructing Early Warning System of impending crises. These events may be seen as acknowledgment that the topic has become of international importance. The aspiration of Early Warning Systems is to construct the model that would help to detect banking crises before they actually occur.

Only if the banking crisis itself is identified and dated correctly it could be possible to try and empirically construct models that might have helped to see the crisis coming. Correct identification is thus the necessary prerequisite. This diploma thesis deals with the topic of banking crises' identification. It also touches upon the connected topic of EWS.

The thesis is divided into two parts: the theoretical part (chapter 1, chapter 2, and chapter 3) and the practical part (chapter 4, chapter 5, and chapter 6).

Traditional method of banking crises' identification is the so-called *Event-method*. Within it, the crises are identified base on anecdotic evidence, discussions with authorities, reports from newspapers and available relevant sources. It stands upon following *events* in the economy, mainly occurrence of run on banks, government interventions, forced mergers in the banking sector etc. The first chapter of the thesis is dedicated to this method.

The second approach towards crises' identification is the so-called *Index method*. It relies on quantitative measures. The index-method incorporates all the attempts of construction of *indexes* for banking sector. In the last decade, there appeared several indexes in academic literature as well as in practical usage of central banks. To these indexes and to the index-method itself is dedicated the second chapter of the thesis.

Lindgren, Garcia, & Saal (1996) classified approaches of banking crises' identification into the three groups: *bottom-up approach*, *aggregate approach*, and *macroeconomic approach*. The classification is dealt with in the second chapter as well.

The third chapter provides the discussion of the Signal approach. Once the crisis is identified, the efforts concentrate on the identification of indicators that could help to predict the crisis. There have been used mainly two approaches for this: the *Signal method*[1] and *econometric models* (under various logit and probit specifications).

Practical part of the thesis, beginning in chapter 4, is dedicated to the identification of banking crises in the 11 selected countries. Chapter 4 provides compilation of crises from the databases relying on event-method; chapter 5 and chapter 6 contain construction of two aggregated indexes for banking sector stability assessment: *Index of Money Pressure* and *Banking Sector Fragility Index*. Indexes themselves are introduced in subchapters 2.2. and 2.3 of the thesis.

Chapter 7 discusses the results.

[1] Sometimes called also signal extraction models or threshold approach.

1. Event Method

The use of event method as tool for banking crises identification have become widespread since the publication of IMF's of its World Economic Outlook in May 1998.

Within it, following operational definition was put into praxis:

"Banking crisis is a situation, in which bank runs and widespread failures induce banks to suspend the convertibility of their liabilities or which compels the government to intervene in the banking system on large scale."

The event-method relies mostly on supervisory sources and listings of government measures undertaken in response to a crisis (Boyd, Nicolo & Loukoianova 2009). It is by far the biggest strand of crises identification employed in research. Certain observable events, such as forced bank closures, mergers, runs on banks, and government emerging measures are taken as signals of impending banking crises (Hagen & Ho, 2007). It identifies banking crisis by occurrence of specific events. Identification is done based on anecdotic evidence, existing literature (be it from the newspapers or academic journals) and on narratives taken from supervisory authorities and expert sources (Caprio and Klingebiel, 2002).

It does not mean, however, that quantitative measures are completely absent. Occurrence of crisis is delineated by specific event, but actual severity of observed events might be captured by quantitative indicators[2].

The main events that the researchers are interested in are bank runs[3] and government interventions, following the above stated definition of IMF from 1998. The two are listed as major events in virtually all databases on banking crises relying on event-method (see Table 8 and sources cited therein; see also appendix A).

In the last decade, classification of banking crises based on event-method has nevertheless been facing serious challenges.

[2] The very well-known example is Demirguc-Kunt & Detragiache (1998), discussed further in the thesis.

[3] Researchers may distinguish the *bank panic* as a term representing massive bank runs as opposed to the bank run on individual banks (i.e. bank runs on small scale). E.g. Freixas & Rochet (2008) think the distinction very important. In this thesis, however, the term *bank run* involves both meanings.

Challenges of event-method

- Within the event method there is permanent problem of how to clearly identify the beginning and end of the crisis (Singh 2009). It could date crises too late, because financial problems usually begin well before a bank is finally closed or merged; it could also date crises too early, because the worst of a crisis may come later after the specific event. Without the final event, it is often difficult or impossible to accurately pinpoint the year in which the crisis ended (Reinhart and Roggof, 2009). Identification of the crisis when it has become severe enough to trigger certain events can lead to the delayed recognition of the crisis (Hagen and Ho 2003).
- When the end of the banking crisis is uncertain, it may happen that what is considered as more crises in country is in reality only prolonged continuation of single crisis. "*... It is not always clear when the crisis is over, and in the case of countries in which there are multiple episodes, it may well be that later events are merely a continuation of those occurring earlier*" (Caprio & Klingebiel 1996, p. 2).
- This method does not identify the different degrees of crisis severity. Caprio & Klingebiel (2003), Laeven & Valencia (2008) and Reinhart and Rogoff (2009) within event-method distinguish between two kinds of banking crises. Between the "systemic" (**severe, Type I**) and "non-systemic" ones (**mild, Type II**). But the uniform criterion for this distinction is only occurrence or not of massive bank runs[4]. Type II is identified when there are neither bank runs nor public takeover, but nevertheless there occur closures, merging, take-over of financial institutions by corporations of other financial houses, or massive government bailouts of an important financial institution(s).[5]

From banking sector perspective, *systemic banking crises* have always been of higher importance than the distresses of individual banks. In the practical part of the thesis I also distinguish between the "systemic" and "mild" banking crises (BSFI) and between "mild" and "extensive" crises (IMP)

[4] See table on the pp. 11 in Reinhart and Rogoff (2009) for summary of their approach.
[5] Table on page 11 in Reinhart & Rogoff (2009)

Reinhart & Rogoff (2009) identified systemic crisis as a situation "*when in a country there is occurrence of following events: Bank runs that led to the closure, merging, takeover by the public sector of one or more financial institutions.*"[6]

The systemic risk of whole banking sector is also approached differently than the risk of individual banks.[7] Although policymakers, financial authorities and researchers are not unanimous on the definition of systemic risk, *"…its broad outlines are generally accepted: it is the possibility that an event will trigger a negative feedback loop that significantly affects financial markets ability to allocate capital and serve intermediary functions, which, in turn, will create spillover effects on the real economy that have no clear self-healing mechanisms.*"[8]

- The most characteristic event that signals banking sector crisis is occurrence of run on banks and/or attack on domestic currency. It is not straightforward to date periods of bank insolvency in the absence of runs and abrupt exchange-rate changes (Caprio & Klingebiel, 1996).

Advantages of event-method

- It is relatively easy to find information on the date of both government intervention and change in banking regulations (Kibritçioglu, 2003).
- Quantitative identification of crises requires long time series for individual countries. But uncovering hidden problems within banking sector often runs into the unwillingness of banks to reveal their true conditions. Event-method is not dependent on the collected data, so it has not got such problems. It may more often get access to insider information.
- Interviews from authorities and involved financial dignitaries may reveal some information that would not be disclosed by quantitative data on banking sector performance.

[6] Reinhart & Rogoff (2009), pp. 11.
[7] The problem of translating risk of individual financial institutions to the risk of whole sector constitute the main problem of so called bottom-up-approach, briefly reviewed in the subchapter 2.6 of the thesis.
[8] Group of Ten (2001), pp. 126; Hendricks, Kambhu, & Mosser (2007), pp. 65; Gramlich et al. (2010), pp. 199

- Reliance on following events might exclude fragile situations in the banking sector that were successfully handled but might otherwise have become crises (Gramlich et al. 2010).

Discussion is summed up in the following table.

ADVANTAGES	DISADVANTAGES
• Straightforward identification of events	• Non-exact dating: Crises may be identified too late; endings may be set too early.
• Preferable to short time series; the only method for detecting historical crises.	• Does not systematically distinguish various degrees of crises severity.
• May contain insider information about true condition of banks (unwillingness of banks to disclose quantitatively).	• Reports predominately Bank Runs or attack on domestic currency
• Not dependent on methodological challenges of data reporting and collecting.	• Does not identify stressed conditions per se, only particular events.
	• Exclude episodes of stress that were managed but otherwise might turn into a crisis.
	• For an individual researcher it is not easy to collect even-based information on banking sector difficulties across the world.[9]

Table 1: Event-method: pros & cons
source: author's compilation

[9] Kibritçioglu (2003), box on the pp. 52

2. Index Method

Although reliance on event method has persisted as the most commonly used till nowadays, the need for qualitatively-driven measures of banking sector stability has become recognized. Indexes that would be able not only to detect periods of high banking sector fragility, but also to continually observe "current health" of banking sector (and generally financial sector) have come into the focus during the last 15 years. On international level, starting points of joint international research in this field were 1998 and 1999.

- October 1998: "*In the Report of the Working Group on Strengthening Financial Systems, 22 finance ministers and governors of central banks gave prominence to assessing the soundness of financial sectors as part of IMF's surveillance work*"[10]
- May 1999: IMF in cooperation with World Bank launched the initiative called Financial Sector Assessment Program. Its proclaimed aim was to identify financial system strengths and vulnerabilities. (Evans et al. 2000)
- International financial organizations, national central banks as well as private institutions "*...have begun to develop Early Warning Systems (EWS) models with the aim of anticipating whether and when individual countries may be affected by a financial crisis.*"[11] Leading position among initiatives was taken by IMF, starting with the publication of IMF (1998).

Over the last 15 years, this field of research has experienced vast expansion in all of its areas.[12] Listing of important partial areas to be covered and the overview of relevant literature can be found in Gramlich et al. (2010). Attempts to construct composite indexes did not limit themselves only to assessment of banking sector condition; the aspiration was to develop composite index that would in some way be able to assess the health of financial sector as a whole, ideally with external sectors and possibility of international contagion in mind.

[10] Evans et al. (2000), pp. 1.
[11] Bussiere & Fratzsher (2002), pp. 5
[12] For the review of the current development in this area see Gadanecz & Jayaram (2009).

Main advantaged and disadvantages of index-method mentioned in the literature are summarized in the following table:

ADVANTAGES	DISADVANTAGES
• Based on the theoretical considerations / models	• Some data series may by biased because of wrong reporting practices.
• Not open to subjective interpretation of the results to the degree that event-method is.	• Time series in sufficient frequency or sufficient time span are often not available.
• Possibility to calibrate indexes to the country-specific characteristics	• Possible bias towards the way of construction; how to choose the method?
• Continuous monitoring of banking sector on monthly basis.	• Crucial data series might not be available at all (mainly the sensitive, e.g. nonperforming loans of banks)
• Might be calibrated and updated at will on the daily basis.	

Table 2: Index-method: pros & cons
Source: author's compilation

One often used methodological classification of models and indexes for identifying impending crises and/or crises that are already in full swing was firstly introduced in Lindgren, Garcia & Saal (1996). They proposed classification of approaches into three groups.

a) Aggregate approach
b) Macroeconomic approach
c) Bottom-up approach

A) Within the **Aggregate approach**, indexes are constructed based on aggregated data for banking sector as such. This approach is represented mainly by attempts to construct overall indexes of banking and/or financial sectors' fragility (see e.g. Kibritçioglu 2003, Hawkins & Klau 2000, Hagen & Ho 2007) Their aspiration is to assess the conditions of whole banking sectors and their tendencies. On the other hand, aggregated data don't deal with the differences in importance of some banks relative to the others, because aggregated data cannot reveal the actual structure of banking sector. The attempts to bring these two

aspects into the comprehensive mix were once titled as "marrying the micro- and-macro prudential dimensions of financial stability"[13].

B) **Macroeconomic approach**, "*...instead of looking at bank balance sheet data for internal sources of unsoundness ... establishes systemic relationship between economy wide variables and indicators of banks soundness.*"[14] It has come into prominence following the IMF's publication of its Outlook in 1998. Numerous studies tried to find relationship between economy-wide variables and the incidence of a banking crisis in a country. To this end, there were used two main methodological approaches: a) "Signal approach" and b) econometric models, mainly various versions of logit and probit models.

- Signal approach was firstly introduced in the field of banking crises in Kaminsky & Reinhart (1999). It was later employed by Reinhart & Rogoff in several of their papers.[15] Detailed description of Signal method can be found in Kaminsky, Lizondo & Reinhart (1998). To this approach is devoted the third chapter of the thesis.
- Logit and probit econometric models, both in univariate and multivariate specifications, have during the recent years already grown into the large body of literature. The first to employ multivariate logit method were Demirgüç-Kunt & Detragiache in their work from (1998). It is also discussed a bit more in the third chapter of the thesis.

  Probit model was developed by researchers of IMF (Gramlich et al. 2010). Logit models were developed by three investment banks: Goldman Sachs, Credit Suisse First Boston, and Deutsche Bank between 1999 and mid-2001 (Gramlich et al. 2010)

c) Bottom-up-approach is discussed in subchapter 2.6.

In the following subchapters I am presenting exposition of (in my view) most significant results in the field of index-method for banking sector stability assessment: Subchapter 2.1 overviews the aggregate indexes currently employed by various central banks. Among few researchers who came up with their own aggregate indexes, I dedicate attention to Hawkins and Klau (2000) with their Banking Sector Vulnerability Index

[13] By Andrew Crocket, general manager of BIS, in the speech at Financial Stability Forum, 2000
[14] Singh (2009), pp. 5.
[15] Reinhart & Rogoff (1999), Goldstein, Kaminsky & Reinhart (2000), Kaminsky & Reinhart (2009)

(BSVI), to Kibritçioglu (2003)[16] and to Hagen & Ho (2000, 2004, and 2007). Descriptions of their indexes constitute subchapters 2.2, 2.3 and 2.4, respectively. Moreover, in the practical part of the thesis I am reconstructing Hagen & Ho's index called Index of Money Pressure (IMP) for the sample of selected countries. I am also constructing Kibritçioglu's (and Singh's) index called Banking Sector Fragility Index (BSFI), with altered set of variables and modified interpretation.

IMF's experts in Boyd, Nicolo & Loukoianova (2009)[17] constructed Simple Banking Model (SBM) on the basic banking theory. Their aim was to put the ongoing research of banking crises' identification and dating on the firm (theoretical) ground. They also wanted to identify the economic variables that could be helpful in identification of impending or potential banking crises. Their theoretical model and results are provided in simplified version in subchapter 2.5 of the thesis. Subchapter 2.6 contains more discussion on the bottom-up approach.

Within the classification of Lindgren, Garcia, & Saal (1996) introduced above, indexes fall into the following groups:

- **MPI**, **BSFI** and **BSVI** are examples of aggregate approach. They rely exclusively on aggregated data on banking sector. Indexes used by central banks, which are presented in 2-1, also belong to this group.
- **SBM** comes under the macroeconomic approach; although it is theoretical model of banking, it is developed (solely) for the purpose (as stated by authors) to enable identification of such economic variables, evolution of which would signal higher probability of banking crises.

2.1. Central banks' indexes

Nowadays many central banks are using own indexes for assessing stability/fragility of their domestic banking sectors. Indexes are often calibrated in a way so as in the best possible way to match country-specific characteristics of their banking sectors. This makes the applicability of individual countries' indexes for the cross-country comparison problematic. Overview of attempts towards composite indexes for assessing financial

[16] and Singh (2009) taking up and modifying his index

[17] I.e. experts affiliated at University of Minnesota, IMF Research Department, and Barclays Capital, respectively.

stability, as nowadays employed by various central banks, is presented in Geršl & Heřmánek (2008). Svoboda (2009)[18] classified indexes according to the data utilized in their construction. Following enumeration is based on these two works. Čihák (2006) presents overview and discussion of Financial Stability Reports that Central Banks periodically publish.

Turkish Central Bank employs the most direct way of index's construction for assessing the soundness of Turkish banking system. It relies on the data collected from banks' balance sheets and on the economy-wide variables; it aggregates them and constructs the index as their weighted average. Variables are chosen so as to monitor several characteristics of banking sector condition. Turkish central bank experts' choice was to employ sub-indices that cover: asset quality, liquidity, foreign exchange rate risk, profitability and capital adequacy.

US Federal Reserve System and Canadian central bank rely on the market data in construction of their index. Compared to data from banks' balance sheets or from supervisory authority, market data has got the advantage of being available in high frequency. In the market data the *expectations* of market participants are incorporated. Index calculated on the basis of these data therefore *"…tend to signal the increased/decreased probability of financial fragility, as perceived by financial markets. They serve as forward-looking measure of financial stability.*"[19] Moreover it is assumed that all information and risks in the economy are in the market data taken account of, these risks are directly projected to the prices on financial markets (Gropp 2004). Market data are not confidential, so replication and verification of the results' is possible. This is not so straightforward with the indexes based on supervisory data, as they are often confidential (Čihák 2007)[20]

[18] Diploma thesis of the Charles University.
[19] Svoboda (2009), pp. 17.
[20] Gropp (2004) and Čihák (2007) are referred to in Svoboda (2009).

Swiss Central Bank constructed cosmopolite index based on banks' balance sheets' data and market data. Their endeavor was to utilize all possibly relevant data available. Their "stress index" comprises data on financial institutions (collected from statistics and balance sheets of banks), data on financial market development (readily available on day-to-day basis) and supervisory information.

Netherland Central Bank transformed their "monetary condition index" into the aggregate index monitoring soundness of Netherland's financial sector. "*Monetary Conditions Index accounts for wide range of variables in economy, which makes aggregate index (which is based on it) account for them as well.*"[21]

2.2. Index of Money Pressure (IMP)

Index of Money Market Pressure (IMP) was constructed and employed in Hagen & Ho (2000), Hagen & Ho (2004) and Hagen & Ho (2007). Authors got inspired by the existing Index of Currency Pressure (ICP) of Eichengreen, Rose and Wyplosz (1995, 1996a, and 1996b).

IMP is constructed based on the theory of matching demand and supply on the money market between central bank and banking sector. They hypothesize that *during the banking distress of crisis there is sharp increase in the banking sector's aggregate demand for central bank reserves*. Following authors' argumentation, the hypothesis is valid in the several possible situations that may arise before the crisis: decline in the quality of bank loans, increase in non-performing loans, sudden withdrawals of banks' deposits, e.g. run on banks, drying up of inter-bank market. All these are quite characteristic features of banking sector's distress, and make banking sector turn to the central bank for help in the form of liquidity injection.

a) Banking sector needs to maintain liquid, thus banks' demand for reserves rises upward. Such liquidity shortage may be the consequence of sharp decline in the quality of bank loans or an increase in non-performing loans.
b) Banks are forced to turn to the central bank for refinancing, when there is sudden occurrence of withdrawals of deposits by the public. E.g. there is run on the bank.

[21] Svoboda (2009), pp. 19

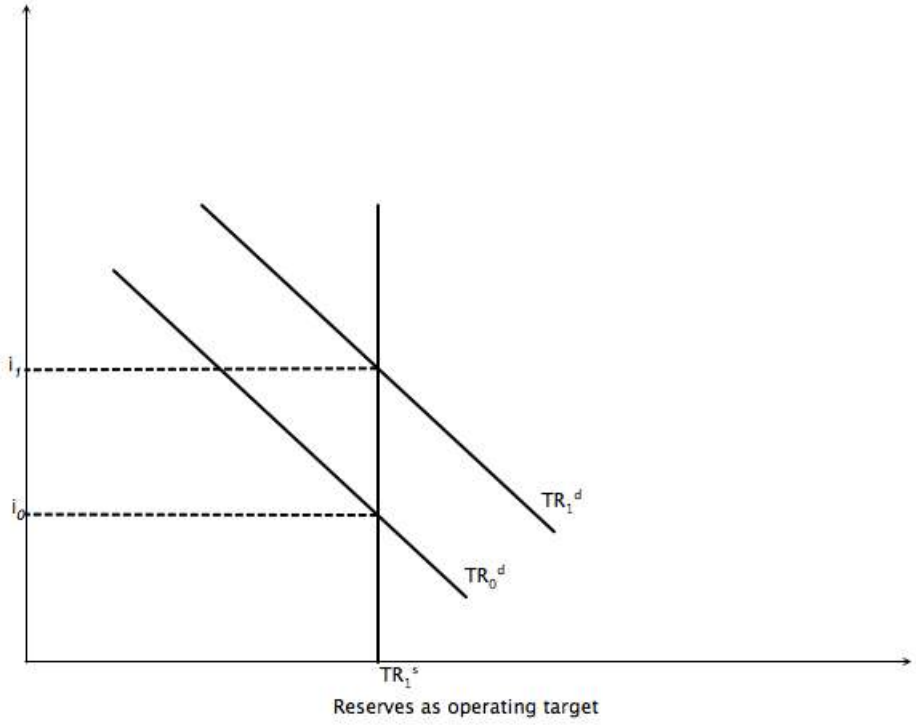
c) Banks may be well unwilling to lend money to troubled banks, preferring to hold safer assets and mainly government bonds. It may be a situation of "dried-up" inter-bank market (Furfine 2002[22])

Central bank is o monopolistic supplier of bank reserves. It can react to increased demand for its reserves in two ways, depending on its proclaimed target of monetary policy:

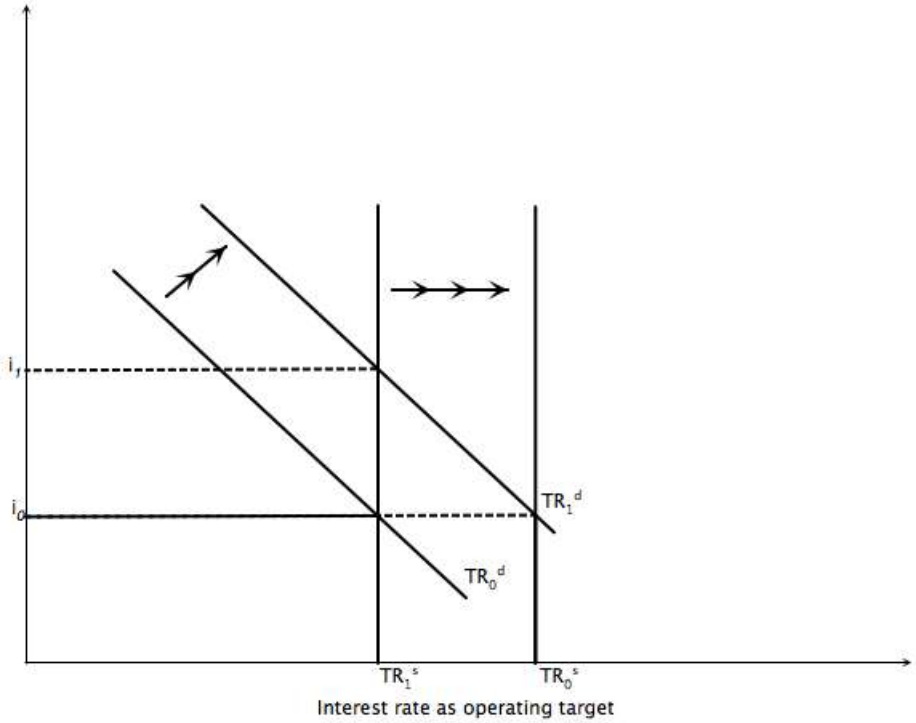
a) In case when the operating target of central bank is the amount of held reserves, it *keeps the supply of bank reserves unchanged and the short-term interest rate will rise*.
b) In case when the operating target of central bank is the short-term interest rate, in order not prevent it from changing central bank has to *provide additional reserves into the banking system*.[23]

Both situations can be depicted using following simple graphs:

[22] Referred to in Hagen & Ho (2007)
[23] Through either open market operations or discount window lending.



Reserves as operating target



Interest rate as operating target

Source: Hagen & Ho (2004)

Reproduced by the author of the thesis

Thus, following the hypothesis, *banking crises should be accompanied* and characterized by a *sharp increase in the short-term interest rate*, a *large increase in the volume of central banks reserves*, or a *combination of both*.[24]

2.2.1. Construction & Interpretation

See practical part of the thesis.

2.3. Banking Sector Fragility Index (BSFI)

This index was proposed by Kibritçioglu from Turkish Central Bank, in the work Kibritçioglu (2003). It was also used in a slightly modified version by Singh (2009)[25]. Its name is Banking Sector Fragility Index (BSFI).

Logic standing behind its construction is the effort to measure the exposure of aggregate banking sector to the main financial risks, such as credit risk, liquidity risk, exchange-rate risk and various market risks.

"**Credit risk** is risk of losses resulting from the failure of counterparty to meet its obligations in accordance with the terms of contract under which the banks have become a creditor of counterparty." It is "potential loss because of the inability of counterparty to meet its obligation", or "a potential loss of portfolio due to the (partial) default of counterparty." Sometimes it is called default risk."[26]

Liquidity risk is "the risk that bank will lose its ability to meet its financial obligations as they are due, or the bank will not be able to fund its assets." Potential of losses is even higher in case of insufficient depth of inter-bank market.

Exchange rate risk is "the risk that the bank may suffer losses as a result of adverse exchange rate movements during a period in which it has an open position in a currency. Where the value of asset/inflow exposures in one currency is not equal to the value of liability/outflow exposures in that currency this is described as an open position. Open positions may be short (liabilities exceeds assets) or long (assets exceeds liabilities) … Banks with a short open position in a currency are exposed to the risk that the currency

[24] Exposition of the IMP is based on Hagen & Ho (2000, 2004, and 2007).
[25] Unpublished or forthcoming
[26] All definitions of the risks (except exchange rate risk) are from Mejstřík, Pečená & Teplý (2008), pp. 141 – 143.

might appreciate, while those with long open position in a currency are exposed to the risk that the currency might depreciate."[27]

Market risk is "risk to the bank of losses resulting from changes in prices, exchange rates and interest rates of financial markets." "It is a summary term for interest rate risk, foreign exchange risk, equity risk and other risk associated with movements in market prices." In still other words, it is "potential loss of a portfolio/assets/derivative due to changes in the markets". Existence of market risk is a result of "uncertainty of future earnings resulting from changes in market conditions."

