



UNIVERSITY OF GOTHENBURG  
SCHOOL OF BUSINESS, ECONOMICS AND LAW

# CHARACTERISTICS OF THE 2009/2010 FINANCIAL CRISIS IN GREECE AND THE PROBABILITY OF A BANK RUN

AUTHORS: ANDERS LUNDSTRÖM AND JOAKIM TIBERG

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Supervisor: Taylan Mavruk



## Abstract

This thesis investigates in what ways, if any, the 2009/2010 financial crisis in Greece is unique and how likely a bank run is to occur in the country. To investigate the first matter, a qualitative approach is used to determine the characteristics of Greece's financial crisis. The characteristics are then compared to those of earlier crises in other countries. The probability of a bank run is determined by a quantitative approach, using the Kaminsky-Reinhart model.

Our results show that the characteristics of the financial crisis in Greece are indebtedness, the Euro, moral hazard and a non-existent acceptance for austerity. Each one of these have also been characteristics of previous crises in other countries, and thus, we do not find the crisis in Greece to be unique. However, it could be argued that some of the events leading up to the characteristics are unique. For example, the way in which the Greece government used its accumulated debt - to give the citizens the world's most beneficial pension terms - is unique. If we were to choose one crisis that resembles the one in Greece the most, the 2008 financial crisis in Latvia would be it.

Signals indicating a financial crisis in Greece have been increasing since 2006/2007, and the probability of a banking crisis was 15% at the end of 2009, but would according to the model probably have been higher if it was not for Greece being a member of the eurozone. A measure of the probability of a currency crisis is also obtained through the model, though this number is probably an overestimate due to the Euro as Greece's common currency. Furthermore, results from the Kaminsky-Reinhart model support previous research on the causality between banking crises and currency crises; signals in Greece were indicating a banking crisis prior to a currency crisis.

Keywords: *Greece's financial crisis, financial crises, currency crises, banking crises, the Kaminsky-Reinhart model, bank runs, moral hazard, the Euro, the eurozone, the European Union, indebtedness, austerity plan, government bailout.*



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# 1 Introduction

*This section gives a brief overview of the topic of economic crises, and also the scope of this thesis within that area of research. We will present a problem discussion, followed by our research questions and the purpose of the thesis.*

## 1.1 Background

Financial crises have been a phenomenon studied for many years, perhaps because of its large impact on society and its unpredictable nature. One of the first crises that can be explained by a failure in the market economy, and thus be labelled a financial crisis, is the "Panic of 1819", which led to several bank failures, foreclosures and high unemployment rates (Skaggs, 1997). Since that was almost 200 years ago, we realize that it cannot be considered a modern phenomenon. A more recent and perhaps more relatable crisis, however, ought to be the current sub-prime mortgage crisis, which started in the United States during 2007, and became excessively apparent in the end of 2008 with the collapse of the Lehman Brothers investment bank.

The crisis that followed Lehman Brothers collapse sent far-reaching shock waves throughout the world economy, partly because of its sudden impacts in a time where a number of economists predicted that a long-term stable market setting had been reached. During the beginning of 2009, it became obviously clear that this was not an American concern, but a multinational recession affecting all of the countries of the world. Some economists state increased internationalization and capital mobility as contributing factors to this rapid geographical spreading. The reasons for the development of the crisis, and for the inability to predict it, have been a clear focus for the research of part of the academic world during the last years. Although this thesis does not intend to predict the future development or the way out for any of the countries affected by the crisis, it will look deeper into certain aspects of it.

Like many European countries, Greece experienced major recession in its economy during 2009. However, for a number of reasons, the crisis seemed to be especially troublesome in Greece, with a budget deficit mounting up to more than 13% of GDP at the end of 2009 (OECD, 2010). The reasons for why this deep downfall was experienced in Greece are

surely multifaceted, though the crisis showed some distinguishing properties compared to traditional recessions. For example, Greece's position as a member of the eurozone might have induced moral hazard in the crisis management, where decision makers knew that the European Central Bank (ECB) and other eurozone countries would intervene in the case of a crisis. Furthermore, the deep impact could also have been caused by an inability to foresee the coming happenings. In summary, Greece constitutes an interesting example of the impact of a modern financial crisis, and how ineffective national leaders and experts can be at neutralizing its consequences.

## 1.2 Problem Discussion

By looking at countries that have been in a similar situation to the one facing Greece, one ought to be able to get a better understanding of the crisis and the chain of events surrounding it. However, to be able to benefit from knowledge about and experience from other crises, one must first know whether other countries have been in the same situation. If the situation in Greece in any way is unique, there is also reason to believe the forthcoming development will differ from that of other countries' with previous crises.

In the eyes of the public, financial crises currently taking place are often seen as one of its kind (Kamin, 1999). In his study, Kamin compares three financial crises: the early 1980s debt crisis of Latin America, the Mexican economic crisis in 1994-1995 and the currency crisis in Asia in 1996-1999. His findings suggest that even though most crises have unique features, they are also more alike than people generally think. Reinhart and Rogoff (2009) reach a similar conclusion in their study *This Time Is Different: Eight Centuries of Financial Folly*. "Our basic message is simple: We have been here before. No matter how different the latest financial frenzy or crisis always appears, there are usually remarkable similarities with past experience from other countries and from history". They also conclude that debt, in one way or another, almost exclusively is the reason behind a financial crisis.

One feature that might be unique to Greece is, however, that it is a part not only of the European Union (EU), but also the eurozone (Dokos, 2009). Thus, the Euro is the country's common currency and Greece's central bank cannot intervene on the money market by using its steering interest rate. Furthermore, since the Euro is the common currency of



most of the European Monetary Union's (EMU's) member countries, a financial crisis in Greece alone may not weaken the Euro enough to get a stabilizing effect on the country's exports, and thus its economy. But are these features really unique? To answer that question, one would have to compare the crisis in Greece to crises in other countries with similar prerequisites. In our study, we will determine the characteristics of the crisis in Greece and compare each one to resembling characteristics of past crises. For example, if we after our analysis believe one characteristic of the crisis in Greece to be the Euro, we will investigate whether any other country has had a crisis characterised by being a member of a currency union or a currency board, and if so, how the country developed after the crisis. We would also like to make clear that this thesis will not try to forecast the future development of the EU, the eurozone or the Euro as the EMU's common currency.

Within macroeconomic theory there is quite a considerable number of models used to forecast and analyse the development of the world economy. Most economic models assume that all markets work efficiently, including the financial market. In the light of the recent turmoil on the financial markets due the sub-prime mortgage crisis and the multinational recession that followed, there seems to be little support for such an assumption. There are, however, economic models that do not make this assumption, and instead focus on modelling shortcomings of these markets. One such model is the Kaminsky-Reinhart (1999) model, which uses 16 different indicators from four sectors of the economy to determine how likely a financial crisis is to occur. The model also weights the indicators to clarify what type of crisis is most likely to emerge: a currency crisis or a banking crisis. We choose to apply this model in this thesis since it is an easily applicable and thoroughly tested model, which yields distinct results in the form of probabilities for crises.

A phenomenon often observed in countries going through a financial crisis is bank runs. While a bank run can be caused by a crisis, it can also work the other way around: the bank run causes a crisis. Rumours and speculation about an upcoming bank run have throughout history become self-fulfilling prophecies (Al-Zein, 2008). As the Kaminsky-Reinhart model determines how likely both currency- and banking crises are to occur, it might also explain whether a bank run is the cause or the symptom of a crisis. In this thesis, we will apply the Kaminsky-Reinhart model to the crisis in Greece and thus determine the causality between these types of crises.

### 1.3 Research Questions

The problem discussion presented above leads us to the following research questions, which are evaluated during the course of this thesis:

- What, if anything, separates the crisis in Greece from other major financial crises?
- Is the crisis in Greece likely to cause a bank run?

### 1.4 Purpose

*The purpose of this study is partly to determine the probability of Greece experiencing a bank run. Furthermore, it is to investigate in what ways, if any, Greece's financial crisis is unique.* The results ought to be of interest to any stakeholder in the Greek banking sector, anyone interested in how to predict financial crises and bank runs, as well as anyone interested in further research on Greece's financial crisis or financial crises in general. For decision makers, the uniqueness of the current crisis is important since it determines if lessons learnt from previous crises could be applied in the crisis management.

## 2 Theory

*This section gives an overview of the theoretical setting that is the context of this thesis. Focus will be on describing theoretical approaches to the modelling of currency crises and banking crises, and also methods to evaluate relationships between these.*

### 2.1 Defining Crises

Before proceeding with the presentation of the theoretical aspects of financial crises, it is appropriate to formally define what both a currency crisis and banking crisis is, and when the economy is considered to be in such states. Reinhart and Rogoff (2009) define a banking crisis as:

- (i) "Bank runs that lead to the closure, merging, or takeover by the public sector of one or more financial institutions, or
- (ii) 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."

A number of banking crises corresponding to both of these definitions have been observed in recent years, e.g. in (i) Argentina in 2001 and (ii) Thailand in 1996.

As for currency crises, also denoted balance-of-payment crises, the definition is more vague. A narrow definition used by e.g. Frankel and Rose (1996) is "a devaluation of exchange rate". Others define it through the use of composite indices describing the pressure on the currency market, as Sachs et al. (1996), or Kaminsky and Reinhart (1999). Radelet and Sachs (1998) define it as a "sharp shift from capital inflow to capital outflow between year  $t - 1$  and year  $t$ ".

## 2.2 Causes of Crises: A Brief Literature Review

A number of principal causes of financial crises have been presented in literature since the middle of the 20th century. A seminal paper by Krugman (1979), bases the explanation on macroeconomic fundamentals, and proposes that a crisis occur when a country with a fixed exchange rate tries to counter its fiscal imbalances by printing excessive amounts of money. This creates an imbalance on the foreign currency market and thus an exhaustion of the foreign reserves, which makes the country vulnerable to speculative attacks on the currency, and eventually leads to a collapse of the fixed exchange rate system. This view of long-term fiscal imbalances being critical the development of a financial crisis has come to be called the *first generation* view. In later years, the focus of the literature has shifted from this view, since the stipulated fiscal disequilibrium in Krugman's model has proved to be absent in many later crises, see e.g. Obstfeld (1994 & 1996).

Instead, a *second generation* view has become the principal focus of how a crisis occur. This view stresses the importance of self-fulfilling expectations and grouping behaviour in capital markets, as described mainly by the field of behavioural finance. Thus, it is not assumed to exist any macroeconomic imperfection for a financial crisis to occur; rather, a crisis occurs if individuals think it will occur, which turns into a self-fulfilling prophesy. As Calvo (1995, p. 1), phrases it:

*If investors deem you unworthy, no funds will be forthcoming and, thus, unworthy you will be.*

This view was pioneered by Obstfeld (1986), which in turn built on work done by Flood and Garber (1984), who examined the effect of self-fulfilling attacks on the gold standard. It is also the basis for a number of more recent theoretical approaches, such as the bank run model by Chang and Velasco (2001).

