Dominik Maltritz · Michael Berlemann
Editors

Financial Crises, Sovereign Risk and the Role of Institutions

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In honor of our esteemed teacher, colleague and friend Alexander Karmann

Preface

According to Wikipedia, a Festschrift "is a book honoring a respected person, especially an academic, and presented during his or her lifetime." Since we have edited this book to honor Alexander Karmann, our highly respected academic teacher, on the occasion of his 65th birthday this book, entitled "Financial Crises, Sovereign Risk and the Role of Institutions", is obviously a Festschrift.

Alexander Karmann was born on the 19th July 1948 in Nuremberg. He started studying mathematics at University of Erlangen-Nuremberg in 1967. Moreover he studied music at the Academy of Music Nuremberg. After passing his exam as a concert pianist he received his diploma in mathematics in 1975. He then switched to Karlsruhe University, where he received his Ph.D. for a dissertation with the title "Competitive equilibria in spatial economies" under the advice of Prof. Dr. Rudolf Henn in 1979. Only 4 years later, he received a venia legendi for economics and statistics at Karlsruhe University after completing his habilitation with a work on Milton Friedman's Permanent Income Hypothesis. In 1986 he accepted an offer of Hamburg University for a professorship in economics. Since 1994 he has been professor of economics, especially monetary economics, at Technical University of Dresden.

Alexander started publishing in international peer-reviewed journals long before the major part of the German community of economists recognized the necessity to take part in the international discussion. As a consequence he has published articles in many international, highly reputed journals such as the Journal of Mathematical Economics, Regional Science & Urban Economics, the Journal of Institutional & Theoretical Economics, the European Journal of Health Economics, the Review of Development Economics, the Journal of Banking & Finance or the Review of International Economics, to name only a few. Different from most contemporary young economists he has worked on a wide variety of fields, including regional economics, the shadow economy, monetary policy, banking and financial markets, financial crises and health economics. He also edited a number of highly relevant contributed volumes. Last but not least he published a textbook on mathematical methods which in the meantime is available in the 6th edition.

Throughout his professional career Alexander has held numerous positions in economic organizations. He has been member of the Directorate of the Verein für

Socialpolitik and is active member of three of its Research Committees (Industrial Economics, Environmental and Resource Economics, Health Economics). Moreover he is Research Professor at Halle Institute for Economic Research/IWH. As of today, Alexander is Director of the Centre for Health Economics at Technical University of Dresden and Chairman of the Directorate of the German Association of Faculties of Economic and Social Sciences (WISOFT e.V.). However, he was and still is not only active in external economic organizations. Alexander also served his Faculty for 5 years as Dean.

Finally and for the two of us surely most important, Alexander did a marvelous job in supporting young academics in their research. Numerous Ph.D. candidates successfully finished their projects under his advice and now work in organizations around the globe. Three of his former staff members hold professorships at Universities and it seems realistic that this number further increases in the future.

All these merits are more than enough to be honored with a Festschrift. However, the primary reason for us to organize this Festschrift is that both of us feel deeply indebted for the great support he gave to us.

When we planned this Festschrift we were well aware of the fact that Festschriften often include a large number of articles on quite heterogeneous topics which stand – if at all – only in loose connection. In the light of the fact that Alexander was active on so many different fields we decided to refrain from producing a mere collection of articles from different fields of economics. Instead, we opted for editing a book on one topic which has been in the centre of Alexander's interest throughout the last years: Financial Crises and Sovereign Defaults. We are happy that besides a number of Alexander's scholars also some colleagues which are experts in the field and which are in close connection with Alexander agreed to contribute to this volume. We would like to use the opportunity to thank all contributors for their fantastic cooperation in this project.

Interestingly enough, Wikipedia cites on its internet page on Festschriften also Endel Tulving, a Canadian neuroscientist, when writing: "a Festschrift frequently enough also serves as a convenient place in which those who are invited to contribute find a permanent resting place for their otherwise unpublishable or at least difficult-to-publish papers." We hope you, Alexander, as well as the other readers of this book will agree that this Festschrift is an exception in this respect.

Hamburg and Erfurt, Germany
July 2013

Michael Berlemann
Dominik Maltritz

Contents

Introduction

Michael Berlemann and Dominik Maltritz

Abstract

The Worldwide Financial Crisis stimulated intensified research on financial crises and sovereign defaults. In this edited volume we provide a variety of papers about important issues related to the recent financial crisis. The papers discuss new modelling approaches to financial crises, defaults, their dependencies and consequences with a special focus on features of financial institutions and financial markets. Many papers have a focus on the European Union and crisis risks of developed countries. The book also provides interesting suggestions to the solution of crises and the improvement of financial stability. This concerns especially the design of institutional features and financial contracts. The introduction provides an overview on the book in general and the individual contributions.

Throughout the last 6 years Europe experienced two enormous financial crises: the Worldwide Financial Crisis and the subsequent European Debt Crisis. Throughout these crises many countries and regions faced banking crises or currency crises and many countries defaulted on their debt obligations or needed external help to avoid debt crises and outright defaults. Yet, in many countries the crises showed features of several types of financial crises at the same time. These problems, of course, did not only influence the financial sectors, but severely impacted the referring economies as well as the social and political atmosphere. The crises which occurred in the decades before, e.g. the Latin American debt crisis of the early 1980s, the

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Mexican Crisis of 1994/95, the Asian Crisis of 1997/98, the Russian Crisis of 1998/99 or the crisis in Argentina – to name a few important examples – also imposed severe burdens on the afflicted economies. However, while these crises were more or less restricted on single developing countries or regions, the two recent financial crises also affected the entire or at least large parts of the developed world.

Due to the often enormous impact of financial crises on economic, social and political life in the affected countries, the causes, the development and the consequences of financial crises have always been an important topic on the agenda of economic research. Economists which have been active on the field of research on financial crises are often fascinated by the complex and challenging topic, as it becomes obvious from a statement of Nobel Price laureate Paul Krugman[1]: "And so I am a bit like a tornado-chaser who has just caught up with a monster twister. I'm as sorry as anyone about those poor people in the trailer park, but I am also more than a bit thrilled to have the chance to watch this amazing spectacle unfold. I can even offer an excuse for my mixed feelings: You learn a lot more about how the global economy works when something goes wrong than when everything hums along smoothly. And maybe the lessons we learn from this crisis will help us avoid, or at least cope better, with the next one." Indeed the last two "next (big) ones", i.e. the Worldwide Financial Crisis and the European Debt Crisis, displayed – besides many similarities to preceding crises – several new features. The most obvious news is that crises can also occur in the most developed countries. As pointed out earlier, most of the previous research focused on crises in the context of developing countries. In addition, the Worldwide Financial Crisis as well as the European Debt Crisis have underpinned the importance of an issue that researchers picked up just in the years before, the strong dependency between different types of crises, i.e. the dependency between banking and currency crises and their relation to sovereign default risk. Moreover, the recent crises revealed in an unpleasant way that weak or wrong features of the institutional setting in the financial sector and the financial markets as well as wrong politics and over-ambitious goals of policy makers (that neglect fundamental economic truths) are important causes of crises.

When the Worldwide Financial Crisis evolved, the crisis issue returned to the top of the agenda of economic research and has remained there since then. In this edited volume we provide a variety of articles written by experts that mostly have worked in this field since long before the current crises started. In these articles some of the most important issues related to the recent financial crises are discussed. The papers discuss new modelling approaches to financial crises, defaults, their dependencies and consequences. The contributions also highlight and discuss several features of financial institutions and financial markets' design and in particular the risks they impose to financial stability. Many papers have a focus on the European Union and problems and risks of developed countries. The book also provides interesting suggestions to the solution of crises and the improvement of financial stability. This concerns especially the design of institutional features and financial contracts.

[1] Krugman, Paul (2002): Asia: What went wrong? (http://www.pkarchive.org/)

Such issues are discussed in the first half of the book while discussions and new economic modelling approaches of different kinds of risk are provided in the second half.

The volume starts out with a paper by Ansgar Belke who suggests an interesting policy alternative for the European Central Bank (ECB). Currently the ECB follows the Outright Monetary Transactions (OMT) approach in order to reduce interest rates for several European countries and to enhance their financing potentials. This approach has been criticized heavily for several reasons. Belke suggests an interesting alternative: The use of gold backed bonds for highly distressed countries. The paper discusses the specific benefits of this approach compared to the OMT approach. In particular there is almost no transfer of credit risk between high risk and low risk countries, losses are borne by specific countries and not by the largest shareholders of the ECB. In addition, the approach would be more transparent, lead not to inflationary risks and would contribute to fostering reforms.

The second paper, which is authored by Michael Berlemann, is concerned with the effects of the two recent financial crises on trust of the citizens of the European Union in the European Central Bank. Berlemann argues that trust is a necessary precondition for a political institution to be able to fulfill its tasks in the long-run. In order to study the effect of the two crises on trust he uses three cross-sections of the Eurobarometer Survey. Employing the results of a logit-estimation-approach Berlemann shows that both crises contributed to a significant decline in trust in the European Central Bank even after controlling for the inferior macroeconomic circumstances in consequence of the crises. Especially the European Debt Crisis turned out be detrimental to average trust in the European Central Bank. He also shows that there are huge differences in the perception of citizens of European Union member countries. Berlemann concludes that the two recent financial crises contributed to an even larger degree of (fiscal) integration of the Euro-Area member countries although this process was initially not intended. While the chosen measures might have been necessary to stabilize financial markets in the short-run he argues that it is inevitable to return to a substantial and democratically legitimized process of European integration. Without such a process European institutions and especially the European Central Bank would hardly be able to (re-)gain the necessary trust of Europe's citizens.

The third paper is authored by Thilo Liebig and Sebastian Wider. This paper is concerned with the regulatory framework with special emphasis on systemically important financial institutions (SIFIs). The authors argue that there is an increased need of quantitative indicators measuring systemic importance of banks. Based on a set of indicators Liebig and Wider argue that the systemic importance of large German banks has somewhat declined over the last 4 years. However, this development is not the result of new policies directly addressing the too-important-to-fail-problem but likely due to the difficult economic environment so that it is too early to judge the newly introduced regulations.

Nikolay Nenovsky and Momtchil Karpuzanov discuss how the institutional framework in Europe in general affects the convergence aims of the European Union and whether it makes the region vulnerable to shocks and crises. Their main

hypothesis is that Europe factually tends to disintegrate due to the fact that European member countries are on quite different stages of integration and differ enormously in their speeds of development. The authors argue this to lead to centrifugal processes within the European Union. As a consequence of the illusionary impression of a safety-net and risk insurance the overall level of risk would be too high and unfavourably distributed among member states, thereby making the European economic system highly vulnerable.

The fifth paper, authored by Andreas Bühn and Daniel Kraaijeveld van Hemert, focuses on the role of tax havens. The authors argue that tax havens are exposed to increased risk of financial collapse and liquidity crises and that this risk increases in the amount of profits shifted to them. Moreover, the authors argue on the basis of available data that tax havens are especially prone to illegal activities such as money laundering. Finally the authors present an analysis of multinational corporations' decisions to export profits to tax havens, taking into account both the risk of tax haven default and the corporate tax rates in high tax countries. Based on the theoretical results the authors derive proposals how financial stability can be increased in the presence of tax havens.

The following articles focus on risks of financial crises and defaults instead of the role of institutional issues.

The sixth paper, authored by Ephraim Clark and Radu Tunaru, may help to zoom out our maybe somewhat narrow view on current events by studying the development of geopolitical and crises risk over the past decades. Using Bayesian Hierarchical and Markov-Chain Monte-Carlo modelling techniques the authors show that the average arrival rate of crises and geopolitical events is about one per year, but arrival rates are non symmetrical and vary over time. Interestingly enough, Clark and Tunaru also find that there is a statistically significant, negative time trend in the arrival rate, which suggests that geopolitical risk is decreasing in the course of time.

A closer inspection of historical financial crises shows that many crises show features of banking, currency and debt crises at the same time. Thus, the relation between different types of crises was picked up in the recent theoretical and empirical literature. Dominik Maltritz discusses a theoretical approach to model this relation in a stochastic and dynamic framework based on stochastic differential equations and compound option theory. This approach especially makes it possible to consider the influence of uncertainty about the amount of the government is able and willing to spend (for crisis avoidance) on crisis risk. In addition, the influence of countries' indebtedness, and in particular the debt's maturity on crisis risk can be analyzed. It is shown that uncertainty increases crisis risk in most situations. The risk of a financial crisis is higher with (higher) outstanding debt repayments. A shorter maturity of debt also tends to increase crisis risk.

One of the most important questions in the current discussion about the European Debt Crisis is whether the Eurozone will survive in its current shape or not. Stefan Eichler analyzes empirically how this drop-out risk is related to the Euro exchange rate. More precisely, he studies whether foreign exchange market investors perceive the risk that vulnerable countries could leave the European Monetary Union. He finds that the Euro typically depreciates against the

U.S. Dollar when the incentive for vulnerable countries to leave the European Monetary Union increases, i.e. because of a rising sovereign default risk or an increasing risk of banking crises.

The following contribution, authored by Christian Hott, is concerned with the usually applied methods of evaluating market risk, which is necessary to calculate the capital requirements of financial intermediaries. Typically Value at Risk models are employed for this purpose. However, Hott argues that this type of model delivers highly pro-cyclical results, i.e. indicates low risks when prices go up and high risk when prices go down. As a result, capital requirements are rather low at the peak of an asset price bubble, right before the losses occur. In addition, the pro-cyclicality of regulation provides an incentive for banks to buy assets when prices go up and to sell them when prices go down, thereby amplifying price fluctuations. Against this background the analysis of Hott delivers two important contributions. First, he evaluates minimum standards for Value at Risk that should help to reduce its weaknesses. Second, he develops a capital add-on for market risk that is, in contrast to Value at Risk, linked to economic fundamentals.