Proxy measures for each of the selected risks are chosen and their percentage changes (in real terms) computed. BSFI is then constructed as their weighted average. So as to none of the variables dominates the index, all are statistically normalized.

2.3.1. Original BSFI

Author of the BSFI's, Aykut Kibritçioglu's, proposition was to take into account three risks: *Credit risk, liquidity risk,* and *exchange-rate risk.* He also suggested proxy variables for these risks:

- *Total Claims of domestic banking sector on private sector* as proxy for credit risk (i.e. claims on private sector – *CPS*).
- *Total deposits in the domestic banking sector* as proxy for liquidity risk (i.e. Total Deposits – *TDEP*).
- *Total foreign liabilities held by domestic banking sector* as proxy for exchange-rate risk (i.e. Foreign Liabilities – *FL*).

His BSFI uses annual percent changes of followed variables and is constructed as their average. Data used are month-to-month. By employing this data-frequency he tried to avoid any seasonality incorporated in the data, because banking crises should not be signaled simply by "*monthly fluctuations in banking variables, such as bank deposits, claims on private sectors, of foreign liabilities. They must be caused by longer term and powerful deteriorations in the banking sector.*"[28]

[27] FSC (2006), pp. 3
[28] Kibritçioglu (2003), p. 4

Proposed index looks as follows:

$$BSFI_t = \frac{\left(\frac{CPS_t - \mu_{cps}}{\sigma_{cps}}\right) + \left(\frac{FL_t - \mu_{fl}}{\sigma_{fl}}\right) + \left(\frac{DEP_t - \mu_{dep}}{\sigma_{dep}}\right)}{3}$$

Where:

$$CPS_t = \frac{LCPS_t - LCPS_{t-12}}{LCSP_{t-12}}$$

$$FL_t = \frac{LFL_t - LFL_{t-12}}{LFL_{t-12}}$$

$$DEP_t = \frac{LDEP_t - LDEP_{t-12}}{LDEP_{t-12}}$$

Symbols μ and σ stand for the arithmetic average and standard deviation of respective variables. Letter *L* put before variables indicate that the variables are in real values.

Interpretation of the index

Interpretation of index's evolution is the indispensable part of its construction. Kibritçioglu's aspiration was that BSFI would not be only the tool for identifying periods of banking crises, but that from its evolution over time it would be possible to get a picture of the evolution of risk–exposure of aggregated banking sector. Based on his proposition, Index is to be interpreted as follows:[29] Increasing values of BSFI signals improving conditions of banking sector, decreasing values deteriorating ones. In the given month, value of BSFI below zero means that risks (those that BSFI monitors) started to materialize.

a) $BSFI > 0$: Values of BSFI above zero indicate healthy banking sector.
b) $0 > BSFI > C$: Values below zero but still above C indicate worsened state of banking sector, but still not full-fledged crisis.
c) $BSFI < C$: Values of index below C mean that systemic banking crisis is under way.

Concrete value of C, which is the threshold between stressed banking sector and banking crisis, is to be set arbitrarily. Author proposes C to be –0.5. Banking sector is in crisis when average of observed indicators annually drops by more than half.

[29] The same interpretation adopted Svoboda in his diploma thesis in Charles University in 2009.

From the point of view of risk-taking, evolution of the index is to be read as follows[30]:

- Values of BSFI above zero mean that banking sector is willing a) to accumulate deposits (*TDEP*), b) to be committed to private sector (*CPS*) and c) to hold foreign liabilities.
- Values "too much" above zero, however, may signal excessive risk-taking of the banks. Although banking sector is healthy, it may be considered as indulging in taking higher risks. Its risk-exposure accumulates.
- Decreasing BSFI, but with values still above zero may be interpreted as risks that started to materialize. Health of the banking sector itself is not endangered, but there might be signals of sobering. It may be sign for higher caution about the future development.
- Values of BSFI below zero and then below the threshold value *C* mean that risks materialized to the extent that has pushed "the banks to suspend the internal convertibility of their liability"[31].

Author constructed also additional index, BSFI2, in which he omitted the variable *TDEP* (The meanings of symbols remain unchanged)

$$BSFI2_t = \frac{\left(\frac{CPS_t - \mu_{cps}}{\sigma_{cps}}\right) + \left(\frac{FL_t - \mu_{fl}}{\sigma_{fl}}\right)}{2}$$

Omitted variable *TDEP* had initially been used as proxy for the exposure of banking sector to liquidity risk. It was a measure used for sudden massive withdrawals, i.e. bank runs. Kibritçioglu (2003) did not discuss in detail the underlying reasons why he omitted this variable. It appears that it was his concession to the then popular opinion that in the modern world bank-runs had not been so serious trigger of banking crises any more. There had been raised voices that liquidity risk itself was not so much of the problematic issue for banking industry anymore. Main back-up arguments for this were the existence of effective deposit insurance, working interbank market, and liquidity interconnection between main banks (mothers) and their subsidiaries in various countries.

[30] Based on Kibritçioglu (2003), box 2, pp. 55; the interpretation was retaken also in Svoboda (2009).
[31] Sentence describing the crisis is from IMF (2008).

Deposit insurance had been supposed to ensure trust of people that they would not lose their money[32], and thus prevent run on bank (i.e. the main situation in which liquidity-risk's exposure of banks materializes). Working and sufficiently deep inter-bank market had been, and still is, supposed to be the place where banks could get access to enough liquidity in case of sudden deposits' withdrawals. Finally, in the modern globalized world it is commonplace that large bank, usually situated in developed country, has many of its own subsidiaries, smaller banks, in numerous countries, usually emerging and transition ones. There was a notion (supported by experience) that the developed countries were already out of risk of bank runs, that people forming long queue before banks trying to massively withdraw all their deposits in panic were think of the past, that the modern developed countries had successfully "graduated"[33] from such experiences. Bank runs were deemed to be left only for emerging countries and/or for the economies in transition. But as long as majority of banking sector in these economies was formed by subsidiaries of large internationally operating banks, they were also deemed to have had no major problems with getting access to sufficient liquidity (from their "mothers"). Thus in the developed countries the bank runs were considered to have been experiences of the past (to have been graduated from) and even in the emerging/transition countries bank runs were no longer deemed as possible trigger for *systemic* banking crisis, since international "mothers" kept an eye on their branches, ready to provide liquidity when needed.

This view has not become the alternative for the main stream opinion on the banking crises incidence. IMF and event-method databases from Table 8 always counted bank runs among the main causes standing behind the occurrence of banking crises. To my knowledge the opinion that bank runs' importance started to fade away were shared quite commonly, though[34]. In any case, it was enough for Kibritçioglu to make him exclude the proxy of them from his index, in order to assess their relative importance. Singh (2009) conducted the same exercise in Kibritçioglu's footsteps.

[32] Although the actual functioning of this had been often subject of research, e.g. Demirguc-Kunt & Detragiache, 2002 and many others.

[33] The term "graduation" of a country from episodes of repeating financial crises was introduced in Reinhart, Rogoff and Savastano (2003).

[34] Knowledge in the field, gain from the studied literature, mainly cited throughout the thesis, and from the many discussions on the topic.

Thus bank runs, traditionally crucial for liquidity risks' exposure of *aggregated* banking sector, had been by developed world beginning to be seen as not sufficient a cause for systemic banking crisis on the grounds that: 1) Incidences of bank runs were limited only to emerging/transition economies. 2) If there was fall of people's trust only towards one, or small number of, domestic banks in emerging country, the banks could have gained sufficient short-term resources on inter-bank market to cushion their current need for liquidity (especially when they were deemed solvent). 3) In the emerging/transition countries, there occurred bank runs also on the "more important domestic banks" or larger number on domestic banks in such an extent that banks were not able to sufficiently help each other on the inter-bank market. In such a case there were supposed to be large international institutions in place, providing liquidity in amount that was needed for their branches not to fall.[35]

Nevertheless, widely scoped financial crisis that broke out in mid-2007 in the United States and spread almost worldwide[36] afterwards, was also accompanied by bank runs, as well as it started by sudden loss of people's trust in the banking practices. In my view it sufficiently showed that liquidity problems may become severe enough even for the largest banks and banking sectors to survive. Moreover, when "mothers" themselves are subject to bank runs, their branches in other countries cannot count on them in providing liquidity injections. Their exposure to liquidity risk (and vulnerability in potential bank run in domestic country) is in this case the same as for other domestic banks. It can well be even more pronounced, when their parent claims their reserves in the effort to solve its own liquidity problems abroad.

I will construct slightly modified version of BSFI in practical part of the diploma thesis. From the traditional point of view, bank runs and liquidity shortage traditionally represented the main components of their risk. Also ongoing situation in banking sectors worldwide suggests that this primary risk, rooted in the basic principle of banking itself, should not be neglected in assessing the fragility of banking sectors.

[35] Argumentation collected mainly on the basis of the literature cited throughout the thesis and on the discussions on the topic. The argumentation holds more strongly in the case of developed countries. In emerging and transition ones, it is true, incidences of bank runs were taken, in spite of everything, more seriously.

[36] Reinhart & Rogoff (2009) in their extensive treaty of financial crises have titled it as "Second Great Contraction".

Problems with materialization of liquidity risk, however, may get another dimension in time to follow: on the 5th of November 2011, Financial Stability Board "completed the development of the critical policy measures to address the systemic and moral hazard risks associated with systemically important financial institutions (SIFIs)"[37]. The development of the measures had been the task assigned to the Financial Stability Board by leaders of G20[38]. In their final publication they provided list of 20 financial institutions, all of them banks that fulfilled the criteria for considering them to be "too big to fail". These banks effectively obtained guarantee of help by governments of G20. What consequences it will bring as to the risk-taking and moral behavior of managers of these banks remains to be seen. Banks that are considered "too big to fail" are: Bank of America, Bank of China, Bank of New York Mellon, Banque Populaire CdE, Barclays, BNP Paribas, Citigroup, Commerzbank, Credit Suisse, Deutshe Bank, Dexia, Godlman Sachs, Group Crédit Agricole, HSBC, ING Bank, JP Morgan Chase, Lloyds Banking Group, Mitsubishi UFJ FG, Mizuho FG, Morgan Stanley, Nordea, Royal Bank of Scotland, Santander, Société Générale, State Street, Sumitomo Mitsui FG, UBS, Unicredit Group, Wells Fargo[39].

2.3.2. Modified BSFI

BSFI was then utilized in a modified way by Indian researcher Singh in Singh (2009). He "*...constructed monthly banking sector fragility index of India and developed the ordered probit model for predicting the banking crisis using macroeconomic indicators*".[40] Author's main purpose consisted of creating Early Warning System (EWS) for India. He utilized BSFI as a tool that could enable him to identify exact months during which banking sector in India was experiencing distress. The identified months then served as explained dummy variables in ordered probit model: crisis month was set to *1*, month without crisis *0*.

[37] The news circulated throughout in the mass media worldwide. Official announcement was released by Financial Stability Board on the 5th of November 2011 in the publication *FSB G-SIFIs: Policy Measures to Address Systemically Important Financial Institutions.* It is available on their official website at: http://www.financialstabilityboard.org/list/fsb_publications/index.htm.

[38] G-20 = group of Twenty Finance Ministers and Central Bank Governors, established in 1999.

[39] 17 banks are from Europe, 8 from USA, and 4 from are Asian banks.

[40] Singh (2009), abstract … maybe also somewhere else in the text…

Singh's specification of BSFI was as follows:

$$BSFI6 = \frac{\frac{Dep_t - \mu_{dep}}{\sigma_{dep}} + \frac{Cred_t - \mu_{cred}}{\sigma_{cred}} + \frac{Inv_t - \mu_{inv}}{\sigma_{inv}} + \frac{FCA_t - \mu_{FCA}}{\sigma_{fca}} + \frac{FCL_t - \mu_{fcl}}{\sigma_{fcl}} + \frac{Rsv_t - \mu_{rsv}}{\sigma_{rsv}}}{6}$$

Where:

$$Dep_t = \frac{LDep_t - LDep_{t-12}}{LDep_{t-12}}$$

$$Cred_t = \frac{LCred_t - LCred_{t-12}}{LCred_{t-12}}$$

$$Inv_t = \frac{LInv_t - LInv_{t-12}}{LInv_{t-12}}$$

$$FCA_t = \frac{LFCA_t - LFCA_{t-12}}{LFCA_{t-12}}$$

$$FCL_t = \frac{LFCL_t - LFCL_{t-12}}{LFCL_{t-12}}$$

$$Rsv_t = \frac{LRsv_t - LRsv_{t-12}}{LRsv_{t-12}}$$

Used symbols stand for:

Dep – annual growth in real time deposits; Cred = annual growth in real non-food credits;

Inv – annual growth in real investment in approved non SLR securities;

FCA – annual growth in foreign currency assets;

FCL – annual growth in foreign currency liabilities;

Rsv – annual growth in real net reserves.[41]

Discussion

"*The monthly banking sector fragility of India was constructed by considering the risk taking behavior of commercial banks in terms of liquidity risk, credit risk and interest rate risk*"[42]. He did not, however, discuss the reasons why he chose just the selected variables at all.

[41] Thus, variables used are: aggregate time deposits, non-food credit, investment in other approved and non-Statutory Liquidity Ratio (non-SLR) securities, foreign currency assets and liabilities, and the net reserves of Commercial banks (In India).

[42] Singh (2009), pp. 9.

He also treats exchange rate risk as part of market risk, or so it seems. He does not mention the risk explicitly in his enumeration, but variables of *foreign assets* and *foreign liabilities* are hardly employed for other purpose. Singh's choice of variables and risks to be observed alters the interpretation of the index itself in several ways. He doesn't present their discussion.

a) **Interest rate risk**: Variable *investment* is employed for capturing exposure of banking sector to interest rate risk. It appears in line with Kibritçioglu's initial intention: In times of healthy banking sector and economic stability, banks tend to invest more freely, amount of their aggregated investment rises. From the perspective of risk-taking, they are willing to take on more risks, exposure to interest rate risk rises as well. In times of decline and/or financial instability, accumulated interest rate risk materializes, and banks cut short on their investments.

b) **Liquidity risk**: Variable *Reserves of banks* was added to the originally proposed *total deposits* for capturing the exposure of banking sector to liquidity risk. Adding the *Reserves* among the variables alters its interpretation. Higher values of reserves in my view cannot be explained as higher risk taking in terms of liquidity risk. It seems that it was adding this variable that made Singh omit the interpretation of high values of his BSFI as increased risk taking.

Decreasing values still retain the same interpretation, however. Values below zero (and under the threshold value) signal the banking sector distress and crisis.

c) **Credit risk**: Variable capturing the exposure of aggregate banking sector to the credit risk is the *non-food credit*. The logic and interpretation seems to be the same as in original BSFI. Different name of used variables reflect by all appearances only the different data sources.[43]

d) **Exchange rate risk:** Kibritçioglu's BSFI works only with variables of *foreign liabilities*, i.e. liabilities denominated in foreign currencies, to capture the exposure of banking sector to exchange rate risk. It seems to be a good question if considering only liability side of the balance sheet is enough to get a real notion of this an exposure. What

[43] Kibritçioglu uses data from International Financial Statistic database of IMF. Singh relied on country-specific data from Indian financial and regulatory authorities. His sources include "The Handbook of Statistics on Indian Economy, and various issues of Reserve Bank of India, Monthly Bulletin". (Singh 2009, pp. 15)

about the asset side? By incorporating variable *foreign currency assets*, Singh seems to be trying to answer the challenge. Why did hi sum them, though? In my view *foreign currency assets* and *liabilities* in the banks' balance sheets offset each other. To sum them together appears to me to be the opposite of the proclaimed objective.

2.4. Banking Sector Vulnerability Index (BSVI)

Hawkins & Klau (2000) constructed and proposed the usage of indexes that would monitor vulnerabilities in 3 selected areas of risk-exposure. They constructed indexes of Financial Market Pressure, External Vulnerability, and Banking System Vulnerability (BSVI). Authors' aim was to employ the three indices to help the researchers to detect economies under the financial pressure, pressure being the indication of lurking financial crisis. On the other hand, they abstained from aggregation of information from the indices into the one cosmopolite index of financial pressure.

"*For several reasons it was decided not to distil this information into a single aggregate index of risk. These include the problem of information about the individual underlying indicators being obscured. As discussions among experts turn on such variables, this can be an important shortcoming.*"[44] The second reason of theirs for not aggregating three sub-indices to aggregate index was following: "*The nature of risks varies and it is inappropriate to "consolidate" different types of risk into one number. For example, some countries' external financing situation can be viable even if their internal banking system may be insolvent.*"[45] These expressed opinions of theirs are in contrast with the trend of contemporary research in this field, where the tendency to create single cosmopolite index by suitable weighting of individual sub-indices is apparent.[46]

In their BSVI, Hawkins & Klau use following variables to approximate banking system vulnerability:

1) The first is the rate of growth of domestic bank credit: very rapid growth has often gone hand in hand with declining loan standard/greater risk.

[44] Hawkins & Klau (2000), pp. 8.
[45] Hawkins & Klau (2000), pp. 8.
[46] For review of development and current state of research in this field see Gadanecz & Jayaram (2009)

2) The second is the growth of borrowing from international banks, which typically reflects increased foreign currency borrowing by domestic residents (sometimes, as in many Asian economies, through local banks).
3) The third, related indicator measures the external borrowing by banks as a percentage to domestic to domestic credit. This is a proxy for the extent to which local bank lending is denominated in foreign currency: such lending leaves borrowers and their banks exposed to significant exchange rate risk.
4) The fourth indicator is the level of real interest rates: very high real rates mean banks will struggle to have loans repaid while very negative rates mean they will struggle to attract deposits.
5) The final indicator used is "stand-alone" credit ratings of the leading banks[47]. While in practice credit rating agencies' assessments have not been sufficiently prescient to make this a leading indicator of banks' condition, it is a useful coincident indicator and a likely influence on future funding costs.[48]

Bands and scores used in the Banking System Vulnerability Index (BSVI)[49] were:

Indicator		-2	-1	0	1	2
Code	**Weight**					
dce	W_1	-	-	$x \leq 5$	$5 < x \leq 10$	$x > 10$
bis	W_2	-	-	$x \leq 5$	$5 < x \leq 25$	$x > 8$
bisdc	W_3	-	-	$x \leq 10$	$10<x\leq25$	$x > 25$
r	W_4	-	-	$-8 \leq x < 2$	$2 < x \leq 4$	$x > 4$ v $x < -8$
bkrat	W_5	A	B to A/B	C to B/C	D to C/D	E to D/E

Table 3: BSVI: Bands and Scores
Source: Hawkins and Klau (2000)

Where:

dce – Increase in domestic credit (to the private sector)/GDP ratio over four quarters (in percentage)

[47] There ratings differ from conventional ratings in that they assess the inherent strength of banks and do not take into account any outside support.
[48] Enumeration on chosen variables is presented in Hawkins and Klau (2000) on pp. 11 and 12. Authors also calculated correlations between pairs of variables so as to identify redundant variables. All five variables turned out to be relevant.
[49] BSVI is abbreviation employed in this thesis by the author.

bis – Increase in liabilities to BIS reporting banks over eight quarters as a percentage to GDP, GDP is converted into US dollars using an exchange rate based on the World Bank Atlas[50] approach

bisdc – Liabilities to BIS reporting banks as a percentage of domestic credit to the private sector.

r – Three-month interest rate less the annualized percentage change in consumer prices over the previous 6 months.

bkrat – Average credit rating of banks.[51]

Authors chose following approach towards the construction of the index, scoring of individual variables and weighting:

a) Index is constructed as weighted sum of the scores of individual indicators.

b) The worst value of the index is the highest one, which is the value of 10 (scored points). The weights are chosen accordingly, so as the maximum value of index would be just ten.

c) Individual indicators are scored on the scale from *-2* to *2*. The former represents the situation of little risk exposure[52]; the latter suggests high exposure to risk[53]. As the table shows, for 4 indicators no minus scores are given.[54]

d) One value of weight for given indicator is not always fixed. It is allowed to slightly change in response to extreme levels of given indicator. When the value of indicator is extremely high, the weight also increases in order to reflect the presumed higher importance of the variable within the index. Weights were chosen in a way that ensures $W_1+W_2+W_3+W_4+W_5=1$.

[50] The Atlas conversion factor for any year is the average of a country's exchange rate (or alternative conversion factor) for that year and its exchange rates for the two preceding years, adjusted for the difference between the rate of inflation in the country, and through 2000, that in the G-5 countries (France, Germany, Japan, the United Kingdom, and the United States). For 2001 onwards, these countries include the Euro Zone, Japan, the United Kingdom, and the United States. A country's inflation rate is measured by the change in its GDP deflator. (World Bank website)

[51] Source of ratings: Fitch IBCA, average of individual ratings.

[52] i.e. the best evaluation of banks' credit rating by Fitch IBCA (grade A)

[53] I.e. the evaluation of their credits as junks (grade E)

[54] Apart from Banking System Vulnerability Index authors construct also two other indexes (Exchange Market Pressure Index and External Vulnerability Index). Variables in these indexes (with one exemption) are allowed to take on negative values.

Actual setting of the weights and respective scoring bands of individual variables are explained by authors followingly: "*The choice of the thresholds between the bands in bound to be somewhat arbitrary.*"[55] "*The indicators we chosen and the weights applied judgmentally, but after consultation with experts and after reviewing the available literature. For simplicity, the same weights were applied to every economy, rather than, for example, distinguishing between exchange rate regimes and degree of openness in choosing the weight to assign the exchange rate. On the face of it, this approach may be regarded as "arbitrary". But on balance, we view it as best suiting our limited aim.*"[56]

2.5. Simple Banking Model (SBM)

As was said, event-method relies on observance of specific events for establishing whether banking sector was or was not experiencing a crisis. In almost all databases of banking crises the important "event" that is taken as undoubted indicator of banking crisis is government intervention. It was even mentioned in IMF (1998) in their seminal definition of banking crises.

However, government intervention itself is arguable not the most precise indicator for dating the banking crisis. Government may intervene either when the crisis in the banking sector is already in full swing or in the very beginning with aim to prevent the financial distress to spread to a full-fledged crisis. Identification that stresses events doesn't provide clear-cut criteria how to set exact date of beginning and end of the banking crisis.

Boyd, Nicolo & Loukoianova (2009) decided to examine this often mentioned problem more closely. They argue, that indicators common in the literature and commonly used in praxis "*actually measure lagged government responses to systemic bank shocks, rather than the occurrence of crises per se (themselves).*"[57] They emphasized that none of the widely referenced databases of banking crisis[58] based their identification of crisis on any theoretical model of banking industry. "*The definition of and measurement of the object*

[55] Hawkins and Klau (2000), pp. 13.
[56] Hawkins and Klau (2000), pp. 9.
[57] Boyd, Nicolo & Loukoianova (2009), pp. 1.
[58] Such as Caprio et al. (2003), Reinhart & Rogoff (2009), Laeven & Valencia (2008) and other cited throughout the thesis.

of study – what a banking crisis is, when it occurs, and how long it lasts – has been at best loosely derived from theory."[59]

In order to identify indicators of banking crisis based upon the theoretical background, they developed simple model of banking industry ("a simple banking model" – SBM) and used its comparative statics to identify possible indicators of shocks to the banking stability, i.e. "*to identify measures of systemic banks shocks.*"[60]

2.5.1 SBM in the simplified version

There is economy consisting of four types of players: government, entrepreneurs, depositors, and banks. The reality of the model runs in discrete time and all agents are risk neutral.

Entrepreneurs: Entrepreneurs are financed by banks with simple bank contracts. The contract pays the bank a loan given interest rate if project is suffesfull.

Depositors: Depositors invest all their funds in a bank at date t to receive interest plus principal at date t+1. Depositors are fully insured, so that the total supply of deposits is not subject to risk.

Banks: Banks collect insured deposits, and pay a flat rate insurance premium (standardized to zero). On their part, banks choose the total amount of lending and the amount of bonds.

Government: The government supplies a fixed amount of bonds to the market. The government also guarantees the deposits. It will intervene whenever bank deposits payments cannot be honored in part or in full. When this occurs, the government will pay depositors all the claims unsatisfied by banks and banks will be bailed out. These payments will be financed by issuing additional bonds, which will be bought by banks that collect new deposits at time t+1. By assumption, the government at time t+2 observes bank profits at t+1.

Bonds: One-period bonds are supplied by government. To keep the simplicity of the model, only banks can invest in bonds. A bond purchased at date t yields a given gross interest rate at date t+1.

[59] Boyd, Nicolo & Loukoianova (2009) pp. 4
[60] Boyd, Nicolo & Loukoianova (2009) pp. 11

Defining banking shock: banking shock occurs at time t+1, when the banking system's profits are negative. When the government ascertains that the banking system has become insolvent, it will cause him to intervene (to respond). As stated above, it will intervene at t+2, when it observes what state the banking sector is in at t+1.

Equilibrium

The model unfolds itself in three unit of discrete time (t, t+1, t+2):

Time t: banks collect deposits, entrepreneurs generate demand, and banks supply funds. Thus deposits, bank loans, and investment in bonds are determined.

Time t+1: outcomes of all projects are realized and kept an eye on by both banks and entrepreneurs. Borrowers pay loans and in turn, banks pay depositors, if possible. It depends upon the profit of banks if they are able to repay all their depositors in full. If profits are positive, they are. If negative, depositors cannot be full paid. By definition systemic bank shock occurs. Depositors are paid by banks by proportion.

Time t+2: the government responds to the crisis by issuing bonds and paying depositors any claim unsatisfied by banks.

Solutions for all endogenous variables are presented in appendix D.