## 2.3 Twin Crises

As indicated in the problem discussion of this thesis, in the case of a banking crisis, there is also a risk that the country will experience a currency crisis. This is a phenomenon which has been observed numerous times in later years, both in developed and developing countries (Kaminsky and Reinhart 1999), and the phenomenon has come to be denoted a *twin crisis*. It is defined to have happened when a currency crisis follows the beginning of the banking crisis within 48 months.

The seminal paper that pioneered the concept of twin crises was that of Kaminsky and Reinhart (1996), where a number of countries that has experienced both currency and banking crises were examined. The paper was focused on finding macroeconomic relations between the two types of events, and the key findings could be summarized in the following way:

- (i) There is no apparent connection between currency and banking crises in the 1970's, when most financial markets were highly regulated. However, a connection was found on the more liberal markets of the 1980's and 1990's.
- (ii) If both types of crises occur, most often the banking crisis precede the currency crisis.
- (iii) The crises are often preceded by fluctuations in domestic and international macroeconomic variables such as real interest rates or money multiplier.

A number of further theoretical studies have been performed to investigate the link between banking crises and currency crises, such as those of Diaz-Alejandro (1985), Calvo (1995) and Chang and Velasco (1998).

## 2.4 The Kaminsky-Reinhart Model

As previously mentioned, the volatile nature of economic crises have been a focus of debate over long time. While a common explanation by people in charge is that "the current crisis is completely different from what has been experienced ever before", some studies are indicating that the economic climate at the time before, during, and after, many crises are indeed following similar distinct patterns (Kamin, 1999), (Reinhart and Rogoff, 2008). As Kindelberger (1978 p. 14), puts it:

*For historians each event is unique. Economics, however, maintains that forces in society and nature behave in repetitive ways. History is particular; economics is general.*

Such similarities have lead researchers to believe that it might be possible to foresee a financial crisis using an econometrical point of view. Kaminsky et al. (1998) studies the collapse of the Asian crises of 1997, using this perspective. In the study, the economic turmoil is connected with the development of a number of macroeconomic variables, in search for statistically proven relationships that might predict coming crises. Continuing this work, Kaminsky (1998) constructs four composite indices based on these macroeconomic variables, and apply these to 102 financial crises to propose "...a warning system that helps to monitor whether a country may be slipping into a situation that is bound to end up in a crisis".

In short, The Kaminsky-Reinhart model, as outlined in Kaminsky (1998) and more thoroughly in Kaminsky and Reinhart (1999), consists of 16 indicators (variables) spread over four sectors of the economy: the *financial sector*, the *external sector*, the *real sector*, and the *fiscal sector*. Each indicator has two threshold values: one to indicate a currency crisis and another to indicate a banking crisis. Depending on the indicator, either an exceeding value or a value below the threshold could be indicating a crisis. These values refer to the value of the cumulative distribution function for the variable, when the mean and standard deviation is estimated from the data set. Thus, a threshold value of 0.9 would mean that any data value for the variable over the 9th decile would trigger a signal<sup>1</sup>.

<sup>1</sup>Thus, explicitly a signalling variable is found by comparing the normalized variable value with the value of the inverse cumulative distribution function of the threshold value.

According to the model, the more indicators signalling a crisis, the more likely a crisis is to occur. As a result of the study by Kaminsky and Reinhart (1999), every variable is also assigned a noise-to-signal ratio  $\omega$ , which measures the predictability of that individual measure. This is later used to evaluate how the variables could predict financial crisis and banking crisis. This ratio is also used to calculate the specific threshold values, as performed by Kaminsky and Reinhart (1999). The threshold is defined as the point where the noise-to-signal ratio is minimized, and thus it is the point where each variable is statistically maximally efficient at describing if a crisis is likely to occur. All of the variables, and their relative threshold values and noise-to-signal ratios, are shown in table 1.

**Table 1:** Variables included in the Kaminsky-Reinhart model, including threshold values for currency and banking crises. Data values are taken from Kaminsky and Reinhart (1999).

Variable	Currency crisis threshold	Banking crises threshold	Noise-to-signal ratio ( $\omega$ )
<i>Financial sector</i>			
M2 Multiplier	> 0.86	>0.90	0.50
Domestic credit	> 0.90	>0.95	0.59
Real interest rate	> 0.88	>0.80	0.45
Lending-deposit credit ratio	>0.80	>0.87	1.93
Excess M1 balances	>0.94	>0.91	0.82
M2/reserves	>0.87	>0.90	0.71
Bank deposits	<0.10	<0.16	1.03
<i>External sector</i>			
Exports	<0.10	<0.10	0.61
Terms of trade	<0.16	<0.19	0.79
Real exchange rate	<0.10	<0.10	0.28
Imports	>0.90	>0.80	1.60
Reserves	<0.15	<0.28	0.71
Real interest-rate differential	>0.89	>0.81	0.52
<i>Real sector</i>			
Output	<0.11	<0.14	0.48
Stock prices	<0.11	<0.14	0.28
<i>Fiscal Sector</i>			
Budget deficit	>0.86	>0.86	0.44

Within the financial sector, seven different variables are observed. The *M2 Multiplier* measures how the ratio between M2 and the monetary base change over time. This is included due to McKinnon and Pill's (1996) "boom-bust cycle" theory that financial crises are linked to rapid growth in monetary aggregates. *Domestic credit to GDP* ratio is another variable used to measure how rapid the growth in credit is. Monetary as well as credit expansion have been associated with financial crises (Kaminsky and Reinhart, 1999). High real interest rates could mean countries having to defend their currencies (while under fixed regimes), whereas low rates could be indicating a loose monetary policy. Either way, the *Real interest rate* is an important variable. An increasing *lending-deposit rate ratio* could signal lower quality on given loans. *Excess M1 balances* and *M2/reserves* are measures used to monitor monetary expansion, whilst *Bank deposits* if decreasing could be indicating a bank run.

*Imports*, *Exports*, *Real exchange rate* and *Terms of trade* are all variables used to see if the currency of a country is overvalued or undervalued, and whether the external sector could be considered weak, which are both potential indicators of a crisis. When it comes to *Reserves* and *Real interest-rate differential*, they are used the same way as *Bank deposits* and *Real interest rate*. Falling indicators within the real sector, such as *Stock prices* and *Output*, often give an early tell of a bursting bubble on the asset market. Finally, the *Budget deficit to GDP* ratio indicates if the public deficit increases rapidly. If so, it could be a sign of public accumulation of debt. These variables are then weighted in several different ways, in order to find the aggregated risk of a currency or a banking crisis.



## 3 Methodology

*This section introduces the reader to the methodological approach of the thesis, followed by a more specific section on the application of the Kaminsky-Reinhart model. Finally, a section discussing the reliability and validity is presented.*

### 3.1 Methodological Approach

The most important methodological aspect of this thesis is that it is divided into two main sections: both a qualitative and quantitative analysis. The qualitative section is an empirical analysis of the financial crisis in Greece, with the objective to determine the characteristics of the crisis and to examine whether the characteristics are unique. Studying characteristics of previous crises in other countries and comparing them to those of the crisis in Greece accomplish the latter. Due to the fact that the crisis in Greece is under progress at the publishing date of this thesis, we have observed an absence of academic literature dealing with it. Therefore, the collection of data for the qualitative part has almost solely consisted of newspaper articles.

The quantitative section applies the Kaminsky-Reinhart model to the situation in Greece. From looking at 14 different indicators within the economy of Greece over time, the model constructs four different indices to estimate the probability of a currency crisis as well as a banking crisis. Furthermore, by looking at which of the indices that first indicate a crisis, we will be able to understand if the crisis is caused by a bank run or the crisis causes a bank run. Contrary to the qualitative section of our thesis, the quantitative part will use data from academic sources and official EU databases. During the quantitative analysis, we will also to a large extent compare the results with those of other applications of the Kaminsky-Reinhart model, and also look for analogues to the findings of the qualitative approach.

### 3.2 Application of the Kaminsky-Reinhart Model

In order to find quantitative support for our sought after answers, an assessment of a number of macroeconomic variables will be performed according to the theory outlined in section 2.4. More specifically, the purpose is to answer the second of our research questions, as outlined in section 1.3; How likely is the crisis in Greece to cause a bank run? As an additional result, the model will be able to predict the risk of a currency crisis, had Greece not been in a currency union<sup>2</sup>.

The Kaminsky-Reinhart model will be applied using empirical data for Greece between the years 2001 and 2009, where the risk of a currency crisis and a banking crisis will be studied over time by inserting time-dependent variables into the model. As seen in section 2.4, there are a number of variables that could be assessed in order to evaluate the risk of a crisis. Based on these variables, Kaminsky and Reinhart (1999) constructs and evaluates four composite indices, which are used to evaluate whether a currency and/or a banking crisis will take place within the coming time. A number of notations are now introduced to define these. Assume that there are  $n$  indicators contained in a vector  $X$ , and that these have threshold values of  $\bar{X}$  as seen in section 2.4. Then we can define a vector  $S_t$  at time  $t$  as:

$$S_t^i = \begin{cases} 1, & \text{if } |X_t^i| > |\bar{X}^i| \\ 0, & \text{if } |X_t^i| < |\bar{X}^i| \end{cases} \quad (1)$$

Thus,  $S_t$  is a vector containing numbers 0 or 1 if the respective indicators are signalling at the time  $t$ . The absolute value is included since some variables will signal an upcoming crisis by a large incline, and others with a large decline. The absolute values make sure that both of these cases are considered<sup>3</sup>. From this vector  $S_t$ , the first, and simplest, composite index could now be calculated. It is obtained by adding the number of signals for a given period, and thus it can take any integer values between 0 and  $n$ :

$$I_t^1 = \sum_{i=1}^n S_t^i \quad (2)$$

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<sup>2</sup>Since Greece is a member of the eurozone, its currency is far less likely to experience a speculative attack than if the county would have had an independent currency.

<sup>3</sup>Since  $X_t^i$  is assumed to be distributed according to the normal distribution, a small absolute value indicated that it is close to the mean value, and thus it is not abnormal. Higher absolute values correspond to outliers on the distribution tails, and these are the signalling values.