In the last contribution to this book, Michael Graff analyzes one of the most influential economic theories, the quantity theory of money. He discusses to which extent the quantity theory can be applied today, especially in the light of the Worldwide Financial Crisis, and whether it has still potential to explain monetary policy. Although the measures taken to deal with the recent crises have led to a spectacular increase in the stock of money, no inflation can be observed, as it is predicted by the quantity theory. This leads to important questions: Is inflation in the pipeline, inevitably to emerge soon or later, as the critics of 'monetary easing' keep claiming? Does the failure of inflation to materialise finally falsify the quantity theory? The contribution tackles these questions by firstly highlighting the most important characteristics of the latest economic slump. Then, an empirical analysis drawing on data on 109 countries from 1991 to the present confirms that the theory still has predictive power: Excess money growth is a significant predictor of inflation although the classical proportionality theorem does not hold.

Altogether, this edited volume provides many interesting insights into the recent financial turmoil and the factors which contributed to the developments. It includes many interesting discussions and approaches to current issues on financial crises and sovereign defaults, the reduction of risk and the improvement of institutions. We therefore hope that this book will contribute to further developing the discussion on necessary regulatory measures and a reform of institutions, thereby hopefully contributing to Krugman's mission that "the lessons we learn from this crisis will help us avoid, or at least cope better, with the next one."

Gold-Backed Sovereign Bonds: An Effective Alternative to OMTs

Ansgar Belke

Abstract

This paper argues that using gold as collateral for highly distressed bonds would bring great benefits to the euro area in terms of reduced financing costs and bridge-financing. It is mindful of the legal issues that this will raise and that such a suggestion will be highly controversial. However, a necessary condition is that the European System of Central Banks (ESCB) has agreed to the temporary transfer of the national central bank's gold to a debt agency in full independence. This debt agency passes the gold along, in strict compliance with the prohibition of monetary debt financing. The paper also explains that gold has been used as collateral in the past and how a gold-backed bond might work and how it could lower yields in the context of the euro crisis. This move is then compared to the ECB's now terminated Securities Market Programme (SMP) and its recently announced Outright Monetary Transactions (OMTs). Namely, a central bank using its balance sheet to lower yields of highly distressed countries where the monetary policy transmission mechanism is no longer working. Beyond some similarities between the moves, the specific benefits of using gold in this manner vis-à-vis the SMP and the OMTs are highlighted. For instance, there is by and large no transfer of credit risk between high risk/low risk countries, losses are borne by specific countries and not by the largest shareholders of the ECB, it would turn out to be more transparent, it would not be inflationary and would foster reforms.

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1 Introduction

The European Central Bank (ECB) opened up its third round of secondary bond market purchases on 6 September 2012. Whether they deliver a permanent reduction in bond yields in the South is highly uncertain. If the ECB's latest sovereign bond purchase programme consisting of Outright Monetary Operations (OMTs) fails, then Europe's options look grim. Austerity and growth programmes have not met expectations and the outlook is further clouded by the fact that the funds available from the IMF and EFSF/ESM are dwindling as a result of other bailouts. Europe is running out of time and options.

Remember that already the now terminated predecessor of the OMTs, the Securities Market Programme (SMP) has always been a controversial option, riddled with potential dangers. It is seen by many as a de facto fiscal transfer from the North to the South and, moreover, a transfer made without democratic consent. By showing willingness to buy the debt of poorly performing countries, the SMP was seen as reducing incentives for necessary long-term reforms. In addition, although the ECB tries to *'sterilise'* these transactions, this is far from an exact science, leaving a risk of higher money supply fuelling inflation (Belke 2013a).

An alternative device to lower yields might be to *issue securitized government debt*, for example, *with gold reserves*. This could achieve the same objectives as the ECB's bond purchases programmes, but without the associated shortcomings. This would clearly raise legal issues but then so too did the ESM, SMP and OMT. This would not work for all countries but would for some of those in most need. In fact, Italy and Portugal have gold reserves of 24 % and 30 % of their 2-year funding requirements. Using a portion of those reserves as leveraged collateral would allow those countries to lower their costs of borrowing significantly.

Employing the national central banks' gold reserves is much more transparent than the SMP, much fairer, and would make it easier to get genuine consent amongst the euro area population and the European Parliament. Nor does it lead to unmanageable fiscal transfers from the North to the South with huge disincentive effects. It does not shift toxic debt instruments onto the ECB. And it does not cause sterilisation problems or increase the difficulty of exiting unconventional monetary policy. Simply speaking, a gold-based solution is much less inflation-prone and does not reduce incentives for the reform of beneficiary countries.

The paper proceeds as follows. Section 2 looks at the problems underlying the current escalating crisis which essentially represent the trigger for the active involvement of the ECB in euro area rescue activities. It is stressed that the breakdown of the monetary transmission mechanism has exacerbated the problem which is mirrored by the ECB's sovereign debt market and LTRO activity. The issue of gold is brought into the debate in Sect. 3. For this purpose, the value of Europe's gold reserves is outlined. Moreover, it is explained that gold has been used as collateral already in the past. The main focus in Sect. 4 is on an explanation of how a gold-backed bond might work and how it could lower yields. We deal with some of the legal issues involved in Sect. 5.

Finally, the move towards a gold-backing of selected euro area sovereign bonds is compared to the SMP and the OMT in Sect. 6. Both programmes relate to a central bank using its balance sheet to lower yields of highly distressed countries where the monetary policy transmission mechanism is no longer working. Similarities and differences between the two moves are highlighted. Many benefits of using gold in this manner vis-à-vis the SMP and the OMT are derived from as, for instance, the absence of any transfer of credit risk between high risk/low risk countries, the fact that losses are borne by specific countries and not the largest shareholder of the ECB (i.e. Germany), and, finally, that it would not be inflationary.

2 Breakdown of the Monetary Policy Transmission Mechanism?

The sovereign debt crisis is eroding long standing assumptions around sovereign debt risk. In developed markets, the rising burden of public debt combined with low economic growth is raising concerns around the long-term ability of some euro area sovereigns to repay.

For some countries, the credit spread in their cost of debt financing has increased significantly. This pattern is said to hamper the so-called monetary policy transmission mechanism. Conversely, changes in long-term sovereign bond yields feed to a certain extent into fluctuations in corporate bond yields and bank lending rates. As a reaction to losses from significant declines in sovereign bond prices, consumers tend to enhance their precautionary savings, which in turn work against the intended stimulus to private consumption from monetary policy easing (Cœuré 2012; ECB 2012).

In addition, sovereign bonds are these days exposed to severe haircuts and will be more so, for instance, in the case of Portugal (in addition to Greece and Cyprus) in the future and, as a consequence, their refinancing capacity has become smaller. At the same time, however, the volume of available collateral in the shape of government bonds has become smaller which has curtailed the refinancing opportunities of commercial banks. The price corrections of sovereign debt also exerted an immediate negative effect on the assets on the banks' balance sheets and, hence, on the risks markets attach to them. This works against the refinancing needs of commercial banks and loans they grant to small and medium-sized enterprises in the troubled euro area countries. What is more, it has the potential to work out as a significant impediment to the provision of loans to the real sector of the economy (Cœuré 2012; ECB 2012).

Undoubtedly, the *ECB's LTRO* facility has helped to address the liquidity crisis for weaker banks. However, it *does not directly address sovereign solvency issues*. The LTRO facility allows banks to post sovereign debt as collateral to get access to cheap ECB funding. Banks in Portugal, Ireland, Italy, Greece and Spain had a 70 % share, i.e. EUR 350 bn of the first EUR 500 bn LTRO. However, the risk of default remains with the banks (Belke 2012a). Sovereign debt still remains on the balance sheet of banks. And there is a collateral top-up requirement if the bonds pledged fall in value or default.

This scenario has prompted the ECB to introduce controversial non-conventional monetary policy tools, such as its Outright Monetary Transactions Programme (OMT) and its predecessor, the Securities Market Programme (SMP). For a deeper assessment of the status quo: the now terminated Securities Market Programme (SMP) and its successor, the Outright Monetary Transactions (OMT) Programme, see in detail Belke (2012d, 2013a).

3 Securing Europe's Debt with Gold

It is by now clear that even in 2013 the euro area will stay under significant stress.[1] However, it is not at all clear whether the ECB or the euro area governments will de facto be able to act properly to choke market fears and bring down (allegedly) overly high government borrowing costs. As unease builds, it may be time to explore new ideas to cut interest rates.

Gold backing of new sovereign debt would be a new idea in that context. At least, it is common knowledge that a few countries which are the most affected by the euro crisis, i.e. Portugal and Italy, hold large stocks of gold. In aggregate, the euro area holds 10,792 tonnes of gold, that is 6.5 % of all the yellow metal that has ever been mined, and worth some $590 bn (Farchy 2011).

These deliberations were the trigger for some to propose that not only the financially distressed governments should *sell* some of their gold (see, for instance, Prodi and Quadrio Curzio 2011). Over the last couple of years, the value of gold has soared until a couple of months ago – and the price level is still relatively high according to historical standards, with again upward potential after its significant fall over the last months. And a popular view is, if there were ever a suitable time that euro area member countries are in need of an unanticipated windfall gain – for instance, to pay interest on their sovereign bonds – it would have been a couple of months ago (Farchy 2011; Pleven 2011).

We feel legitimized to argue that this would have been a mistake. For quite apart from the fact that a massive dump of gold would have dampened its price even further, the euro area debt woes are now so large such that *gold sales would only scratch the surface of the problem* (Alcidi et al. 2010). This is because the gold holdings of the financially distressed euro area countries (Greece, Ireland, Italy, Portugal and Spain) would account for only 3.3 % of their central governments' total outstanding debt.

Instead, euro area member countries should *securitise part of that gold* through issuing sovereign bonds backed by gold. The latter could be enacted in a rather simple way. But one could also structure it to contain tranches of different risks. The main point in both variants is that gold would serve to provide sovereign bonds

[1] This assessment has been supported by a recent analysis conducted by the German Institute for Economic Research (DIW); see Fichtner et al. (2012).

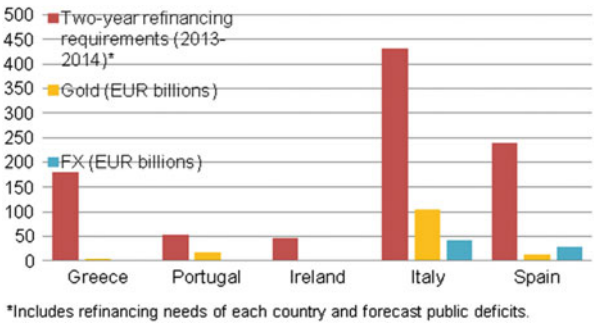

Fig. 1 Refinancing requirements and reserves

with further safeness – and thus comfort investors who do not give credence to euro area government balance sheets any more.

3.1 Significance and Materiality of Gold Reserves

Let us start from the overall realistic presumption that using gold as collateral would *not work for all countries but would do so for some* of those in most need. France and Germany hold significant reserves but enjoy low unsecured borrowing costs. Greece, Ireland and Spain, on the other hand, do not hold enough gold for it to be a viable solution Italy and Portugal, however, hold gold reserves of 24 % and 30 % of their 2-year funding requirements and could have a material impact of their debt servicing costs (Fig. 1).

3.2 Historical Record of Gold as Collateral

Collateral schemes have been utilized before on quite a few occasions. In the 1970s, for instance, Italy and Portugal employed their gold reserves as collateral to loans (i.e., direct loans not bonds) from the Bundesbank, the Bank for International Settlements and other institutions like the Swiss National Bank. Italy, for instance, received a $2 bn bail-out from the Bundesbank in 1974 and put up its gold as collateral.[2] More recently, in 1991, India applied its gold as collateral for a loan with the Bank of Japan and others. And in 2008, Sweden's Riksbank used its gold to raise some cash and provide additional liquidity to the Scandinavian banking system (Belke 2012e; Farchy 2011; World Gold Council 2012).

Paul Mercier (2009), at that time deputy director of market operations at the ECB, mirrors historical experiences as follows: *"In a generalised crisis that leads to the repudiation of foreign debts or even the international isolation of a country [. . .] gold remains the ultimate and global means of payment that is still accepted and it is one of the reasons used by some central banks to justify gold holdings."*

[2] However, the resulting interest rate reductions were not made public in both cases.

In his words, countries have in history headed towards their gold reserves only in their toughest situations. What is more, lenders are most probably requiring that this gold is transported to a neutral location. Gold-backed bonds could help in some respects but would not be a full and all-comprising solution. Questions arise, for instance, over the unintended impact on unsecured debt yields. There is scant evidence that the idea has received any significant support from policy makers up to now. Even if euro area political leaders accepted the idea in the end, significant legal obstacles would loom on the horizon most notably connected with the fact that a large share of the gold is held by central banks and not by treasuries (Farchy 2011; Tett 2012). Nonetheless, the concept of gold-backed bonds certainly is worth a closer discussion.

But it appeared rather "old-fashioned to ever suggest that any investor would claim gold as collateral" only a decade ago; "in the era of cyber finance, securities such as treasury bonds tended to rule" (Tett 2012). However, over the past few months, groups like LCH.Clearnet, ICE and the Chicago Mercantile Exchange have to an increasing extent begun to accept gold as collateral for margin requirements for derivatives trades (World Gold Council 2012). In addition, in summer 2012 the Basel Committee on Banking Supervision issued a working paper in which it suggested that gold should be one of six items to be employed as collateral for margin requirements for non-centrally cleared derivatives trades, joint with assets such as treasury bonds (Basle Committee on Banking Supervision 2012).