	Adverse Shocks		
Endogenous variables	p decreases	α increases	Y decreases
Total Loans	↓	↓	↓
Total Deposits	↓	↓	↓
Bond interest rate	↓	↑	↓
Loan rate	↑	↑	↑
Deposit rate	↓	↑	↑
Loan rate - Deposit rate	↑	↑	↑
Realized profits	↓	↓	↓

Table 4: SBM: identified shocks
Source: Boyd, Nicolo, Loukoianova (2009)

Small p stands for entrepreneurs' conditional expectations about the probability of their investments' success in time t+1: $p \equiv E_t P_{t+1}$.

As is seen from the table, there are three identified triggers of systemic bank shocks: Shocks affecting p, α, and Y. These shocks reflect the following situations: "a decline in firms' probability of a good outcome (decline in p); a decline in firms ' demand for loans

due to a decline in *Y*; or a decline in consumers' demand for deposits, prompted by a decline in *α.*"[61]

Importantly, table shows that there are variables that *shift in the same direction for all causes of the shocks*. Concretely, notwithstanding the form of shocks, *total loans* and *total deposits* decline; *Loan rate increases*; *difference between loan rate and deposit rate* increases, and the *realized profits* fall.

The model suggests that these variables should be closely followed in connection to the impending banking crises, because they react to the main adverse shocks to the banking industry in the given way, grounded in theory.

In the words of authors' of the model: "*The model allows us to identify a systemic bank shocks with a severe decline in loans, deposits, bank profits, and significant increases in interest rate margins.*"[62]

2.6. (Shortly on) Bottom-up approach.

Within the **bottom-up approach**, researchers try a) to assess the probabilities of failure of individual banks and b) somehow to transpose them into the probability of failure of whole banking system. The most important variables in this case are Probability of Default (PD) and Loss-Given-Default (LGD). The main challenge of this approach is how the PD and LGD of individual institutions are to be translated into PD and LGD of whole sector.

2.6.1. Financial state of individual institutions

As to the risk of default on the level of individual institutions, attention is paid to the calculation of two main components: *probability of default* (PD) and to the *Loss-given-default* (LGD), i.e. magnitude of wealth that is lost in case of default (either on the part of institution or on the part of counterparty). Over the past 20 years the attention of researchers as well as bankers has been turned primarily on estimating PD parameter. Official recognition of the equal importance of LGD parameter in the obtaining better picture of financial vulnerability came in 2005: in the New Basel Capital Accord (BASEL

[61] Boyd, Nicolo , & Loukoianova (2009), pp. 15.
[62] Boyd, Nicolo , & Loukoianova (2009), pp. 15.

II), LGD was explicitly recognized as a key risk component. It also permitted banks to estimate LGD by their internal methods and use their estimates of LGD for calculating capital adequacy (BCBS[63] 2005).

In the wake of BCBS 2005, research with main concern on establishing models for calculation LGD parameter dramatically increased (Jakubík & Seidler 2009). Jakubík (2007), having classified approaches towards risk assessment into three broad groups[64], also stated that: "*…The aim of all approaches is an estimation of firm's default probability and loss given default.*"[65] I limit myself to few domestic researchers. In the Czech Republic there are experts affiliated with Czech National Bank and Charles University who dedicated their efforts to LGD calculation. Jakubík & Seidler (2009a) discussed estimation of LGD and calculated it for selected companies traded on the Prague Stock Exchange. The same authors (Jakubík & Seidler, 2009b) presented a method in which LGD can be extracted from market observable information using adjusted Mertonian structural approach. Even before, Jakub Seidler dedicated his diploma thesis as well as subsequent working paper at Charles University (Seidler 2008a,[66] (Seidler 2008b) to the topic.

[63] Basel Committee on Banking Supervision
[64] The groups are a) traditional models, b) structural models based on pricing of options, and c) so-called reduced form models.
[65] Jakubík (2007), pp. 60.
[66] Available at: http://ies.fsv.cuni.cz/work/index/show/id/1063/lang/en

Indicator	Advantages	Disadvantages
Average DD* or z-score (or probability of default)	• Easy to calculate from individual institutions' DDs, z-scores, or PDs.	• Does not reflect contagion (correlation across failures). • Does not reflect differences in loss given default in institutions, even though that can be partially addressed by weighting. • DD requires liquid market in financial institutions' stocks; liquid bond or CDS markets required if those markets are used to estimate PDs.
Portfolio DD or portfolio z-score	• Easy to calculate. • Unlike simple averaging, reflects to some extent the differences in institution sizes and correlation across institutions.	• Does not fully reflect contagion, correlation across failures. • Does not fully reflect differences in loss given default in institutions.
First-to-default and *n*th-to-default indicator.	• Clear theoretical underpinnings for the nth-do-default indicator.	• Do not fully reflect different LGDs in institutions. • FTD does not measure systemic risk.
Expected number of defaults (END) indicator	• Relatively easy to interpret	• Does not reflect different LGDs in institutions. Difficult to calculate, not a closed-form expression. • Focuses only on central tendency of the distribution. • Depends on total number of institutions.
Financial soundness ratios (capital adequacy, nonperforming loans to total loans)	• Relatively easy to calculate	• No clear link to probabilities of default found yet. • No clear link to systemic stability found yet.
Stress test results	• Takes into account differences in LGD in institutions. • Takes into account extreme situations.	• Methodology not yet settled. • Sensitivity to assumptions. • Focus on extreme situations.
"Stress Index" of Swiss National Bank	• Clear definition	• Unclear relationship to probabilities of default and systemic stability.
Distribution of systemic loss	• Captures differences in loss given default in institutions. • Captures correlation across institutions failures. • Focuses only on central tendencies.	• May be difficult to calculate in some cases; no closed-form expression.

Table 5: Indicators of financial institutions' soundness; Čihák (2007); *DD = distance-to-default.

The measures of financial stability from the above table are results of various techniques: PD derived from *fundamental data*, PD derived from *market data*, distance to default (DD) within portfolio approach, and First and *n*th to default.

The indicator that has become popular recently[67] is so-called **Z-score**. "*The Z-score measures the number of standard deviations a return realization has to fall in order to deplete equity, under the assumptions of normality of banks' returns. A higher z-score corresponds to a lower upper bound of insolvency risk–a higher z-score therefore implies a lower probability of insolvency risk*"[68]. Z-score can be computed both from fundamental and market data. In the latter case z-score utilizes stock price data to calculate the volatility of banks' economic capital (Denmark National Bank 2004[69]). In this case it is renamed to distance-to-default (DD).

Z-score is defined or summarized as $z \equiv (k+\mu)/\sigma$, k is equity capital as percent of assets, μ is average after-tax return as percent on assets, and σ is standard deviation of the after-tax return on assets, as a proxy for return volatility (Čihák 2006, Hesse & Čihák 2007).

Z-score has the advantage of being able to adequately capture the risk of insolvency even among heterogeneous groups of institutions. On the other hand, it is not constructed in a way that would capture correlation issues between individual institutions, nor LGD component of risk. See table.

Market based Indicators of individual institutions' PD include **distance do default** (DD), **bond prices**, and **credit default swaps** (for more reference see box 1 in Čihák 2006, pp. 11). Advantages and disatvantages of these are collectively summarized in the first row of the table.

The performance of market-based indicators is empirically confirmed in many studies.[70]

[67] Among others Boyd & Runkle (1993), Maechler, Mitra & Worrell (2005), Beck & Laeven (2006), Demirguc-Kunt, Detragiache & Thiesel (2006), Hesse & Čihák 2007

[68] Hesse & Čihák (2007), pp. 7.

[69] Referred to in Hesse & Čihák (2007)

[70] Reviews of related literature is available in Čihák (2006).

2.6.2 Transposing from the level of individual institutions to the whole financial sector

Whereas the literature and models dealing with insolvency and default probability of individual financial institutions is rich and still growing at fast pace, … "the links between defaults in individual institutions and system-wide crises remain inadequately understood, despite some recent attempts to transpose the existing indicators of the probability of default in individual institutions to the systemic level."[71] Literature dealing with financial state of individual institutions is abundant. The main issue remains with the adequate interlink between levels of individual institutions and that of whole country (Čihák 2006).[72] It is just the problem of adequate transposing individual defaults to the probability of default of whole sector, which have been problematic spot for assessing financial stability under this approach. Lindgren, Garcia & Saal (1996) stated that financial stability was endangered when sufficiently large number of institutions is insolvent. This is the most straightforward, but at the same time the least sophisticated approach. Similarly treats the problem also Singh (2009): "*the concern for systemic instability is warranted when the probability of insolvency become significant for large proportion of country's banking assets (i.e. for sum of all banks in the country).*"[73]

The other possibility is to take average, or weighted average, of DD or PD of individual banks.[74] "*Taking a simple average can lead to very misleading results, because it does not take into account the differences in the size of institutions (and therefore Loss Given Default (LGD)). The use of weighted averages of DDs or PDs addresses this issue to some extent, but still does not address the issue of correlation of defaults among institutions. Because of the correlation, DDs and PDs for individual institutions are not simply additive.*"[75] That led the efforts to employ features of vaarious statistical distributions and see their suitability in interlinking individual institutions with the whole sector. The most elegant of these are con*tingent approach* and *copula approach*. They "*…are impressive for their sophistication and elegance; however, they are based on*

[71] Argued in Čihák (2007)
[72] Problem of "marrying" micro- and macro- prudential dimensions of financial stability is still not satisfactorily solved, see. e.g. speech Crocket (2000)
[73] Singh (2009), pp. 4.
[74] As tried e.g. Tudela & Young (2003)
[75] Čihák 2006, pp. 12.

multiple assumptions and are not easy to handle."[76] In Gramlich (2010) there is provided literature overview of the application of these methods.

Despite ongoing attempts to translate the existing indicators of PD in institutions to the system-wide level, there still isn't good understanding of links between defaults of individual institutions and default of whole sector. The correct translation remains a challenge in this field.

[76] Gramlich (2010)

3. The Signal Approach

The method is in the literature also referred to as "*signal-extraction models*", or "*threshold approach*". It was originally developed for the purposes of business cycles' theory, with the aim to identify turning points of business cycles. Researchers had been using the method for evaluation of the ability of macroeconomic and financial time series to predict business-cycle turning points (Diebold & Rudebusch (1989), Stock & Watson (1989).

The Signal approach is described in detail in Kaminsky, Lizondo & Reinhart (1998).

The first to apply this method for prediction of *banking crises* were Kaminsky & Reinhart (1999). In their words, they "*...offer*(ed)[77] *an alternative approach to examine the evolving nature of the crises, pinpoint their origin, and gauge their probability conditioned on signals from one or more indicators.*"[78] It was further elaborated in Borio & Lowe (2002) and Borio & Drehman (2009). Edison (2003) also built on it.

In the last decade, the Signal approach has been used by quite a few researchers with the aim to compare its results to that of other methods, mainly econometric models under logit and probit specifications. The first notable example is Demirgüç-Kunt & Detragiache (2005). Authors compare results of signal method to logit regression model with the conclusion that logit regression is more suitable.[79] Misina & Tkacz (2008) also conclude that the results of the approaches differ.

The current state of understanding seems to be that Signal method is more suitable for the prediction of banking crises on the country level – it is more open to the country-specific adjustments – than the econometric models. The econometric models, in their turn, better detect crises on multinational or regional levels. E.g. Davis & Karim (2008) documented that signal approach was better at predicting country-specific crises, while the econometric models were better at predicting the global problems. *"...the use of multinominal logit model may be better suited to the global EWS whereas the Signal extraction approach may be better suited to country specific EWS.*"[80]

[77] Past tense employed by author for the purposes of the thesis.
[78] Kaminsky & Reinhart (1999), pp. 487.
[79] Referred to also in Gramlich et al. (2010)
[80] Davis & Karim (2008) p. 38

3.1. Procedure:

Following is based mainly on Kaminsky, Lizondo & Reinhart (1998), Demirgüç-Kunt & Detragiache (2005), Kaminsky & Reinhart (1999), and Goldstein et al. (2000)

To apply Signal approach, four sets of judgments need to be made:

a) *Crisis*: what is classified as a crisis?
b) *List of indicators*: What are the variables that could potentially indicate future crisis, i.e. what variables will be examined as potential indicators?
c) *Signal*: What evolution of indicators is taken as signal of a pending crisis and what is considered normal evolution?
d) *Good signal vs. false alarm*: After the indicator issues a signal, does crisis really break out in a reasonably near future, or was it false alarm?

a) What is classified as a crisis?

To empirically identify indicators of potential crisis is not possible without at first identifying what is the banking crisis itself and when it occurred. Two main approaches to the task are *event-method* and *index-method,* as discussed in the first two chapters of the thesis. Within the Signal approach, the few academic works that are counted as the most prominent have so far relied exclusively on the event-method[81]. The reason for it, however, is *not* that events are acknowledged as better than indexes. The reason for preference of event-method over indexes is as yet not satisfactory length of relevant time series. "*The main reason for following this approach has to do with the lack of high-frequency data that capture when a financial crisis is under way."*[82] Other reasons for not choosing indexes are enumerated in the table on advantages and disadvantages on index-method on the page 8 of the thesis.

[81] These all published works cited throughout the third chapter.
[82] Kaminsky & Reinhart (199), pp. 476.

b) List of variables

List of potential indicators are usually chosen according to the theory. The lists of main indicators of major interest usually do not vary much in the research. Even, they are almost identical throughout the EWS construction, notwithstanding the approach adopted – signal approach or econometric modeling. There is consensus that variables are chosen as to represent three main areas of economy, these being *financial sector*, *external sector*, and *real sector*.

Ideally, presence of each indicator in the list should be theoretically justified, so as it would be possible to state hypothesis of its expected impact on the impending crisis.

For the sake of exposition, I am presenting the list of variables as used in the seminal work on Single approach (Kaminsky & Reinhart 1999) and in the modern work on probit regression, the aspiration of which is the same; i.e. to identify economy-wide variables that would help to foresee the crisis (Singh 2009).

Kaminsky & Reinhart (1999)

Financial sector

- M2 multiplier; Ratio of domestic credit to nominal GDP; The real interest rate of deposits[83]; the ratio of lending-to-deposits interest rates.

Other financial indicators

- Excess real M1 balances; Real commercial-bank deposits; Ratio of M2 divided by foreign-exchange reserves.

External sector

- *Current account*: the percent deviation of the real exchange rate from trend; the value of exports and imports; terms of trade.
- C*apital account*: Foreign-exchange reserves; Domestic-foreign real interest-rate differential on deposits.

[83] Financial liberalization and financial reforms in many countries led increases in real interest rates; see e.g. Galbis (1993). That financial liberalization in a country leads to higher financial fragility is accepted notion; see e.g. Caprio & Summers (1993), Stiglitz (1994), Allen (2005).

Real sector

- Industrial production; Index of equity prices.
- *Fiscal variable*: overall budget deficit as a percent of GDP.

Singh (2009)

Financial sector

- Yields on 91 days Treasury bills; weighted average call money rate; aggregate deposits of residents; Bank credit to commercial sector; M3 money supply; reserves money

External sector

- Export; Import; Real effective exchange rate; foreign exchange reserves

Real sector

- Output; inflation; stock price index

Box 1: EWS: examined indicators
Sources: Kaminsky & Reinhart (1999), Singh (2009); own collection.

c) Threshold

The threshold values are selected on an indicator-by-indicator basis. It is important to take into account the Type I and Type II errors.

Type I error is the situation of rejecting the null hypothesis[84] when it is true. Thus it is a situation when variable signals crisis, but it eventually doesn't happen.

Type II error is the situation of not rejecting the null hypothesis when it is false. Thus it is a situation when variable doesn't signal crisis, but it eventually happen.

When the indicator crosses the threshold, it is said to have *issued a signal*, or *waved the red flag*. The situation of Type I error is known as the *false signal* and the situation of Type II error is called the *missed crisis*.

Thus, threshold for issuing the signal (waving red-flag) are always set with consideration the both Types of errors. The ideal is in some way to hit the balance between the risk of many false signals (Type I error) and the risk of too many missed crises (Type II error).

[84] Null hypothesis is that there is no crisis, banking sector is stable.

The tradeoff between the two types is always the same: "*The price of reducing the number of false alarms is accurately calling a lower proportion of crises.*"[85]

d) Good signal vs. false alarm

All criteria for good vs. bad signals are based on the play of setting the balance between the Type I and Type II errors. The most common approach is to minimize the in-sample so-called the *noise-to-signal ratio* (*Nts*). Following is Noise-to-signal ratio from Kaminsky & Reinhart (1999). It was employed also in Davis & Karim (2008)

The "adjusted" noise-to-signal ratio, for setting the optimal threshold value, illustrated by following box:

	Crisis occurs in the following 24 months	Crisis occurs in the following 24 months
Indicator issues a signal	A	B
Indicator does not issue a signal	C	D

Table 6: Adjusted noise-to-signal ratio
Source: Kaminsky & Reinhart (1999)

If a variable signals (waves a red flag) and a crisis occurs in the following 24 months (counted in cell A) the signal is considered accurate. If a variable signals and no crisis occurs in that time frame (counted in cell B), the signal is said to be a false alarm or noise. Hence, a perfect indicator would only have entries in cells A and D. More generally, the noise-to-signal ratio for any indicator is given by the number of entries in

$$NtS = \frac{\frac{B}{(B+D)}}{\frac{A}{(A+C)}}$$ [86]

Hence, it is the ratio of false signals to all possible bad signals divided by the ratio of good signals to all possible good signals. An extremely noisy indicator would have few entries in A and D, many in B and C.[87]

[85] Kaminsky & Reinhart (1999)
[86] Abbreviation NtS is mine.
[87] Kaminsky & Reinhart (1999), footnote on the pp. 488, verbatim.

3.2. Current state

The most notable (in my view) endeavor in the field represents the work of Kaminsky & Reinhart (2009). Authors' contribution is the incorporation of housing prices into the list of indicators as potential "signals". They also compare the "signaling strength of housing prices" to the other commonly considered variables.[88] By incorporating housing prices into the list of indicators, authors filled important gap in the early warning literature (Kaminsky & Reinhart 2009, pp. 279). Moreover, they provide compilation of the indicators that have so far been identified as the best and words predictors of banking crises in the literature using the signal approach. The table is as follows:

Indicator rank (best to worst)	Description	Frequency
BEST		
Real exchange rate	Deviation from trend	Monthly
Real housing prices	Twelve-month (or annual) percentage change	Monthly, quarterly, annually
Short term capital inflows/GDP	In percentage points	Annually
Current account balance/ investment	In percentage points	Annually
Real stock prices	Twelve-month percentage change	Monthly
WORST		
Institutional investor (II) and Moody's sovereign ratings	Change in index	Biannually (II), monthly (Moody's)
Terms of trade	Twelve-month percentage change	Monthly

Table 7: Signal approach: Indicators of Banking Crises - a summary
Source: Reinhart & Rogoff (2009)[89]

[88] Ranking was set according to the noise-to-signal ratio.
[89] Authors' claim to have collected the table from the sources: Kaminsky, Lizondo, & Reinhart (1998); Kaminsky & Reinhart (1999); Goldstein, Kaminsky, & Reinhart (2000) along with their own calculations.

Practical Part

4. Event-Method

In the practical part of the thesis, I am constructing two indexes for the assessment of banking sector fragility and for identification of banking crises. Firstly, I replicate Index of Money Pressure (IMP), as presented in Hagen & Ho 2003, 2004 and 2007. Index is based on the theory of equilibrium on the money market between Central bank and banking sector. It is constructed from nominal and presented in chapter 2.3 in the thesis. Secondly, I construct Banking Sector Fragility Index – BSFI – in a slightly changed version from both its original proposition in Kibritçioglu 2003[90] and its modified form in Singh (2009). BSFI is constructed from real data and presented in the subchapter 2.2. Both this indexes falls into the category of index method for identification of banking crises periods. They follow aggregate approach, as discussed in the chapter two of the thesis.

Selected countries were chosen according to the stage of their development. Guiding rule was to select countries of three groups: emerging, developed and transition ones. Turkey, Thailand and Mexico constitute the sample of emerging countries. The group of developed countries contains Germany, USA, United Kingdom, Japan & Norway. In the sample there are also three countries that have lived through transition from planned economy to the market one. These are Czech Republic, Slovak Republic, and Estonia. For them, indexes are constructed only for the period after 1989. For the Czech and Slovak republic, representing kind of my "home" countries, indexes are constructed starting from the split-up of the former Czechoslovakia.

To have something to compare my results to, I compiled incidences of banking crises for the selected countries, as presented in modern databases on banking crises. The collection is based on the databases collected on the basis of the event-method. My aim of this exercise is twofold: a) to compare incidences of the crises as identified by indexes to those provided by official databases, and b) to compare outputs of indexes to each other.

The incidences of bank crises are collected from the databases: Reinhart & Rogoff 2009 (R&R), Luc & Valencia 2008 (L&V), Demirgüç-Kunt & Detragiache 2005 (D&D), and Caprio et al. 2005. Caprio et al. database is taken from Honohan & Laeven 2009 (column H&L in the table). Although available scholar classifications of banking crises worldwide are quite numerous, these four works were chosen, as they are generally recognized to be systematic, comprehensive and generally accepted and referenced in academic world.

[90] And as replicated in Svoboda (2009)

Country	R&R (2009)	L&V (2008)	D&D (2005)	H&L(2005)
Developed countries				
Germany	1977	Non		late 1970s
Japan	1992-1997	1997	1992-1994	1992-
			1992-2002**#	
Norway	1987-1993	1991	1987-1993	1990-1993
United Kingdom	1974-1976	2007		1974-1976
	1984			1980s
	1991			1990s
	1995			
United States	1984-1991	1988	1981-1992	1988-1991
		2007	1980-1992**	
Emerging countries				
Mexico	1981-1982	1981	1982	1981-1991
	Sep1982-1991	1994	1994	1994-2000
	Oct 1, 1992		1994-1997**	
	1994-1997			
Thailand	Mar 1, 1979	1983	1983-1987	1983-1987
	Oct 1983-1987	1997	1997-2002#	
	May 1, 1996			
Turkey	1982-1993	1982	1982**	1982-1985
	Jan 1, 1991	2000	1991	
	Apr 1, 1994		1994	
			2000-2002**#	
Transition countries				
Czech Republic	1994-1995*	1996		1989-1991
Slovak Republic	1997*	1998		1991-1995
Estonia	1992-1995	1992		1992-1995
	1994			
	1998			

Table 8: Crises episodes in selected countries: Event-method

Source: Reinhart & Rogoff (2009), Laeven & Valencia (2008), Demirgüç-Kunt & Detragiache (2005), Caprio et al. (2005)[91], collected by the author of the thesis.

* *R&R database quotes mistakenly year 1991*(remark of mine)

** *IMF Working Paper 05/96*

The crisis was still ongoing as of 2005

As seen, the dates of individual banking crises in followed countries in official databases differ, often markedly. The fact was stressed also in Boyd et al 2009. The exact

[91] Available in Honohan & Laeven (2005)

dating is arbitrarily given by collector of given database. Depending on his definition what the crisis is, how to set its beginning and end, or the peak of the crisis, the identified crises differ among databases:

D&D (2005) cover 94 countries over the period from 1980 to 2005. They did not include any transition countries into their dataset. Thus they do not provide dates of banking crises for CR, SR and Estonia. They provide operational definitions in Demirgüç-Kunt & Detragiache (2002)[92]. Their aim is to survey systemic banking crisis. They define them as: "*a situation in which significant segments of the banking sector become insolvent or illiquid, and cannot operate without special assistance from the monetary or supervisory authorities.*"[93]

While relying on event-based method, they introduce simple quantitative measures as thresholds, when such an event may be called banking crisis. For the event to be labeled as crisis, at least one of following conditions has to be met: 1) The ratio of non-performing assets to total assets in the banking system exceeded 10% 2) The cost of the rescue operation was at least 2% GDP. 3) Banking sector problems resulted in a large-scale nationalization of banks. 4) Extensive bank runs took place or emergency measures such as deposit freezes, prolonged bank holidays, or generalized deposit guarantees were enacted by the government in response to the crisis (for more discussion on these conditions see Demirgüç Kunt & Detragiache 1998). The weak point of D&D's identifying of banking sector crises is dating of their beginnings and ends. Here they mainly rely on the previous research of Lindgren et al. (1996) and Caprio and Klingebiel (1996)[94]

L&V (2008) cover extensive dataset of countries over the period from 1970 to 2007. They focus only on systemic banking crises, not on "*banking system distress events that affected isolated banks but were not systemic in nature*"[95]. They employ broad definition of banking crisis, but rely also on more explicit quantitative indicators. Under their definition systemic banking crisis occurs when "*...a country's corporate and financial sectors experience a large number of defaults and financial institutions and corporations face*

[92] Referred to in Boyd, Nicolo & Loukoianova (2009)
[93] Demirguc-Kunt & Detragiache (2002), pp. 1381.
[94] As they state on the pp. 1381.
[95] Laeven & Valencia (2008), pp. 5.

great difficulties repaying contracts on time."[96] Their approach being event-based, they combined quantitative data with subjective assessment. They identify the year of crisis when at least one of the following happened:

a) Deposit runs; this they defined as a monthly percentage decline in deposits in excess of 5%.
b) Introduction of deposit freezes or blanket guarantees.
c) Central bank or government intervention, mainly in the form of liquidity support; their definition of extensive liquidity support as claims from monetary authorities on deposit money banks to total deposits of at least 5% and at least double the ratio compared to the previous year.[97]

Apart from setting the year of the crisis as the year coinciding with one of the above events, authors abstained from trying to identify the years of beginning and end of the crisis.

H&L (2005) cover 126 countries over the period from the second half of the 1970s to 2005. They provide dates not only on banking crises, but also more general on bank insolvency. Periods of banks insolvency are set with the degree of arbitrariness, however, as authors admit (Caprio et al. 2005). Importantly, H&L do not state any explicit definition of the beginning and the end of the banking crisis, nor do they distinguish between systemic and non-systemic crisis.