Kaminsky (1998), however, also identifies a flaw in this index; by simply summing over the number of signals, one does not consider the severity of the abnormal behaviour when a variable signals for a crisis. In reality, it is reasonable to assume that a more extreme deviation from the normal values is a stronger indication of a crisis. Thus, a more extreme form of signalling,  $SE_t$ , is defined. This takes the value of 1 when an extreme limit,  $\bar{X}_e$  is passed, where the extreme limit corresponds to the upper half of the interval above the ordinary limit. E.g. if the ordinary limit is placed at the 8th decile, the extreme limit is at the 9th decile. The earlier limit, now corresponding to a mild signalling, is denoted using variable  $SM_t$ , which takes a value of 1 for data values of  $X_t$  between only the 8th and 9th decile. Mathematically, we can express these as:

$$SM_t^i = \begin{cases} 1, & \text{if } |\bar{X}_e^i| > |X_t^i| > |\bar{X}^i| \\ 0, & \text{otherwise} \end{cases} \quad \text{and} \quad SE_t^i = \begin{cases} 1, & \text{if } |X_t^i| > |\bar{X}_e^i| \\ 0, & \text{if } |X_t^i| < |\bar{X}_e^i| \end{cases} \quad (3)$$

The second composite index is now constructed by giving the extreme signals twice the significance of the normal ones, and thus it can take all integer values between 0 and  $2n$ .

$$I_t^2 = \sum_{i=1}^n SM_t^i + 2SE_t^i \quad (4)$$

As for the third index, it is constructed to meet the fact that all variables might not be signalling at the same time. In reality, the exports might collapse one month, then the reserves the next month, and the imports the third month. To cope with this, the signals are added not just in this time period, but also in a number ( $s$ ) of preceding time periods.

Here, we do a small change in methodology from that of Kaminsky (1998) and Kaminsky and Reinhart (1999). Both these studies used monthly data, and used  $s = 8$  for the number of months looking backwards. Since this study will be performed using yearly data, we round the time span up to one year, and thus add the time  $t$  and  $t - 1$  for the third index:

$$I_t^3 = \sum_{i=1}^n S_t^i + S_{t-1}^i \quad (5)$$

Of course, the use of less frequent data points lowers the amount of information one can obtain from the results, but it also lowers the risk of signalling variables being unsynchronized in time.

A fourth index is also constructed. This is based on what empirical predictability power each indicator was found to possess in the study by Kaminsky and Reinhart (1999). This is measured in terms of the noise-to-signal ratio,  $\omega$ , which is shown in table 1 in section 2.4, and which is defined as:

$$\omega = \frac{\beta}{1 - \alpha} \quad (6)$$

In this equation,  $\alpha$  is the size of type I errors in the model, and  $\beta$  is the size of type II errors. The specific values for  $\omega$  are taken from Kaminsky and Reinhart (1999, table A2), which are equivalent to those of Kaminsky (1998), though it includes data for the budget deficit-to-GDP ratio, and also more significant digits. In the last composite index, the noise-to-signal ratio is used for weighing the variables, according to:

$$I_t^4 = \sum_{i=1}^n \frac{S_t^i}{\omega^i} \quad (7)$$

Since  $\omega$  can obtain non-integer values, this fourth index  $I^4$  is the only index that can take continuous values. It is the index that is found to predict both currency and banking crises best by Kaminsky and Reinhart (1999). Based on this last index,  $I^4$ , Kaminsky and Reinhart (1999) calculated the conditional probability for a crisis to occur, based on the empirical data for the 102 crisis that were studied. These were calculated both for currency and banking crises. The probabilities are shown in table 2, here corrected for the fact that this study includes only 14 of the 16 original variables. This is done by multiplying the original probabilities with a factor  $\frac{16}{14}$ . All in all, this data could be used to give an indicative measure of the probability of Greece experiencing a crisis<sup>4</sup>. These probabilities express the expected fraction of countries that experience a crisis at a certain indicator value.

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<sup>4</sup>Note that these are both monotonically increasing, with one aberration; the probability for a currency crisis is higher when  $I^4$  takes values of 1-2, than it is for values of 2-4.

**Table 2:** Conditional probabilities for the risk of a country experiencing a currency or banking crisis, based on the value of composite indicator 4. Adopted from Kaminsky (1998), corrected for the use of 14 variables instead of the original 16. Values are rounded to two significant digits for readability.

Value of indicator 4	Probability of a currency crisis	Probability of a banking crisis
0-1	0.11	0.034
1-2	0.25	0.057
2-3	0.21	0.069
3-4	0.24	0.10
4-5	0.31	0.14
5-7	0.38	0.15
7-9	0.53	0.18
9-12	0.74	0.31
>12	0.85	0.42

### 3.3 Reliability and Validity

Since the financial crisis in Greece is ongoing at the time of the publishing of this thesis, the qualitative part has mainly used newspaper articles as sources. Financial Times and The Economist have been used almost inconclusively. Thus, despite the lack of more academic sources, we believe the reliability of the sources to be strong. Furthermore, since the qualitative part is based upon our subjective views and opinions, the conclusions we reach could differ from those of any other individual. As will be shown in coming sections, Greece has at previous occasions used falsified data, and economists still fear the data to be falsified. If so would be the case, the numbers and results from the quantitative model used could be understated. The use of academic sources will be possible when such are published, and would improve the reliability of the sources for the qualitative part of this thesis.

As for the use of the Kaminsky-Reinhart model, it is hard to assess the validity when it comes to the probability of crises, since additional factors will play important roles. Principally, the bond between Greece and the European Central Bank through the currency union most probably lowers the risk of both a currency crisis and a banking crisis significantly. In case of a bank run, the ECB would have to support Greece in order not to

jeopardize the financial integrity of other member states. Another crucial aspect is that since the model only considers relative outliers in changes of variables, it will signal to some extent no matter if the country is experiencing a crisis or not.

The validity of the quantitative analysis could be increased by finding more data for the variables; both by finding country-specific proxies for the two omitted variables in the Kaminsky-Reinhart model, and by increasing the resolution of the data points to quarterly, or even monthly measurements. As for the case of Greece, such data proved not to be available. It is also important to remember that this is not intended as a statistical test of predictability of the model itself, as only one sample crisis is included. It is rather a case study, or an empirical test of the applicability of the Kaminsky-Reinhart model on a country in a currency union, assuming that it is in general valid.

## 4 Empirical Analysis

*This section holds an analysis of the 2009/2010 financial crisis in Greece, using a qualitative approach. Focus will be on what characterizes the Greece crisis, and how it differs from previous ditto.*

### 4.1 Background

Greece became a member of the European Union in 1981 and adopted the Euro as its common currency in 2001. Greece is a small, open economy, characterised by a large public sector, which amounts for about 40% of GDP. In 2007, the Greece economy accounted for 2.5% of the eurozone GDP and 1.8% of the EU's GDP (Eurostat, 2010).

The average retirement age in Greece is 58 years, unlike most European countries where it is 65 years (The Economist, 2010a), and according to the Organisation for Economic Co-Operation and Development (OECD), Greece's pension system is "among the most generous in the world". Greece also has the highest military expenditures of all EU member states, measured as a percentage of GDP. This can partly be explained by the harsh relations between Greece and Turkey, dating back to the 19th century when Greece got separated from the Ottoman Empire (The Irish News, 2010). While public expenditures are kept relatively high, tax revenues are below the European average of 40% of GDP, and account for about 32% of GDP. The relatively low tax revenues could partly be explained by corruption and illicit labour (Financial Times, Atkins and Hope, 2010). Workers' terms within the public sector could also, measured by European standards, be considered beneficial. For example, from a fulltime work year, government workers get paid 14 monthly salaries. Furthermore, fulltime in Greece often means 7-hour workdays, including breaks (The Washington Post, Ahrens, 2010). In 2005, Greece was ranked 22nd in The Economist Worldwide quality-of-life-index - a higher rank than those of countries such as Germany, France and the United Kingdom.

Within the eurozone, the Stability and Growth Pact (SGP) and the Maastricht Treaty (MT) constitute a framework including certain fiscal policy criteria the member countries must fulfil over time. Apart from the inflation criterion - annual government debt and deficit also have predetermined target levels. The government debt target is 60% of a

member country's GDP - or, if the debt to GDP ratio is higher than 60%, it is required to decline at a reasonable rate towards 60%. The public balance criterion states that member countries should have a medium-term balanced public fiscal condition. Under the economic cycle it is, however, allowed for countries to have a public deficit of 3% of GDP (Dokos, 2009). Table 3 shows a comparison between a number of economic measures for Greece and the eurozone.

**Table 3:** Comparison between various economic measures for Greece and the eurozone. All figures are expressed as a percentage of GDP. Provisional data is marked <sup>P</sup>. Note that Greece is also included when calculating the eurozone numbers. (Source: Eurostat)

Variable	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
<i>Government debt</i>										
Greece	103.4	103.7	101.7	97.4	98.6	100.0	97.8	95.7	99.2	115.1
Eurozone	69.2	68.2	68.0	69.1	69.5	70.1	68.3	66.0	69.4	78.7
<i>Loans</i>										
Greece	18.2	17.6	14.9	13.5	12.2	11.3	11.9	9.6	8.5	8.1
Eurozone	13.2	12.4	11.8	12.4	12.0	11.8	11.5	10.8	11.0	11.9
<i>Long-term debt</i>										
Greece	83.8	85.5	85.6	81.7	84.5	87.5	84.9	85.0	88.1	101.8
Eurozone	-	49.0	48.9	49.6	50.4	51.2	50.3	48.8	49.4	55.8
<i>Public balance</i>										
Greece	-3.7	-4.5	-4.8	-5.6	-7.5	-5.2	-3.6	-5.1	-7.7	-13.6
Eurozone	0.0	-1.9	-2.6	-3.1	-2.9	-2.5	-1.3	-0.6	-2.0	-6.3
<i>GDP growth rate</i>										
Greece	4.5	4.2	3.4	5.9	4.6 <sup>P</sup>	2.2 <sup>P</sup>	4.5 <sup>P</sup>	4.5 <sup>P</sup>	2.0 <sup>P</sup>	-2.0 <sup>P</sup>

During 2000-2008, Greece's government debt to GDP ratio has been fluctuating closely around 100%. In 2009, the ratio increased vastly; something that could also be observed in the rest of the eurozone, although to a lower extent. Whilst the debt level has been increasing since 2007, pure loans have actually been decreasing since 2000. Debt consisting of long-term securities other than shares, i.e. government bonds, have been used to pay off loans and raise the total level of debt. Greece's public balance has been in a deficit during the entire period 2000-2009. In 2009, the highest level so far observed was reached: 13.6% of GDP. When looking at Greece's real GDP growth rate, notice that the values shown for the period 2004-2009 are provisional. The OECD also provides estimates for the GDP



growth rate for years 2010 and 2011, which are -3.0%, and -0.5%, respectively.

As the economic data of Greece show, the country has never really been close to meeting the eurozone fiscal policy criteria. Even so, during the first years of the euro implementation, Greece magnified the data after counselling from the investment bank Goldman Sachs. By using a process called securitization, where future cash flows are aggregated into asset-backed securities (ABS), Greece managed to improve their economic data so it to a higher degree would fulfil the SGP criteria. One example of how Greece used securitization is when the country in 2001 packed a seven year long annuity (future revenues) from the EU's structural fund into an ABS; another is how state lottery future revenues got securitized. From 2001-2004 it is estimated the nation raised about 4 billion Euros on securitization. At the time Greece used the process there was nothing prohibiting it, but the EU changed the rules in 2004 and since then securitized products have been included in public debt (Financial Times, Hope, 2010a).