What is more, Curzio (2012) acknowledges that when Romano Prodi suggested in 2007 that Italy should use its gold reserve to pay the debt, the reaction was negative. The Italian Finance Minister in 2009 wanted to tax gold and the European Central Bank opposed the idea. Curzio concludes that Italy at the moment has little resources to invest in growth and should consider asking Germany or any other Asian sovereign fund for a loan with its gold reserve as collateral. Rather, Curzio and Prodi suggest using gold reserves as collateral for a bond.[3]

Accordingly, Giuseppe Vegas, Chairman of Consob recently suggested a treasury fund with the rating of *'Triple A'* collaterized by the jewels of the state namely the shares of ENI, ENEL, buildings, gold reserves and currency as an instrument to reduce the interest payment on the government debt.[4]

All this amounts to a picture which suggests that a creeping change of attitudes is going on. This evolution takes place less in terms of the desirability of gold per se, but more through the growing riskiness and undesirability of other allegedly "safe" assets like sovereign bonds. This pattern will probably not reverse soon. This is so especially because markets long waited to see what the ECB might really do after September 6th and, after this date, whether Spain would be the first case for outright market operations a couple of weeks later in October 2012 (Rees 2012; Tett 2012).

[3] See: http://www.firstonline.info/a/2012/09/11/alberto-quadrio-curzio-usare-loro-come-collaterale/4097075e-c2ac-4bd4-9567-0d6877d3a1e0

[4] See: Corriere della Sera, 26 June 2012, http://www.corriere.it/economia/12_giugno_26/fondo-immobili-societa-quotate-bot-vegas_31aeeb20-bfa8-11e1-8089-c2ba404235e2.shtml

4 The Yield Reduction of Gold-Backed Debt: First Estimates

Sovereign yield analysis does not typically consider gold reserves are in during normal conditions (in history, default has often been triggered with reserves intact); so the chosen bond structure would need to offer *very explicit risk reduction* to benefit from lower risk spread. Sovereigns have historically sought to retain their gold to assist recovery, and thus often default on debt obligations rather than sell down reserves. Examples from the past are Argentina and Russia.

We now deliver evidence that gold backing of sovereign debt reduces the annual yield, thus supporting the monetary transmission mechanism. Clearly, the functioning of the monetary policy transmission mechanism could be improved in the short-run since the yields on government bonds – as a key reference point for other interest rates – fall significantly because of sharply falling risk premia of gold-backed bonds. In the case of Portugal, for instance, this would make up for several percentage points on 5-year bonds. The *hedge* that the gold would provide against a default as an example of an extreme event would surely attract investors such as emerging market governments and sovereign wealth funds. If a country such as Portugal or even Italy were to default, the price of gold, especially if it is denominated in euro would sky-rocket (Baur and Lucey 2010; Saidi and Scacciavillani 2010; Farchy 2011).

We take the following approach to show this for the example of Portugal (see Table 1). For this purpose, we develop a top-down model to quantify the change in yield when sovereign debt is backed by gold. The credit risk characteristics of bonds/debt are typically driven by three main factors: the *probability of default* (PD), the *expected unsecured recovery rate* in the event of default and the *collateral/guarantee recovery* in the event of default. The yield rate is modeled as: (*risk free rate*) + (*risk premium*) with the risk premium as a proxy for the compensation for the credit risk of the asset and calculated as *PD**(*1-total recovery rate*). Financial stress on a sovereign leads to increase in its bond yields as the severity of the crisis translates into an increase in risk free rate, an increase in the probability of default and a decrease in expected recovery rate in the event of default. In the following, we give an illustrative analysis of the issues.

The main logic behind the calculations runs as follows. Starting with the analysis of *unsecured* debt, we begin with the estimated annual yield of unsecured debt. In this example we are looking at a 5 or 6 year bond, so have taken as a starting point a hypothetical distressed yield of 10 % (assumption 1). Then look at an equivalent CDS rate to calculate an annual probability of default (assumption 2). Next calculate the recovery in the event of a default. Historically this has been 30–80 %, so take 50 % (assumption 4). Total recovery in the case of unsecured debt is then 50 %. A check of the calibration of the calculations delivers the following: the total recovery equals 50 %; the annual likelihood of default is 16 %, therefore the risk premium amounts to 8 % (= (100–50) times 0.16). Adding this to the risk-free rate of 2 % equals a 10 % yield.

We now consider the case of *secured debt* and compare it to unsecured debt, using a similar calculation logic. Next take the Euro risk free rate, which is

Table 1 Yield differential of gold-backed sovereign bonds: the case of Portugal

Parameters	Stress unsecured sovereign bond (%)	Gold backed facility @ 33 % collateral (%)	Gold backed facility @ 50 % collateral (%)
a. Gold secured portion	0	33	50
b. Estimated annual yield	10.0[1]	6.00	5.00
c. Risk free rate	2.00	2.00	2.00
d. Risk premium e * (1 − f)	8.00	4.00	3.00
e. Annual probability of default	16[2]	12[3]	12[3]
f. Total recovery after collateral (1 − a) * g + (a * h)		66.70	75.00
g. Expected unsecured recovery	50[4]	50	50
h. Gold collateral recovery (approx.)		100	100

Assumptions:
[1]Standalone unsecured yield as per example from a 5Y Portugal bond yield
[2]As per 5Y CDS value
[3]Estimate a 25 % PD reduction in a gold backed structure
[4]Sovereign default recoveries historically 30–80 % (depends on debt size and bargaining power) – 50 % conservative average assumed

conservatively taken as 2 % (looking at German 2 year yields for example). The risk of default is assumed to be 25 % lower due to the incentive of losing gold collateral and now amounts to 12 % (assumption 3). Assume now that total recovery in the event of default is increased due to the partial gold backing. Calculate the overall recovery rate using the assumption of 100 % recovery of the gold element and of a 50 % recovery of the rest in the partially collateralised structure. Calculate the risk premium by multiplying the probability of default by the loss given default (1 – recovery rate). Add the risk premium to risk-free rate to obtain the estimated annual yield.

Table 1 essentially deals with a Portuguese example bond which is 33 % and 50 % collateralised by gold. This obviously implies that it only collateralises part of its 2–year needs. If the example should be one whereby all its bonds are collateralized, the percent collateral backing will be needed to be reduced, to something below 30 %. If one takes exactly 30 %, the total recovery after collateral is 0.35 (i.e. (1–0.3) times 0.5) and the risk premium amounts to 4.2 % (i.e. 0.35 times 12 %). The estimated annual yield then is 6.2 %.

In principle, the *calibrated* sovereign bond yield reductions could be compared to the econometrically estimated effects of the SMP. Due to the recent character and limited time range of the SMP, empirical investigations of its effectiveness are still rare. Kilponen et al. (2012) investigate the impact of an array of different euro area

rescue policies on the sovereign bond yield spreads, but only through dummy variables coded as one on the day of announcing the respective measure. Hence, they do not test for a permanent impact of SMP measures. They find a significant effect of SMP announcement. Steinkamp and Westermann (2012) make use of a SMP variable as a control variable in an estimation equation – however, with an insignificant result.

5 Legal Hurdles and Practicalities

It should be recognised that there are legal and political considerations, as there were with the SMP.[5]

Reserve ownership is the first critical issue. In most countries, gold reserves are held and managed by central banks rather than governments. Specifically, in the euro area, gold reserves are managed by the Eurosystem which includes all member states' central banks and the ECB (Treaty on the Functioning of the European Union, Article 127, and Protocol on the Statute of the European System of Central Banks (ESCB) and of the ECB, Article 12).

C*entral bank independence* represents the second issue. National central banks must remain independent of governments in pursuit of their primary objective of price stability. The EU treaty expressly prohibits direct financing of governments by central banks. One should be mindful of the legal issues that this will raise and that such a suggestion will be highly controversial. It is specifically likely to raise questions as to whether or not this represents a breach of the prohibition on monetary financing. National central banks must remain independent of governments in pursuit of their primary objective of price stability (EU Treaty, Article 130). What is more, the EU treaty expressly prohibits direct monetary financing of governments by central banks (EU Treaty, Article 123).

The third issue relates to the *limited potential* of *gold reserve sales*. There exist longstanding gold sale limits which are valid until 2014 that could potentially limit collateral transfers and would need to be addressed. The Eurosystem central banks are currently signatories to the 3rd Central Bank Gold Agreement (CBGA) which restricts net sales of gold reserves to 400 tonnes p.a. combined.[6] A number of other major holders – including the US, Japan, Australia and the IMF – have announced at other times that they would abide by the agreement or would not sell gold in the same period. Hence, the CBGA agreement could serve as a constraint on the size of potential gold reserve transfers until 2014, as it commits signatories to collectively sell no more than 400 tonnes of gold p.a. between September 2009–2014. Gold collateral could be interpreted as outside the scope of the CBGA or the maturity of

[5] For this section see also World Gold Council: http://www.gold.org/government_affairs/new_financial_architecture/gold_and_the_eurozone_crisis/ and Belke (2012e).

[6] See: http://www.ecb.int/press/pr/date/2009/html/pr090807.en.html

the bonds could be staggered in order to limit the amount of gold coming onto the market in the event of a default.

Undoubtedly, there are *important legal issues* that clearly need to be addressed, but that was *also the case at least to the same extent as with the ESM, SMP and OMT*. European legislation may need to be amended to accommodate a gold pledge for sovereign debt. This could be done by elaborating an amendment to the Treaty which establishes pledged gold as segregated from Eurosystem central banks and other national banks (for details see, for instance, Smits 2012).

6 Gold-Backed Bonds Versus SMP/OMT

The outcome of the most recent Italian elections, the Cypriot haircut combined with a dramatic decline of countries like Italy and Greece on the World Bank's governance indicators have, among other recent events, vividly demonstrated that in the absence of a mechanism to manage an orderly sovereign default, adjustment programmes lack credibility and the balance sheet of the ECB is put at risk. *Only sovereign funds* (including gold-backed sovereign bonds) tend to reveal the *true opportunity costs* to the initiators. However, if one chooses the way through the ECB and the printing press, the *opportunity costs* of adjustment programmes *wrongly* appear to be close to *zero*.[7] This is especially so if (as in the current case of the SMP) these programmes are *not transparent* enough.

6.1 Discouraging Results from Bond Purchasing Programmes: A Case for Gold-Backed Bonds

The addiction of Italian, Spanish and French commercial banks on financing through the ECB is currently still significantly higher than usual. The bigger this share gets, the more demanding it will be for Southern euro area banks to tap other ways of financing, especially with an eye on the fact that the ECB enjoys a de facto preferred creditor status. Finally, emancipating the banks from ECB funding may turn out to be more and more complicated. As in July 2012 alone, deposits of approximately EUR 75 bn left Spain and partly landed in Germany (where the money supply is by now increasing more strongly), it is clear that we have to deal with a huge dimension of capital flight from the South which is funded by the ECB money printing press (Belke 2012c). Later on, after the announcement of the OMT programme by Draghi (2012) in September 2012, sovereign bond yields in Southern euro area member countries went down. However, this must not necessarily be

[7] This opportunity cost argument is also a counter-argument against those arguing that the ECB does not risk to suffer in financial terms from holding sovereign bonds because the ECB could agree to get repaid far in the future, say in 20 years or so, if the respective country really goes bankrupt. See Belke and Polleit (2010).

interpreted as a sign of sustainable recovery. On the contrary even: because you have toxic debt instruments on board of the ECB, there is a huge degree of path dependence: in order to defend the value of the ever riskier assets o nits own balance sheets, the ECB is forced to stand ready with ever larger bazookas – and the ECB is very credible in defending its own fate. For investors such as Goldman Sachs, Blackrock and other Hedge Funds in London's Westend it is thus a quite safe bet to invest in the financially distressed euro area member countries' bonds for the time being. In other words, the probability is very high that in the months to come there will be *silence on the sovereign bond yield front* – but for the *wrong reasons*. Moreover, it will almost certainly be combined with financial repression and fiscal dominance (Belke 2013a).

Given this background, it is clear that the bazookas and even ECB government bond purchases cannot be expected to reduce the borrowing cost of its government in a systematic fashion – rather the opposite (Belke 2013a). If anything, they put downward pressure on the euro and favor the euro area core and exporting country, Germany. This adds to the steadily increasing lack of structural convergence in the euro area. Persistently high bond yields lead to a divergence and fragmentation of the euro area member states. Going through a continuation of its policy to flood the economy with money, the ECB risks that any specific monetary policy measure will no longer have a uniform effect on all euro area economies. If the impression among outside investors grows that the current stance of monetary policy is easing the pressure for reform in the problem countries too greatly and the euro zone fragments slowly thereby, their departure from the euro zone as a whole would become a true risk (Belke 2012b).

Quite soon, but in any case after the Germen federal elections in autumn/winter 2013 secondary market purchases by the EFSF/ESM might be deemed necessary, in order to substitute foreign investors (which currently flee abroad for structural reasons), for instance, in Spanish government debt securities.

In this vein, it might turn out after some weeks that the complementary ECB measures announced on September 6th will not deliver a permanent reduction in bond yields in the South. Then, at the latest, *one should look for a "last resort" solution*, since the supply of alternative options looks to be exhausted because all austerity and growth programmes do not meet the expectations. Additionally, international support from the IMF, the EFSF and other institutions usually granted to troubled economies and preferred over gold-backed issuance is stretched as a result of other bailouts (Bundesbank 2012).

Going for *gold-backed sovereign debt* would, however, be one obvious *alternative*. Despite all current denials, the point in time may have come to use valuable and fungible assets such as gold to provide the Southern countries with temporary, but crucial in the current crisis of confidence, bridge-financing heading towards a complete long-term solution. To be more explicit here, such a proposal does not address the gold-backing of euro or stability bonds whose usefulness is conceded by

the EU Commission only in the very long perspective.[8] Nor is it directly related to the recent debt redemption funds proposal by the German Council of Economic Advisors according to which the EFSF and later also the ESM firepower should ultimately be increased by a gold coverage of bonds.[9]

According to Sect. 3.2, Gold has been already used in the 1970s by Portugal and Italy to raise loans from the Bundesbank and the Bank for International Settlements (BIS). More recently, India managed to take a gold-backed loan from Japan. Gold prices tend to move counter-cyclically, which is likely to reinforce its stabilizing effect in the current situation of financial stress. We do explicitly not propose to simply raise revenue from any short-term selling of the gold reserves, as recently agreed by Cyprus.[10] That would only drive down the price of gold (Alcidi et al. 2010; Pleven 2011; World Gold Council 2012). Moreover, it would represent a clear breach of the prohibition of monetary financing public debt. Finally, gold sales simply raise additional revenues to finance the public budget which allows new expenditures and would be counter-productive because they would lead to even higher indebtedness. In contrast, gold-backing of sovereign bonds exerts disciplinary effects on the budget since the government does not want to get rid of its gold pledge.