H&L provide rich evidence about identified crises of theirs in form of narratives, in the form similar to that provided in the *Appendix A* at the end of this thesis.[98] Having reviewed the evidence from Caprio et al (2005), Boyd et al. (2009) summarized: "*In five out of 166 episodes, the beginning of a crisis is defines as a bunk run, but neither quantification nor a precise dating is reported.*"[99]

R&R (2009) worked with the most extensive dataset of countries, both with respect to their number and to the time period they covered. Their dataset is up to now the most

[96] Leaven & Valencia (2008), pp. 5.
[97] Points based on Boyd, Nicolo & Loukoianova (2009). Individual descriptions based on Leaven & Valencia (2008).
[98] The anecdotic evidence of the crises in our sample countries was collected mainly on from Reinhart & Rogoff and sources cited therein. H&L (2005) with involved database Caprio et al (2005) is one of the main sources. See appendix A.
[99] Boyd, Nicolo & Loukoianova (2009), pp. 9.

comprehensive and complete dataset of banking crises. Their approach remains strictly event-based, however. In setting the year of banking crisis, they rely on existing studies of banking crises and on the financial press", as well as "many country-specific studies (Reinhart & Rogoff 2008). Specifically, they "mark a banking crisis by two types of events: (1) bank runs that lead to the closure, merging, or takeover by the public sector of one or more financial institutions…; and (2) if there are no runs, the closure merging, takeover, or large-scale government assistance of an important financial institution (or group of institutions), that marks the start of a string of similar outcomes for other financial institutions."[100] In their discussion about the approach adopted (table on pp. 11 in Reinhart & Rogoff (2009)) author admit that identification based of observing events does not enable to set beginning of the crisis accurately, as well as that to pinpoint the year in which the crisis ended is impossible.

[100] Reinhart & Rogoff (2008), pp. 80.

5. Banking Sector Fragility Index

5.1. Data:

For the construction of BSFI I used the data from International Financial Statistic (IFS) database of International Monetary Fund (IMF).

Reserves

The variable Total Reserves of Banking Sector is taken as "*reserves*" from IFS's line 20 for the countries: Japan, Norway, United Kingdom, USA, Mexico, Thailand, Turkey, Czech Republic, Slovak Republic, Estonia.[101] As to the Germany, variable that was taken to represent reserves is "*Claims of Monetary Authorities*", IFS's line 20.

Foreign Liabilities & Foreign Assets

Variables used for Foreign Liabilities and Foreign assets were: "*Foreign Liabilities of Deposit Money Banks*", IFS's 26C and "*Foreign Assets of Deposit Money Banks*", IFS's line 21. The data are for every country of the selected dataset.

Total Deposits

Total deposits of banking sector are captured by the summation of relevant variables. For Japan, Norway, USA, Mexico, Thailand, and Turkey these are "*Demand Deposits*" and "*Time, savings and foreign currency deposits*". For Czech Republic, Slovak Republic and Estonia, representing transition countries in the sample, total deposits are taken as sum of "*demand deposits*" and "*other deposits*". United Kingdom provides the data on total deposits already summed up, under the heading "*demand deposits + time, savings and foreign currency deposits*". As to the Germany, till the 1992 I used "*demand deposits*" plus "*other deposits of other residents".* After the adoption of euro, data collection methodology changed. From January 1992 I employ "*demand deposits*" plus "*demand deposits of other sectors*" plus "*other deposits*" to approximate total deposits. All variables used for total deposits are taken from MFI's FSI database, as sum of lines 24 and 25. For UK it was line 25L.

[101] All countries except Germany

Claims on Private Sector

For two transition countries, Czech Republic and Slovak Republic data with the heading "Claims on other resident sectors" are used. For all other countries, the data are "Claims on private sector". Data are taken from IFS database, line 22D.

Case of Germany

Germany experienced two important changes during the period captured by the data: The re-unification of Germany in 1990, and adoption of new currency, euro, in 1999. All observed variables experienced large shifts in reaction to new situations. In each case, abrupt changes happened in single months (January 1991 and January 1999). BSFI is constructed in a way that always projects the change in single month to the whole year of BSFI output. The shift was solely result of systemic changes and methodological adjustments, and as such in my view did not reflect real changes in risk-exposure of Germany's banking sector during both the years 1991 and 1999. I did not include these years in the index. I also omit them when calculating means and standard deviation of BSFI and of its variables. This is the reason of two gaps in the graph for Germany. Conversion exchange rate between DM and Euro was set by ECB on December 31. 1998 at following rate: 1.95583 DM/EUR.

5.2. Construction

I construct BSFI in modified version of Kibritçioglu (2003) and Singh (2009):

$$BSFI_{4t} = \frac{\left(\frac{TDEP_t - \mu_{tdep}}{\sigma_{tdep}}\right) + \left(\frac{CPS_t - \mu_{cps}}{\sigma_{cps}}\right) + \left(\frac{RES_t - \mu_{res}}{\sigma_{res}}\right) + \left[\left(\frac{FL - \mu_{fl}}{\sigma_{fl}}\right) - \left(\frac{FA - \mu_{fa}}{\sigma_{fa}}\right)\right]}{4}$$

Where:

$$TDEP_t = \frac{rTDEP_t - rTDEP_{t-12}}{rTDEP_{t-12}}$$

$$CPS_t = \frac{rCPS_t - rCPS_{t-12}}{rCPS_{t-12}}$$

$$RES_t = \frac{rRES_t - rRES_{t-12}}{rRES_{t-12}}$$

$$FL_t = \frac{rFL_t - rFL_{t-12}}{rFL_{t-12}}$$

$$FA_t = \frac{rFA_t - rFA_{t-12}}{rFA_{t-12}}$$

$TDEP_t$ stands for percent change in real Total Deposits during the year from *t-12* to *t*. *CPS*, *RES*, *FL*, and *FA* stand in given order for percent changes in *Claims on Private Sector*, *Reserves*, *Foreign Liabilities*, and *Foreign Assets*. FSI database contain nominal time series. They were deflated by countries' Consumer price index.

TDEP and *RES* capture the exposure of aggregate banking sector to the liquidity risk. Claims on private sector capture the exposure of aggregate banking sector to the credit risk. Foreign liabilities and foreign assets capture the exposure of aggregate banking sector to exchange rate risk. The both of them together are seen as single variable. Foreign assets enter the formula with negative sign, as they are offsetting the movement in the liabilities side.

5.3. Interpretation

Values above zero depict situation of no fragility in banking sector. Values of BSFI below zero suggest the situation of fragility, of stressed condition in the banking sector. Values of BSFI below but close to zero represent the situation that I will call **the Stress**

Condition (SC). When values of BSFI fall under the threshold value, the banking crisis is supposed to be under way. Again I label this situation in the same way as in Singh 2009, **the Banking Crisis (BC)**. Values far above zero, although they do not signal fragility per se, may be seen as signal of excessive accumulation of risk in the banking sector (Kibritçioglu 2002). I.e. too high values of CPS may be interpreted as lax credit policy on the part of banks. Their willingness to provide credits is high, thus their exposure to the credit risk (although not yet materialized) rises. Similarly, abrupt rise in the foreign liabilities makes banks vulnerable to abrupt changes in exchange rate. Positive changes in reserves, however, can hardly be explained as excessive accumulation of liquidity risk[102]. Because of this, I do not include situation of excessive risk taking among the BSFI outputs.

The threshold value, signaling where the fragility of the banking sector is medium and where there is already a crisis (high fragility), is to be set arbitrarily. Again following Singh, I set threshold value as the standard deviation of the index itself. It is set with the regard to the most common approach to financial stress: "*Financial stress is most often referred to as the deviation of current financial conditions from their ... trend and is measured in standard deviations from the mean*"[103]

When value of BSFI in given year is under the zero, but is still above the minus of the standard deviation of its movement, fragility is seen as manageable with respect to its history. To sum up, movement of BSFI is interpreted as follows:

a)	$BSFI > 0$	*Stability*
b)	$-\sigma < BSFI < 0$	*Stressed contidions*
c)	$BSFI < -\sigma$:	*Banking crisis*

BSFI is probable to suffer from several limitations: Firstly, variables capturing exposure of aggregated banking sector to risks are chosen arbitrarily, with respect to data availability. E.g. credit risk could be better approximated by share of nonperforming loans to total loans, as is common praxis in research. Nevertheless, data on nonperforming loans for aggregated banking sector for every country are not available, and they are the kind of

[102] The variable did not figure in the original proposition of BSFI, where high values of BSFI were taken to symbolize excessive-risk taking, seeming as good idea.
[103] Gramlich et al. (2010), pp 203 with references cited therein.

data, which are generally very hard to obtain and to be reliable, because of understandable reluctance of banks to provide them, officially revealing structure or their loan portfolio in the process. Another possibility is that individual risks will offset each other. The purpose of the index is to identify banking crisis, though. As such, we are interested in the situation, when average of changes in followed variables are together so low that they individual offsetting is not likely. As suggested by Kibritçioglu and explicitly stated in Singh (2009): "*bank failure refer to a situation in which the excessively rising liquidity, credit, interest rate or exchange rate risk pushes the bank to suspend the internal convertibility of its liability.*"[104]

Results

Constructed BSFI and tables with identified periods of banking crises are provided in appendix B.

[104] Pp. 9, footnote

6. Index of Money Pressure (IMP)

IMP is constructed as weighted average of changes in two variables: a) ratio of reserves to banks deposits, and b) short-term interest rates, based on the underlying theory presented in subchapter 2.3.

The index is defined as:

$$IMP_t = \frac{\Delta\left(\frac{CS_t}{TDEP_t}\right)}{\sigma\left[\Delta\left(\frac{CS_t}{TDEP_t}\right)\right]} + \frac{\Delta\left(i - CPI\right)_t}{\sigma\left[\Delta\left(i - CPI\right)_t\right]}$$

Where:

CS_t is credit support from monetary authority to the banking system. In other words, it stands for total reserves of central bank that are held by banking sector in time t

$TDEP_t$ is total non-bank deposits in the banking sector.

6.1. Data

The first component of the index, measuring the percent change in injected liquidity into the banking sector, is put together by dividing "*Credit Support from Monetary Authority*" by "*Total Deposits*"

Total Deposits

Total Deposits are constructed differently from the Total Deposits of BSFI. Their sum of IFS' line 24, line 25, and 26C. These are "*demand deposits*", "*Time, Savings and Foreign Currency Deposits*", and "*Foreign Liabilities*" of deposit money banks. For UK it is sum of IFS line 25L and 26C: "*Demand and Time, Savings and Foreign Currency Deposits*" plus "*Foreign Liabilities*". I followed the method of Hagen & Ho (2000, 2005, and 2007).

Credit Support

Credit support from monetary authority was taken as "*Claims of Monetary Authorities on Deposit Money Banks*", IFS line 12E. Alternatively it is "*Credit from Monetary Authorities to Deposit Money Banks*", IFS line 26G. The data series for these lines are mostly identical. When available, I always preferred line 26G. For the United Kingdom, data was not available in IFS.

Interest Rate

Time series for nominal interest rate are taken from IFS line 60B, titled "*Money Market Rate*". It is also possible to use Treasury bill rate, government bond yield, deposit rate, and discount rate as substitutions, as Hagen & Ho (2003) did. Nevertheless, money market rate data was available for all my sample-countries. Several countries provided series called "*call money rate*" in the line 60B. I employed it for the Germany, Norway, and Japan. USA's specific time series is "Federal funds rate", Mexico has provided series called "bankers' acceptance", and Turkey has got "Interbank Money Market Rate". For the Slovak Republic, dates on Money Market Rate were not available for the period January 1993 – December 1999. For this period, I used "*average deposit rate*".

The nominal interest rates were transposed into the real one using Fisher Formula. It says that nominal interest rate is equal to real rate plus inflation: $i \approx r + \pi$. CPI for each country, IFS line 60, was taken as approximation of inflation.

6.2. Interpretation

Following Hagen & Ho, I identify banking crises to be periods in which IMP exceeds the *98.5* percentile of the given country. Index is not designed to distinguish between different levels of fragility. Its aim is the identification of periods when the stressed conditions/crises have projected into to the dramatic changes in money market (liquidity injection of central banks or interest rates shooting upward). Sometimes changes in followed variables are so abrupt that incorporating them into the calculation distorts statistical properties of the whole index. E.g. presence of too excessive values shifts the 98.5 percentile upwards and the values that would have otherwise been identified as crises are now not. Considering this possibility, I decided not to include values of BSFI exceeding the two standard deviations into the calculation of the percentile.

Hagen & Ho (2003) also hints at the ambiguities of crises' dating around the peak of IMP. Crises identified by IMP are said to might be even 2 years leading or lagging indicator of the beginning of the real crisis. This leaves relatively comfortable time span correlation with real crisis. It is a result of the fact that MPI quantitatively captures discrete events of either a) excessive liquidity injection or b) real interest rate shooting upwards. Such liquidity injection by central bank may happen in response to the ongoing crisis. In this case crisis itself may well be already full under way, when liquidity injection takes place, and IMP records it. Or liquidity injection may happen when the crisis is anticipated. In this case it happens before the crisis, and IMP's high values are leading indicators of the crisis. Nevertheless, such an injection may be well timed and prevents the crisis itself from happening. In this case, although IMP shots upwards, real crisis does not happen. This situation is known as type I error.

In my view all this allow for relatively wide scope of interpretations of IMP.

7. Results

Constructed IMPs and tables with identified periods of banking crises are provided in appendix B.

BSFI & IMP

Although the indexes are quantitative measures, some subjective assessment was unavoidable in classifying their outputs. Based on the results, I decided to classify crises operationally into two new groups: the "mild crises" and the "extensive crises". Moreover, (following Singh 2009), I classify the crisis to be of systemic nature when BSFI for prolonged period of time alternates between regions of SC and BC. In this case the occurrence is treated as that of "systemic crisis". On the other hand, when IMP or BSFI identified longer period of crisis with only single months of "stability" in between, I decided to treat whole such period as one occurrence.

While comparing crises' episodes of IMP and BSFI to that collected in the Table 8, I decided to deem the crises as matching (as occurrence of the same crisis) if they were dated within the maximum gap of year and a half between them.[105] The reason for it is acknowledged practical impossibility of setting the beginnings and the ends of the crises exactly. Government interventions may come when the actual crisis is well under way, or they may be measure taken when the banking problems are still expected[106].

BSFI identified in total 44 periods of banking crises in our sample of countries. Out of those, 23 occurred in developed countries, 11 in emerging ones, and 10 crises were identified in the transition countries. It wouldn't make sense to compare the number of crises across the groups, because of different time spans of available data[107]. Out of 44 crises identified by BSFI, 13 crises fall to the categories of "extensive" or "systemic ones".

IMP in its turn identified 37 periods of banking crises in the sample of our countries. Out of those, 18 occurred in developed countries, 9 in emerging ones, and 10 crises were identified in the transition countries. Out of 37 crises identified by IMP, 11

[105] It is an approach similar to Hagen's and Ho's.
[106] Discussion in the table …
[107] Lengths of the observed periods varied from around 20 for transition countries to well around 40 years for developed countries. See appendix.

crises come under the category of "extensive ones". IMP is constructed to detect crises by one-time rise in liquidity or interest rate. It is not designed with the aim of monitoring ongoing evolution of crisis. Thus, I refrain from calling "extensive crises" to be systemic ones.

When compared to the event-method[108] our 2 indexes fare as follows.

BSFI over-identified 15 crises[109] (out of which 7 cases were in the case of Norway) while it was unable to detect Thailand crisis of the years 1983 up to 1987 (reported by R&R and H&L). In the case of UK it missed two crises, 1991 and 1995 (identified by R&R).

IMP over-identified 11 crises (out of which 5 were again in the case of Norway), while it was unable to identify the same Thailand crisis as the BSFI. It missed also crisis in Turkey 1991 (identified by R&R and D&D).

What may be interesting is that our two indexes over-identify crises mostly in developed countries (even with Norway, the most striking case, not taken into account). This may hint that the threshold was set either too low or that event method is too conforming in those cases.

More discussion to follow in two weeks (who cares about Christmas)

		No. of crises	Over-identification	Non-identification
BSFI	Developed	23	11	2
	Emerging	10	0	1
	Transition	11	4	0
IMP	Developed	18	9	0
	Emerging	9	2	2
	Transition	10	0	0

Table 9: results of IMP & BSFI vs. results from table 8

[108] Table 8

[109] Over-identification are those periods, in which Indexes report crises but the crises are not confirmed in the Table 8

Source: own calculation

Czech Republic – case study

- Threshold value for BSFI: -0.691
- Threshold values IMP: 1.562

CZE is reported (by **BSFI**) to have experienced 2 crises. The first lasted for a relatively long period of time, from May 96 to June 2002. During these years, BSFI entered 6 times region of Stressed Conditions, and 6 times region of banking crises, without accessing stability region even once. This persistent alternation between SC and BC puts the crisis into the category of "systemic ones". Second crisis is detected as starting at the end of the available data. Onset of crisis is given at the very last month of time series, February 2009. It seems to be reaction to the meltdown in world financial markets, starting in mid2007 in USA.

Discussing the table 8, it is seen that the crisis in the given period is mentioned also by L&V (2008). As L&V reports solely the crises that are systemic, BSFI output seems to be confirmed. R&R give the crisis one year before BSFI detected it[110]. Because R&R rely on event-method, drawbacks of which as to the exact dating of crises are well known (see chapter 1), it seems likely that the crisis they refer to is the same one as detected by BSFI. Even, in this particular case BSFI seems to detect crisis more accurately than R&R do (see comparing of our outputs to real development further). H&L (2005) do not report this crisis at all. Instead, they give crisis in the Czech Republic from 1989 till 1991. Those were the three years right after the Velvet Revolution. As in this period "banking sector of Czech Republic was virtually nonexistent and needed to start from scratch" (Tůma 2002), it is not straightforward what authors of the dabase meant by placing the crises just there. The situation in the banking sector of the Czech Republic in that time, however, was surely turbulent. D&D do not have any transition country included in their sample. Thus they provide no crises for Czech Republic.

None of the databases reports the crisis in 2009, as this year is already beyond their time span. In the 2009 the consulted databases were already published.

[110] They set the crisis into the year 1994-1995.

IMP reports that CZE suffered from two banking crises periods. The first one is the "extensive" crisis from October 1996 to December 1996, with IMP crossing the threshold once more shortly afterwards, in June 1997. Second crisis was mild one, because IMP crossed the threshold only by small margin.[111] IMP suggests it lasted longer, however, crossing the threshold in two separate months, June 2008 and January 2009.

The first, "extensive", crisis is provided with the same dating also in R&R and L&V. IMP is on guard for liquidity injection, and the same event is observed by L&V and R&R in their definitions of crisis. This might be the reason why IMP and the two databases in this case well coincide.

The crisis identified by IMP in 2008 and 2009 is again beyond the time range of databases from Table 8.

Both IMP and BSFI in the CZ case show relatively good match in identified crises. They both identified two of them, in each case with overlapping timing. Moreover, none index identified crisis that would not be reported by the second index.

Indexes IMP and BSFI seem to outperform the classification of crises as contained in databases based on event-method[112]. Systemic banking crisis is confirmed to have been unfolding during the period given by BSFI and hinted at by IMP. This confirmation is found in the case studies literature on the Czech banking sector experience – Singer and Bárta (2006), Dědek (2001), Tůma (2002)[113].

[111] Value of IMP in June 2008 is 1.73; in the January 2009 it was 1.62, the threshold value is 1.562

[112] Dependent on the specific databases used. Concrete case studies of Czech Republic experience from domestic authors would shed more insight for sure. Every case study could be accompanied by IMP and BSFI for cross-checking, e.g.

[113] Elaborate discussion of these sources is provided in Svoboda (2009).

Conclusion

I drafted the diploma thesis on the topic of banking sector crises, their identification and dating. The theoretical part includes the chapters from the first to the third, whereas the chapters from the fourth to the seventh.

I classified the methods for banking crises' identification from two perspectives. First classification is the *event-method* vs. *index-method*. The event-method (chapter 1) relies on qualitative data and anecdotic evidence, whereas the index-method (chapter 2) tries to construct indexes based on qualitative data. The main features of both methods are summarized in the tables in respective chapters. *Event method*'s main drawback is the exact dating of beginning and end of the crises. It follows strictly occurrence of events, mainly bank runs and government interventions (following definition of IMF). Such interventions, however, need not perfectly coincide with banking crises. Thus event-method may identify rather dates of government interventions than banking crises themselves.

On the other hand, *index-method* has got the limitations in form availability of time series. For most countries relevant time series are not long enough to exhibit sufficiently good statistical properties. Moreover, to construction of the index that would be general enough and rooted in the theory of banking is complex task.

The second classification distinguishes approaches towards the assessment of banking sector fragility into three groups. All three, bottom-up approach, aggregate approach, and macroeconomic approach, are introduced in the second chapter of the thesis.

Bottom-up approach tries to transpose risk of default of individual institutions into the systemic risk of default. At the same time, it is this transposition what constitutes its main problem. *Aggregate approach* uses aggregate data on whole banking sector. It is, in turn, not able to detect differences in fragility that stem from the structure of the banking sector. *Macroeconomic approach* tries to interlink the state of overall economy with the state of its banking sector. The main way how to do it, signal approach, is introduced in chapter 3. Despite the large body of literature that has emerged during the last decade, unambiguous results in the field have not yet been obtained.

In the chapter 4 there begins the practical part of the thesis. I chose 11 countries, out of which 3 were transitive economies, 3 emerging ones and 5 developed countries. Chapter

4 provides periods of banking crises for these countries, as collected from the main databases of the event-method. The identified periods differed across the databases in considerable extent, which suggests the event-based method, although it is historically prevailing and still mostly used, cannot claim to be benchmark in itself. The table and the discussion of underlying sources are provided in chapter 4 of the thesis.

Chapters 5 and 6 are then devoted to the index-method. In the chapter 5 I constructed *Banking Sector Fragility Index* in a modified version from that in Kibritçioglu (2003) and Singh (2009). In chapter 6 I replicated *Index of Money Pressure*, as developed and used in Hagen & Ho 2007. I slightly differed from their recommendation, however, in the interpretation of the index.

Chapter 7 provides the discussion of the results. Both indexes exhibit similar results of identified crisis, in spite of the fact that both of them are based on diametrically different methodologies (the first on the matching of the supply and demand on the money market, the second one on the exposure of banking sector to financial risks). I also compared the banking crises as identified by both indexes to the crises that were identified based on the event-method, as was provided in chapter 4.

Results show that the approaches did not bear identical results. Classified crises vary across both event-method and index-method. Indexes nevertheless seem to exhibit more closeness to each other than databases based on events do.

At the end of the thesis there is discussion of the results for Czech Republic. Indexes seem to have outperformed the databases for this country: databases give quite various dates for the banking crises in Czech Republic, but both indexes are focused on two specific periods. Both indexes identified them (and only them). These periods were also confirmed as crises by the case studies on Czech banking sector experience.

On the other hand, indexes gave odd results in the case of Norway, where they identified a few crises that were not set by databases.

Overall, usage of indexes for help in identifying banking sector's crises seems to be well deserved. They can uncover hidden distress in banking sector even in absence of government interventions and bank runs. In such cases event-method doesn't reveal any crisis. On the other hand, sufficiently sophisticated and empirically correct index still remain to be constructed.

Sources

Literatures

1. Vít Bárta & Miroslav Singer: "The Banking Sector After 15 Years of Resturcturing: Czech Experience and Lessons", BIS papers no 28, August 2006.
2. Andrew Berg, Eduardo Borensztein, Catherine Pattillo: „Assessing Early Warning Systems: How Have They Worked in Practice?", IMF Working Paper, No. 52/04, Washington 2004.
3. C. Borio & M. Drehman: "Assessing the risk of banking crises – revisited." BIS quarterly Review, March 2009.
4. C. Borio & P. Lowe: "Asset prices, financial and monetary stability: exploring the nexus." BIS Working paper no. 114, July 2002.
5. John Boyd, Gianni De Nicolo & Elena Loukoianova: "Banking Crises and Crisis Dating: Theory and Evidence." IMF working paper no. 141, 2009.
6. J. Boyd & D. Runkle: "Size and Performance of Banking Firms." Journal of Monetary Economics, Vol. 31, 1993, pp. 47-67
7. Matthieu Bussiere & Marcel Fratzscher: "Towards a New Yearly Warning System of Financial Crises." ECB working paper no. 145, May 2002
8. Caprio Gerard Jr., and Daniela Klingebiel. "Episodes of Systemic and Borderline Financial Crises." In "Managing the real and fiscal effects of banking crises", World Bank discussion paper no. 428, Washington D.C. 2002. pp. 31 – 49.
9. Gerard Caprio & Lawrence Summers: "Finance and Its Reform: Beyond Laissez-Faire". Policy Research WP No. 1171, World Bank, Washington, 1993.
10. Carmen M. Reinhart & Kenneth S. Rogoff: "This Time is Different: A Panoramic View of Eight Centuries of Financial Crises", NBER, April 16, 2008 (see internet sources)
11. Martin Čihák: "How Do Central Banks Write on Financial Stability? IMF working paper no. 06/163, June 2006.
12. Martin Čihák: "Systemic Loss: A Measure of Financial Stability." Czech Journal of Economics and Finance, 1-2, 2007, pp. 5-26.