Securitization is only one of many measures used to manipulate data one way or the other. After 2004 and the ban on securitization, new creative accounting methods were discovered; one of them being the use of currency swaps. In October 2009, the newly elected Greece government admitted its predecessor had been manipulating the country's economic data, and the real deficit and debt were higher than previously stated<sup>5</sup>. The statement drew worldwide attention to Greece, and the event could be seen as the start to Greece's financial crisis. Yet to the publishing date of this thesis, economists still fear the current economic data of Greece to be falsified (The Economist, 2010b).

The situation in Greece became unbearable in April 2010, when the country experienced problems when trying to borrow funds on the money market. As a result, the eurozone-countries agreed upon a rescue plan that would provide Greece with up to 30 billion Euros in loans. The interest rate was set to 5%, between the IMF lending rate and the market rate (Financial Times, Chaffin et al., 2010).

Germany stands out as one of the major net lenders to Greece, and if Greece would default, a significant amount of German assets is likely to be written down. Thus, it comes as no surprise Germany has been the leading force behind offering Greece a rescue plan. Still, Germany has been pointing out Greece must be punished for their wrongdoings (The Economist, 2010b). If Germany alone had decided the terms of the package, Greece would

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<sup>5</sup>The economic data used in this thesis has been revised since then and is now, allegedly, correct.

only have been offered to loan money at the market rate.

As a consequence of the rescue plan, Greece a few weeks later announced a 24 billion Euros austerity plan that would lower the country's public deficit with 10-11 percentage points within three years, and thus reaching this specific SGP criteria. The savings were to be made from layoffs as well as a freeze of wages in the public sector and abandonment of the two extra monthly wages within the public sector (Financial Times, Hope, 2010b). This was in addition to already announced higher and new taxes (The Washington Post, Ahrens, 2010), increased pension age to 65 years and lower pensions (The Economist, 2010a). Up until the point when the additional austerity plan was announced, demonstrations and strikes had been a common element in the streets of Athens and all over Greece, but had so far not caused any deaths. However, the new saving measures sparked more violent demonstrations, culminating in the deaths of three bank employees, trapped inside a bank set on fire by demonstrators (Financial Times, Hope et al., 2010).

In May 2010, the states of the eurozone, supported by the IMF, created a 750 billion Euro aid package, aimed at governments that run into severe financial difficulties. The measure was taken to prevent other countries in the eurozone from ending up in the same situation as Greece. Furthermore, by securing potentially insolvent countries with liquidity, chances are market participants will be willing to grant the suffering countries loans at lower rates than before. The initial market reaction after the package was positive, with globally rising stock markets, appreciation of the Euro and falling Greek government bond yields (Financial Times, Barber et al., 2010).

## 4.2 Characteristics of Greece's Financial Crisis

In the aftermath of the Lehman Brothers collapse in 2008, most of the world's economies experienced a severe downturn. Europe was no exception, nor was Greece. When the country's real GDP growth rate turned to negative for the first time in over a decade in 2009, many of the indicators (public balance, debt to GDP ratio, etc.), already above preferred levels, increased dramatically. It became apparent Greece was in deeper routed trouble than other eurozone countries, and as time passed, the characteristics of the crisis also became increasingly clear. Based upon the presented Background section on Greece's financial crisis, we choose to focus on four specific aspects of the crisis. These are selected

since they have shown to be distinct characteristics that stand out in Greece, and also provide a good way to compare certain aspects of different crises. The characteristics are treated individually below.

*Indebtedness.* After a decade of falsification of economic data through various financial products, reality finally caught up with Greece. The nation's debt to GDP ratio has been fluctuating around 100% during 2000-2008. The public deficit has steadily remained on the negative side, and in 2009 it increased sharply to 13.6% of GDP. When GDP stopped growing, it was only a matter of time until the country could not pay amortization and interest on its debt. The yield on Greek government bonds increased to a high enough level to make it impossible for the nation to settle its situation. Obviously, the country had been heavily indebted for a long time, but what were the underlying causes? The answer is simply large public spending combined with insufficient yields. A large public sector with generous terms such as high pensions, low pension age and extra salaries to government employees, combined with high military expenditures, also calls for matching revenues to back the expenses. With tax revenues far below the European average, a growing indebtedness was inevitable.

*The Euro.* When Greece joined the eurozone, the country lost its monetary sovereignty; the Bank of Greece could no longer intervene on the money market or use its steering interest rate to stimulate the economy. With the key European Central Bank (ECB) interest rate kept low (ECB, 2010), the lack of monetary intervention is not currently an issue for Greece, but the Euro is. If Greece can be considered the eurozone's most troublesome country, it is unlikely that the Euro is depreciated proportionally to the economic downturn in Greece. The fact that Greece is only a minor part of the eurozone also strengthens the hypotheses. Greece has simply lost the advantage of having a proportionally depreciated currency to stimulate exports and get the economy back on track. When the rest of the eurozone begins to experience growing economies, with a higher key interest rate from the ECB and an appreciating Euro, it might get even more painful for Greece. When devaluation is not an option, an austerity plan like the one Greece has presented is all that remains. In other words: an internal devaluation. However, the internal devaluation is likely to last longer and hit the nation harder than if Greece would have had an independent currency to stabilize the economy.

*Moral hazard.* It could be argued that Greece ought to be excluded from the eurozone, given that the country for a long period has been falsifying its economic data. However, if Greece was to be ruled out of the eurozone, chances are loans granted by others would have to be written down, or even written off. Even if Greece has not deliberately been accumulating debt while hoping it at some point would be written off, the situation could still be considered a moral hazard to the extent that it would be too costly for other member countries of the eurozone to exclude Greece. Germany stands out as a major net lender to Greece, and thus has a financial self-interest in keeping Greece within the eurozone. There is also a political aspect to the dilemma; how would the world react on the eurozone excluding a member state? It is likely the EU would consider it a major setback if Greece was to abandon the Euro, since no nation has previously left the eurozone. Thus, it actually lies within most European countries' self-interest to rescue Greece; the country has in many aspects become too important to fail. However, to not evoke incentives leading to future moral hazards, it is important that the help given to countries in need of aid is not too generous. The rescue plan the countries of the eurozone established for Greece and the following austerity plan send an important message to the rest of the eurozone: Do not get into debt problems. We consider the lesson on moral hazard learnt by the eurozone.

*Non-existent acceptance for austerity.* Whilst the Greek government has approved the austerity plan, the Greek people have not. Massive demonstrations and strikes arranged by powerful unions or just mobs of angry people have been dominating the headlines during the initial months of 2010. The anger among Greeks for the austerity plan is not very hard to understand; Greeks have got used to beneficial terms - higher taxes combined with budget cuts will be quite a dramatic adjustment. This raises the question: how can the austerity plan reach acceptance among Greeks? Sooner or later, either the government or the demonstrators must give in on their demands. The demonstrations and strikes are certainly not helping the economy, and we consider this to be Greece's most crucial issue.

### **4.3 What Makes Greece's Financial Crisis Unique?**

By comparing the characteristics of Greece's financial crisis to those of earlier crises, we will be able to get an idea of how unique the crisis in Greece really is. The characteristics presented in the previous session will be used to analyze the matter.

*Indebtedness.* Debt, in one way or another, is by far the most common reason financial crises occur, according to previous research on the matter by Reinhart and Rogoff (2009). To mention a few, the 1980s crisis of Latin America (Kamin, 1999), Argentina's default in 2001 and the mid-90s crisis in Asia (Reinhart and Rogoff, 2009) were all caused by debt problems. The indebtedness of Greece may to a certain extent be caused by unique mechanisms, such as 14 monthly salaries a year for government workers, but that makes less difference - we argue it is merely a different name for the same thing seen many times before: accumulation of debt. The use of financial products to make things appear better than they really are is not new either: Repo 105 is an example of a measure used for so called window-dressing, modification of financial statements, used by Lehman Brothers in the global crisis triggered in 2008 (Financial Times, Braithwaite, 2010).

*The Euro.* When a country desires to implement the Euro as its common currency, usually a trial period is conducted to see how well the country meets eurozone standards. During the trial period, the local currency of the country is pegged to the Euro and hence such countries share the features of being a member of the eurozone. Latvia constitutes an example of a country having been in a very similar situation to the one facing Greece, concerning the Euro. In 2008, a loan from the IMF on 7.5 billion Euros was given to Latvia to ease their stressed financial situation. The country's currency, the Latvian lat, was already pegged to the Euro, and when investors put downward pressure on the lat, the government did everything in its power to keep the peg. An internal devaluation took place, resulting in austerity measures with heavy cutbacks within the public sector. Unlike Greece however, demonstrations and strikes were not as harsh and the austerity measures reached general acceptance (Financial Times, 2010).

*Moral hazard.* The events that occurred in the United States in 2008 brought discussions on moral hazard up to date. When it became apparent that many banks and financial institutions were on the edge to bankruptcy, the US government wanted to signal that irresponsible behaviour was not to be tolerated. Lehman Brothers did not receive any government help. When the investment bank went into bankruptcy, a chain reaction was triggered in the integrated international economy (Financial Times, El-Erian, 2008). The US government realized that it could not let anymore major financial institutions fail - it would be too much of a threat to the global economy. The government set up a federal rescue fund to help financially troubled institutions, one of them being Bank of America. The link to Greece is not all too far-sighted. Greece might not be too big to fail, but as

pointed out before, the country is too important to fail from a political perspective. Even if moral hazard may not have been the principal reason behind any of the crises, it did surely exist in both.

*Non-existent acceptance for austerity.* In 2008, the collapse of three Icelandic banks triggered a situation of high unemployment, inflation and debt at the same time as the Icelandic króna depreciated sharply. To rebuild the country's economy, the IMF gave Iceland a loan on 2.1 billion Dollars. Only a year earlier, the nation had been top ranked in GDP per capita. The very sudden transformation of the economy resulted in three months of massive demonstrations. In January 2009, the government finally gave up to a certain extent, but not on the austerity measures. Instead, a number of officials left their posts, including the prime minister. In the weeks that followed the resignations, the demonstrations attenuated (The Wall Street Journal, Forelle, 2009). In contrast to Greece, the anger of the Icelandic people were to a greater extent aimed at the politicians who many Icelanders blamed to be responsible for the crisis, than at the austerity measures themselves. Nevertheless, the example of Iceland shows that whilst demonstrators can be persistent, a situation that initially seems unbearable can in time reach general acceptance.

So what makes the crisis in Greece unique? Our answer is that up until this point in time: nothing. All characteristics of the crisis have also been characteristics of previous crises, although many of the variables in previous crises could be considered to be the same things but with different names than in Greece. If we were to choose one crisis that resembles the one in Greece most widely, the Latvian experience would be it. But, what went relatively smooth in Latvia is Greece's most significant challenge and also a characteristic that could add uniqueness to the crisis in Greece if not resolved: the general acceptance of the austerity plan. If the Greek government cannot find a way to make the violent demonstrations stop, it could in a worst-case scenario threaten the monetary cooperation of the entire eurozone, not to mention the relations within the EU. For the case of everybody involved, the demonstrations better attenuate, like they not all too long ago did on Iceland.