Let us now compare the move to gold-backed bonds to the ECB's SMP and OMT programmes according to which the central bank uses its balance sheet to lower yields of highly distressed countries where the monetary policy transmission mechanism is no longer working. We also outline similarities between the two moves.

[8] The European Commission (2011), p. 9, proposes in its Green Paper "on the feasibility of introducing Stability Bonds" that "... Stability Bonds could be partially collateralised (e.g. using cash, gold, shares of public companies etc.)". See also Farchy (2011). Prodi and Curzio (2011) argue that further innovation is necessary with a European Financial Fund (EFF) that issues EuroUnionBonds (EuBs). According to their proposal, euro area member States confer capital to the EFF proportionally to their stakes in the ECB. The capital should be constituted by gold reserves of the European System of Central Banks. Gold could be placed as collateral.

[9] See German Council of Economic Advisors (2011): "To this end, each country participating must guarantee 20 % o*f its loan by pleadi*ng currency reserves (gold or foreign exchange holdings)". The Telegraph mentions in this context that Southern Europe's debtor states must pledge their gold reserves and national treasure as collateral under a €2.3 trillion stabilisation plan gaining momentum in Germany. See http://www.telegraph.co.uk/finance/financialcrisis/9298180/Europes-debtors-must-pawn-their-gold-for-Eurobond-Redemption.html.

[10] The gleaming bars in the vaults of the Greek central bank are worth $5.8 billion. If Athens were to sell that gold, the Greek state would theoretically be able to meet at least part of the debt payments due soon without any outside help. See http://www.time.com/time/world/article/0,8599,2080813,00.html#ixzz27U4AE3Uw. For the Cypriot case see Terazono et al. (2013).

6.2 Comparison of Gold-Backed Bonds with the Bond Purchasing Programmes

Using gold as collateral through gold-backed bonds are consistent with the logic underlying the SMP and the OMTs and achieves similar outcomes. It is available to the ESCB on its balance sheet and is under the independent control of the Governing Council. It would significantly lower yields in malfunctioning markets, thus re-opening the monetary transmission mechanism.

However, it is superior to the SMP and OMT with respect to a wide array of criteria. Admittedly, it could be argued at first glance that the transfer of gold reserves to say a debt issuing agency which in turn will serve investors would be in breach of the prohibition of monetary financing of government debt. But gold is not directly sold to euro area governments and, hence, cannot without further ado be viewed as a fiscal transfer between the central bank and the government.

Any closer analysis of this issue has to take into account that our proposal leads to a change of items on the asset side of the ESCB, i.e. an exchange of gold against claims of the debt agency. But whereas gold is a pledge and thus automatically returns onto the ESCB's balance sheet, the purchased sovereign bonds have in the end to be sold actively by the ESCB. (Note also that, for the same reason, a gold-backed bond very much like a covered bond is much more attractive for risk-averse private investors.) This makes significant and permanent fiscal transfers under bond purchasing programmes even more likely. However, it would clearly be preferable to a revival of the ECB bond-buying programme SMP in the shape of the OMT, which shares the same inherent flaw.

Employing the national central banks' gold reserves is much more transparent, being an important argument vis-à-vis the euro area population and also the European Parliament which traditionally lays much emphasis on transparency of EU governance. It does not necessarily lead to unmanageable and disincentivising fiscal transfers from the North to the South (Belke 2013a). Hence, gold-backed bonds do not imply significant transfers of credit risk between high risk/low risk countries. Potential losses are on closer inspection borne by specific countries and not by the largest shareholder of ECB and main guarantor of the rescue funds (i.e. Germany). This in turn reduces the probability of a downgrading of Germany and its final step-out from the funds and, thus, makes the ESM firewall more sustainable. This adds to the benefit of gold-backed bonds that also Italy and Portugal would become even stronger guarantors of the ESM.

From a general equilibrium point of view it could be argued theoretically that gold constitutes an asset accruing to the economy as a whole. To pledge it, then means to take it away from debt covered by unsecured bonds or even from the debt of the private sector. A "two-tier market" would emerge: consisting of gold-backed bonds and less attractive uncovered bonds. In that way, the effect of gold-backed bonds might net out. What is more, the introduction of gold-backed bonds might have an impact on the balance sheet of the ESCB through exactly this channel – in

combination with a potential impact on the distribution of seigniorage.[11] However, under gold-backed bonds you bring in something new to the equation with an asset that was not previously used. An investor holding unsecured debt should not automatically assume that he has recourse to compensation in the form of gold should there be a default on the unsecured bond.

Even better, the implementation of gold-backed bonds does not shift toxic debt instruments on board the ECB as is the case with respect to the OMTs for which the Governing Council of the ECB has decided on September 6th, 2012, to suspend the application of the minimum credit rating threshold for central government assets as collateral. On the contrary, gold serves as high-value collateral.

It also does not lead to any sterilization problem and growing problems of exiting unconventional monetary policy which make the SMP path-dependent and nearly irreversible in the short- to medium run which contradicts any bridge-financing character. Simply speaking, a gold-based solution would be less inflation-prone. Those arguing that the gold-backing solution would decouple the money supply and hard currency potentially leading to hyperinflation neglect the current non-role of gold for backing a currency.[12] But above all, the use of gold as collateral avoids or at least lessens in importance the reduction of incentives for reform in the beneficiary countries under the SMP and the OMT. The reason is that lacking fiscal discipline or reform effort of a eurozone member country puts its gold reserves at risk and gold thus delivers the best incentive structure. What is more, gold-backing of bonds strictly follows the above mentioned principle that only sovereign funds tend to reveal the true opportunity costs to the initiators.

We argued earlier that the ESCB can *attach conditions to its gold transfer* such as the implementation of structural reforms. The move would not only fix the monetary policy transmission mechanism but also provide the time to implement the necessary reforms.

The main message can be coined as follows. First, a gold-backed bond could be justified in the same manner as the SMP and the OMT. Second, a gold-backed bond would not have the intrinsic disadvantages of the SMP and/or the OMT: there is no immediate fiscal transfer, no risk of an inflation tax and it should increase incentives for structural reform and not reduce those. Hence, also countries like Cyprus should think about gold-backing their sovereign bonds instead of selling their gold in order to make sure some sound bridge-financing.

Gold prices have found themselves in a multi-year rally for which easy global monetary policies have been credited quite frequently. And it has turned out in the meantime that the recent decrease in the gold price since midst-of April has been caused on the one hand exactly by growing concerns that Cyprus would be forced to

[11] This argument is well-known from the discussion about the net benefits from the introduction of Eurobonds and from the preferred creditor status or seniority in the case of government insolvency (Modigliani-Miller theorem). I owe this insight to Daniel Gros.

[12] Instead, potential costs would admittedly arise, if the gold pledge would get lost in case of government insolvency and would lack as a backing of the new currency in the case of a eurozone exit of the specific country.

sell gold from its reserves and, thus, potentially mirrors a stronger monetarisation of gold reserves.

Both the recovery of the US currency and US growth forecasts have contributed to the recent fall in the gold price. Gold has been running up in the recent weeks against redemptions by large exchange-traded funds – such as that led by George Soros who significantly profited also from the recent announcement of nearly unlimited quantitative easing by the Bank of Japan – which have been investing in the metal. But note that at the same time central banks and especially small and private investors not only in India and Turkey have invested in gold to an increasing extent.

Referring to the first argument, it is important to note that Cypriot sales volumes are expected to amount to about 10 tonnes but the initial announcement raised some fears that other euro area member countries may feel inclined to sell their gold reserves to shore up their finances (Belke 2013b). So the general assessment prevailing on the markets is that "gold should remain in demand as an alternative currency against the backdrop of a possible devaluation race between currencies" or even a currency war (Shellock 2013; Belke 2013c).

In addition, an increasing number of central banks interprets falling gold prices as an opportunity to increase their gold reserves. And central banks such as the Central Bank of South Korea emphasise that the recent fall in the gold price is no source of concern because gold positions are part of their long-run strategy of diversifying its currency reserves (Handelsblatt 2013). Exactly this aspect should make gold investments attractive for investors in general: not only the absolute movements in the price of gold are important but its development *in comparison to* other asset prices such as stock prices.

In history, the incredible increase in gold prices took place independent on the development of stock returns. Gold has thus contributed to a lower volatility exposure of portfolios and thus clearly served as an insurance and stabilizing mechanism. In this context, it is also important to note that gold has preserved its purchasing power, which may well be volatile in the short run, in the medium to long-run. With an eye on the historical experiences with any paper money standard as well as on the current crisis, it seems highly advisable to include gold in any portfolio – because not only the loss of the money's purchasing power is emanating but there also savers risk to be expropriated as shown by the case of the Cyprus rescue.

In addition, inflation expectations in the euro area are characterised by the stylised fact that a decreasing number of forecasters expect a rate slightly below 2 %, the ECB's target rate. Instead, both the likelihood that inflation may take values beyond 2.5 % and the probability of inflation rates below 1.5 % have increased substantially (Lamla and Sturm 2012; EEAG 2013). Hence, there is absolutely no necessity to follow those anticipating deflationary momentum only because there is a short- to medium-run buckle in the gold price development.

Given this background, this contribution feels legitimized to adopt the expectations of numerous analysts who see the long-term trend into gold as a crisis and inflation-proof save haven as unabated. Particularly since the exit from

unconventional monetary policies turns out increasingly difficult due to the lack of interaction among the world's leading central banks.

What is more, Portugal finds itself in an increasingly dramatic economic downturn and Italy is suffering from declining credibility due to institutional insufficiencies such as quality of government and the rule-of-law. In this scenario, reputational gains by issuing gold-backed bonds appear to be increasingly desirable. Also gold-backed bonds represent a beneficial way out of the controversially debated gold sales in the context of the Troika agreement (Belke 2013b).

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Trust in the European Central Bank Throughout the Worldwide Financial Crisis and the European Debt Crisis

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Abstract

In this paper we use three cross-sections of the Eurobarometer Survey to study how European citizens' trust in the European Central Bank evolved throughout the Worldwide Financial Crisis and the European Debt Crisis. Employing the results of a logit-estimation-approach we show that both crises contributed to a significant decline in trust in the European Central Bank even after controlling for the inferior macroeconomic circumstances in consequence of the crises. We also show that the effects of the two crises on trust in the European Central Bank differ considerably in the member countries of the European (Monetary) Union.

1 Introduction

A principal-agent problem is a situation where one actor (the principal) delegates some of his power to another actor (the agent) to fulfill a certain task.[1] Typically, the basic reasoning behind the delegation is a reduction of transaction costs (resulting from informational asymmetries) or a way of tying one's own hands. While the act of delegation is driven by the expectation that the agent will act in a way which is consistent with the preferences of the principal, the agent might use its informational advantage to pursue his own goals. In order to pretend moral hazard problems, which might occur in this setting, the principal typically monitors the behavior of the agent. Within this process the agent typically reports to the principal (in certain intervals) and explains on request why certain actions have been undertaken. Whenever the principal is unsatisfied with the way the agent pursues his task, he has the option to fire him.

[1] See e.g. Calvert et al. (1989).

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An often helpful way of illustrating the relationship between citizens and governmental institutions is to think of this relationship as an principal-agent problem with the citizens being the principals and governmental institutions fulfilling the role of agents. However, the exact relationship between citizens and certain governmental institutions differs from case to case. A very special case is typically the role of a state's central bank. First, the relationship between citizens and central banks is typically a two-stage principal-agent-relationship. On the first stage citizens delegate the power to conduct monetary policy to the government. On the second stage the government delegates this power further to the central bank. While such a two-stage principal-agent relationship often accrues with governmental institutions, a specialty of central banks is that these are very often granted high degrees of independence from the government. While the degrees of central bank independence vary considerably from country to country, over the last decades many countries have increased their levels of central bank independence.[2] In their survey of the literature Eijffinger and de Haan (1996) mention three reasons for granting central banks independence from the government. First, governments tend to have a preference for "easy money" since monetary tightening tends to worsen the budget. Independent central banks can withstand the pressure to conduct a loose monetary policy much easier. Second, there is an inter-relation between monetary and fiscal policy. Whenever fiscal policy is dominant, money supply becomes endogenous whenever the public is not willing to absorb additional debt. An independent central bank will be perceived as much tighter opponent of fiscal policy as a dependent one.[3] Third, independent central banks might be part of the solution of the time-inconsistency problem of monetary policy.[4] However, making a central bank independent from its direct and its indirect principal (the government and the citizens) reduces the possibilities to monitor the agent (the central bank) and is often perceived as a severe democratic deficit.

In the light of this setting it is obvious that central banks urgently need public trust. Without this trust, a central bank will hardly succeed in reaching its tasks. As an example, low trust in the central bank to achieve low inflation will likely end in high inflation expectations. In order to avoid a severe economic downturn a central bank then might feel forced to conduct a loose monetary policy, thereby justifying high inflation expectations, which further erodes the trust in the capabilities of the central bank. Finally, a severe and lasting loss in public trust might end up in a reform of monetary institutions.[5]

Due to the fact that the European Central Bank is a supranational institution, its democratic deficit is even larger as in the case of national central banks. The fact that the European Central Bank is typically judged to be among the most independent central banks of the world further indicates that its need of trust in the member

[2] See e.g. Polillo and Guillén (2005).

[3] Sargent and Wallace (1981).

[4] Kydland and Prescott (1977), Barro and Gordon (1983) and Rogoff (1985).

[5] For a similar line of argument see Ehrmann et al. (2012).