13. Andrew Crocket: “Marrying the micro- and macro-prudential dimensions of financial stability” Speech at Basel, Switzerland, 21. September 2000.
14. Philip E. Davis, Dilruba Karim: “Comparing Early Warning Systems for Banking Crises”, Journal of Financial Stability, Vol 4, Issue 2, pp. 89-120, 2008.
15. Oldřich Dědek: “Bank Consolidation in Czech Republic.” BIS paper no. 4, August 2001.
16. Asli Demirgüç-Kunt and E. Detragiache. “Cross-Country Empirical Studies of Systemic Bank Distress: A Survey.” International Monetary Fund, Working paper no. 96, 2005.
17. Asli Demirgüç-Kunt A., E. Detragiache & T. Thiesel: “Banking on the Principles: Compliance with Basel Core Principles and Bank Soundness.” IMF Working paper no. 242, 2006. (Washington, International Monetary Fund).
18. Asli Demirgüç-Kunt, Aslí & Enrica Detragiache: “Does Deposit Insurance Increase Banking System Stability? An Empirical Investigation”, Journal of Monetary Economics, Vol. 49, 2002, pp. 1373-1406
19. Asli Demirgüç-Kunt, Aslí & Enrica Detragiache: “The Determinants of Banking Crises: Evidence from Developing and Developed Countries”, IMF Staff Papers, Vol. 45, 1998, pp. 81 – 109.
20. Francis Diebold & Glen Rudebush: “Scoring the Leading Indicators.” Journal of Business, 62(3), pp. 369-91, July 1989.
21. Hali Edison: “Do Indicators of Financial Crises Work? Av Evaluation of an Early Warning System”, International Journal of Finance and Economics, Vol. 8 (2003), Issue 1, pp. 11-53, 2003.
22. Barry Eichengreen, Andrew K. Rose & Charles Wyplosz: “Exchange Market Mayhem: The Antecedents and Aftermath of Speculative Attacks.” Economic Policy, 21, 249-96, 1995.
23. Barry Eichengreen, Andrew K. Rose & Charles Wyplosz: “Speculative Attacks on Pegged Exchange Rate” An Empirical Exploration with special Reference to the European Monetary System.” In The New Transatlantic Economy, edited by Matthew B. Canzoneri, Wilfred J. Ethier & Vittorio Grilli, pp. 191-228. Cambridge, New York, Melbourne: Cambridge University Press, 1996a

24. Barry Eichengreen, Andrew K. Rose & Charles Wyplosz: "Contagious Currency Crises: First Tests." Scandinavian Journal of Economics, 98:4, 804-31, 1996b
25. Xavier Freixas & Jean-Charles Rochet: "Microeconomics of Banking", 2nd edition, The MIT Press, Cambridge, Massachusetts, London, England, 2008.
26. Blaise Gadanecz & Kaushik Jayaram: "Measures of financial stability – a review." IFC bulletin no. 31, pp. 365-380, 2009.
27. Vincente Galbis: "High Real Interest Rates Under Financial Liberalization: Is There a Problem?" IMF working paper no. WP/93/7, January 1993.
28. Adam Geršl and J. Heřmánek: „Indicators of financial system stability: towards an aggregate financial stability indicator?" Prague Economic Papers 2/2008, pp. 127-142.
29. M. Goldstein, G. Kaminsky & C. Reinhart: "Assessing Financial Vulnerability: an Early Warning System for Emerging Markets." Institute of International Economics, Washington DC, June 2000.
30. Dieter Gramlich, Gavin L. Miller, Mikhail V. Ovet, Stephen J. Ong: "Early Warning Systems for Systemic banking Risk: Critical Review and Modeling Implications", Banks and Bank Systems, Volume 5, Issue 2, 2010.
31. D. F. Gray, R. C. Merton & Z. Bodie: "New Framework for Mearusing and Managing Macrofinancial Risk and Financial Stability", IMF, prepared for the Bank of Canada's conference in Ottawa, Canada, November 7-8, 2007.
32. D. F. Gray, R. C. Merton & Z. Bodie: "A New Framework for Analyzing and Managing Macrofinancial Risk". Conference of Finance and the Macroeconomy, New Your University, October 2002.
33. D. F. Gray, R. C. Merton & Z. Bondie: "A New Framework for Analyzing and Managing Macrofinancial Risk of an Economy", NBER paper no. 12637, 2006.
34. John Hawkins & Marc Klau: "Measuring Potential Vulnerabilities in Emerging Market Economies." BIS working paper no. 91, October 2000.
35. Darryll Hendricks, John Kambhu, & Patricia Mosser: „Systemic Risk and the Financial System", Federal Reserve Bank of New York; Economic Policy Review, Vol 13, No. 2, pp. 65 – 80, 2007.

36. H. Hesse & M. Čihák: „Cooperative Banks and Financial Stability“, IMF working paper no. 02, 2007. (Washington, International Monetary Fund)
37. Patrick Honohan & Luc Laeven, “Systemic Financial Crises: Containment and Resolution”, Cambridge University Press, 2005
38. Peter Jakubík & Jakub Seidler: „Estimating Expected Loss Given Default.“ Financial Stability Report of Czech National Bank (CNB’s FSR), 2008/2009.
39. Petr Jakubík: “Macroeconomic Environment and Credit Risk.” Czech Journal of Economics and Finance (Finance a úvěr), 57(1-2), 2007, pp. 60 – 78.
40. Jurgen von Hagen & Tai-Kuang Ho: “Money Market Pressure and the Determinants of Banking Crises.” Journal of Money, Credit and Banking, pp. 1037-1067, 2007.
41. Jurgen von Hagen & Tai-Kuang Ho: “Money Market Pressure and the Determinants of Banking Crises.” Centre for Economic Policy Research, Discussion Paper No. 4651, October 2004.
42. Kaminsky & Reinhart. “The Twin Crises: “The Causes of Banking and Balance of Payments Problems.” American Economic Review, Vol 89, pp. 473 – 500., 1999
43. G. Kaminsky, S. Lizondo & C. Reinhart: “Leading indicators of currency crises.” IMF Staff Papers no. 1, volume 45, pp. 1-48, March 1998.
44. G. Kaminsky: “Currency and banking crises: the early warnings of distress.” IMF working paper no. 178, December 1999.
45. Graciela L. Kaminsky & Carmen M. Reinhart: “The Twin Crises: The Causes of Banking and Balance-of-Payments Problems.” The American Economic Review, volume 89, pp. 473-500. June 1999.
46. L. Laeven and F. Valencia, „Systemic Banking Crises: A New Database.“ International Monetary Fund, Working Paper no. 224, 2008.
47. Luc Laeven & Ross Levine: “Corporate Governance, Regulation, and Bank Risk Taking”, 2006 (see internet sources).
48. C. J. Lindgren, G. Garcia & M. I. Saal: “Bank Soundness and Macroeconomic Policy.” IMF publication, 1996.
49. Andrea Maechler, Sroborna Mitra & DeLisle Worrell: “Exploring Financial Risks and Vulnerabilities in New and Potential EU Member States”, paper presented in

New and Potential Conference on Financial Stability and the Convergence Process in Europe, October 6-7, 2005.

50. Michal Mejstřík, Magda Pečená & Petr Teplý: „Basic principles of banking“, Karolinum 2008.
51. Carmen M. Reinhart, Kenneth S. Rogoff, and Miguel A. Savastano: “Debt Intolerance.” Brooking Papers on Economic Activity 1 (Spring), pp. 1 – 74, 2003
52. C. M. Reinhart and K. Rogoff, „This time is different: Eight Centuries of Financial Folly.“ Princeton University Press, 2009.
53. Carmen M. Reinhart & Vincent R. Reinhart: “Forecasting Turning Points in Canada.” March, 1996. Available in MPRA (Munich Personal RePEc Archive), MPRA Paper No. 13884, posted on 09. March 2009. (see also internet sources)
54. A. Saunders & Allen, L.: “Credit Risk Measurement”, 2nd edition, John Willey & Sons, New York, 2002.
55. Jakub Seidler a) “Implied Loss Given Default.” Diploma thesis, Charles University, 2008.
56. Jakub Seidler b) “Implied Loss Given Default: Structural-model Approach.” IES working paper, 26/2008, Charles University, Institute of Economic Studies, 2008.
57. Joseph E. Stiglitz: “The Role of State in Financial Markets.” In “Proceedings of the World Bank Annual Conference on Development Economics”, ed. By M. Bruno & Boris Pleskovic, World Bank, Washington.
58. Svatopluk Svoboda: “Financial Stability and Fragile Banking Systems.” Charles University, diploma thesis, 2010.
59. M. Tudela & G. Young: “Predicting Default Among UK Companies: A Merton Approach”, Financial Stability Review, Bank of England, UK, June 2003, pp. 104-114.
60. Zděnek Tůma: “Banking Sector Development in the Czech Republic”, East-West Conference, Österreichische Nationalbank,Vienna, 2002.
61. BCBS: “International Convergence of Capital Measurement and Capital Standard: A Revised Framework.” Basel Committee on Banking Supervision – BIS, November 2005.

62. Financial Supervision Commission (FSC): "Banking guidance note (BGN 6.0): Foreign Exchange Risk Management", 31st March, 2006 (see internet sources)
63. Group of Ten: „Consolidation in the Financial Sector", Bank for International Settlement (SIS) publication, Basel, January 2001.

Internet Sources

1. Financial Stability Board: http://www.financialstabilityboard.org/list/fsb_publications/index.htm
2. Carmen M. Reinhart & Vincent R. Reinhart: "Forecasting Turning Points in Canada." March, 1996. Available in MPRA (Munich Personal RePEc Archive), MPRA Paper No. 13884, posted on 09. March 2009. (see also internet sources): available at: http://mpra.ub.uni-muenchen.de/13884/
3. World Bank website: http://data.worldbank.org/about/country-classifications/world-bank-atlas-method. (Definition of Atlas conversion factor).
4. J. Seidler: "Implied Market Loss Given Default." Charles University, diploma thesis, 2008: http://ies.fsv.cuni.cz/work/index/show/id/1063/lang/en
5. Andrew Crocket: "Marrying the micro- and macro-prudential dimensions of financial stability" speech at Basel, Switzerland, 21. September 2000: www.bis.org/review/rr000921b.pdf
6. Luc Laeven & Ross Levine: "Corporate Governance, Regulation, and Bank Risk Taking", 2006: http://www.ecb.int/events/pdf/conferences/ecbcfs_conf9/bank_stability_4_14.pdf
8. Financial Supervision Commission (FSC): "Banking guidance note (BGN 6.0): Foreign Exchange Risk Management", 31st March, 2006. Available at: http://www.gov.im/lib/docs/fsc/handbooks/guides/banking/bgn6.pdf

Appendix

Appendix A

Banking crises for sample countries – narratives

Collected from the following Reinhart & Rogoff (2009) and references cited therein (those are: Bordo et al., 2001; Caprio & Klingebiel, 2003, Bernanke & James 1990; Conant 1915[114]; Bordo & Eichengreen 1999; Kaminsky & Reinhart 1999, Reinhart 2002, Jonung & Hagberg 2002; Oksendal 2007; Jácome 2008; Temin 2008; Flath 2005)

Japan

- *1872 – 1876*: The National Bank Act forced banks to accept the government's paper notes, causing nine or ten banks to fail. (Conant 1915)
- *1882 – 1885*: Deflationary measures depressed trade, and four national banks failed, five suspended operations, and ten were consolidated. (Conant 1915)
- *1901*: There were trade deficits and reserve losses as well as significant output losses; growth fell by 6 percent in one year. (Bordo and Eichengreen 1999)
- *1907*: The Tokyo stock market crashed in early 1907, and there was global uncertainty; the Bank of Japan intervened for some banks and let other banks fail. The recession was severe. (Bordo and Eichengreen 1999)
- *1917*: Japan went off the gold standard (Borde et al. 2001, Flath 2005)
- *September 1923*: A Tokyo earthquake led to bad debts that shook the Bank of Tokyo and Chosen. They were restructured with government aid. (Bernande and James 1990)
- *April 1927*: A banking panic led to tighter regulation. The failure of Tokyo Watanabe bank led to runs and a wave of failures; fifteen banks were unable to make their payments. The government's unwillingness to bail out the banks led to more uncertainty and other runs. The crisis resulted in bank consolidations. (Bernanke and James 1990, Bordo et al. 2001)
- *1992 – 1997*: Banks suffered from a sharp decline in stock market and real estate prices. In 1995, estimates of nonperforming loans were $469-1,000 billion or 10-25 percent of GDP; at the end of 1998 they were estimated at $725 billion or 18 percent

[114] Utilized for the incidence of the banking crises from before 1900 with the exceptions of the United States and the United Kingdom.

of GDP; and in 2002 they were 35 percent of total loans. Seven banks were nationalized, sixty-one financial institutions closed, and twenty-eight institutions merged. (Bordo et al. 2001; Caprio and Klingebiel 2003)

Estonia

- *November 1930*: Two medium-sized banks failed; the ensuing panic lasted until January 1931. (Bernanke and James 1990)
- *September 1931*: There were waves of general bank runs. (Bernanke and James 1990)
- *1992 – 1995*: Insolvent banks accounted for 41 percent of financial system assets. Five banks' licenses were revoked, and two major banks were merged ant nationalized while two more merged and were converted to a loan recovery agency. (Caprio and Klingebiel 2003)
- *1994*: The Social Bank, with 10 percent of financial system assets, failed. (Caprio and Klingebiel 2003)
- *1998*: Three banks failed (Caprio and Klingebiel 2003)

Czech Republic

- *1991 –?* : There have been several bank closings since 1993. In 1994-95, 38 percents of banking system loans were nonperforming. (Caprio and Klinebiel 2003)

Germany

- *1857*: Hamburg Bank was rescued by the Austrian National Bank; this restored confidence and dispelled the crisis; Hamburg Bank repaid its loan in six months. (Conant 1915)
- *1901*: Triggered by Russia's crisis, stock prices in Berlin fell by 61 percent; the problem hit mortgage banks first, but discount banks provided liquidity, Dresdner Creditanstalt, the Bank of Leipzig, and Leipzig Bank failed. There was a modest slowdown in the rate of growth. (Conant 1915, Bordo and Eichengreen 1999)
- *1931*: There were twin crises in which banks were recapitalized or their deposits guaranteed by the government. Bank runs exacerbated troubles building since mid-

1930; many banks were unable to make payments, and there was a bank holiday. (Bernanke and James 1990, Bordo et al. 2001, Temin 2008)

- *1977*: Giro intitutions faced problems. (Caprio and Klingebiel 2003)

Mexico

- *1883*: The Mexican government borrowed widely and then suspended payments (June 1885); foreign investments fell, leading to a credit crisis and bank runs, and banks stopped lending. National Bank and Mercantile Bank merged into National Bank of Mexico (Banamex) in 1884 to meet the government's demand for a loan (Conant 1915).
- *1893*: National Bank absorbed Mexican Mercantile Bank, its main competitor (Conant 1915)
- *February 1908*: There was a severe credit shortage due to the U.S. crash; banks could not collect debts; the Mexican Central Bank and many state banks failed. Other banks survived with federal assistance or by merging. The failures caused many bankruptcies and prevented economic activity. The government cautioned against overexpansion of credit; in February a circular warned against unsafe loans, and restrictions were imposed in June. (Conant 1915)
- *1929*: Payments were suspended after a run on the major banks. (Bernanke and James 1990)
- *1981-1982*: There was capital flight; the government responded by nationalizing the private banking system. (Borde et al. 2001)
- *September 1982 – 1991*: The government took over the banking system (Kaminsky and Reinhart 1999, Caprio and Klingebiel 2003)
- *October 1992*: Several financial institutions that held Ajustabonos were hurt by the rise in real interest rates in the second half of 1992. (Kaminsky and Reinhart 1999)
- *1994 – 1997*: In 1994, nine banks were intervened and eleven participated in the loan/purchase recapitalization programs of thirty-four commercial banks. The nine banks accounted for 19 percent of financial system assets and were deemed insolvent. One percent of bank assets were owned by foreigners, and by 1998, 18 percent of

banks assets were held by foreign banks. (Bordo et al. 2001, Caprio and Klingebiel 2003, Jácome 2008)

Norway

- *1898*: There was real estate speculation; the bubble burst when interest rates increased, and many banks failed. The Bank of Norway stepped in and prevented the crisis from spreading. (Jonung and Hagberg 2002)
- *1921 – 1923*: Reckless lending during the war and the global downswing in the early 1920s causes bank instability (Bordo et al. 2001, Jonung and Hagberg 2002)
- *1931*: Norway abandoned the gold standard; the Norges Bank provided much support to smaller banks to prevent a systemic crisis. The situation was more successfully managed than in 1921 crisis. (Bordo et al. 2001, Oksendal 2007)
- *1936*: Legislation introducing a tax on bank deposits led to many withdrawals. (Bernanke and James 1990)
- *1987-1993*: Two regional savings banks failed. The banks were eventually merged and bailed out. The Central Bank provided special loans to six banks suffering from the recession of 1985-1986 and from problem real estate loans. The state took control of the three largest banks, with 85 percent of banking system assets. (Kaminsky and Reinhart 1999, Bordo et al. 2001, Jonung and Hagberg 2002, Caprio and Klingebiel 2003)

Slovakia

- *1991*: In 1991, unrecoverable loans were estimated at 101 billion crowns – about 31 percent of loans and 15 percent of GDP. (Caprio and Klingebiel 2003).

Thailand

- *March 1979*: Following the stock market crash, one of the largest finance companies failed. The bailout of the financial sector began. (Kaminsky and Reinhart 1999)
- *October 1983 – 1987*: Large losses in a finance company led to runs and government intervention. Authorities intervened in fifty finance and security firms and five

commercial banks, with about 25 percent of financial system assets; three commercial banks (with 14 percent of commercial bank assets) were deemed insolvent. (Kaminsky and Reinhart 1999, Bordo et al. 2001, Caprio and Klingebiel 2003)

- *May 1996*: As of May 2002, the Bank of Thailand shut down fifty-nine of ninety-one financial companies (13 percent of financial system assets and 72 percent of finance company assets) and one of fifteen domestic banks and nationalized four banks. A publicly owned assets management company held 29.7 percent of financial system assets as of March 2002. Nonperforming loans peaked at 33 percent of total loans and were reduced to 10.3 percent of total loans in February 2002. (Bordo et al. 2001, Reinhart 2002, Caprio and Klingebiel 2003)

Turkey

- *July 1931*: There were runs on branches of German banks in the wake of the German crisis. (Bernanke and James 1990)
- *1982-1985*: Three banks were merged with the state-owned Agriculture Bank and then liquidated; two large banks were restructured. (Bordo et al. 2001, Caprio and Klingebiel 2003).
- *January 1991*: The start of the war led to massive withdrawals and a run on banks, prompting the government to guarantee all deposits. (Kaminsky and Reinhart 1999)
- *April 1994*: Three banks failed in April (Bordo et al. 2001, Caprio and Klingebiel 2003)
- *2000*: Two banks closed, and nineteen banks have been taken over by the Savings Deposit Insurance Fund. (Caprio and Klingebiel 2003).

United Kingdom (only from 1900)

- *1974-1976*: There was a "secondary" banking crisis. (Bordo et al. 2001, Caprio and Klingebiel 2003)
- *1984*: Johnson Matthey Bankers failed. (Caprio and Klingebiel 2003)
- *1991*: The Bank of Credit and Commerce International failed. (Caprio and Klingebiel 2003)
- *1995*: Barings failed. (Caprio and Klingebiel 2003)

United States (from 1900)

- *March 1907*: There were global credit restrictions and domestic financial excesses, increasing the number of state banks, and a rising ratio of deposits to cash reserves set the stage for a crisis. Real estate and stock speculation bubble burst; the crisis spread from New York nationwide. The growth rate fell by 9 percent per year. J. P. Morgan, the Bank of Montreal, and the treasury of New York replenished liquidity. (Conant 1915, Bordo and Eichengreen 1999)
- *July 1914*: The New York Stock Exchange closed until December in response to the war; however, a banking crisis was avoided by flooding the country with emergency currency to prevent hasty withdrawals. (Bordo el al. 2001)
- *1929-1933*: During the Great Depression, thousands of banks closed; failures were correlated with particular Federal Reserve districts. The Bank of the USA failed in December 1930; between August 1931 and January 1932, 1860 banks failed. (Bernanke and James 1990, Bordo et al. 2001)
- *1984-1991*: There were 1400 savings and loan and 1300 bank failures. (Bordo et al. 2001, Caprio and Klingebiel 2003)

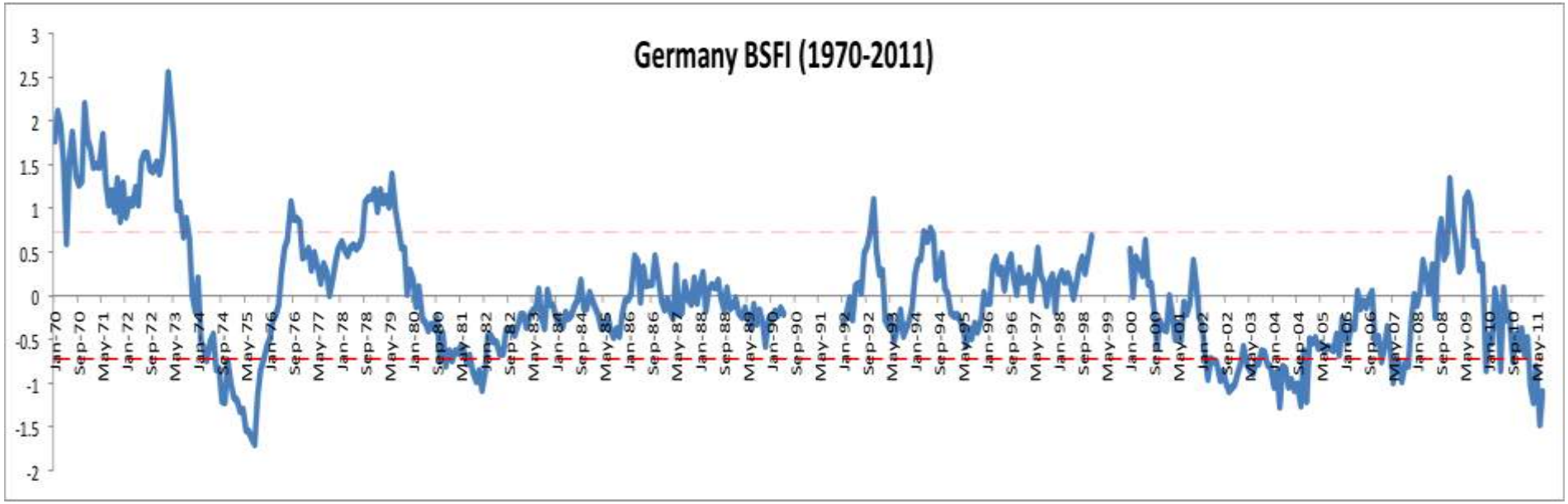
Appendix B

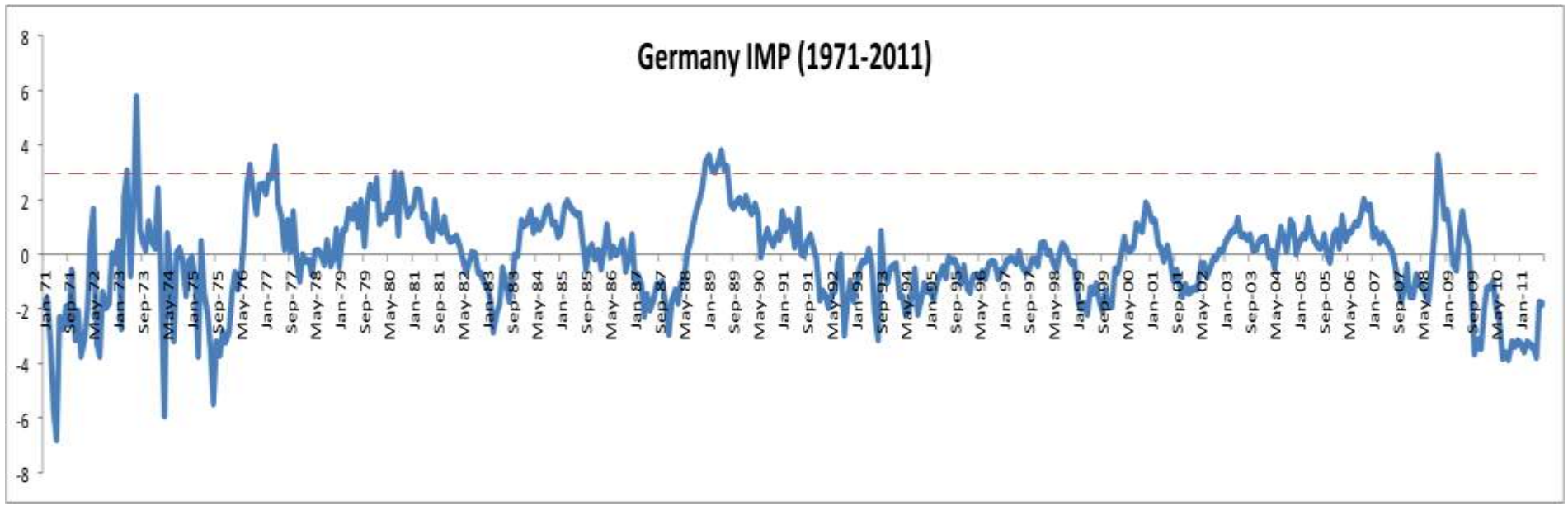
BSFI & MPI for the countries

Germany (BSFI: Jan 70 – Jul 11, IMP: Jan 71 – Aug 2011)

BSFI		IMP
sd = 0.713		98.5 per = 2.946
SC	BC	IMP
		Oct 1, 1972
		Jan 1, 1973
Jun 1, 1973		
08.1973 - 09.1973		
	Oct 1, 1973	
11.1973 - 12.1973		
	01.1974 - 04.1975	
05.1975 - 10.1975		
		Feb 1, 1976
		Oct 1, 1976
Aug 1, 1979		
10.1979 - 03.1980		
	Apr 1, 1980	
May 1, 1980		
	Jun 1, 1980	
Jul 1, 1980		
	Aug 1, 1980	
09.1980 - 12.1980		
	Jan 1, 1981	
Feb 1, 1981		
	03.1981 - 07.1981	
08.1981 - 12.1982		
02.1983 - 03.1983		
05.1983 - 02.1984		
04.1984 - 05.1984		
07.1984 - 07.1985		
Nov 1, 1985		
06.1986 - 10.1986		
12.1986 - 01.1987		
03.1987 - 04.1987		
Jun 1, 1987		
Sep 1, 1987		
02.1988 - 03.1988		
		06.1988 - 01.1989
05.1988 - 11.1989		
07.1991 - 10.1991		
09.1992 - 06.1993		
07.1994 - 05.1995		
07.1995 - 08.1995		
Oct 1, 1996		
Mar 1, 1997		
Jun 1, 1997		
Dec 1, 1997		
Aug 1, 1999		
03.2000 - 03.2001		
06.2001 - 08.2001		
	09.2001 - 08.2002	
Sep 1, 2002		
	10.2002 - 02.2003	
03.2003 - 04.2003		
	05.2003 - 04.2004	
May 1, 2004		
	Jun 1, 2004	
07.2004 - 10.2005		
12.2005 - 03.2006		