## 5 Results of the Kaminsky-Reinhart Model

*The used data and results of the quantitative analysis, using the Kaminsky-Reinhart model of crisis prediction, are presented in this section. Procedures and data values for all calculations are presented, as well as what these aim to find.*

### 5.1 Presentation of Data

The empirical data for Greece was obtained from IFS (2010), where annual values were calculated for 14 of the 16 variables listed in section 2.4. The real exchange rate and the real interest-rate differential were omitted due to lacking applicability, stemming mainly from the fact that Greece does not have an independent currency that is pegged using a fixed exchange rate regime. Thus, these variables are considered to not support the analysis, which is why they are not considered further. This action is compensated by normalizing the crises probabilities to the use of 14 variables, as will be explained more later on.

As for the remaining variables, most of them are, according to the methodology specified in Kaminsky (1998) and Kaminsky and Reinhart (1999), defined as relative annual percentage changes. Thus, a signal is triggered when the change in a variable between two consecutive years is abnormally high, not when the variable itself is high. Exceptions to this are the excess M1 balances, the real interest rate and lending-deposit credit ratio, which should be expressed in their nominal values according to the model. All included variables were normalized with their mean and variance, in order to make them compatible with the threshold values of section 2.4, which are expressed as percentiles in a normal distribution.

Descriptive statistics for these (non-normalized) variables are shown in table 4, which includes the mean, median, standard deviation, max and min of the data sets. Properties and calculation methodology for all of the variables are now briefly treated individually, following the order of table 4. The development between 2002 and 2009 of all these variables can be seen in figures 4 - 6, in the complementary data appendix.<sup>6</sup>

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<sup>6</sup>Note that the statistics in the table are for the percentage change of most of the variables, as they are entered in the model. In contrast, the complementary data appendix contains time plots of their nominal values for simplicity.

**Table 4:** Descriptive statistics of the variables that are used in the Kaminsky-Reinhart model. All, except for the excess M1 balances, the real interest rate and lending-deposit credit ratio are expressed as one-year percentage changes. Hyphens indicate inapplicable variables. For all variables, there are 9 (annual) data points in total.

Variable	Mean	Median	Std. dev.	Min	Max
<i>Financial sector</i>					
M2 Multiplier	-3.59	-2.01	9.54	-22.0	7.95
Domestic credit to GDP	1.74	1.54	4.14	-5.76	9.07
Real interest rate	-1.63	-1.80	1.37	-4.01	0.64
Lending-deposit credit ratio	1.92	1.69	0.890	1.25	4.00
Excess M1 balances	0.565	0.544	6.77	-10.7	8.70
M2/reserves	70.1	45.6	125	-76.7	302
Bank deposits	5.06	5.87	6.33	-5.68	12.0
<i>External sector</i>					
Exports	11.3	11.2	14.9	-17.1	30.1
Terms of trade	-44.4	-111	275	-296	533
Real exchange rate	-	-	-	-	-
Imports	11.9	10.2	17.9	-13.6	42.4
Reserves	26.3	-17.0	138	-72.7	352
Real interest-rate differential	-	-	-	-	-
<i>Real sector</i>					
Output	-0.821	0.509	3.44	-8.85	2.02
Stock prices	17.5	28.8	39.3	-54.8	59.1
<i>Fiscal Sector</i>					
Budget deficit to GDP	20.6	25.3	38.1	-30.8	76.6



The M2 multiplier is the ratio of the M2 measure of money stock to the base money in the economy. The M2 measure is usually an aggregated measure of all physical currency part of bank reserves, and most checking, savings and money market accounts. However, the exact definition differs between countries. The M2 multiplier has been quite volatile in Greece during the studied time period.

The ratio of domestic credit to GDP is calculated by dividing deflated domestic credit by nominal GDP, based on the annual data obtained from IFS (2010). This measure has been relatively stable in Greece during the last decade.

In the calculation of the real interest rate  $r$  from the nominal interest rate  $i$ , the Fisher equation is used, as shown in equation (8). The *ex post* inflation  $\pi$  is estimated by the percentage change in consumer price index.

$$1 + i = (1 + r)(1 + \pi) \quad \implies \quad r = \frac{1 + i}{1 + \pi} - 1 \quad (8)$$

The lending-deposit credit ratio is obtained by dividing the lending rate by the discount rate. As stated earlier, this variable is not expressed as percentage changes between annual levels. This ratio has been fluctuating within a quite wide span prior to the crisis.

Proceeding with the excess M1 balances, the derivation is somewhat more complex. The use of this measure stems from Krugman's (1979) framework of that excess liquidity may be created to ease the conditions for financial institutions. It is generally estimated using a multiple linear regression, with the real M1 balance, being the independent variable<sup>7</sup>. The dependent variables are real GDP,  $Y$ , the nominal interest rate,  $i$ , and a linear time trend,  $T$ . This yields an estimated demand for M1 balances, and the excess M1 balances are then defined as the error term,  $\epsilon$ , in this linear regression. The full regression is seen in equation (9), and properties of the resulting coefficients are shown in table 5.

$$\frac{M_1}{P} = \beta_0 + \beta_1 Y + \beta_2 i + \beta_3 T + \epsilon \quad (9)$$

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<sup>7</sup>Calculated as the nominal M1 balances,  $M_1$ , deflated using the consumer price index  $P$ .

**Table 5:** Properties of the coefficients obtained when performing the regression of excess M1 balances. Regression  $r^2 = 0.8809$ ,  $N = 9$ ,  $F$  statistic: 22.1944.

Variable	Notation	Coefficient	Standard Error	t-value	p-value
GDP	$Y$	-3,10	15,7	-0,198	0,850
Interest rate	$r$	0,503	0,0759	6,63	0,000568
Time trend	$T$	-0,0490	3,11	-0,0158	0,988

The ratio of M2 to reserves is similar to that of the M2 multiplier, however in this case the denominator is the reserves. This measure has had a very turbulent development in recent years, where an initial moderate increase in years 2002 - 2007 was followed by a large increase in 2008, and then a sharp decline in 2009. The two following variables, bank deposits and exports are simply twelve month changes of the respective IFS data values. The bank deposits are aggregated data of demand deposits plus time, savings, and foreign currency deposits, while the export data is aggregated for both goods and services.

The terms of trade were calculated by dividing an index of export prices (the unit value of exports) with an index of import prices, following the methodology of Kaminsky and Reinhart (1999). The extreme percentage changes in this variable stems from the fact that it generally fluctuates around zero. In the last years, however, it has been constantly decreasing, which is consistent with the theory of Dornbush et al. (1995), with crises inferring losses of international competitiveness. As was the case with bank deposits and exports, the imports and reserves are simply one-year percentage changes of the respective IFS data series. The reserves show a quite significant difference in mean and median data, which is due to the fact that it has been quite steadily decreasing during 1999 - 2004, and then stayed at a low level until 2009, when a rise was observed. The industrial output and stock market indices are given explicitly by IFS, and thus the percentage changes are calculated without any significant data processing. The output variable showed a relatively large decrease in 2009, while the decline in stock prices could be observed one year earlier.

The final variable is the ratio of the budget deficit to real GDP. After increasing steadily from 4 to 8% in 2000 - 2004, a decline was experienced in 2005 and 2006, to a level of 3.5%. After this, sharp increases followed, with the deficit mounting up to about 8% in 2008 and 14% in 2009. Note that these number are nominal values, as shown in the complementary data appendix, and not relative changes, as shown in table 4.

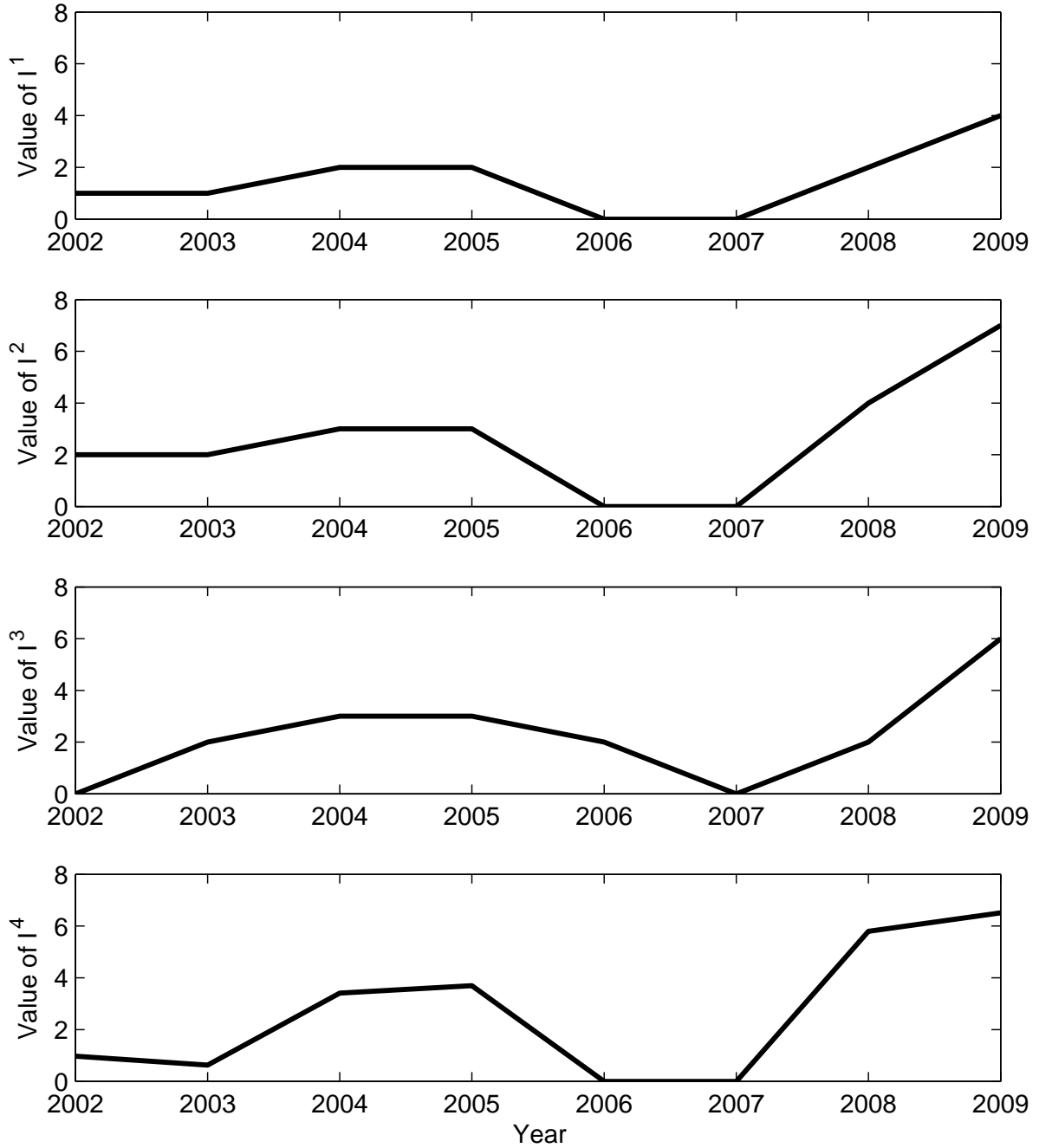
## 5.2 Results of the Indices

The four composite indices of the Kaminsky-Reinhart model, which are defined in section 3.2, were calculated for years 2002-2009, and plotted versus time in order to see if there might be any indications of a banking or currency crisis. These plots are shown in figure 1 for currency crises, and figure 2 for banking crises.