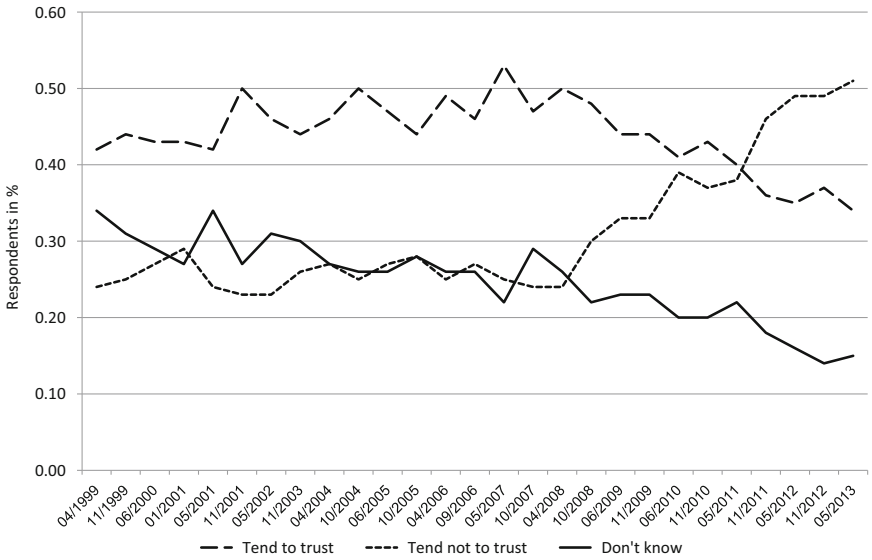

Fig. 1 Trust and distrust in the European Central Bank (EU Member Countries)

countries is highly important. Moreover, the European Central Bank is a comparatively young institution which cannot look back on a long history of success and obviously needs time in order to gain trust among the citizens of the European Union. In order to monitor the trust in its institutions, the European Commission regularly conducts surveys on the citizens attitudes towards the attitudes of Europe's citizens. Since 1999 the bi-annually conducted Eurobarometer Survey also includes a question on the citizens' trust in the European Central Bank. In the survey, the respondents are asked the following question: "For each of the following European bodies, please tell me if you tend to trust it or not to trust it." The respondents can choose from the following three answers: "Tend to trust", "Tend not to trust" and "Don't know". In Fig. 1 we show how the respondents (aggregate of all EU member countries) answered to the question in the period since the European Central Bank took over responsibility for monetary policy. The displayed lines indicate that, although fluctuating to some extent, the share of respondents tending to trust or distrust the European Central Bank were quite stable until the end of 2007. While on average 64 % of the answering respondents expressed their trust in the European Central Bank in this period, only 34 % declared their distrust.

However, since then, trust in the European Central Bank started declining. In the period of 2008–2013 on average only 52 % declared to trust the European Central Bank while the remaining 48 % answered to distrust it. A number of empirical studies have argued that the decline of trust in the European Central Bank since 2008 is somewhat related to the recent financial crises,[6] namely the Subprime Crisis and the European Debt Crisis.

[6] See e.g. Drometer (2011), Roth (2009), Roth et al. (2012), Ehrmann et al. (2012) and Wälti (2012).

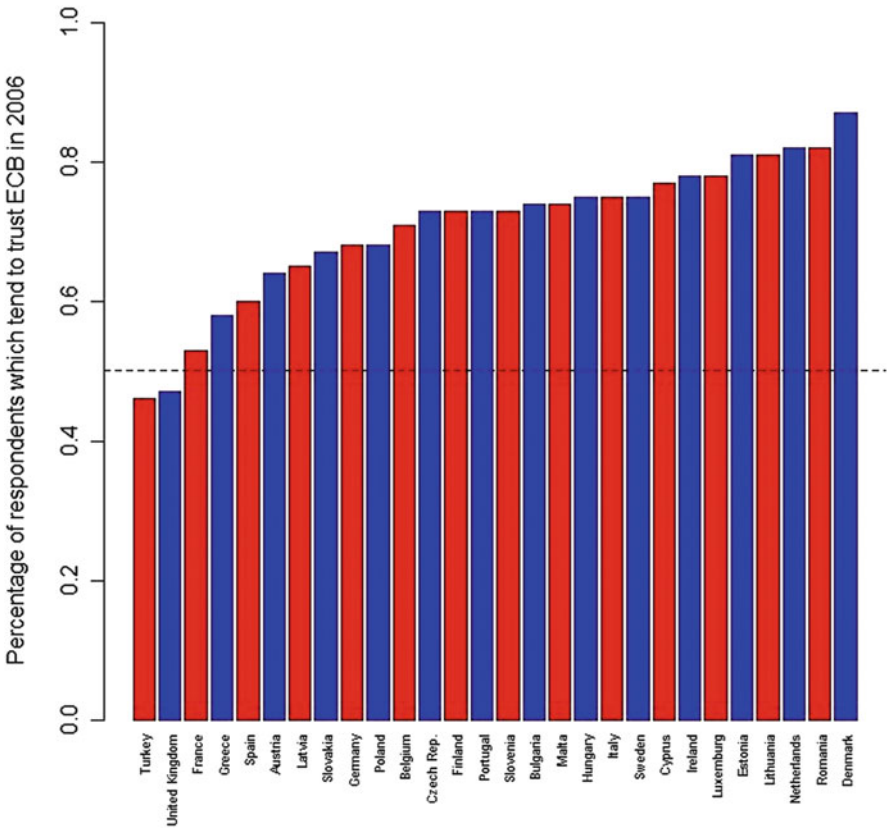

Fig. 2 Trust in the European Central Bank 2006, Eurobarometer Survey eb65

While it is quite likely that the two financial crises had an influence on the perception of the European Central Bank, aggregate data mask the quite different levels of trust in the European countries. As Fig. 2 reveals, the levels of trust in the European Central Bank already differed considerably before the two financial crises occurred. While in 2006 in almost all EU and EU accession countries (with the exception of Turkey and the United Kingdom) net trust was larger than 50 %, there was already a good deal of variation in average trust of the populations in Europe. While more than 80 % of the Danish population tended to trust the European Central Bank in 2006, e.g. the French were considerably more pessimistic in their evaluation.

Six years later, the general level of trust in the European central bank is much lower (see Fig. 3). Interestingly enough, European citizens' evaluations of the European Central Bank are nowadays much more diverse than in 2006. While the Danish population is still trusting the European Central Bank to a large extent, the Greek and the Spanish populations are now highly sceptic. While initially the literature considered the decision to enter the European Monetary Union as

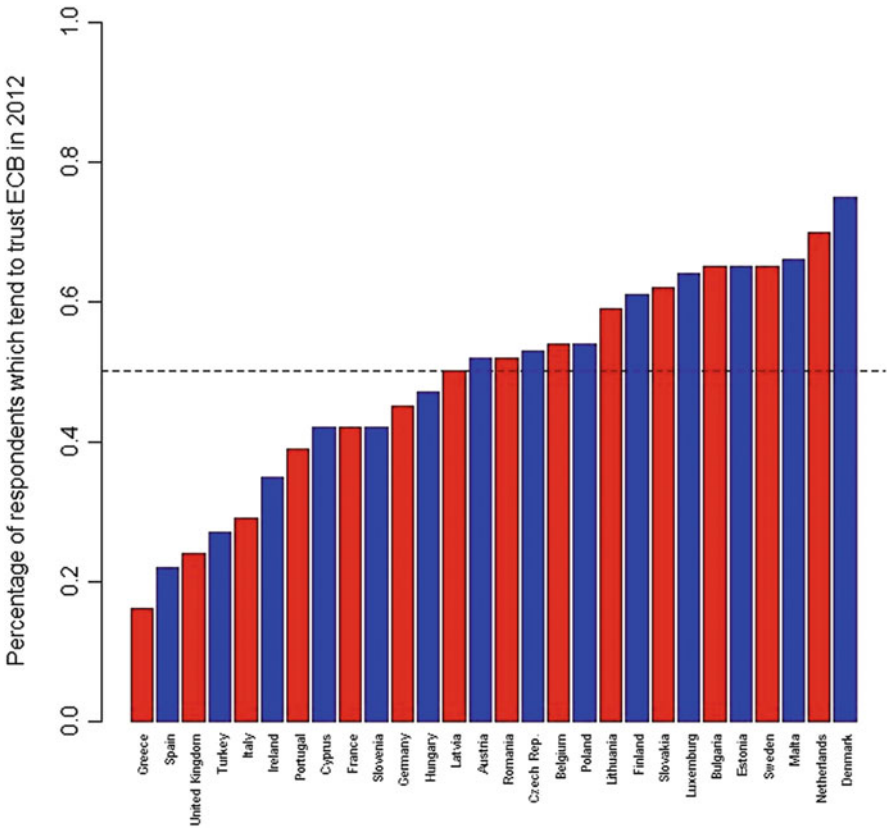

Fig. 3 Trust in the European Central Bank 2012, Eurobarometer Survey eb77

irrevocable, recently various authors have argued that sovereign states have the option to withdraw from the Euro (see e.g. Eichengreen 2007).

Financial crises might influence trust in the European Central Bank in two different ways. First, financial crises are typically causing deep macroeconomic recessions. As it has shown by Stevenson and Wolfers (2011), the trust in governmental institutions is linked to the macroeconomic circumstances. Thus, the loss of trust in the European Central Bank might be the result of the economic recession in consequence of the Worldwide Financial Crisis and/or the European Debt Crisis. Second, it is well possible that trust in the European Central Bank eroded as a consequence of the impression that the European Central Bank's performance in preventing and/or managing the recent financial crises was bad. While the Worldwide Financial Crisis evolved in the United States and made its way through the international financial system, the European Debt Crisis is more or less a European phenomenon. Moreover, the two crises differ in their degree of asymmetry. While

the Subprime Crisis had a rather symmetric effect on most European countries, the European Debt Crisis is highly asymmetric in both causes and consequences.[7]

In this paper we aim at studying the effects of the two recent financial crises on the trust in the European Central Bank. In line with the existing literature we base our empirical analysis on the Eurobarometer Survey. In order to study the effects of the two recent financial crises on trust in the European Central Bank we use micro-data from three Eurobarometer waves: the first wave of interviews was conducted in the pre-crisis time (2006), the second one after the Worldwide Financial Crisis evolved (2009) and the third one after the European Debt Crisis unravelled (2012). After combining the micro-data with data describing the macroeconomic circumstances in the referring regions we estimate a common model describing trust in the European Central Bank. We then use the estimated model to generate predictions of the average level of trust a certain country should exhibit, given its micro-structure and its macro-conditions. We then interpret deviations of the factual level of trust from the predicted level as measures of country-specific trust in the European Central Bank.

We find that on average both crises, the Worldwide Financial Crisis and the European Debt Crisis led to a decrease of trust in the European Central Bank, even after controlling for country specific micro-structures and macroeconomic conditions. However, the loss of trust throughout the European Debt Crisis is double in size of the one in consequence of the Worldwide Financial Crisis. We also find a wide diversity of reactions to the two crises in the member countries of the European Union.

The paper is organized as follows. Section 2 delivers a review of the related literature. Section 3 describes the empirical approach and introduces the employed data. Section 4 presents and discusses the estimation results. Finally, Sect. 5 concludes.

2 Review of the Related Literature

To the best of our knowledge, the few existing empirical studies of the determinants of trust in the European Central Bank all base on data from the Eurobarometer Survey, conducted twice a year by the European Commission. One question in the survey asks whether the respondent tends to trust the ECB or not. The answer to this question is then used as proxy for trust in the European Central Bank. The existing empirical studies can be subdivided into two groups: those employing an aggregate measure of the respondents in a country and those which make use of the micro-data.[8]

[7] For a comparison of the differences between the Subprime Crisis and the European Debt Crisis see e.g. Lane (2012).

[8] There are also some studies which focus on the trust or the desirability of the Euro, see e.g. Banducci et al. (2003). However, we skip this literature from this survey because of comparability reasons (see also Ehrmann et al. (2012) for a discussion of the comparability of the attitudes towards the European Central Bank and the Euro).

The first group of studies uses a measure of aggregate trust in the ECB as explanatory variable.[9] This strand of the literature consists of papers by Fischer and Hahn (2008), Roth (2009), Wälti (2012) and Roth et al. (2012). While the paper by Fischer and Hahn (2008) is not concerned with financial crises, the studies by Roth (2009), Roth et al. (2012) and by Wälti (2012) directly focus on the effect of the Subprime Crisis and the European Debt Crisis on the trust of Europe's citizens in the European Central Bank.

The early paper by Fischer and Hahn (2008) studies the trust of the citizens of 12 EU countries in the ECB throughout the start-up phase from 1999 to 2004 and is thus not concerned with the effects of financial crises. Fischer and Hahn (2008) find a strong and significant negative impact of inflation and a positive influence of economic growth on trust in the ECB. While unemployment turns out to have no significant effect, unemployment spending tends to increase and active labor market policies tend to decrease trust in the ECB.

The first empirical paper concerned with the effects of the worldwide crisis on trust in the European Central Bank was published by Roth (2009). In a purely descriptive analysis he shows that the upcoming crisis quickly eroded trust in the European Central Bank in those 12 countries which adopted the Euro quite early.

Wälti (2012) studies the period of 1999–2010 and covers the same 12 countries as Roth (2009). He controls for the macroeconomic circumstances by including inflation, unemployment and growth of industrial production into his regression equation. In addition to that he studies whether sovereign bonds yields and the development of stock, banking and financial market indices explain the trust in the European Central Bank. While macroeconomic variables in general turn out to have little (inflation) or no (unemployment, growth of industrial production) explanatory power, Wälti (2012) finds rising government bond yields to decrease the trust in the European Central Bank. Moreover, he finds the financial index return to be positively related to trust, a finding he interprets as an indication that financial distress is trust-decreasing.