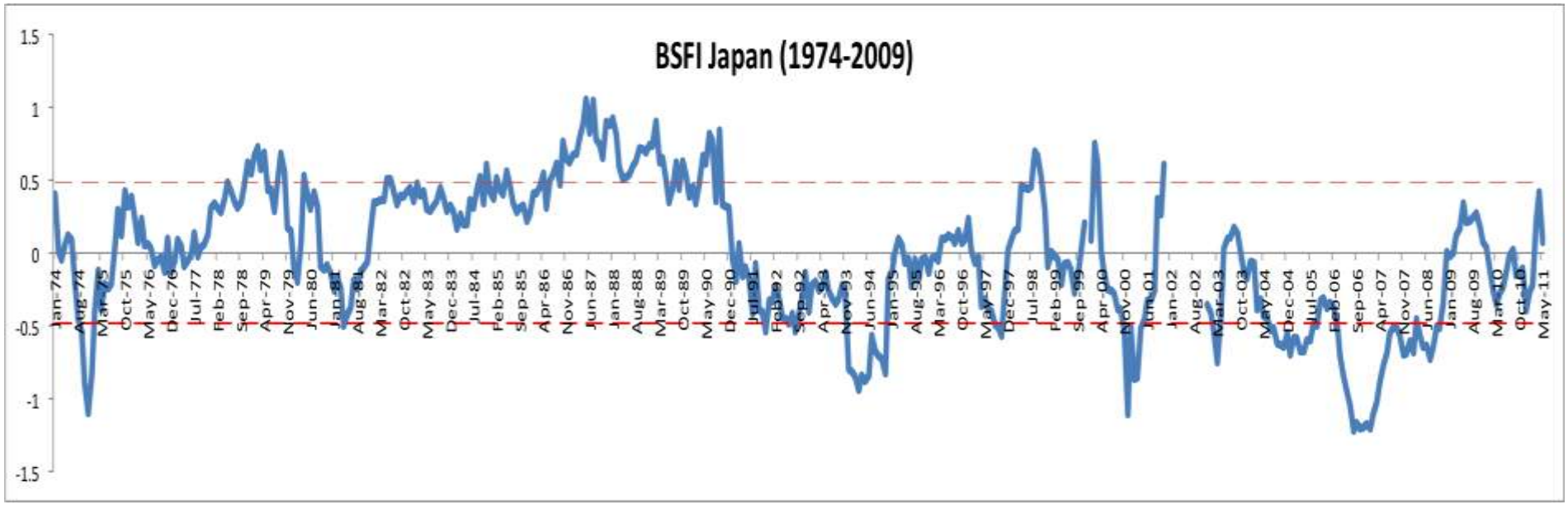
05.2006 - 06.2006		
	Jul 1, 2006	
08.2006 - 10.2006		
	11.2006 - 04.2007	
May 1, 2007		
Jul 1, 2007		
Jan 1, 2008		
		Apr 1, 2008
	Jun 1, 2009	
07.2009 - 08.2009		
Oct 1, 2009		
	Nov 1, 2009	
01.2010 - 02.2010		
	Mar 1, 2010	
04.2010 - 08.2010		
	09.2010 - 01.2011	

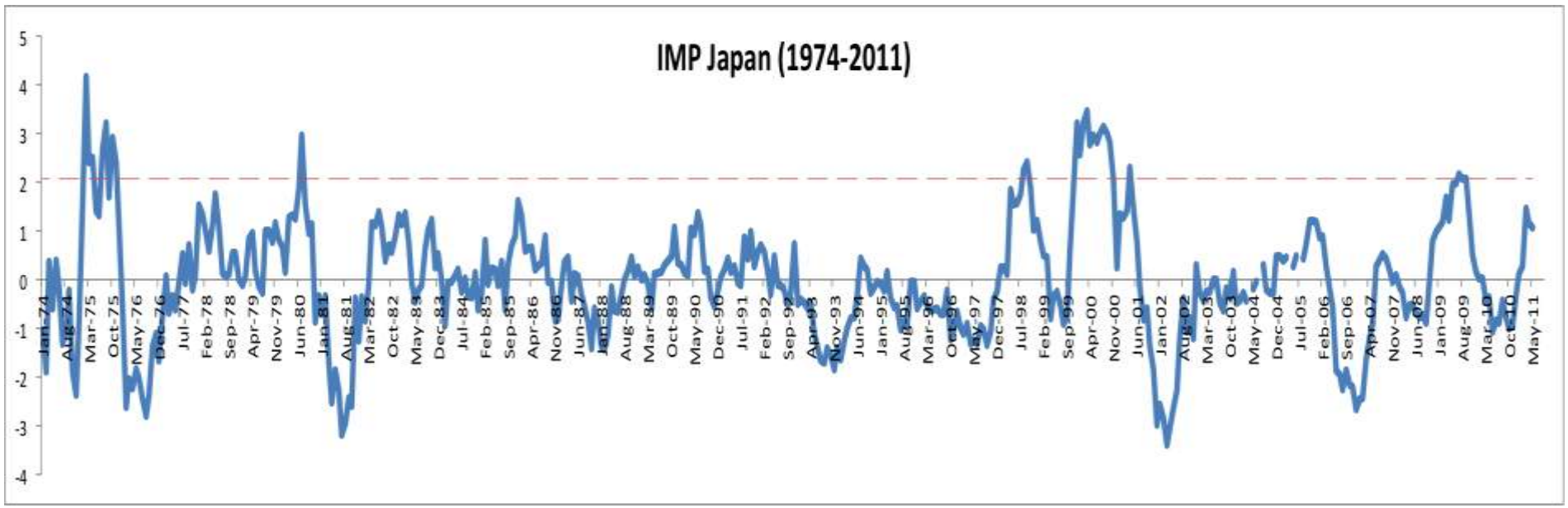

Germany BSFI (1970-2011)
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Jan-70
Sep-70
May-71
Jan-72
Sep-72
May-73
Jan-74
Sep-74
May-75
Jan-76
Sep-76
May-77
Jan-78
Sep-78
May-79
Jan-80
Sep-80
May-81
Jan-82
Sep-82
May-83
Jan-84
Sep-84
May-85
Jan-86
Sep-86
May-87
Jan-88
Sep-88
May-89
Jan-90
Sep-90
May-91
Jan-92
Sep-92
May-93
Jan-94
Sep-94
May-95
Jan-96
Sep-96
May-97
Jan-98
Sep-98
May-99
Jan-00
Sep-00
May-01
Jan-02
Sep-02
May-03
Jan-04
Sep-04
May-05
Jan-06
Sep-06
May-07
Jan-08
Sep-08
May-09
Jan-10
Sep-10
May-11


Germany IMP (1971-2011)
8
6
4
2
0
-2
-4
-6
-8
Jan-71
Sep-71
May-72
Jan-73
Sep-73
May-74
Jan-75
Sep-75
May-76
Jan-77
Sep-77
May-78
Jan-79
Sep-79
May-80
Jan-81
Sep-81
May-82
Jan-83
Sep-83
May-84
Jan-85
Sep-85
May-86
Jan-87
Sep-87
May-88
Jan-89
Sep-89
May-90
Jan-91
Sep-91
May-92
Jan-93
Sep-93
May-94
Jan-95
Sep-95
May-96
Jan-97
Sep-97
May-98
Jan-99
Sep-99
May-00
Jan-01
Sep-01
May-02
Jan-03
Sep-03
May-04
Jan-05
Sep-05
May-06
Jan-07
Sep-07
May-08
Jan-09
Sep-09
May-10
Jan-11

JAPAN (BSFI: Jan 74 – May 11, IMP: Jan 74 – 20011)

BSFI		IMP
sd = 0.482		98.5 per = 2.073
SC	BC	IMP
Sep 1, 1973		
01.1974 - 02.1974		
	03.1974 - 06.1974	
		08.1974 - 10.1974
07.1974 - 12.1974		
		01.1975 - 02.1975
		04.1975 - 05.1975
01.1976 - 04.1976		
06.1976 - 07.1976		
10.1976 - 12.1976		
Feb 1, 1977		
07.1979 - 08.1979		
		Jan 1, 1980
03.1980 - 09.1980		
	Oct 1, 1980	
11.1980 - 05.1981		
07.1990 - 08.1990		
10.1990 - 04.1991		
	May 1, 1991	
06.1991 - 11.1991		
	Dec 1, 1991	
Jan 1, 1992		
	Feb 1, 1992	
03.1992 - 05.1993		
	06.1993 - 05.1994	
06.1994 - 08.1994		
11.1994 - 09.1995		
08.1996 - 01.1997		
	02.1997 - 04.1997	
May 1, 1997		
		02.1998 - 03.1998
Jun 1, 1998		
08.1998 - 03.1999		
11.1999 - 04.2000		06.1999 - 04.2000
	05.2000 - 10.2000	Oct 1, 2000
11.2000 - 02.2001		
	06.2001 - 05.2002	
06.2002 - 07.2002		
	08.2002 - 09.2002	
Oct 1, 2002		
05.2003 - 12.2003		
	01.2004 - 03.2005	
04.2005 - 09.2005		
	10.2005 - 08.2007	
Sep 1, 2007		
	10.2007 - 04.2008	
May 1, 2008		
07.2008 - 08.2008		
		01.2009 - 02.2009
07.2009 - 01.2010		
03.2010 - 08.2010		

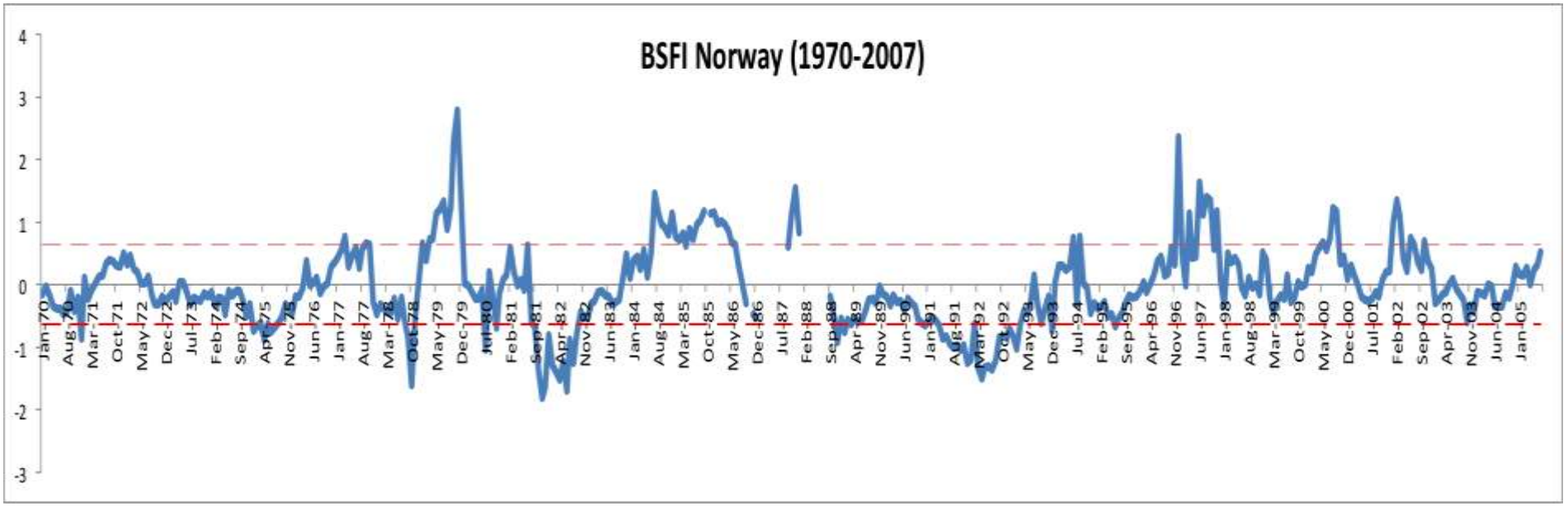

BSFI Japan (1974-2009)
1.5
1
0.5
0
-0.5
-1
-1.5
Jan-74
Aug-74
Mar-75
Oct-75
May-76
Dec-76
Jul-77
Feb-78
Sep-78
Apr-79
Nov-79
Jun-80
Jan-81
Aug-81
Mar-82
Oct-82
May-83
Dec-83
Jul-84
Feb-85
Sep-85
Apr-86
Nov-86
Jun-87
Jan-88
Aug-88
Mar-89
Oct-89
May-90
Dec-90
Jul-91
Feb-92
Sep-92
Apr-93
Nov-93
Jun-94
Jan-95
Aug-95
Mar-96
Oct-96
May-97
Dec-97
Jul-98
Feb-99
Sep-99
Apr-00
Nov-00
Jun-01
Jan-02
Aug-02
Mar-03
Oct-03
May-04
Dec-04
Jul-05
Feb-06
Sep-06
Apr-07
Nov-07
Jun-08
Jan-09
Aug-09
Mar-10
Oct-10
May-11


IMP Japan (1974-2011)
5
4
3
2
1
0
-1
-2
-3
-4
Jan-74
Aug-74
Mar-75
Oct-75
May-76
Dec-76
Jul-77
Feb-78
Sep-78
Apr-79
Nov-79
Jun-80
Jan-81
Aug-81
Mar-82
Oct-82
May-83
Dec-83
Jul-84
Feb-85
Sep-85
Apr-86
Nov-86
Jun-87
Jan-88
Aug-88
Mar-89
Oct-89
May-90
Dec-90
Jul-91
Feb-92
Sep-92
Apr-93
Nov-93
Jun-94
Jan-95
Aug-95
Mar-96
Oct-96
May-97
Dec-97
Jul-98
Feb-99
Sep-99
Apr-00
Nov-00
Jun-01
Jan-02
Aug-02
Mar-03
Oct-03
May-04
Dec-04
Jul-05
Feb-06
Sep-06
Apr-07
Nov-07
Jun-08
Jan-09
Aug-09
Mar-10
Oct-10
May-11

Norway (BSFI: Jan 70 – May 07, IMP: Aug 72 – Jan 07)

BSFI		IMP
sd = 0.640		98.5 per = 1.275
SC	BC	IMP
07.1969 - 05.1970		
	Jun 1, 1970	
08.1970 - 09.1970		
02.1972 - 09.1972		
		Feb 1, 1974
12.1972 - 06.1974		
	07.1974 - 08.1974	
Sep 1, 1974		
	Oct 1, 1974	
Nov 1, 1974		
	12.1974 - 01.1975	
02.1975 - 09.1975		
Nov 1, 1975		
02.1976 - 03.1976		
05.1977 - 02.1978		
	03.1978 - 04.1978	
May 1, 1978		
		05.1979 - 06.1979
08.1979 - 12.1979		
	Jan 1, 1980	
Mar 1, 1980		
	Apr 1, 1980	
May 1, 1980		
Oct 1, 1980		
Dec 1, 1980		
Feb 1, 1981		
		Jun 1, 1981
		10.1981 - 11.1981
		Jan 1, 1982
	03.1981 - 03.1982	
04.1982 - 03.1983		
		Nov 1, 1985
Mar 1, 1986		
05.1986 - 06.1986		
03.1988 - 04.1988		
	May 1, 1988	
Jun 1, 1988		
	Jul 1, 1988	
08.1988 - 05.1990		
	Jun 1, 1990	
07.1990 - 09.1990		
	10.1990 - 07.1991	
Aug 1, 1991		
		Mar 1, 1992
		05.1992 - 06.1992
	09.1991 - 08.1992	
09.1992 - 12.1992		
02.1993 - 05.1993		
	Jun 1, 1993	
Jan 1, 1994		
04.1994 - 11.1994		
	Dec 1, 1994	
01.1995 - 07.1995		
Sep 1, 1995		
Aug 1, 1996		
Jul 1, 1997		
12.1997 - 01.1998		
Mar 1, 1998		
May 1, 1998		
		05.1998 - 06.1998

08.1998 - 12.1998		
02.1999 - 03.1999		
May 1, 1999		
09.2000 - 03.2001		
07.2002 - 10.2002		
01.2003 - 09.2003		
11.2003 - 04.2004		


BSFI Norway (1970-2007)
4
3
2
1
0
-1
-2
-3
Jan-70
Aug-70
Mar-71
Oct-71
May-72
Dec-72
Jul-73
Feb-74
Sep-74
Apr-75
Nov-75
Jun-76
Jan-77
Aug-77
Mar-78
Oct-78
May-79
Dec-79
Jul-80
Feb-81
Sep-81
Apr-82
Nov-82
Jun-83
Jan-84
Aug-84
Mar-85
Oct-85
May-86
Dec-86
Jul-87
Feb-88
Sep-88
Apr-89
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Jan-91
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Apr-96
Nov-96
Jun-97
Jan-98
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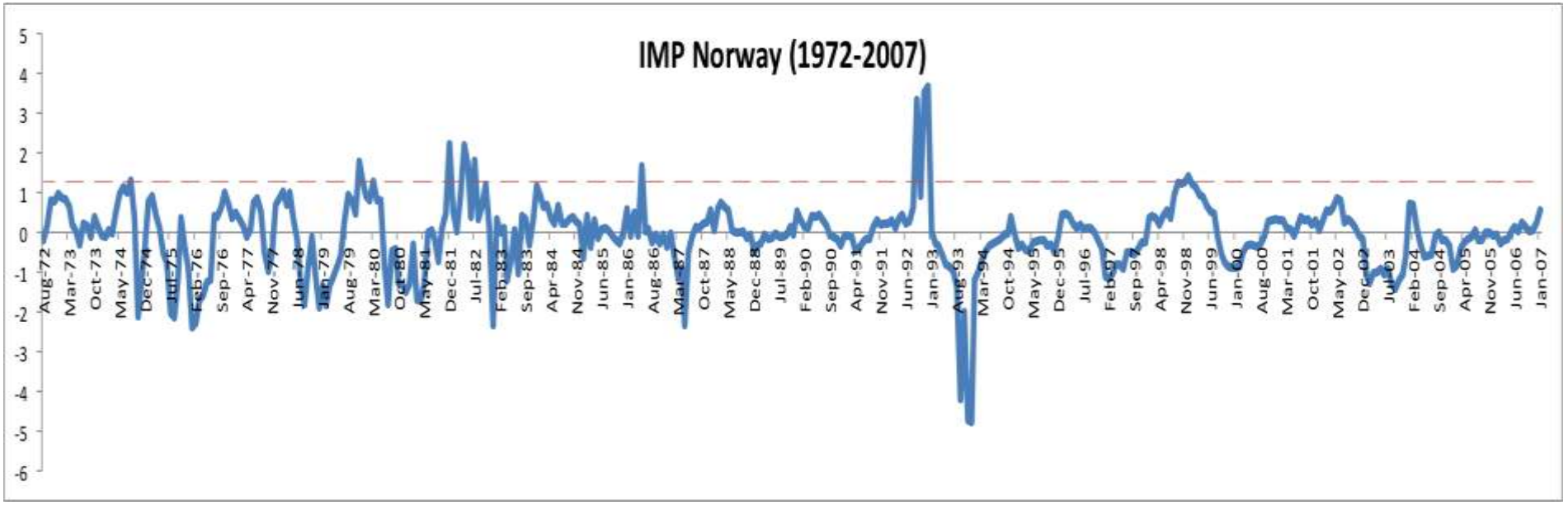
Apr-03
Nov-03
Jun-04
Jan-05


IMP Norway (1972-2007)
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
Aug-72
Mar-73
Oct-73
May-74
Dec-74
Jul-75
Feb-76
Sep-76
Apr-77
Nov-77
Jun-78
Jan-79
Aug-79
Mar-80
Oct-80
May-81
Dec-81
Jul-82
Feb-83
Sep-83
Apr-84
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Jun-85
Jan-86
Aug-86
Mar-87
Oct-87
May-88
Dec-88
Jul-89
Feb-90
Sep-90
Apr-91
Nov-91
Jun-92
Jan-93
Aug-93
Mar-94
Oct-94
May-95
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Jul-96
Feb-97
Sep-97
Apr-98
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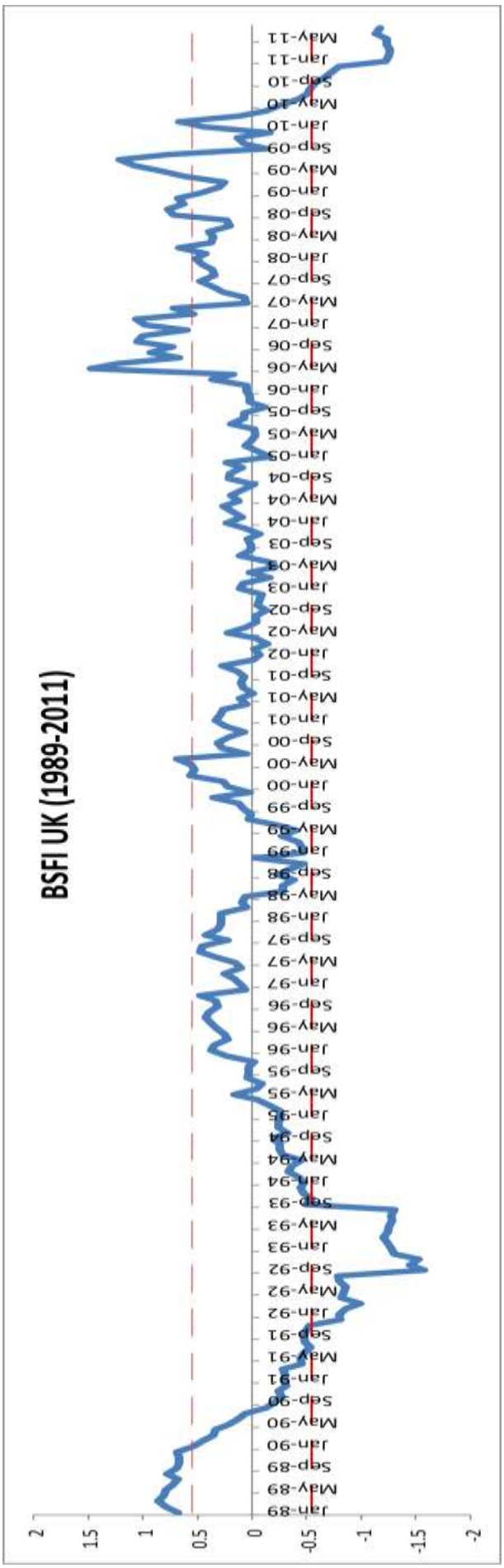
Jun-99
Jan-00
Aug-00
Mar-01
Oct-01
May-02
Dec-02
Jul-03
Feb-04
Sep-04
Apr-05
Nov-05
Jun-06
Jan-07

UNITED KINGDOM (BSFI: Jan 90-Jul 11)

sd = 0.547	
SC	BC
02.1990 - 05.1991	
	06.1991 - 02.1993
Mar 1, 1993	
	Apr 1, 1993
05.1993 - 10.1994	
12.1994 - 01.1995	
May 1, 1995	
12.1997 - 12.1998	
Dec 1, 2000	
06.2001 - 10.2001	
01.2002 - 06.2002	
Sep 1, 2002	
11.2002 - 12.2002	
May 1, 2003	
Feb 1, 2004	
07.2004 - 08.2004	
11.2004 - 12.2004	
Apr 1, 2005	
Mar 1, 2009	
Jun 1, 2009	
10.2009 - 02.2010	
	03.2010 - 01.2011


BSFI UK (1989-2011)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Jan-89
May-89
Sep-89
Jan-90
May-90
Sep-90
Jan-91
May-91
Sep-91
Jan-92
May-92
Sep-92
Jan-93
May-93
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May-02
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Jan-03
May-03
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Jan-04
May-04
Sep-04
Jan-05
May-05
Sep-05
Jan-06
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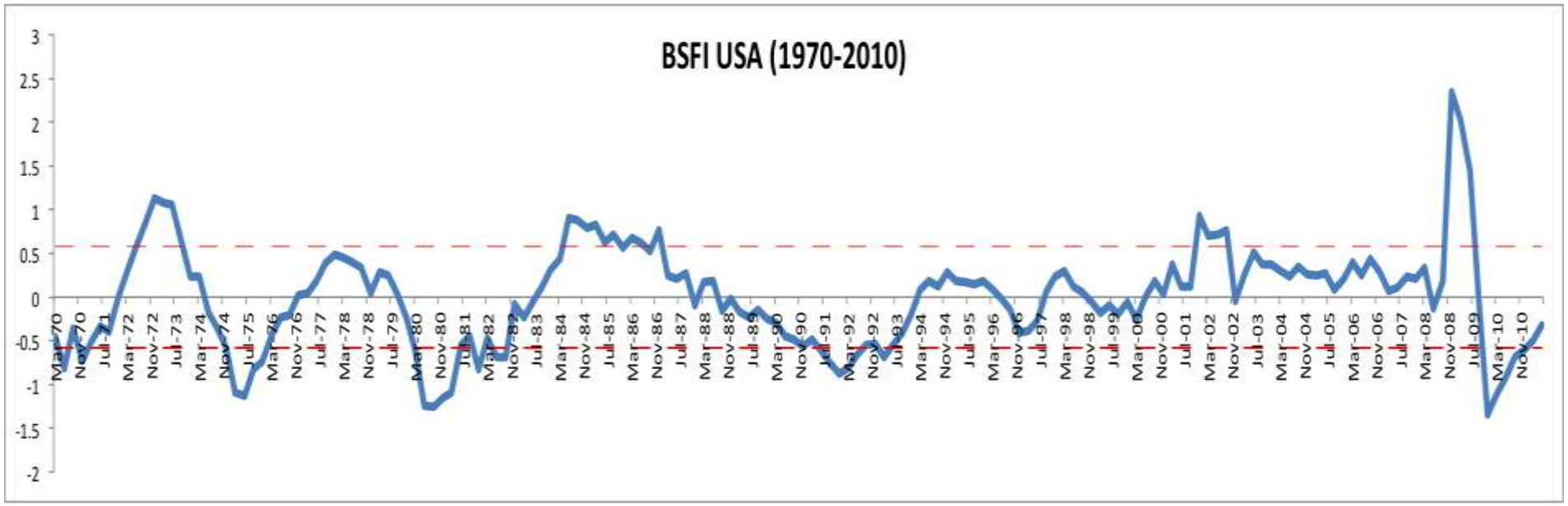
Jan-07
May-07
Sep-07
Jan-08
May-08
Sep-08
Jan-09
May-09
Sep-09
Jan-10
May-10
Sep-10
Jan-11
May-11