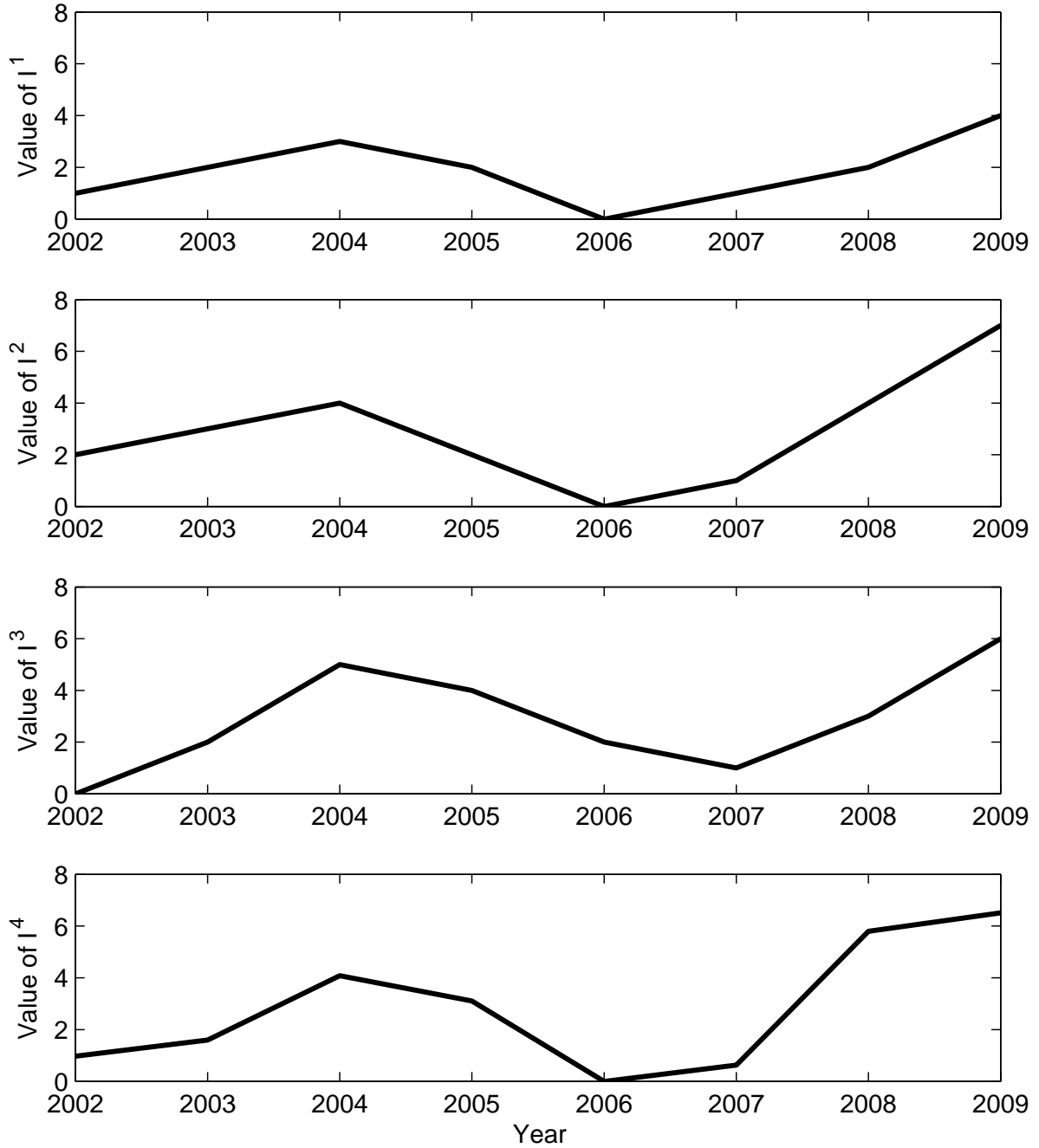
Turning first to figure 1, the first index  $I^1$  signals to some extent for a currency crisis during 2009, and to some extent also during 2008. However, while the level in these years is higher than average, it is not a very strong effect compared to other indices. Regarding index  $I^2$ , there is a much sharper increase during 2008 and 2009, and it also assumes a higher value during these years. It is also noticeable that the index is comparably high in the years 2004-2005. The third index,  $I^3$ , seems to have a worse predictability power than its non-averaged counterpart,  $I^1$ . The curve seems spread out over time, which is reasonable due to the averaging that is being made in this index. The best predictability power, however, must be assigned to index  $I^4$ . It had quite high levels during 2004-2005, but after low levels during 2006 and 2007, a sharp increase followed in 2008. It is superior in the way that it has by far the most distinct value in 2008, making it suitable for the prediction of a future currency crisis.

As for the signals for a banking crisis seen in figure 2, there is also in this case a clear indication of increasing problems in recent years. Again, composite index  $I^1$  gives a quite weak signal, where the level of 2009 is almost the same as the level for the, comparably calm, year of 2004. Indicators  $I^2$  and  $I^3$  show similar behaviour, among which  $I^2$  renders the most distinct signal in recent years. Also in this case, the composite indicator  $I^4$  shows very good results. This is clearly seen by the high attained value as early as 2008, which indicates a good predictability power.

In summary, all of the indices show some signals of a crisis, both in the case of currency and banking crisis. However, the banking indices showed a somewhat slower increase, with most levels increasing already in 2007. For comparison, all of the four indices showed a value of 0 in the case of currency crises as late as 2007. As it seems, the current crisis has led to an increased risk for both a currency crisis and a bank run. However, it is hard to estimate which effect this will have for Greece, given the membership in the eurozone, and also whether this fact has affected the values of these variables.



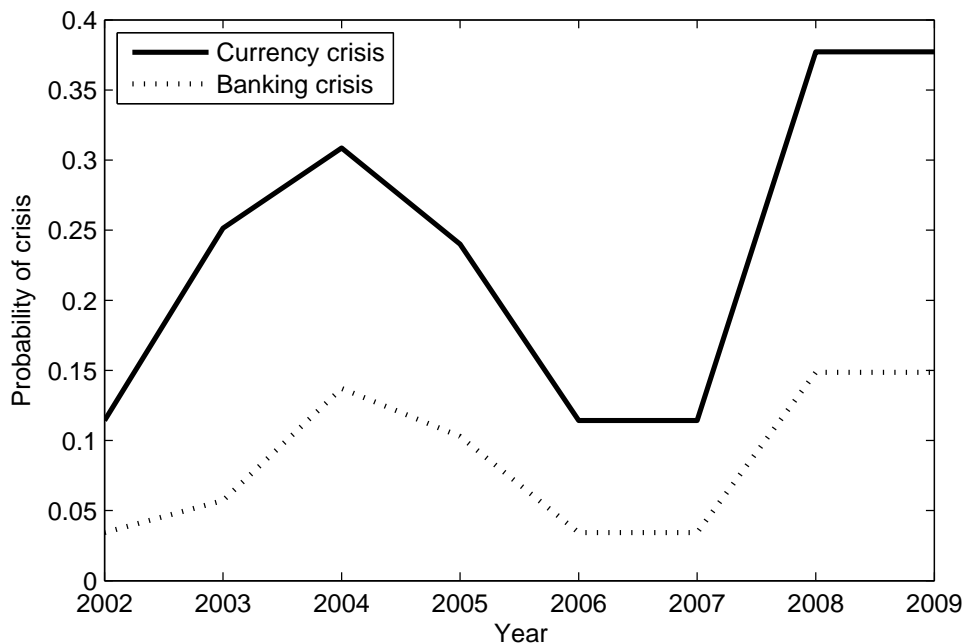
**Figure 1:** Results of the Kaminsky-Reinhart model for the risk of a currency crisis. The four composite indices are shown in order from top to bottom, where  $I^1$  is seen at the top.



**Figure 2:** Results of the Kaminsky-Reinhart model for the risk of a banking crisis. The four composite indices are shown in order from top to bottom, where  $I^1$  is seen at the top.

The probability of both types of crises has also been calculated, using the data presented in table 2, in section 3.2. The result is two time-dependent crisis probabilities, based on the fourth composite index  $I^4$ . These can be seen in figure 3. As it seems, there is a significant risk of both a currency and a banking crisis in Greece due to the current financial turmoil, as predicted by the Kaminsky-Reinhart model. The statistical risk of a currency crisis amounts to 35%, while for banking crises the corresponding value is 15%. Note that this difference do not stem from a higher numerical value of composite indicator  $I^4$  for the case of currency crises than for banking crises; they assume the exact same values for the years 2008-2009, but since the probabilities shown in table 2 are higher for currency crises at the same index level, the resulting risk is higher for currency crises.

There is also a significant peak in 2004 in the probabilities for both types of crises, which was during a period of relative economic calmness in Greece. A reason for this might be the imposed rules about debt securitization from the European Union, as explained in section 4.1. For Greece, this caused securitized products to be included in public debt, to avoid doubtful accounting measures. These changes might have imposed an external shock on the economic figures of 2004, and since the Kaminsky-Reinhart model focuses on changes of these variables, a higher probability of crises might therefore have been measured.



**Figure 3:** Probability of currency and banking crises in Greece for the years 2002-2009, as predicted by the Kaminsky-Reinhart model.

## 6 Discussion

*The findings of this thesis are summarized in this section, together with a result discussion and suggestions for further work within the subject which could be supported by, or complementary to, this thesis.*

### 6.1 Result Discussion

The Greek government's most severe challenge is to reach general acceptance for the austerity plan. Since the people of Greece have got used to living with beneficial terms, the task will not be an easy one to complete. However, as a recent example from Iceland shows, it can be done. If the austerity plan reaches general acceptance, we believe the country has a good chance of recovery, but due to the internal devaluation the process will be painful and lengthy. If not, default is a more likely outcome.