Roth et al. (2012) focus again on the same 12-country-sample but concentrate on the three control variables inflation, unemployment and economic growth. The authors consider the period of 1999–2011 and study whether the determinants of trust in the European Central Bank changed throughout crisis-times. Roth et al. (2012) find that trust in the European Central Bank was solely depending on economic growth in the pre-crisis time whereas trust depended on inflation and unemployment throughout the crisis.

The second group of studies consists of papers employing the micro-data of the Eurobarometer Survey. This group consists of papers by Kaltenthaler et al. (2010), Farvaque et al. (2012), Arnold et al. (2012) and Ehrmann et al. (2012).

[9] The various employed measures differ to some extent. While e.g. Fischer and Hahn (2008) use the share of respondents answering they tend to trust the ECB in all respondents as measure, Wälti (2012) excludes those respondents answering that they do not know from the measure by using net trust.

Motivated by the observation that trust in the European Central Bank tended to erode in the course of time, Kaltenthaler et al. (2010) study which factors can explain this development. The authors are especially interested in three (partially competing) hypotheses: (1) European citizens might feel that European institutions (such as the ECB) do not articulate the citizens interests in an adequate manner, (2) information on the role of these institutions are becoming worse and (3) citizens judge the performance of European institutions in an egocentric manner. Besides employing a number of socio-demographic control variables such as age, gender, marital status, employment status, home region, religious belief and political orientation, Kaltenthaler et al. (2010) include a number of variables as proxies for the three described hypotheses in their analysis of the spring 2006 Eurobarometer wave. While the authors find supporting evidence for the first two hypotheses, the results deliver little empirical evidence in support of the egocentric perspective as the respondents tend to orientate their answers more on the economic situation of Europe as a whole rather than the one in their country of residence.

Farvaque et al. (2012) are primarily interested in the socio-demographic factors of those people tending to trust the European Central Bank. They base their study on micro-data from the Eurobarometer Survey for the period of 1999–2011. The authors find education and income to raise trust in the ECB. The same holds true for people with optimistic expectations on the economic situation and those with comparatively conservative political orientation.

The study by Arnold et al. (2012) studies the determinants of trust in various institutions of the European Union, among them the European Central Bank. Although the study uses Eurobarometer data for 2005–2010 (for all EU member states) it is not explicitly concerned with the effects of financial crises. Arnold et al. (2012) find respondents trusting their national institutions also have a higher probability of trusting the European Central Bank. However, respondents from countries with higher levels of corruption tend to have less trust in the European Central Bank. Moreover, respondents judging EU-membership to be beneficial for their countries also tend to have more trust in the European Central Bank. The same holds true for respondents with higher interest in politics, respondents which turned out to be satisfied with democracy and with life in general. Political orientation remains without important effect on trust in the European Central Bank. Among the socio-demographic factors gender, age, education and occupation turn out to have significant effects on trust. While female and elderly respondents turn out to have less trust, an occupation has a positive effect. Higher educated individuals, somewhat surprisingly, turn out to have less trust in the European Central Bank. It also comes as a surprise that the authors do not find a decreasing time trend in the employed data, thereby indicating that the financial crisis did not directly affect trust in the institutions of the European Union.

Ehrmann et al. (2012) directly focus on the effects of the global financial crisis on trust in the European Central Bank. Their sample period covers 1999–2010 and thus mainly excludes the European Debt Crisis. The authors aim at gaining empirical evidence towards three, not necessarily exclusive hypotheses on the reasons for the downturn in trust in the European Central Bank. According to the Economy

Hypothesis, the central bank is held responsible for the economic contraction in consequence of the crisis. The Europe Hypothesis argues that the crisis in general showed that the institutions of the European Union – and thus also the European Central Bank – are incapable of solving global economic problems. According to the Banks Hypothesis Europe's citizens either see the European Central Bank as a bank itself, (falsely) blame it for not using supervisory or regulatory responsibilities or interpreting the European Central Bank's policy as some sort of inappropriate bail-out of the banking system. The empirical results presented by Ehrmann et al. (2012) point into the direction that all three hypotheses to some extent explain the trust pattern of the European Central Bank. Different from Roth et al. (2012) the authors argue that there is little reason to believe that the way how economic agents form trust in the European Central Bank has changed throughout the Subprime Crisis.

3 Empirical Approach and Data

Our empirical approach basically consists of three major steps, which shall be explained in the following in the necessary detail.

In the first step we basically conduct a microeconometric analysis of individual answers to the Eurobarometer Survey. We employ three cross-sections of micro-data from the survey. The first of the three waves (eb65) was conducted in May 2006 and thus well before the Subprime Crisis unfolded. The second wave dates back to June 2009 (eb71) and was thus conducted after the Subprime Crisis occurred but before the European Debt Crisis unraveled. The third wave we employ is the May issue of the 2012 survey (eb77). We include all EU and EU accession countries into our analysis for which data for all three waves are available.

Our microeconometric analysis concentrates on explaining which factors determine a respondent's answer on the earlier described question whether he or she tends to trust the European Central Bank or not. As it is usual in the literature we neglect the "Don't know" answers, leaving us with a dummy variable which is coded as "1" whenever the respondents answers to trust the European Central Bank and "0" otherwise. As our explanatory thus has the character of a dummy variable we use a logit estimation approach in our empirical analysis.[10]

As control variables we use a number of socio-demographic factors. The choice of our micro-control-variables is based on the earlier summarized previous empirical literature and restricted by data-availability. More precisely, we control for gender (dummy for female respondents) and age (in years). We also control for the occupational status of the respondents by including a number of dummy variables (with house-persons as control group): students, unemployed persons, retirees,

[10] We repeated the whole analysis using a probit approach. The results, which are available upon request from the authors, remain unaffected by doing so.

self-employed persons, managers, persons with other white-collar jobs and manual workers.

Besides using the micro-control-variables we also control for the macroeconomic circumstances at the time when the surveys were conducted. Following the previous literature we add the prevailing inflation rate, the unemployment rate and the rate of real GDP growth to the regression equation. All referring data was extracted from the Eurostat Database.

When conducting our logit-regression we pool the data from all sample countries and all sample years. Since the error-terms from the same sample country and the same year will be correlated, we estimate the model with clustered standard errors.

In the second step of our analysis we use the estimated coefficients to generate predictions. For every sample country and all three sample years we calculate probability of an average respondent to trust the European Central Bank. The predicted values indicate the levels of trust which can be explained by the composition of micro-factors of the population and the prevailing macroeconomic circumstances.

In the third and final step we compare the predicted values with the factual values for the sample countries and years. We argue that the "residual" can be interpreted as a measure of excess trust (or distrust) of the population of the referring sample country in the European Central Bank. We then study how the residual evolves as a consequence of the two financial crises.

4 Estimation Results Determinants of Trust in ECB

In Table 1 we report the results of the described pooled logit-regression. Female respondents turn out to have significantly less trust in the European Central Bank as male respondents, a finding which is in line with most previous findings. The age variable is insignificant.[11] Age thus seems not to play a decisive role in explaining trust in the European Central Bank. This finding is supported by the fact that the dummy variable for retired persons also turns out to be insignificant.[12] Students turn out to have significantly more trust in the European Central Bank than the reference group. This result is in line with the finding in earlier studies that highly educated individuals tend to have more trust in the European Central Bank. Similarly, self-employed people, managers and holders of other white-collar jobs are significantly more trustful as the reference group. Manual workers and unemployed persons tend to have significantly lower trust in the European Central Bank.

[11] We also experimented with a linear-quadratic variant of the age variable. However, the results remained insignificant.

[12] In order to rule out that multicollinearity is the reason why both age-related variables perform badly in explaining trust in the European Central Bank we repeated the estimation without one of the two variables. However, in none of the specifications these variables became significant.

Table 1 Estimation results pooled logit-regression

Variable	Coefficient	Standard deviation	Z-Score	P(Z > |Z|)
Intercept	1.205	0.189	6.369	0.000
Female (dummy)	−0.193	0.018	−10.617	0.000
Age (in years)	0.001	0.001	0.739	0.460
Student (dummy)	0.418	0.050	8.346	0.000
Unemployed (dummy)	−0.310	0.046	−6.719	0.000
Retired (dummy)	0.024	0.040	0.591	0.554
Self-employed (dummy)	0.231	0.045	5.068	0.000
Manager (dummy)	0.556	0.044	12.677	0.000
Other white-collar job (dummy)	0.174	0.039	4.488	0.000
Manual worker (dummy)	−0.167	0.041	−4.027	0.000
Inflation rate (in %)	−0.059	0.036	−1.646	0.100
Unemployment rate (in %)	−0.074	0.017	−4.446	0.000
Real GDP growth (in %)	0.034	0.014	2.432	0.015
AIC	78,403			
Nagelkerke's R-Square	0.150			
LR-test	7.470			
p-value LR-test	0.000			
Observations	63,129			

Interestingly enough, the coefficients of all three macroeconomic variables turn out to be significant, at least on the 90 %-confidence-level, and exhibit reasonable signs. Inflation tends to depress trust in the European Central Bank. In the light of the fact that our regression contains more than sixty thousand observations one might feel tempted to argue that a 90 %-confidence-level is inappropriately low. However, due to the fact that we estimate our regression with clustered standard errors we only have a very low degree of variation in the macro-variables (28 sample countries per survey). Thus it is appropriate to use lower confidence-levels for the macroeconomic control variables. Higher unemployment rates also decrease trust in the European Central Bank while higher real growth rates of GDP have the opposite effect.

According to Nagelkerke's Pseudo R-Square the explanatory power of the regression is quite satisfactory. A Lagrange-Multiplier-Test indicates that the estimated model is superior to a model including only a constant.

Table 2 reports the marginal effects for the explanatory variables. Since the marginal effects depend on the level of the explanatory variables we evaluate them at the example of an imaginary individual. This imaginary individual is a male home-person in the age of the average respondent to the survey, i.e. 47.7 years. For the three macroeconomic variables we impute the average values in the whole sample (inflation rate: 2.6 %, unemployment rate: 9.2 %, real GDP growth: −0.2 %).

Among the dummy variables, the dummy for students and managers have the strongest positive effects. Working in the function of a manager increases the

Table 2 Marginal effects

Variable	Coeff.	Marginal effect	Marginal effect * Δ	Ref. value	Δ
Female (dummy)	−0.193	−0.047	−0.047	0	1.0
Age (in years)	0.001	0.000	0.003	47.7	18.2
Student (dummy)	0.418	0.101	0.101	0	1.0
Unemployed (dummy)	−0.310	−0.075	−0.075	0	1.0
Retired (dummy)	0.024	0.006	0.006	0	1.0
Self-employed (dummy)	0.231	0.056	0.056	0	1.0
Manager (dummy)	0.556	0.134	0.134	0	1.0
Other white-collar job (dummy)	0.174	0.042	0.042	0	1.0
Manual worker (dummy)	−0.167	−0.040	−0.040	0	1.0
Inflation (in %)	−0.059	−0.014	−0.028	2.6	2.0
Unemployment rate (in %)	−0.074	−0.018	−0.073	9.2	4.1
Real GDP growth (in %)	0.034	0.008	0.044	−0.2	5.4

probability to trust the European Central Bank by 13.4 percentage points. Similarly, being a student increases the probability to express trust in the European Central Bank by 10.1 percentage points. Being unemployed decreases the probability to trust the European Central Bank by 7.5 percentage points.

Within the group of macroeconomic variables, inflation turns out to have the smallest effect on trust in the European Central Bank. An increase of inflation by one standard deviation (i.e. 2.0 percentage points) decreases the probability to trust by 2.8 % age points. The marginal effect of an increase in the growth rate by one standard deviation (i.e. 5.4 percentage points) increases the probability to express trust in the European Central Bank by 4.4 percentage points. However, the strongest effect is resulting from increases in the unemployment rate. An increase of the unemployment rate of 4.1 percentage points (one standard deviation) results in a decrease of the probability to trust the European Central Bank of 7.3 percentage points.

5 Simulation Results

In order to study how the two financial crises affected the underlying level of trust in the European Central Bank we use the estimation results from the previous section to construct a measure of excess trust for three different points in time: before the two crises evolved (2006), after the Subprime Crisis started (2009) and after the European Debt Crisis unfolded (2012). In order to do so we use the estimated coefficients to generate predictions of average trust in the European Central Bank on the country-level. More precisely, we generate the prediction by calculating the probability that an average citizen of a country will answer to tend to

trust the European Central Bank, given the macroeconomic circumstances prevailing at that time in the referring country.

We then calculate the difference between factual and predicted trust (i.e. excessive trust) in the European Central Bank. Whenever the difference turns out to be positive, the average citizen of a country turns out to be overly trustful. In this case more citizens declare to trust the European Central Bank as it can be explained by the citizens micro-attributes and the prevailing macroeconomic situation. Whenever excessive trust turns out to be negative, the citizens of a country are overly suspicious about the European Central Bank.

5.1 Trust in the ECB Before the Crises (2006)

We start out with the situation well before the Subprime and the European Debt Crises started. In Fig. 4 we show excess trust in the European Central Bank in 2006. In most of the sample countries we find a positive value for excess trust. Interestingly enough, 7 out of the 9 countries with the highest excess trust in the European Central Bank are East-European transformation countries. Romania (19 %) and Bulgaria (17 %) exhibited the highest levels of excess trust, followed by Denmark (14 %), Hungary (13 %), Poland (12 %), Slovakia (12 %), Estonia (11 %), Lithuania (11 %), Poland (11 %) and Malta (10 %). In all these countries the level of excess trust is at least 10 %, indicating that the number of individuals tending to trust the European Central Bank is 10 percentage points larger than predicted by the regression model.

The intermediate group of countries with somewhat lower but still positive levels of excessive trust consists of Italy (9 %), the Netherlands (9 %), Belgium (8 %), Ireland (7 %), Luxemburg (7 %), Cyprus (6 %), Germany (6 %), Sweden (5 %), Finland (4 %), the Czech Republic (3 %) and Slovenia (2 %).