USA (BSFI: Mar 70-Jun 11)

BSFI		IMP
sd = 0.581		98.5 per = 1.663
MF	BC	ISC
Sep 1, 1969		
	Dec 1, 1969	
Mar 1, 1970		
	Jun 1, 1970	
01.1971 - 03.1971		
02.1974 - 03.1974		
	02.1975 - 06.1975	
		Dec 1, 1975
01.1976 - 03.1976		
Jun 1, 1979		
		Jun 1, 1980
	05.1980 - 09.1980	
02.1981 - 03.1981		02.1981 - 03.1981
	Jun 1, 1981	
Sep 1, 1981		
	02.1982 - 03.1982	
10.1982 - 12.1982		
Jun 1, 1987		
11.1989 - 09.1990		
	08.1991 - 12.1991	
05.1992 - 06.1992		
	Sep 1, 1992	
04.1993 - 06.1993		
08.1996 - 12.1996		
06.1999 - 12.1999		
Jun 1, 2002		
		Mar 1, 2006
Dec 1, 2007		
		10.2008 - 12.2008
Mar 1, 2009		
	02.2010 - 06.2010	
11.2010 - 12.2010		


BSFI USA (1970-2010)
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Mar-70
Nov-70
Jul-71
Mar-72
Nov-72
Jul-73
Mar-74
Nov-74
Jul-75
Mar-76
Nov-76
Jul-77
Mar-78
Nov-78
Jul-79
Mar-80
Nov-80
Jul-81
Mar-82
Nov-82
Jul-83
Mar-84
Nov-84
Jul-85
Mar-86
Nov-86
Jul-87
Mar-88
Nov-88
Jul-89
Mar-90
Nov-90
Jul-91
Mar-92
Nov-92
Jul-93
Mar-94
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Nov-96
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Mar-98
Nov-98
Jul-99
Mar-00
Nov-00
Jul-01
Mar-02
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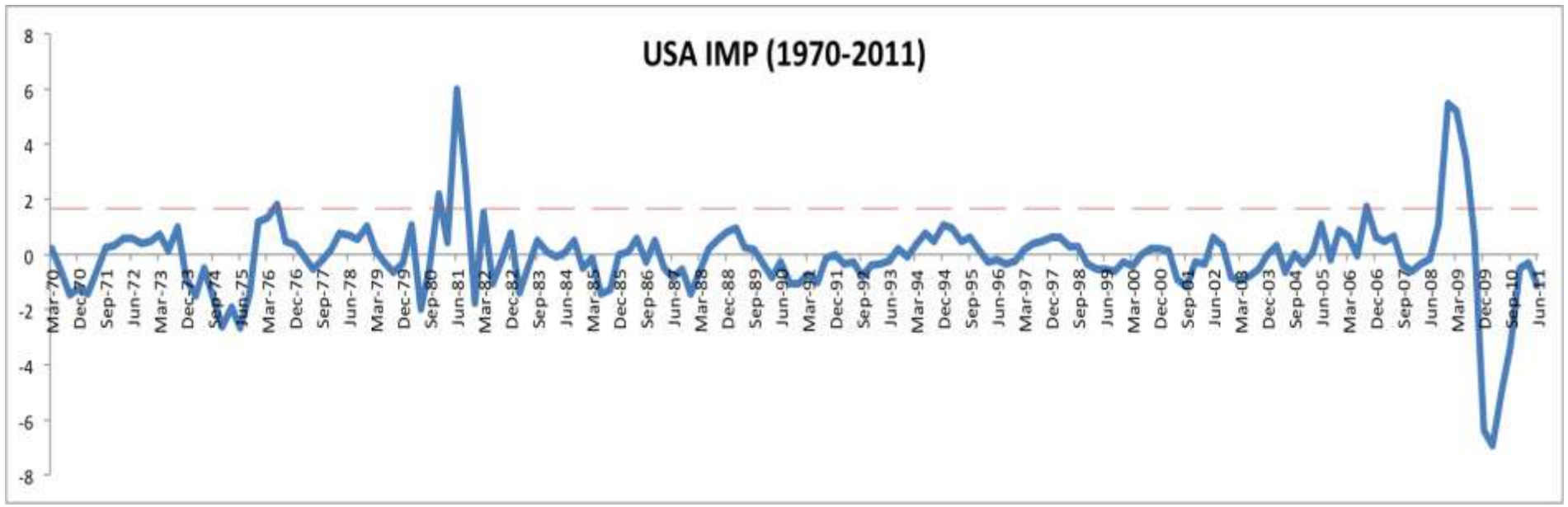
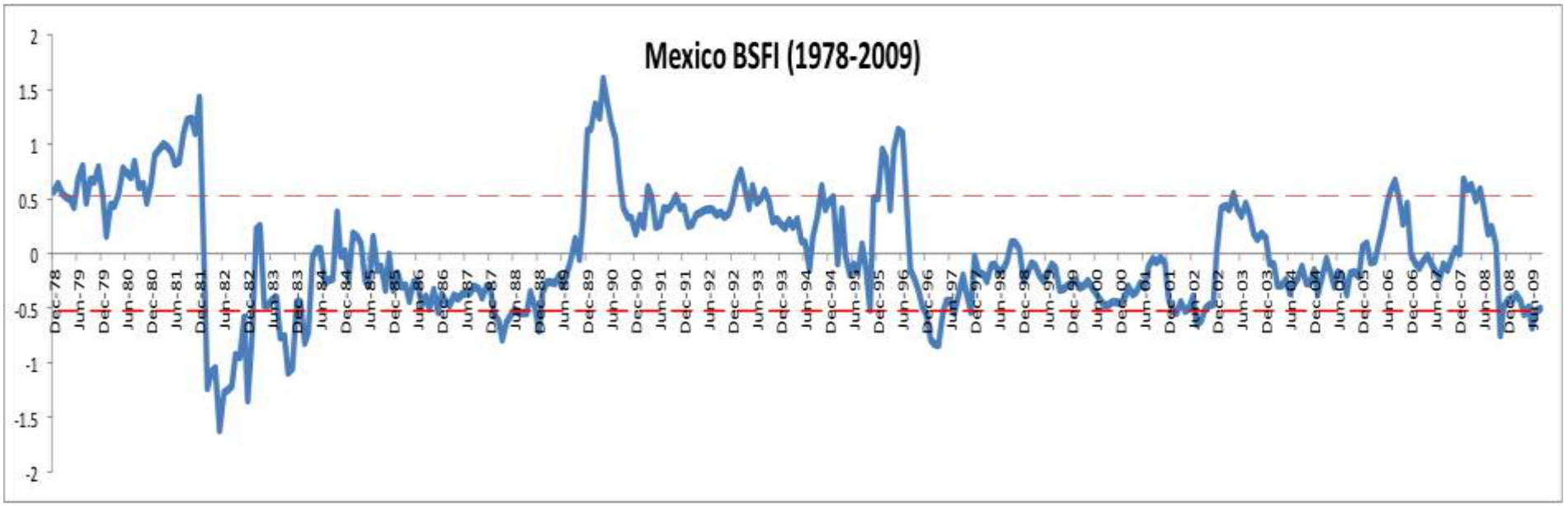
Jul-09
Mar-10
Nov-10


USA IMP (1970-2011)
8
6
4
2
0
-2
-4
-6
-8
Mar-70
Dec-70
Sep-71
Jun-72
Mar-73
Dec-73
Sep-74
Jun-75
Mar-76
Dec-76
Sep-77
Jun-78
Mar-79
Dec-79
Sep-80
Jun-81
Mar-82
Dec-82
Sep-83
Jun-84
Mar-85
Dec-85
Sep-86
Jun-87
Mar-88
Dec-88
Sep-89
Jun-90
Mar-91
Dec-91
Sep-92
Jun-93
Mar-94
Dec-94
Sep-95
Jun-96
Mar-97
Dec-97
Sep-98
Jun-99
Mar-00
Dec-00
Sep-01
Jun-02
Mar-03
Dec-03
Sep-04
Jun-05
Mar-06
Dec-06
Sep-07
Jun-08
Mar-09
Dec-09
Sep-10
Jun-11

Mexico (BSFI: Dec 78-Aug 09)

BSFI		IMP
sd = 0.528		98.5 per = 2.355
MF	BC	ISC
	08.1981 - 07.1982	
10.1982 - 01.1983		
	02.1983 - 05.1983	
06.1983 - 07.1983		
	08.1983 - 09.1983	
Oct 1, 1983		
01.1984 - 03.1984		
May 1, 1984		
Jul 1, 1984		
11.1984 - 12.1984		
02.1985 - 04.1986		
	May 1, 1986	
06.1986 - 06.1987		
	07.1987 - 11.1987	
Dec 1, 1987		
	01.1988 - 03.1988	
04.1988 - 05.1988		
	Jun 1, 1988	
07.1988 - 02.1989		
		09.1988 - 03.1989
Apr 1, 1989		
Jan 1, 1994		
		06.1994 - 07.1994
Aug 1, 1994		
		09.1994 - 12.1994
10.1994 - 01.1995		
03.1995 - 04.1995		
02.1996 - 05.1996		
	06.1996 - 10.1996	
11.1996 - 12.1996		
	Jan 1, 1997	
02.1997 - 04.1997		
	May 1, 1997	
06.1997 - 02.1998		
06.1998 - 07.2001		
	Aug 1, 2001	
09.2001 - 12.2001		
	01.2002 - 02.2002	
03.2002 - 05.2002		May 1, 2002
07.2003 - 05.2005		
08.2005 - 09.2005		
		May 1, 2006
06.2006 - 04.2007		
	Apr 1, 2008	
05.2008 - 09.2008		
	Oct 1, 2008	
Nov 1, 2008		
	Dec 1, 2008	
01.2009 - 02.2009		


Mexico BSFI (1978-2009)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Dec-78
Jun-79
Dec-79
Jun-80
Dec-80
Jun-81
Dec-81
Jun-82
Dec-82
Jun-83
Dec-83
Jun-84
Dec-84
Jun-85
Dec-85
Jun-86
Dec-86
Jun-87
Dec-87
Jun-88
Dec-88
Jun-89
Dec-89
Jun-90
Dec-90
Jun-91
Dec-91
Jun-92
Dec-92
Jun-93
Dec-93
Jun-94
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Jun-95
Dec-95
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Dec-96
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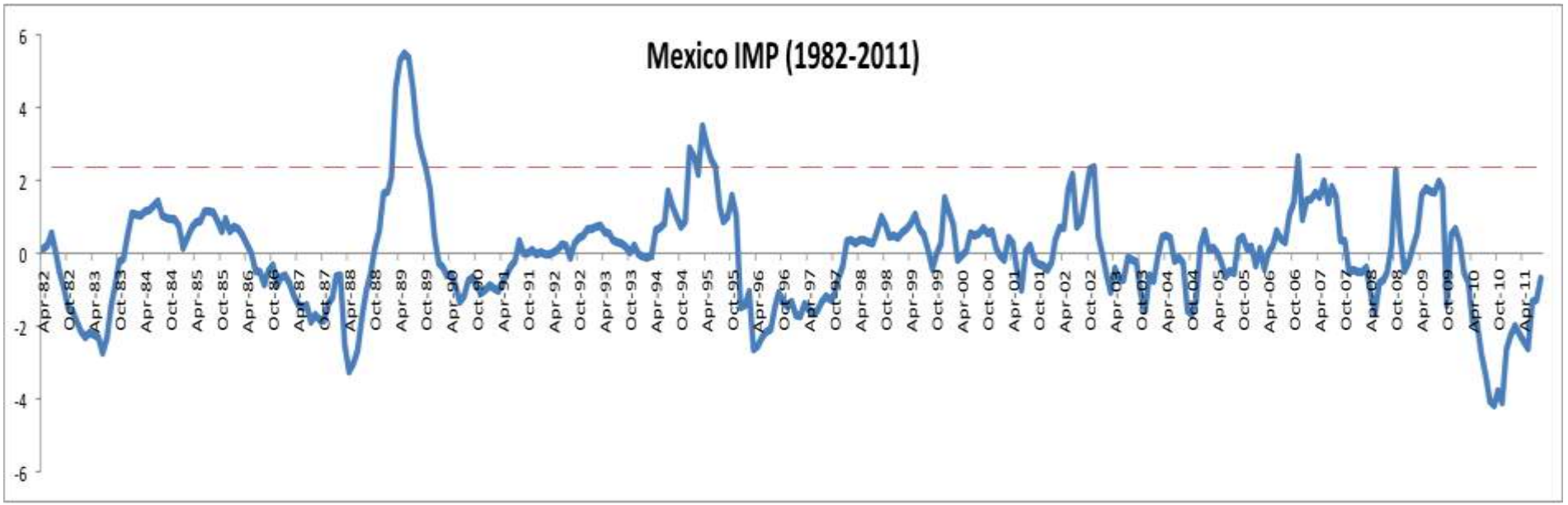
Dec-07
Jun-08
Dec-08
Jun-09


Mexico IMP (1982-2011)
6
4
2
0
-2
-4
-6
Apr-82
Oct-82
Apr-83
Oct-83
Apr-84
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Apr-85
Oct-85
Apr-86
Oct-86
Apr-87
Oct-87
Apr-88
Oct-88
Apr-89
Oct-89
Apr-90
Oct-90
Apr-91
Oct-91
Apr-92
Oct-92
Apr-93
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Apr-01
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Apr-02
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Apr-03
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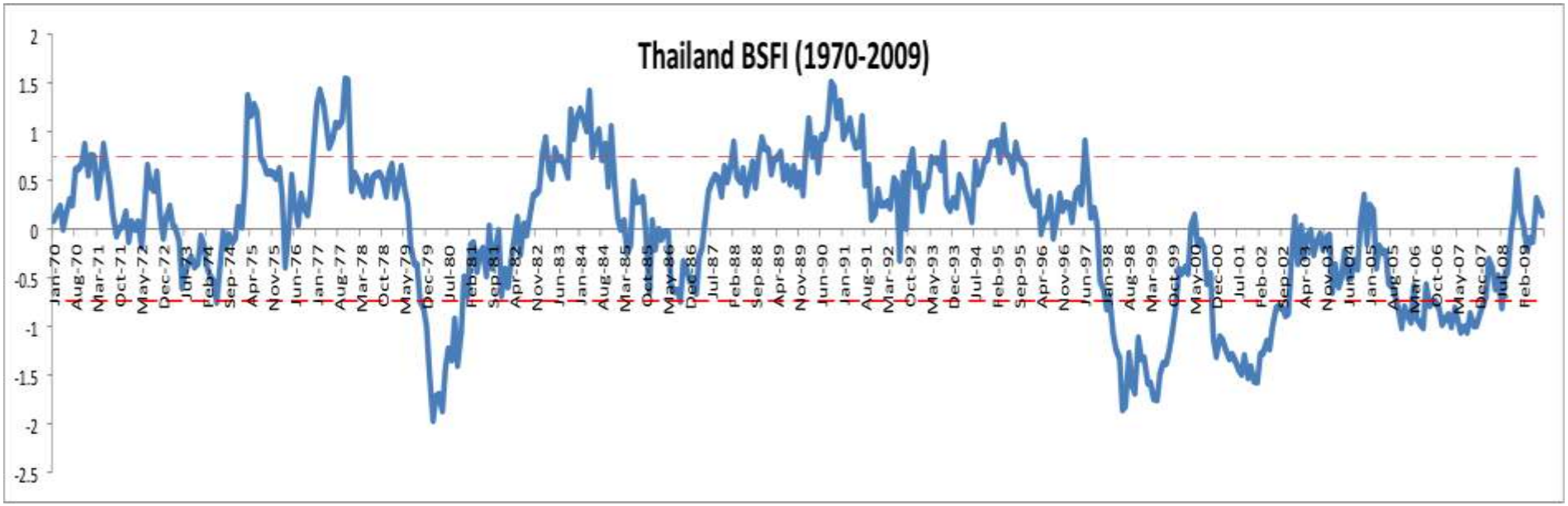
Apr-04
Oct-04
Apr-05
Oct-05
Apr-06
Oct-06
Apr-07
Oct-07
Apr-08
Oct-08
Apr-09
Oct-09
Apr-10
Oct-10
Apr-11

THAILAND (BSFI: Jan 70-Aug 09)

BSFI		IMP
sd = 0.742		98.5 per = 2.180
SC	BC	IMP
03.1971 - 04.1971		
Jul 1, 1971		
Sep 1, 1971		
Nov 1, 1971		
Jun 1, 1972		
10.1972 - 10.1973		
	Nov 1, 1973	
12.1973 - 05.1974		
09.1975 - 10.1975		
01.1979 - 03.1979		
	04.1979 - 05.1980	
06.1980 - 01.1981		
		10.1980 - 02.1981
03.1981 - 10.1981		
Dec 1, 1981		
Feb 1, 1982		
10.1984 - 11.1984		
04.1985 - 05.1985		
07.1985 - 10.1986		
Jan 1, 1992		
Oct 1, 1995		
Feb 1, 1996		
05.1997 - 06.1997		
	Jul 1, 1997	
Aug 1, 1997		
		07.1996 - 10.1997
	09.1997 - 05.1999	
06.1999 - 09.1999		
12.1999 - 04.2000		
	05.2000 - 05.2002	
Jun 1, 2002		
Aug 1, 2002		
10.2002 - 03.2004		
Jun 1, 2004		
09.2004 - 03.2005		
	04.2005 - 08.2005	
Sep 1, 2005		
	10.2005 - 12.2005	
Jan 1, 2006		
	02.2006 - 07.2007	
08.2007 - 12.2007		
	Jan 1, 2008	
02.2008 - 04.2008		
09.2008 - 11.2008		
		Dec 1, 2008


Thailand BSFI (1970-2009)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
Jan-70
Aug-70
Mar-71
Oct-71
May-72
Dec-72
Jul-73
Feb-74
Sep-74
Apr-75
Nov-75
Jun-76
Jan-77
Aug-77
Mar-78
Oct-78
May-79
Dec-79
Jul-80
Feb-81
Sep-81
Apr-82
Nov-82
Jun-83
Jan-84
Aug-84
Mar-85
Oct-85
May-86
Dec-86
Jul-87
Feb-88
Sep-88
Apr-89
Nov-89
Jun-90
Jan-91
Aug-91
Mar-92
Oct-92
May-93
Dec-93
Jul-94
Feb-95
Sep-95
Apr-96
Nov-96
Jun-97
Jan-98
Aug-98
Mar-99
Oct-99
May-00
Dec-00
Jul-01
Feb-02
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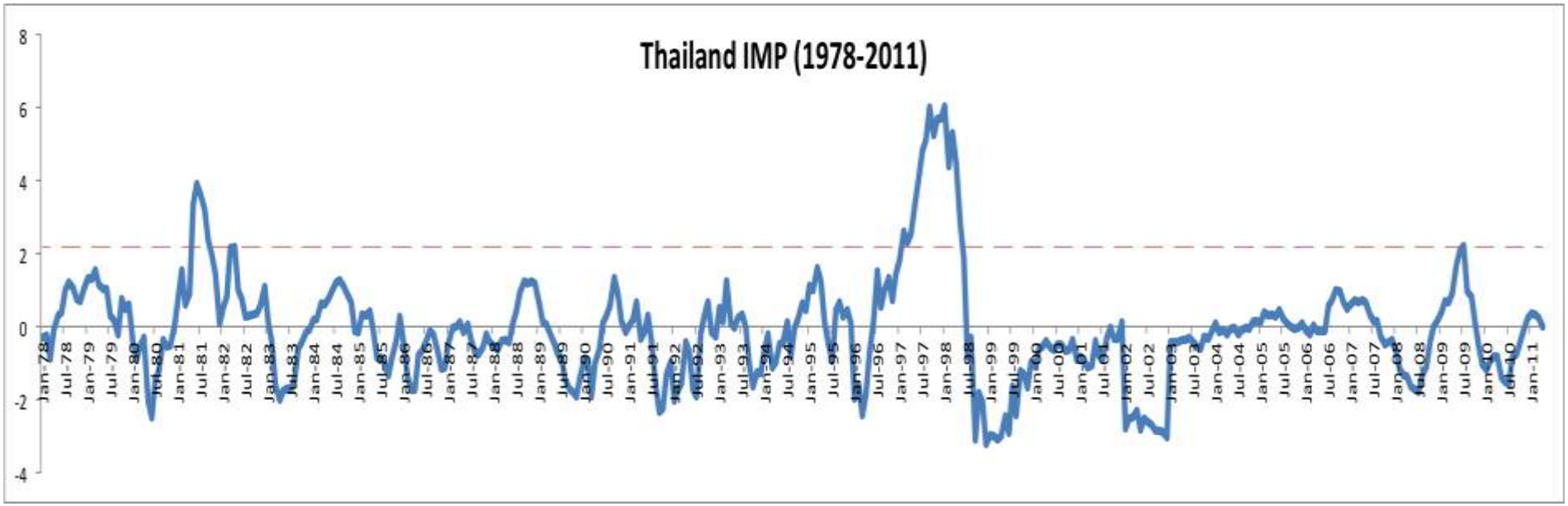
Apr-03
Nov-03
Jun-04
Jan-05
Aug-05
Mar-06
Oct-06
May-07
Dec-07
Jul-08
Feb-09


Thailand IMP (1978-2011)
8
6
4
2
0
-2
-4
Jan-78
Jul-78
Jan-79
Jul-79
Jan-80
Jul-80
Jan-81
Jul-81
Jan-82
Jul-82
Jan-83
Jul-83
Jan-84
Jul-84
Jan-85
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Jan-86
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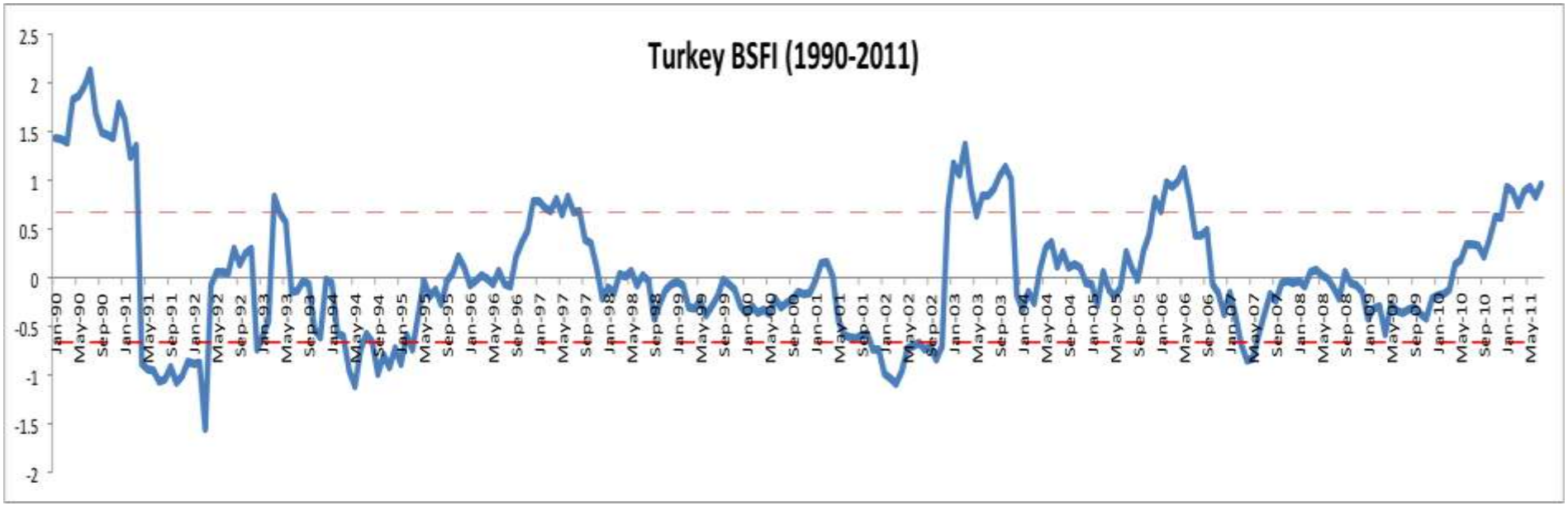
Jan-08
Jul-08
Jan-09
Jul-09
Jan-10
Jul-10
Jan-11

TURKEY (BSFI: Jan 90-Jul 11)