Comparing the resulting currency and banking crisis probabilities of 35% and 15%, respectively, we see that this is a quite low number. Kaminsky and Reinhart (1999) does out-of-sample testing on four countries during the 1997 Asian crisis, and found that in three cases did 60 - 70 % of the indicators signal, corresponding to crisis probabilities of roughly 80% and 35%, respectively. Vickers (2006) backtests the model on the 2002 Uruguayan currency and banking crises and found corresponding probabilities to be 27% and 65%, respectively. Clearly, the results of the indices in the Kaminsky-Reinhart model were indicating problems in Greece for the recent years of economic turmoil. As seen in comparison to other results, however, the signals seem to be quite mild. Furthermore, as addressed in section 3, the validity of this model is probably lower in the case of Greece compared to other crisis countries due to the membership in the eurozone, and the stabilizing effects of the ECB.

Earlier studies have found that the indicator showing the best predictive power was  $I^4$  (Kaminsky and Reinhart, 1999). This clearly seems to be the case also in this study, and in general the results of this thesis are well comparable to Kaminsky and Reinhart (1999). Another notable comparison is that of one of the principal results of the study by Kaminsky and Reinhart (1996), who found that banking crises most often precede currency crises in the case when both are present. Indeed, this can be observed in our data as well; while the

data for the years 2008-2009 are almost identical for all indices when comparing currency and banking crises, the latter has significantly higher values for 2007, which is the case for all indices. This seems to indicate that the causality of the two types of crisis, when applied to Greece, is indeed following the direction suggested by Kaminsky and Reinhart (1996).

## 6.2 Conclusions

According to our research, we find the four characteristics of the financial crisis in Greece to be indebtedness, the Euro, moral hazard and a non-existent acceptance for austerity, each one explained thoroughly in section 3.2. We do not find any of the characteristics of the crisis to be unique. However, it could be argued that some of the events leading up to the characteristics are unique. For example, the way in which the Greece government used its accumulated debt - to give the citizens the world's most beneficial pension terms - is unique. The fact that one of the characteristics of the crisis in Greece was indebtedness as well as that the crisis is not unique corresponds well to what previous research on financial crises by Reinhart and Rogoff (2009) and Kamin (1999) have concluded.

As for the Kaminsky-Reinhart model, it showed a significant increase in the probability of both a currency and banking crisis in Greece during the most recent years of financial turmoil. Currently, the probability of a currency crisis is estimated to a 35%, while the probability of a banking crisis is assessed to 15%. However, these values, particularly that of a currency crisis, are likely to be lower in reality, due to the stabilizing effect of the European Central Bank. The risk of a banking crisis seemed to be increased, as predicted by most composite indices, prior to that of a currency crisis. The index measures of a banking crisis is generally also higher than that of currency crises when comparing years of economic tranquility. Instead, the measures of currency risks increased more dramatically before the crisis of 2009. Perhaps some of the increased values of 2004 could be explained by the introduction of new regulatory restrictions discussed in section 4.1.



### 6.3 Suggested Further Research

During the creation of this thesis, we have at many a time stumbled upon sidetracks to our research questions that we have felt urged to investigate, yet could not do so due to limitations in time and scope. In our opinions, two examples of such sidetracks which would serve well as areas of future research for others, are:

- What further modifications could be made to the Kaminsky-Reinhart model in order to adjust it to the application on a country in a currency union?
- The optimum currency area criteria: In what areas are the eurozone suboptimal?

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## Bibliography

### Papers

- Al-Zein E. (2008). Reserve Requirements, the Maturity Structure of Debt, and Bank Runs. IMF Working Paper 108(08), 18.
- Calvo G A. (1995). Varieties of Capital-Market Crises. RES Working Papers n:o 4008.
- Chang R, Velasco A. (2001). A Model of Financial Crises in Emerging Markets. Quarterly Journal of Economics 116(2), 489-517.
- Chang R, Velasco A. (1998). Financial Fragility and the Exchange Rate Regime. NBER Working Paper, No. 6469, Cambridge, Mass: National Bureau of Economic Research.
- Diaz-Alejandro C. (1985). Good-bye Financial Repression, Hello Financial Crash, Journal of Development Economics, 19, 1-24.
- Dokos F. (2009). Fiscal Policy in EU During the First Years of Euro Adaptation - The Case of Greece. Bachelor's thesis in Economics. 24(09), 3-6.
- Dornbusch R, Goldfajn I, and Valde R. (1995). Currency Crises and Collapses. Brookings Papers on Economic Activity. (2), 219-70.
- Flood R, Garber P. (1984). Collapsing exchange-rate regimes: Some linear examples. Journal of International Economics. 17, 1-13.
- Frankel J, Rose A. (1996). Currency Crashes in Emerging Markets: Empirical Indicators. CEPR Discussion Papers 1349.
- Kamin S. (1999) The Current International Financial Crisis: How Much Is New?. Board of Governors of the Federal Reserve System: International Finance Discussion Papers 636, 4-10.
- Kaminsky, G. (1998) Currency and banking crises: the early warnings of distress. International Finance Discussion Papers. 629 (202)
- Kaminsky G, Lizondo S, Reinhart C. (1998). Leading indicators of currency crises. Staff Papers-International Monetary Fund. 45(1):1-48.

- Kaminsky G, Reinhart C. (1996). The Twin Crises: The Causes of Banking and Balance-of-Payments Problems. Board of Governors of the Federal Reserve System (U.S.). (544).
- Kaminsky G, Reinhart C. (1999). The twin crises: the causes of banking and balance-of-payments problems. *American Economic Review*. 89(3): 473-500.
- Kindelberger C. (1978). *Manias, panics, and crashes*. New York: Basic Books.
- Krugman P. (1979). A Model of Balance-of-Payments Crises. *Journal of Money, Credit, and Banking*. 11(3), 311-325.
- McKinnon R, Pill H. (1996). Credible Liberalizations and International Capital Flows: The "Overborrowing Syndrome". *Financial Deregulation and Integration in East Asia*, NBER-EASE Volume 5. National Bureau of Economic Research, Inc. 7-50.
- Obstfeld M. (1996). Models of currency crises with self-fulfilling features. *European Economic Review*, 40, 1037-1047.
- Obstfeld M. (1986). Rational and self-fulfilling balance-of-payments crises. *The American Economic Review*, 76, 72-81.
- Obstfeld M. (1994). The Logic of Currency Crises. *Cahiers Economiques et Mon'etaires*, XLIII, 189-213.
- Radelet S, Sachs J. (1998). The East Asian Financial Crisis: Diagnosis, Remedies, Prospects. *Brookings Papers on Economic Activity* 1: 1-74.
- Reinhart C M, Rogoff K S. (2009). *This Time Is Different: Eight Centuries of Financial Folly*. E-book. ISBN: 978-1-4008-3172-2.
- Reinhart C M, Rogoff K S. (2008). Is the 2007 US Sub-Prime Financial Crisis So Different? An International Historical Comparison. *American Economic Review*. 98(2): 339-344.
- Sachs J, Tornell A, Velasco A. (1996). Financial Crises in Emerging Markets: The Lessons of 1995, *Brooking Papers on Economic Activity*, No. 1, 147-217.
- Skaggs N. (1997). Crisis of 1819. in Glasner, David; Cooley, Thomas F., eds. *Business cycles and depressions: an encyclopedia*. New York: Garland Publishing.

Vickers S. (2006). Could the Kaminsky-Reinhart Model Have Predicted the 2002 Uruguayan Currency and Banking Crises? Duke University. Durham, NC, USA.

## Newspaper Articles

Financial Times. Atkins R, Hope K. (2010). A Heracleian task. 6 May 2010, Asia Ed1, 09.

Financial Times. Barber T, Atkins R, Oakley D, Mackenzie M. (2010). Markets rally on EU bail-out. 11 May 2010, USA Ed2, 01.

Financial Times. Braithwaite T. (2010). Fuld defends Lehman's use of 'Repo 105'. 19 April 2010, FTCOM.

Financial Times. Chaffin J, Pignal S, Hope K. (2010). Eurozone in € 30 bn loans deal for Greece. 12 April 2010, London Ed3, 01.

Financial Times. El-Erian M. (2008). Only new thinking will save the global economy. 4 December 2008, Asia Ed1.

Financial Times. Hope K. (2010a). Securitisations set sights on Greek ruins. 16 Feb 2010, London Ed1, 06.

Financial Times. Hope K. (2010b). Greece agrees €24bn austerity package. 29 April 2010, FTCOM.

Financial Times. Hope K, Barber T, Oakley D. (2010). Greek premier vows to push on with cuts as three bank workers die in Athens protest. 6 May 2010, London Ed3.

Financial Times. (2010). Lex Column: Greece/Latvia. 7 May 2010, London Ed1.

The Economist. (2010a). Sound and fury. 27 March 2010, EC, ECN, 394.

The Economist. (2010b). Leaders: Acropolis Now. 1 May 2010, EC, ECN, 395.

The Economist. (2005). Worldwide quality-of-life-index. Online.  
[www.economist.com/media/pdf/quality\\_of\\_life.pdf](http://www.economist.com/media/pdf/quality_of_life.pdf) (accessed 2010-05-13)

The Irish News. (2010). World - Cost of Greek military criticised. 29 May 2010, IRISHN, 23.

The Wall Street Journal. Forelle C. (2009). Iceland's Leadership Collapses as Ire Over Crisis Intensifies. 27 January 2009, World; A6.

The Washington Post. Ahrens F. (2010). Economy Watch. 3 May 2010. Online. [http://voices.washingtonpost.com/economy-watch/2010/05/greek\\_debt\\_bailout\\_concessions.html](http://voices.washingtonpost.com/economy-watch/2010/05/greek_debt_bailout_concessions.html) (accessed 2010-05-13)