In only 7 sample countries, excessive trust turns out to be negative in 2006. We find slightly negative values for Spain (−1 %), Latvia (−1 %) and Greece (−5 %). In Austria (−8 %), Turkey (−9 %) and France (−11 %), excessive trust exceeds −5 %. However, we detect the by far lowest level of excessive trust in the United Kingdom (−21 %) where the predicted level of trust exceeds the factual level by more than 20 percentage points. As the citizens of the United Kingdom are well-known to be quite sceptic on the European Union and especially the European Monetary Union, the latter finding is not too surprising.

One might suspect that excess trust in the European Central Bank is related to the indebtedness of the referring countries. However, as of 2006 public debt was not perceived as a major problem in Europe. As Lane (2012) argues, the Euro Area and the United States shared a similar debt dynamics until 2007. Nevertheless, at the country level, the Euro Area member countries differed to quite some extent. Even within the group of the so-called GIPS-countries (Greece, Italy, Ireland, Portugal, Spain) there were remarkable differences in the accumulation of public debt. Italy and Greece had debt-to-GDP ratios of more than 90 % since the early 1990s. Similarly, Ireland had a 90 % debt-to-GDP ratio in the early 1990s. However,

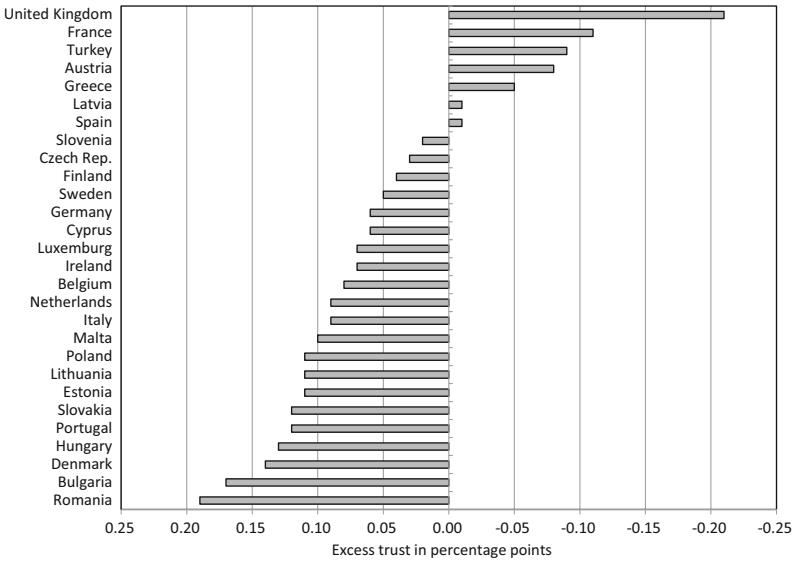

Fig. 4 Excess trust in the European Central Bank 2006

due to the enormous growth rates of GDP Ireland managed to decrease this ratio below 30 % in 2006. Spain and Portugal never exceeded the 60 % debt-to-GDP ratio before 2006. However, although there was quite some variation in the debt-to-GDP ratios among the member countries of the European Union and the Euro Area, the correlation coefficient of −0.27 (European Union) respectively −0.22 (Euro Area) indicates that there was little relation between indebtedness and excess trust in the European Central Bank,

5.2 Trust in the ECB After the Worldwide Financial Crisis (2009)

The next cross section of data, we consider here, dates back to spring 2009. At that time, large parts of the world experienced a deep economic crisis. The crisis initially evolved in the United States and, later on, resulted in the Worldwide Financial Crisis of 2007–2009.[13] Before the crisis evolved, the housing market in the United States experienced a huge boom. This boom was triggered by very high leverages in the U.S. housing market (Geanakoplos 2010) and comparatively low interest rates, possibly accompanied by irrational exuberance.[14] In general,

[13] For a summary of the Worldwide Financial Crisis see Mishkin (2011).

[14] Various studies argued that the developments in the U.S. housing market have to be qualified as a bubble rather than a boom. In line with Shiller (2007), the empirical studies by Ferreira and Gyourko (2011) and Berlemann et al. (2012) argue that the bubble started developing as early as in the late 1990s. Other studies, such as Dreger and Kholodilin (2011) and Phillips and Yu (2011) date the beginning of the boom/bubble to the early 2000s.

collateral rates in the U.S. were very low in the early 2000s. In the course of time these low collateral rates were more and more extended even to the subprime segment and thus allowed people with low wages and little wealth to buy houses (Mayer et al. 2009), thereby driving house prices up and up. House prices finally peaked in mid 2006. At that time the first scaring news about increasing homeowner delinquencies spread into the market (see Geanakoplos 2010). As a consequence, collateral rates were increased slightly and house prices fell by 1.8 % in the second half of 2006. Early in 2007 the reports for delinquencies further worsened and caused strong price drops of subprime bonds. As a consequence of strongly increasing required down payments on houses (Geanakoplos 2010, reports an increase of collateral rates from 3.2 % in the last quarter of 1996 to 15.9 % 1 year later) the demand for new houses almost collapsed, thereby leading to quickly falling house prices. Since the loan contracts typically included no-recourse collateral, the borrowers factually had the option to walk away from their loan contract by giving up their houses which served as collateral. As in many cases the house prices fell below the credit volumes more and more homeowners decided to make use of the exit option, leaving the borrowers with huge amounts of loss. Not surprisingly, more and more U.S. mortgage finance companies got into serious trouble.

However, the crisis on the U.S. housing market quickly spread to other countries. This was primarily due to the rapid development of the market for credit default swaps (CDS). This type of security is factually an insurance contract for a bond. Credit default swaps allowed to sell the default risk of the mortgage loans to other market participants. Banks around the globe bought this type of bonds and, as a consequence, participated in the losses created in consequence of the downturn of the U.S. market. When it became obvious that many European banks held significant amounts of subprime papers in their balance sheets, the interbank market in Europe almost dried up. Instead of investing excess liquidity in the interbank market banks started hoarding liquidity. In August 2007 the European Central Bank allowed banks in the Euro Area to draw every amount of overnight liquidity needed. The European Central Bank also provided additional refinancing operations with maturities of 3 and 6 months and changed the rules of reserve maintenance. Factually, this resulted in lengthening the maturity of outstanding operations (Eichler and Hielscher 2012). Moreover, the European Central Bank decided to carry out a number of fine-tuning operations in order to smooth money market interest rates and to provide liquidity to banks in the Euro Area with severe liquidity shortages. As Eichler and Hielscher (2012) argue, the European Central Bank factually acted as a Lender of Last Resort since summer 2007 and took over the role of the malfunctioning European interbank market.

Despite the measures taken by the European Central Bank, the European banking sector remained highly fragile. Various banks such as the German Sachsen LB had to be bailed out or completely collapsed (e.g. Northern Rock). When Lehman

Brothers collapsed in September 2008 the turmoil of financial markets finally resulted in a worldwide financial crisis. As a reaction on the crisis, the European Central Bank lowered the rate for main refinancing operations in between October 2008 and May 2009 to 1.00 % in several steps. This policy of "easy money" contributed to increasing the short-term liquidity of European banks. Moreover, the European Central Bank introduced the Enhanced Credit Support Program in October 2008, which consisted of a bunch of policy measures. The European Central Bank switched to a Fixed Rate Full Allotment Tender for all refinancing operations. In addition, the number of institutions eligible for fine-tuning operations was extended, the list of accepted securities extended and the necessary rating threshold lowered. The European Central Bank also provided more longer-term refinancing operations and supplied foreign exchange swaps.

Altogether, the interest rate policy of the European Central Bank and the Enhanced Credit Support Program contributed significantly to stabilizing the banking sector in the Euro Area throughout the year 2009. However, the program factually led to a severe increase in the European Central Bank's net lending position to the banking sector.

It is an intriguing question how the Worldwide Financial Crisis and the reaction of the European Central Bank influenced excess trust in the European Central Bank. Figure 5 visualizes the changes in excess trust in the European Central Bank for various groups of countries. With the exception of the group of south-east Euro-Area countries, excess trust in the European Central Bank decreased in between 2006 and 2009. However, on average excess trust in the European Central Bank in the sample countries was still slightly positive as of 2009. As Table 3 indicates, there is quite some variation in the reaction of the citizens to the Worldwide Financial Crisis.

In the group of the GIPS countries we find strong negative effects on excess trust in Italy (−22 %) and Portugal (−19 %) as well as in Greece (−9 %). While excess trust in the European Central Bank remained almost unchanged in Ireland (−3 %) the Spanish citizens seemed to be quite satisfied with the European Central Bank's policy measures (+13 %). One might attribute this finding to the fact that both Spain and Ireland were facing similar house price dynamics as the United States. In both countries the house price bubbles burst in 2008. And in both countries, a large number of banks were highly engaged in financing the house price boom and suffered severe losses when the bubble burst. The fact that we find no or even a positive effect of the Worldwide Financial Crisis on excess trust indicates that the citizens of Ireland and Spain tended to judge the lending of last resort transactions of the European Central Bank as adequate.

Altogether, we find quite diverse effects of the Worldwide Financial Crisis on excess trust in the European Central Bank. In seven of our sample countries (Spain, Malta, Estonia, Slovakia, Finland, Latvia and Lithuania) we find indications for increasing excess trust in the European Central Bank. In five countries (Ireland, Cyprus, Austria, Sweden and Denmark) excess trust remains almost unchanged in between 2006 and 2009. In the remaining 16 countries (Greece, Italy, Portugal, France, Slovenia, Belgium, the Netherlands, Germany, Luxemburg, the Czech

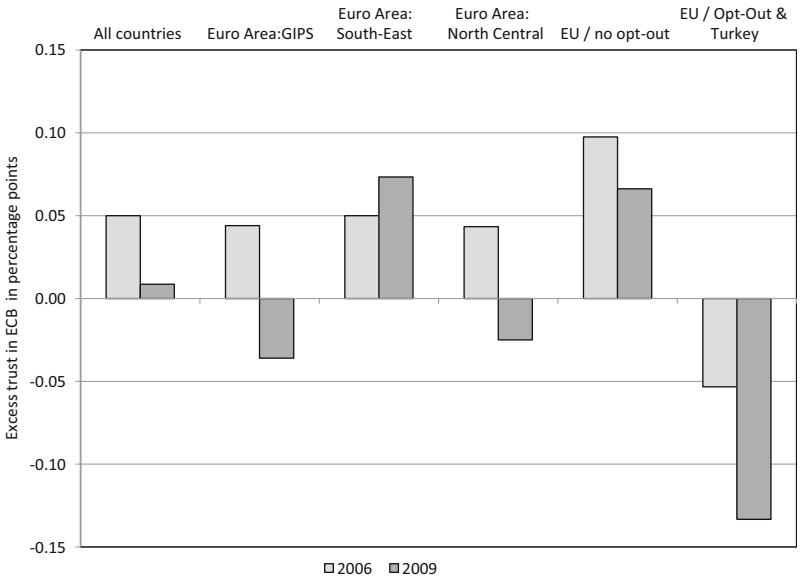

Fig. 5 Excess trust in European Central Bank before and after the Subprime Crisis

Republic, Poland, Hungary, Bulgaria, Romania, the United Kingdom and Turkey) excess trust decreased considerably.

Again we study whether the degree of excess trust in the European Central Bank is associated with the indebtedness of the referring countries. Different from 2006, we now find a comparatively strong negative correlation (−0.62) between the debt-to-GDP ratio and excess trust for the Euro-Area countries. For the member countries of the European Union the correlation coefficient is only slightly lower (−0.59).

5.3 Trust in the ECB After the European Debt Crisis (2012)

Until early in 2010, the development of European sovereign debt attracted little attention of policymakers and central bankers (Lane 2012). In the light of the fact stabilizing the banking system captured almost all political attention it is not too surprising that the accumulation of large public debt in various European countries became not a disputed issue earlier. While the Worldwide Financial Crisis itself contributed significantly to triggering the European Debt Crisis, two additional and in principle easily visible factors prepared the ground for the crisis. First, some European countries (especially Greece) lacked discipline in managing government spending and revenues (Sinn 2012). Second, various European countries such as Greece, Portugal and Italy suffered from a gradual erosion of competitiveness which led to low economic growth rates and made sovereign debt hardly sustainable (Eijffinger and Hoogduin 2012). The Worldwide Financial Crisis further

Table 3 Excess trust in European Central Bank 2006, 2009 and 2012

	2006	2009	2012	Δ(09–06)	Δ(12–09)
Euro area: GIPS countries					
Greece	−0.05	−0.14	−0.13	−0.09	0.01
Spain	−0.01	0.12	−0.07	0.13	−0.19
Ireland	0.07	0.04	−0.14	−0.03	−0.18
Italy	0.09	−0.13	−0.25	−0.22	−0.12
Portugal	0.12	−0.07	−0.02	−0.19	0.05
Euro area: South-East					
France	−0.11	−0.24	−0.16	−0.13	0.08
Slovenia	0.02	−0.03	−0.17	−0.05	−0.14
Cyprus	0.06	0.04	−0.09	−0.02	−0.13
Malta	0.10	0.16	0.03	0.06	−0.13
Estonia	0.11	0.33	0.08	0.22	−0.25
Slovakia	0.12	0.18	0.11	0.06	−0.07
Euro area: North-Central					
Austria	−0.08	−0.10	−0.17	−0.02	−0.07
Finland	0.04	0.21	0.00	0.17	−0.21
Belgium	0.08	−0.11	−0.08	−0.19	0.03
Netherlands	0.09	0.03	0.03	−0.06	0.00
Germany	0.06	−0.07	−0.23	−0.13	−0.16
Luxemburg	0.07	−0.11	−0.03	−0.18	0.08
EU member countries (no opt-out)					
Latvia	−0.01	0.19	−0.04	0.20	−0.23
Czech Rep.	0.03	−0.04	−0.09	−0.07	−0.05
Sweden	0.05	0.03	−0.02	−0.02	−0.05
Lithuania	0.11	0.29	0.05	0.18	−0.24
Poland	0.11	−0.06	−0.03	−0.17	0.03
Hungary	0.13	0.00	−0.02	−0.13	−0.02
Bulgaria	0.17	0.02	0.11	−0.15	0.09
Romania	0.19	0.10	−0.10	−0.09	−0.20
EU member countries (opt-out) & Turkey					
Denmark	0.14	0.13	0.12	−0.01	−0.01
United Kingdom	−0.21	−0.32	−0.38	−0.11	−0.06
Turkey	−0.09	−0.21	−0.26	−0.12	−0.05

contributed to making the already weak countries even more vulnerable. The Crisis almost immediately caused a deep recession in almost all European countries. As a consequence of decreasing GDP and in the light of the quickly collapsing tax revenues the debt-to-GDP-ratio worsened in many countries. Moreover, many countries offered support to their banks in order to avoid a breakdown of the financial system, thereby further weakening government budgets.