BSFI		IMP
sd = 0.665		98.5 per = 2.006
SC	BC	IMP
	10.1990 - 09.1991	
Oct 1, 1991		
	Jun 1, 1992	
07.1992 - 08.1992		
12.1992 - 09.1993		
	10.1993 - 12.1993	
01.1994 - 02.1994		
	03.1994 - 07.1994	
Aug 1, 1994		
	Sep 1, 1994	
10.1994 - 03.1995		
		Jun 1, 1995
07.1995 - 08.1995		
10.1995 - 11.1995		
01.1996 - 02.1996		
06.1997 - 08.1997		
Dec 1, 1997		
		Jun 1, 2000
02.1998 - 07.2000		
		08.2000 - 12.2000
		Feb 1, 2001
11.2000 - 04.2001		
	05.2001 - 05.2002	
06.2003 - 09.2003		
06.2004 - 08.2004		
10.2004 - 12.2004		
Mar 1, 2005		
04.2006 - 08.2006		
	09.2006 - 11.2006	
12.2006 - 08.2007		
12.2007 - 02.2008		
04.2008 - 09.2009		


Turkey BSFI (1990-2011)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Jan-90
May-90
Sep-90
Jan-91
May-91
Sep-91
Jan-92
May-92
Sep-92
Jan-93
May-93
Sep-93
Jan-94
May-94
Sep-94
Jan-95
May-95
Sep-95
Jan-96
May-96
Sep-96
Jan-97
May-97
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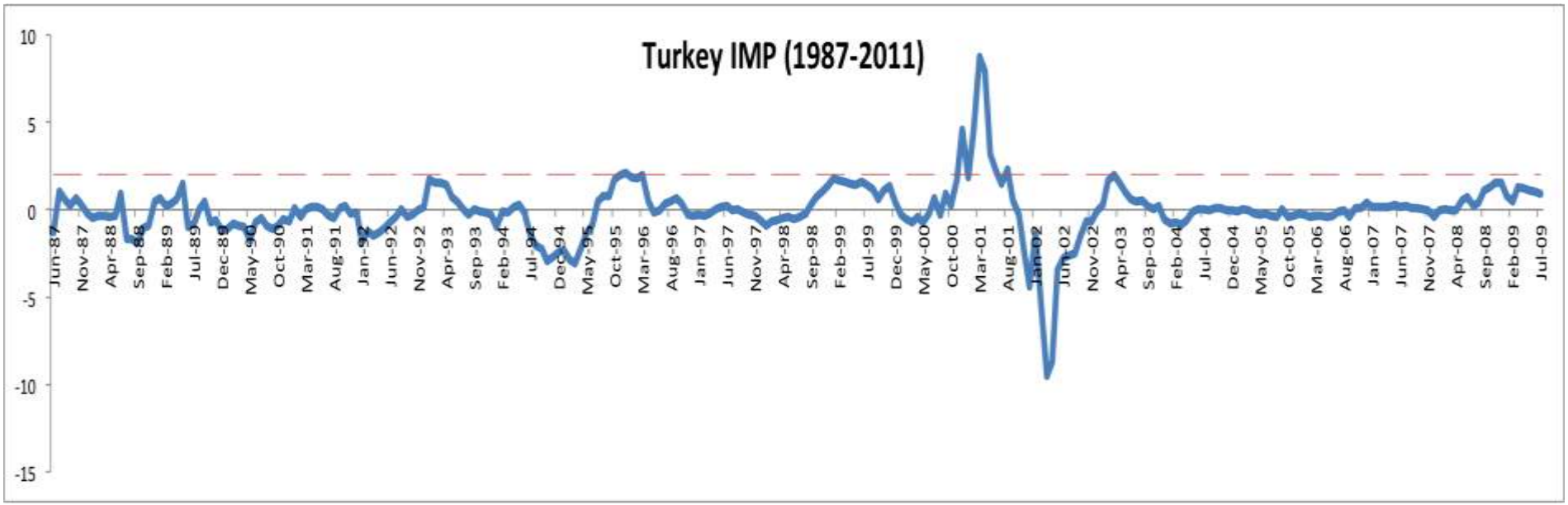
May-09
Sep-09
Jan-10
May-10
Sep-10
Jan-11
May-11


Turkey IMP (1987-2011)
10
5
0
-5
-10
-15
Jun-87
Nov-87
Apr-88
Sep-88
Feb-89
Jul-89
Dec-89
May-90
Oct-90
Mar-91
Aug-91
Jan-92
Jun-92
Nov-92
Apr-93
Sep-93
Feb-94
Jul-94
Dec-94
May-95
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Mar-96
Aug-96
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Jun-97
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Jul-99
Dec-99
May-00
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Jan-02
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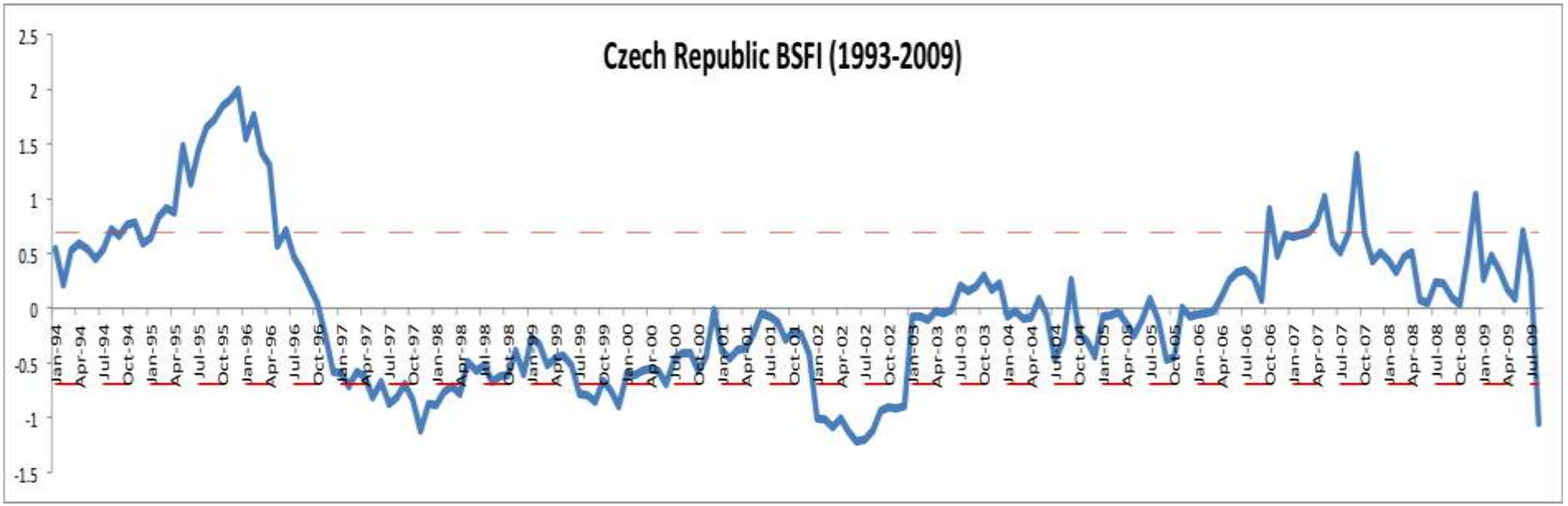
Apr-03
Sep-03
Feb-04
Jul-04
Dec-04
May-05
Oct-05
Mar-06
Aug-06
Jan-07
Jun-07
Nov-07
Apr-08
Sep-08
Feb-09
Jul-09

Czech Republic (BSFI: Jan 90-Jul 11)

BSFI		IMP
sd = 0.692		98.5 per = 1.562
SC	BC	IMP
05.1996 - 07.1996		
	Aug 1, 1996	
09.1996 - 10.1996		
	Nov 1, 1996	
Dec 1, 1996		11.1996 - 12.1996
		Jun 1, 1997
	01.1997 - 10.1997	
11.1997 - 12.1998		
	01.1999 - 03.1999	
Apr 1, 1999		
	05.1999 - 06.1999	
07.1999 - 06.2001		
	07.2001 - 06.2002	
07.2002 - 12.2002		
07.2003 - 10.2003		
12.2003 - 02.2004		
04.2004 - 12.2004		
02.2005 - 04.2005		
06.2005 - 09.2005		
		Jun 1, 2008
		Jan 1, 2009
	Feb 1, 2009	


Czech Republic BSFI (1993-2009)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
Jan-94
Apr-94
Jul-94
Oct-94
Jan-95
Apr-95
Jul-95
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
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Jan-99
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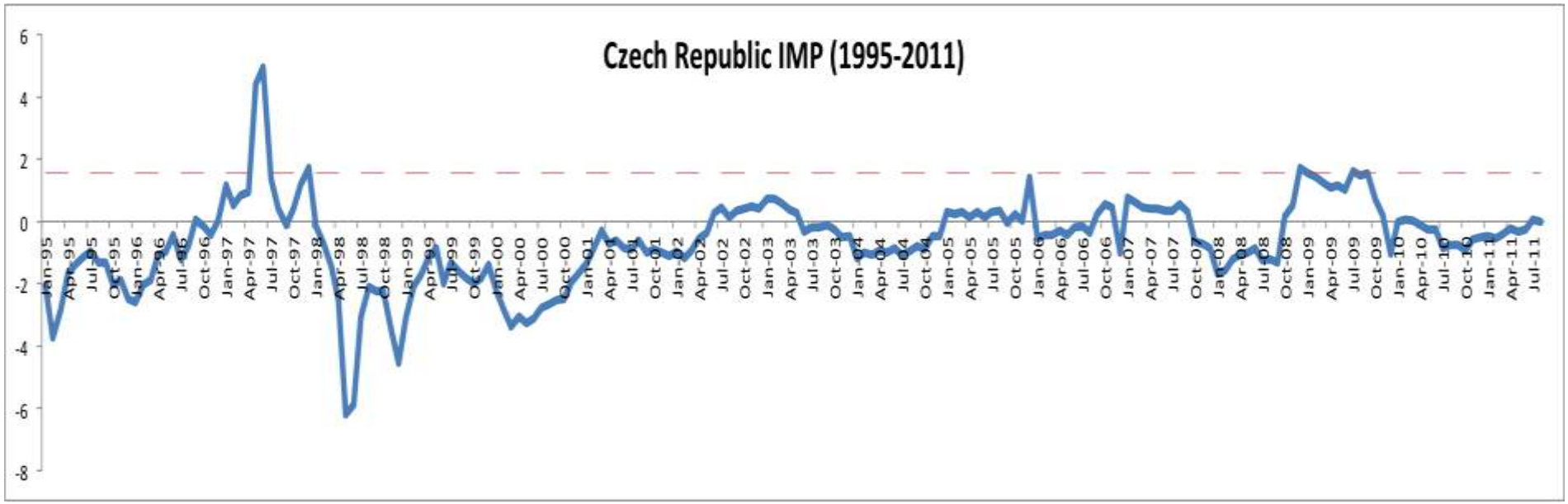
Jan-09
Apr-09
Jul-09


Czech Republic IMP (1995-2011)
6
4
2
0
-2
-4
-6
-8
Jan-95
Apr-95
Jul-95
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
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Jan-99
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Apr-07
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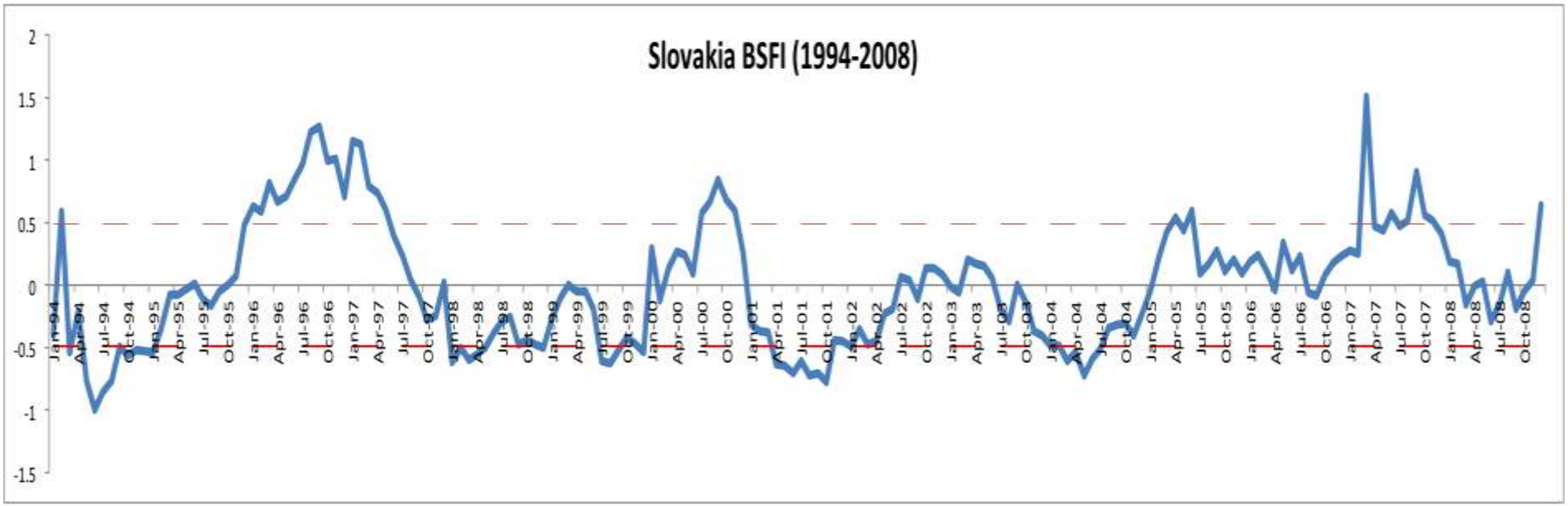
Jul-09
Oct-09
Jan-10
Apr-10
Jul-10
Oct-10
Jan-11
Apr-11
Jul-11

Slovak Republic (BSFI: Jun 93-Dec 10)

BSFI		IMP
sd = 0.489		98.5 per = 1.382
SC	BC	IMP
Jul 1, 1993		
	Sep 1, 1993	
Oct 1, 1993		
	11.1993 - 07.1994	
08.1994 - 11.1994		
01.1995 - 03.1995		
		Apr 1, 1996
03.1997 - 05.1997		
		Jun 1, 1997
	07.1997 - 11.1997	
		Mar 1, 1998
12.1997 - 05.1998		
	Jun 1, 1998	
07.1998 - 08.1998		
10.1998 - 12.1998		
	01.1999 - 03.1999	
04.1999 - 05.1999		
	Jun 1, 1999	
Aug 1, 1999		
07.2000 - 09.2000		
	10.2000 - 04.2001	
05.2001 - 06.2001		
	Jul 1, 2001	
08.2001 - 12.2001		
Mar 1, 2002		
07.2002 - 08.2002		
01.2003 - 02.2003		
04.2003 - 08.2003		
	09.2003 - 01.2004	
02.2004 - 07.2004		
Oct 1, 2005		
02.2006 - 03.2006		
09.2007 - 10.2007		
12.2007 - 01.2008		
03.2008 - 04.2008		


Slovakia BSFI (1994-2008)
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-1
-1.5
Jan-94
Apr-94
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Jul-95
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Jul-96
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Jan-97
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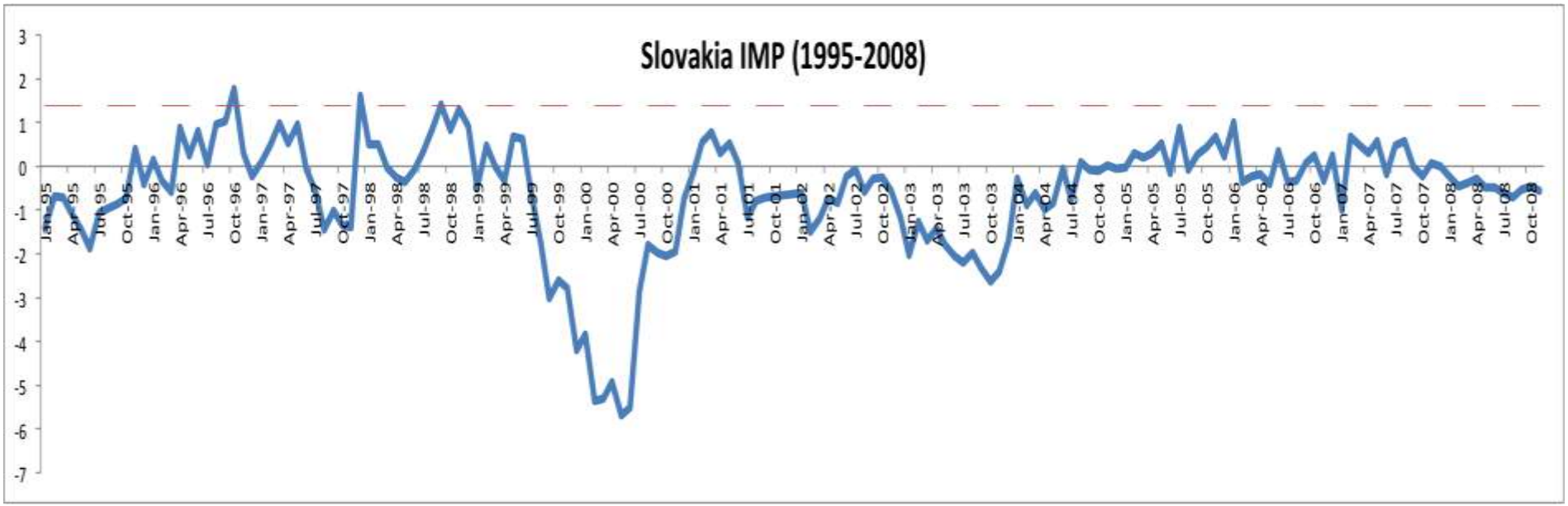
Oct-08


Slovakia IMP (1995-2008)
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
Jan-95
Apr-95
Jul-95
Oct-95
Jan-96
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Jan-97
Apr-97
Jul-97
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Jan-98
Apr-98
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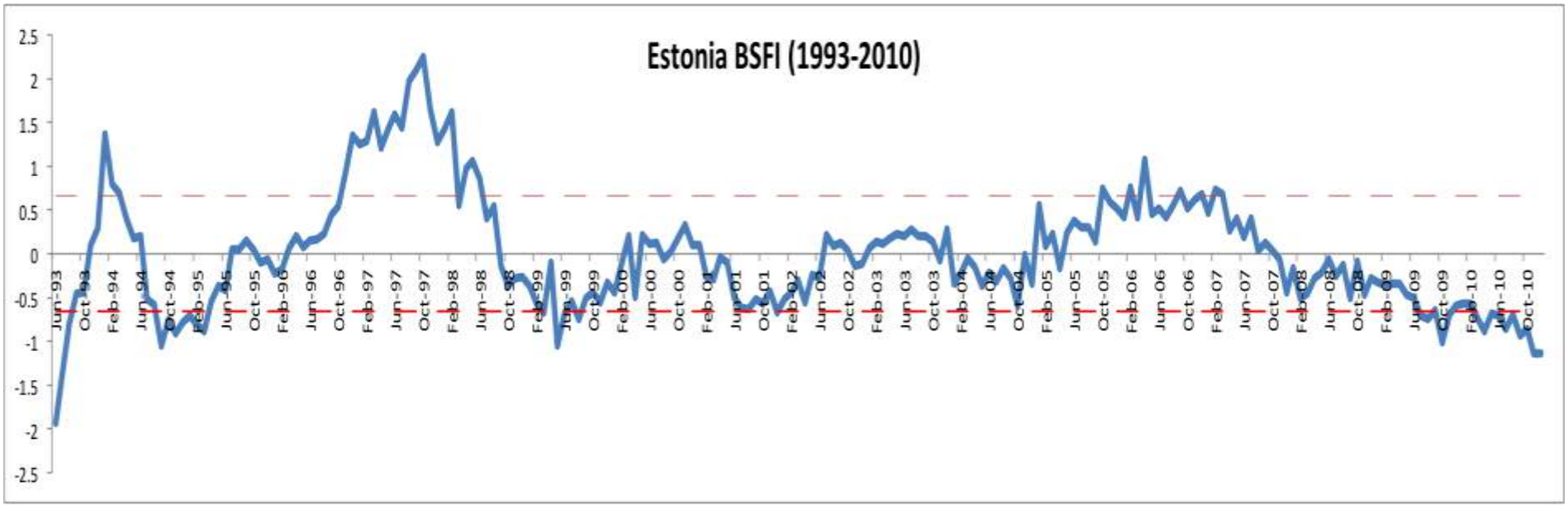
Oct-06
Jan-07
Apr-07
Jul-07
Oct-07
Jan-08
Apr-08
Jul-08
Oct-08

ESTONIA (BSFI: Jun 93-Dec 10)

BSFI		IMP
sd = 0.663		98.5 per = 2.016
SC	BC	IMP
	12.1992 - 02.1993	
03.1993 - 04.1993		
	03.1994 - 09.1994	
		09.1994 - 10.1994
10.1994 - 12.1994		
05.1995 - 08.1995		
		Aug 1, 1996
		Oct 1, 1996
		May 1, 1997
03.1998 - 08.1998		
	Sep 1, 1998	
Oct 1, 1998		
	11.1998 - 12.1998	
Jan 1, 1999		
	Feb 1, 1999	
03.1999 - 08.1999		
Oct 1, 1999		
Feb 1, 2000		
08.2000 - 05.2001		
	Jun 1, 2001	
07.2001 - 12.2001		
05.2002 - 06.2002		
May 1, 2003		
07.2003 - 06.2004		
Oct 1, 2004		
05.2007 - 12.2008		
	01.2009 - 02.2009	
Mar 1, 2009		
	04.2009 - 05.2009	
06.2009 - 08.2009		
	09.2009 - 06.2010	


Estonia BSFI (1993-2010)
2.5
2
1.5
1
0.5
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-0.5
-1
-1.5
-2
-2.5
Jun-93
Oct-93
Feb-94
Jun-94
Oct-94
Feb-95
Jun-95
Oct-95
Feb-96
Jun-96
Oct-96
Feb-97
Jun-97
Oct-97
Feb-98
Jun-98
Oct-98
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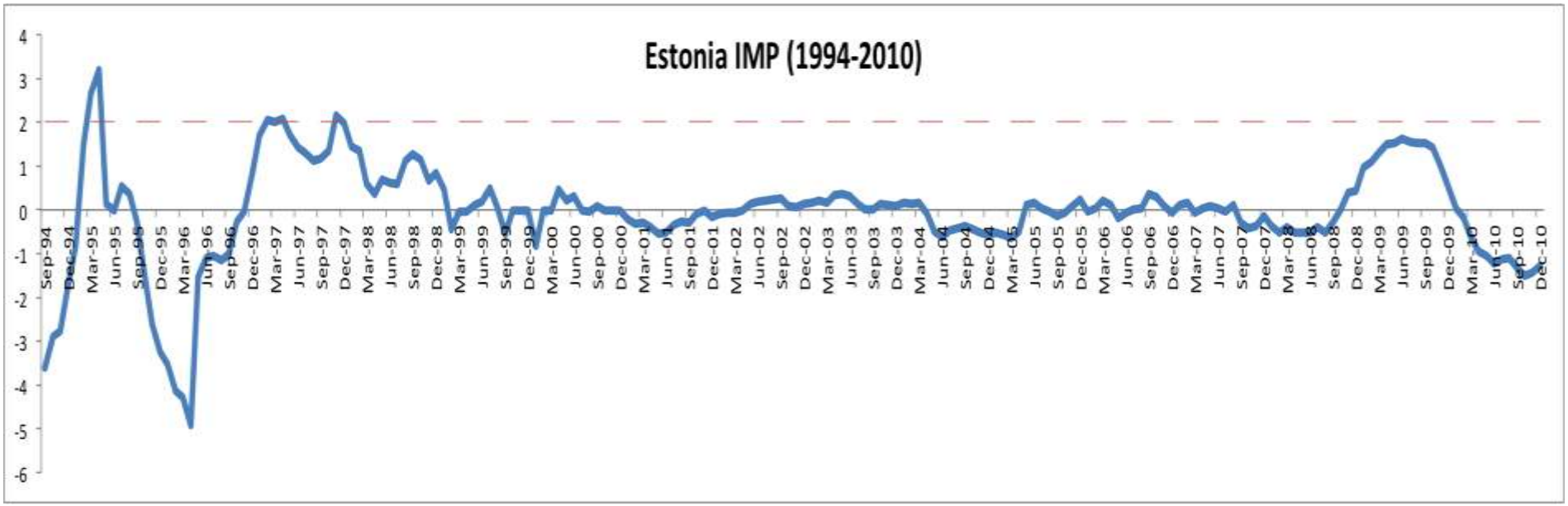
Feb-10
Jun-10
Oct-10


Estonia IMP (1994-2010)
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3
2
1
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Appendix C

Solutions for SBM

Equations for endogenous variables in the Simple Banking Model from the chapter

$$X = \frac{N}{N+1} \cdot \frac{pY}{1+\alpha} - \frac{\alpha}{1+\alpha} B^S$$

$$Z = \frac{N}{N+1} \cdot \frac{pY}{1+\alpha} + \frac{1}{1+\alpha} B^S$$

$$B = B^S$$

$$r = \frac{\alpha}{1+\alpha}\left(\frac{N+1}{N} B^S + pY\right)$$

$$R^L = Y \frac{1+\alpha(N+1)}{(N+1)(1+\alpha)} + p^{-1} \frac{\alpha}{1+\alpha} B^S$$

$$R^D = \frac{\alpha}{1+\alpha}\left(\frac{N}{N+1} pY + B^S\right)$$

$$R^L - R^D = \frac{Y}{N+1} \cdot \frac{1+\alpha\left[N(1-p)+1\right]}{1+\alpha} + \left(p^{-1}-1\right) \cdot \frac{\alpha}{1+\alpha} B^S$$

Where:

X – Total amount of loans

N – Total number of banks

p – Probability banks` yield in time t+1

Y – Investment Yield

α – slope of demand for deposits

B – Total bonds

Z – Total deposits

R^L – Loan supply (supply of deposits)

R^D – Demand for deposits

B^S – Government supply of bonds

r – Gross interest rate on bonds

Source: Boyd, Nicolo, & Loukoianova (2009)