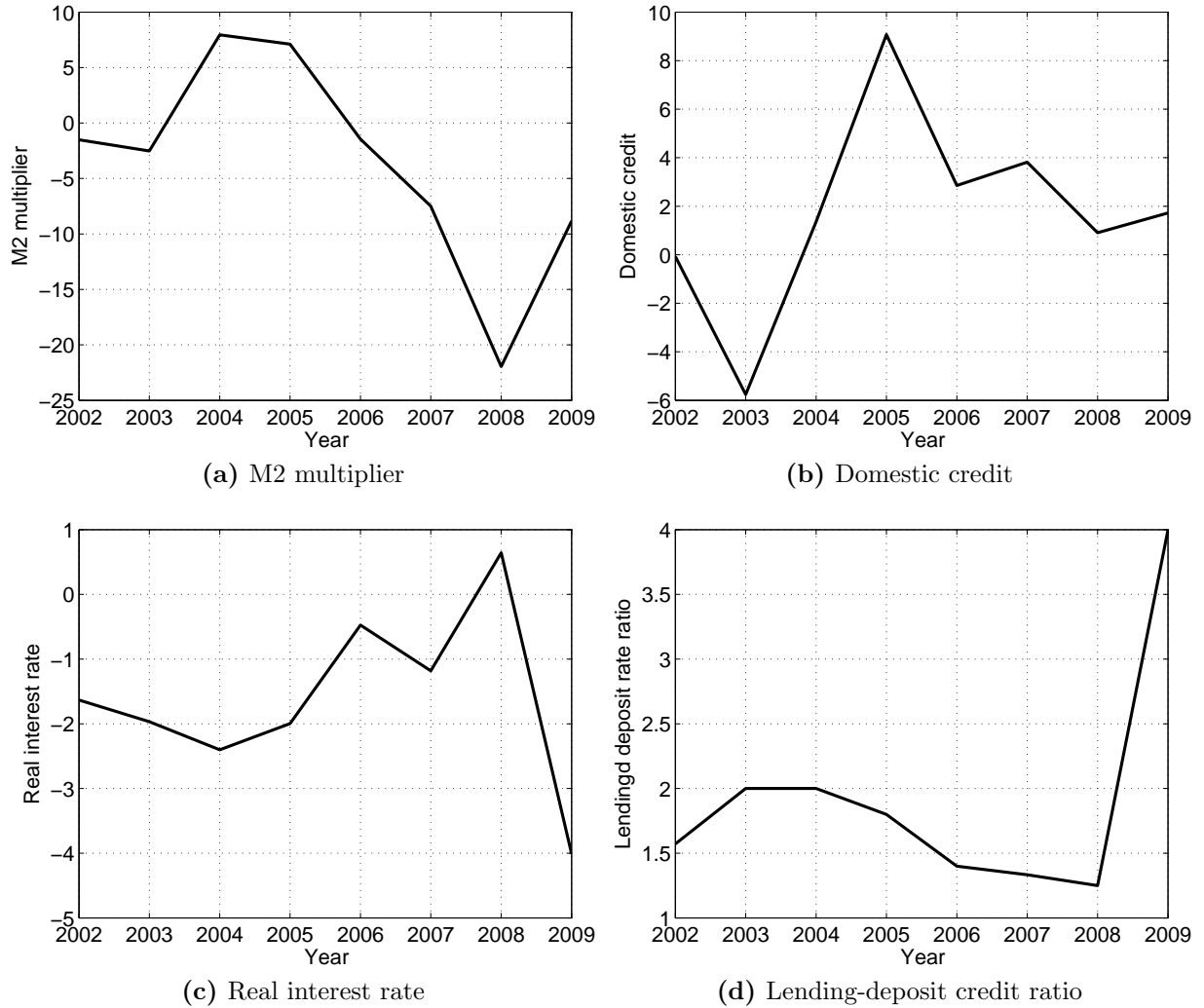
### **Internet Sources**

European Central Bank, [www.ecb.int](http://www.ecb.int) (accessed 2010-05-14)

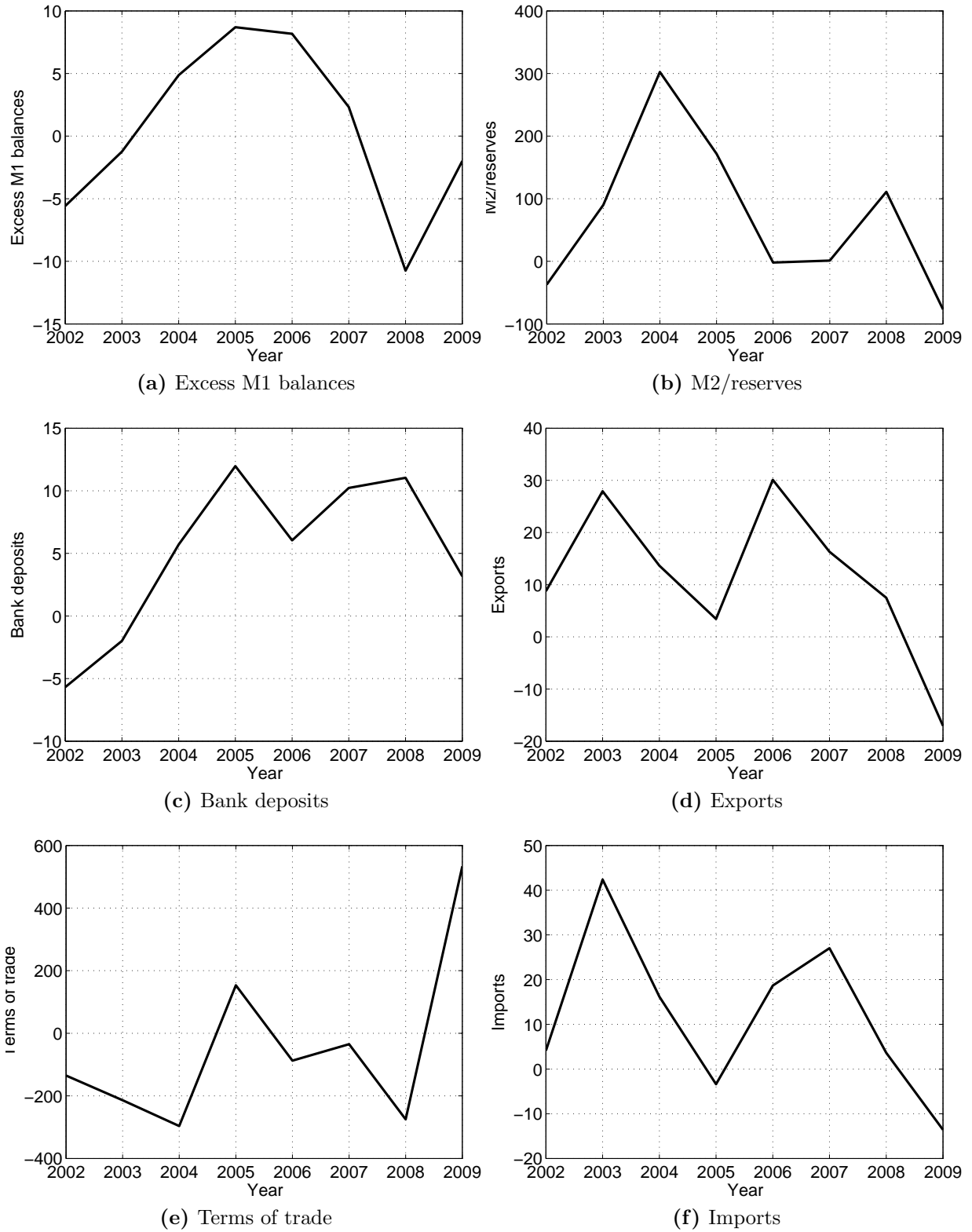
OECD Statistics Database, [www.stats.oecd.org](http://www.stats.oecd.org) (accessed 2010-04-10)

Eurostat, [www.ec.europa.eu/eurostat](http://www.ec.europa.eu/eurostat) (accessed 2010-05-14)

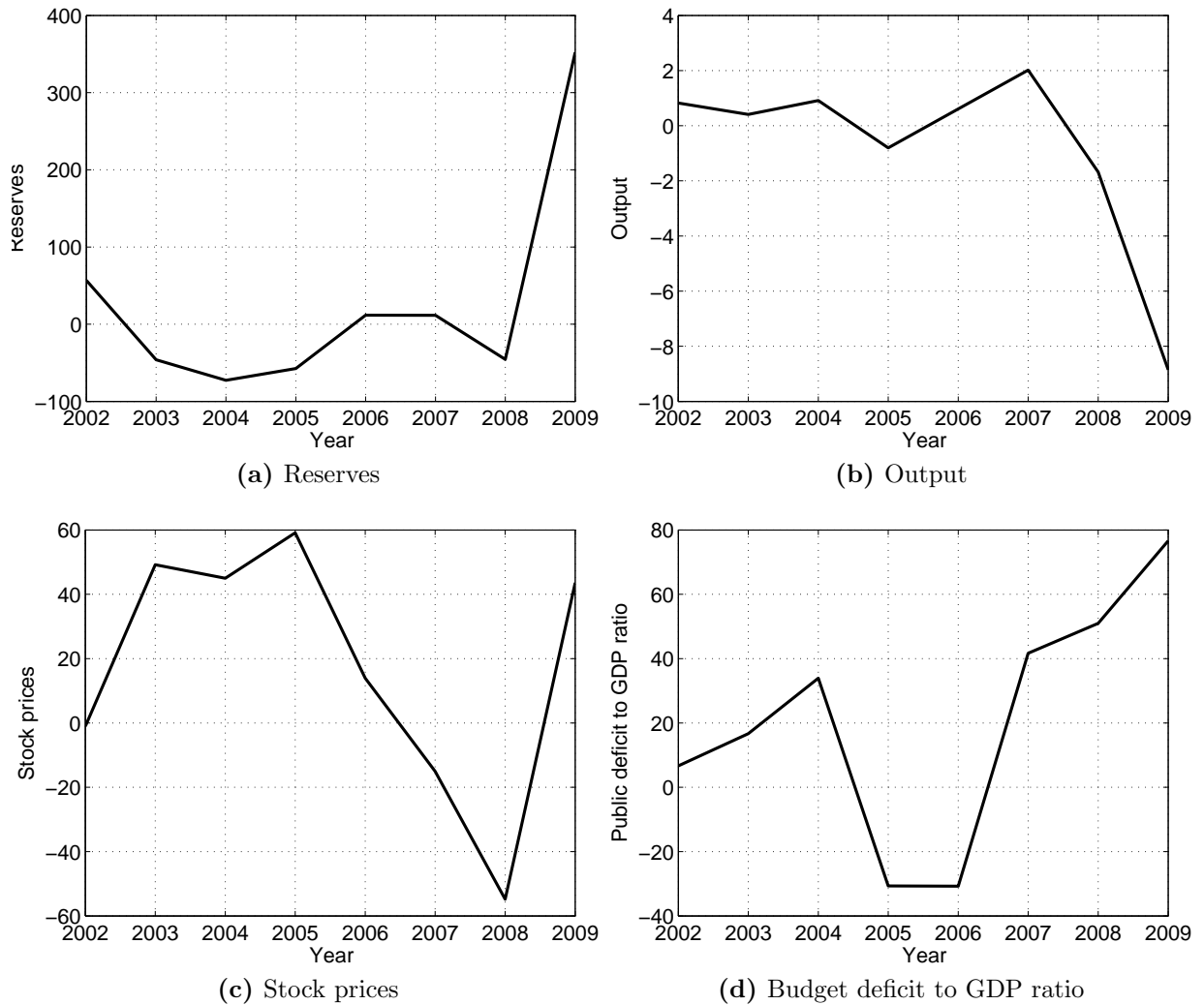
## Complementary Data



**Figure 4:** Plots of macroeconomic variables listed in table 4. Note that the nominal values are shown, not the percentage change as they are entered in the model.



**Figure 5:** Plots of macroeconomic variables listed in table 4. Note that the nominal values are shown, not the percentage change as they are entered in the model.



**Figure 6:** Plots of macroeconomic variables listed in table 4. Note that the nominal values are shown, not the percentage change as they are entered in the model.