In late 2009 various European countries such as Ireland, Spain and especially Greece reported large increases in the debt-to-GDP-ratios. In early 2010 the yield

spread between Greek and German bonds started increasing. In May 2010 Greece was shut out of the bond market and received a support program by the European Union and the International Monetary Fund on the condition to implement structural reforms and fiscal stabilization programs. In November 2010 Ireland had to ask for support. Portugal followed in April 2011, Spain and Cyprus in June 2012.

Initially, the solution of the European Debt Crisis was naturally seen as a task of the governments of the members of the Euro-Area. While throughout the Worldwide Financial Crisis it was more or less uncontroversial that the European Central Bank had to act as a lender of last resort in order to stabilize the banking system it was less clear whether this was also the case in the European Debt Crisis. As outlined earlier, the European Debt Crisis evolved in countries like Greece and Portugal primarily as a consequence of mismanaged government budgets, although the crisis was finally triggered by the Worldwide Financial Crisis. It is explicitly not the task of the European Central Bank to support the governments of the member countries of the Euro-Area in financing their budgets. According to the Treaty the European Central Bank is not allowed to buy government bonds on the primary market. While it is not forbidden to buy on the secondary market until the start of the European Debt Crisis the European Central Bank had the conviction that buying government bonds on the secondary market should be strictly limited (Eijffinger and Hoogduin 2012).

When the European Debt Crisis started unfolding in May 2010 the European Central Bank had to decide on whether and how to react. When considering this decision the European Central Bank was well aware that the European Debt Crisis constituted again a severe thread to the European banking system as many European banks held significant amounts of government bonds of the countries in trouble. The discussion on the appropriate policy measures within the European Central Bank was highly controversial. The then president of the German Bundesbank Axel Weber was strongly opposing plans to buy government bonds of the crisis states. After he was overruled in this issue several times he resigned early in 2011. The German Council member Jürgen Stark was also not in favor of such a policy (Panico and Purificato 2013), neither was it Weber's successor Jens Weidmann. However, opposition to these plans not only came from Germany but also other north-European Euro-Area countries such as Finland or the Netherlands.

After an intensive discussion within the European Central Bank (and of course in the public and in academia) officials finally opted for a set of active policy measures in order to prevent a breakdown of the European banking sector. A first decision, the European Central Bank made, was to postpone an increase in the main refinancing rate, although rising inflation was expected at that time. By keeping the interest rates low, the European Central Bank significantly contributed to ensuring cheap refinancing conditions for the Euro-Area member states. While this decision was obviously not in line with the primary goal of the European Central Bank to keep inflation low, the decision was at least not against the ECB constitution. A second decision was to reintroduce a number of those policy measures, which had already been used to overcome the preceding Worldwide Financial Crisis. Among these measures was the fixed rate full allotment tender

procedure. Third and possibly most important and controversial, the European Central Bank decided to launch the Securities Markets Programme. Within this program the European Central Bank directly purchases government bonds of Euro-Area member states. While initially no reliable information on the exact composition of the purchased portfolio existed, it was suspected that the European Central Bank primarily bought Greek, Portuguese and Irish bonds.[15] In September 2012 the program was terminated. According to a press release of 21st February 2013 the European Central Bank owns government bonds with a book value of 208.7 bn. Euros as of 31.12.2012. The portfolio consists of Italian (47.4 %), Spanish (20.9 %), Greek (14.8 %), Portuguese (10.3 %) and Irish (6.5 %) bonds.

Besides this catalogue of intended policy measures, the European Central Bank contributed to refinancing of the European crises countries via the Target-2-mechanism. This line of argument was introduced into the discussion by the German economist Hans-Werner Sinn.[16] Basically he argues that the German Bundesbank as well as other central banks in the core of the Euro-Area[17] secretly provide loans to countries in the periphery at the expense of their own banks. This issue has been discussed intensively in both academia and the public since June 2011.

In order to study how the European Debt Crisis and the chosen policy measures influenced trust in the European Central Bank we study the latest cross-section of the Eurobarometer Survey which was available when this article was written, the spring 2012 wave. Figure 6 shows the results of excess trust in 2009 and 2012 for various groups of countries. Obviously, on average excess trust in the European Central Bank decreased considerably. While the Worldwide Financial Crisis decreased excess trust in the European Central Bank by only 4 percentage points from 5 % to 1 % excess trust further eroded by 8 percentage points in between 2009 and 2012 to a level of −7 %. Thus, on average the citizens of the sample countries judged the role the European Central Bank played throughout the European Debt Crisis as inadequate. However, as Table 3 indicates, there is again a good deal of country-variety in the results.

In only a few countries (Bulgaria, France and Luxemburg), excess trust in the European Central Bank developed positively, thereby indicating that the citizens of the referring countries tended to judge the chosen policy measures to be adequate. In the rest of the sample countries, the European Debt Crisis left trust in the European Central Bank either unaffected or led to a significant downturn in excess trust. The group of countries in which trust in the European Central Bank remained unaffected consists of Greece, Portugal, Belgium, the Netherlands, the Czech Republic, Sweden, Poland, Hungary and Denmark. In the remaining sample countries, excess trust in the European Central Bank decreased significantly.

[15] See e.g. Belke (2010).

[16] For a detailed discussion see Sinn and Wollmershäuser (2012).

[17] Besides the German Bundesbank, the central banks of Finland, the Netherlands and Luxemburg are creditors in the Target-2-System.

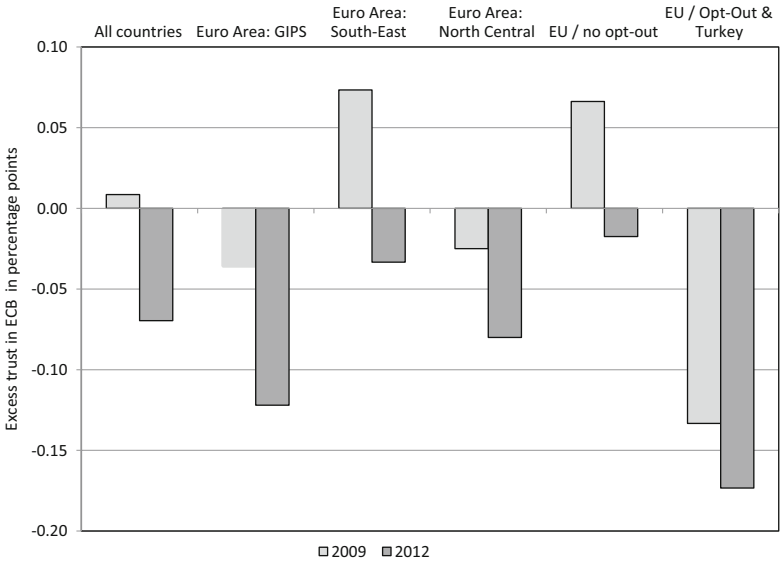

Fig. 6 Excess trust in European Central Bank before and after the European Debt Crisis

This holds especially true for the three Baltic countries, Finland, Romania, Spain, Ireland and Germany.

As outlined earlier, the policy measures undertaken by the European Central Bank were highly controversial in the Council. Germany established as the main opponent of direct purchases of government bonds of the crises states. Both, the president of the German Bundesbank, Jens Weidmann, as well as the German government constantly argued against this policy. The German citizens seem to support this view which materializes in a strong decrease of excess trust in the European Central Bank of 16 percentage points. While the president of the Bank of Finland, Erkki Liikanen, supported the purchase of government bonds, the Finnish government was in opposition to this policy. The reaction of the Finnish citizens to the policy measures of the European Central Bank throughout the European Debt Crisis was highly negative as excess trust decreased by 21 percentage points. In the other two countries which are creditors within the Target-2-System and which are also belonging to the more hard-nosed group of Euro-Area members, the Netherlands and Luxemburg, we find the citizens to react less critical to the actions undertaken by the European Central Bank. While excess trust in the European Central Bank remained unchanged in the Netherlands, Luxemburg belongs to the small number of countries in which citizens' trust in the European Central Bank slightly increased throughout the European Debt Crisis. Interestingly enough, France also belongs to this group. While France did yet not need support of the European Union, the International Monetary Fund or the European Central Bank, the French debt-to-GDP ratio increased considerably in between 2006 and 2012. As a consequence, there have been rumors from time to time that France could get into

serious trouble, too. One might speculate that the European Central Bank's willingness to buy bonds of European crisis states has thus had a positive effect on trust of the French citizens in the European Central Bank.

It is also interesting to study the group of crisis countries. Even in this group, which consists of Greece, Ireland, Portugal, Spain and Cyprus, there is quite some variance in the reaction to the European Debt Crisis. In both Greece and Portugal the citizens seem to be quite satisfied with the role the European Central Bank played throughout the European Debt Crisis. In both countries excess trust in the European Central Bank marginally increased in between 2009 and 2012. However, in Ireland, Spain and Cyprus the citizens' excess trust in the European Central Bank eroded significantly. As outlined earlier, the crises in Ireland, Spain and Cyprus were not triggered by excessive government expenses but by excessive lending of the banking sector. One thus might speculate that the citizens of these countries had the impression that the European Central Bank somewhat contributed to the banking crises. However, when interpreting this finding it is important to note that the rescue packages for Spain and Cyprus were realized after the spring 2012 Eurobarometer wave was conducted.

Even after the European Debt Crisis evolved we find a negative correlation of −0.52 between the debt-to-GDP ratio and excess trust in the European Central Bank in the member countries of the European Union (for the member countries of the Euro Area, the coefficient is slightly higher), although the correlation is slightly smaller than before the European Debt Crisis. Interestingly enough, the European Central Bank's policy to buy government bonds to rescue the crises states seems not to have contributed to a significantly higher trust in the European Central Bank in highly indebted countries.

Conclusions

As outlined in the introduction, policy institutions need public trust to be able to fulfill their tasks. When the European Central Bank took over the responsibility for monetary policy in the member states of the Euro-Area its reputation was necessarily low as the citizens of the Euro-Area member countries had no experiences with the newly established supra-national institution. The public discussion about who should become first president of the European Central Bank, where it should be located and especially about the adequate monetary policy strategy initially contributed to a comparatively low level of trust in the newly established central bank. As of 1999, only every second respondent to the Eurobarometer Survey declared to trust the European Central Bank. Although the European Central Bank managed its task to control inflation well until mid of the 2000s, trust in its work did not raise by much. Until 2007 the share of respondents to the Eurobarometer answering to tend to trust the European Central Bank has never reached 60 %. To some extent one might attribute this development to the fact that the Euro-Area was enlarged in several steps, thereby introducing some additional uncertainty about the future of the Euro-Area. When the Worldwide Financial Crisis evolved, trust in the European Central Bank started eroding. We showed that this result holds true even when controlling for the worsening macroeconomic conditions in Europe. During the European Debt Crisis,

the erosion of trust in the European Central Bank continued. It seems that the European Central Bank's policy to insert huge amounts of liquidity into the market, to act as a lender of last resort and to buy large amounts of sovereign debt on the primary market has contributed significantly to the erosion of public trust. Interestingly enough, on average neither the countries profiting from these policies nor the countries financing the support tend to be satisfied with the crisis management of the European Central Bank. However, the reaction of the respondents from the various member countries of the European Union turns out to be highly heterogeneous. To some extent this finding reflects the strongly differing views on the adequate role and strategy of the European Central Bank within Europe and the Euro-Area. In the light of the highly unconventional policy measures chosen by the European Central Bank throughout the two recent financial crises the differing views on the basic rules for the Euro-Area and the European Union as a whole became even more obvious. These circumstances make it hard if not impossible for the European Central Bank to (re-)gain the trust of the citizens of the Euro-Area, which is necessary to fulfill its tasks.

Somewhat perversely, it seems that the two recent financial crises which themselves were at least to a significant extent caused by a deficient construction of the European Monetary Union contributed to an even larger degree of (fiscal) integration of the Euro-Area member countries. In order to stabilize the situation policymakers have moved quickly towards realizing a fiscal and liability union, often without consulting the responsible parliaments. Although one might have found it inevitable to stabilize the situation in the short-run it also seems inevitable to return to a substantial and democratically legitimized process of European integration. Without such a process European institutions will hardly be able to (re-)gain the necessary trust of Europe's citizens which is obviously necessary to fulfill their tasks.

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SIFIs in the Cross Sea: How Are Large German Banks Adjusting to a Rough Economic Environment and a New Regulatory Setting?

Thilo Liebig and Sebastian Wider

Abstract

In the aftermath of the financial crisis, policymakers at both global and national levels have begun to implement a range of regulatory measures designed to address systemic risk more consistently. One of the key elements of this has been a framework to contain the moral hazard and the negative externalities related to systemically important financial institutions (SIFIs). Regulators are seeking to make these institutions more resilient and to avoid future defaults. Another line of defense in this context is a more efficient restructuring and resolution regime. Against this backdrop, there has been increased interest on the part of policymakers in quantitative indicators measuring systemic importance. Based on indicator categories proposed by the Basel Committee on Banking Supervision (BCBS) we illustrate how, in principle, a set of indicators like this can be used to monitor the development of banks' systemic importance over time. Overall, the set of indicators suggests that the systemic importance of large German banks has declined somewhat over the last 4 years. This finding appears to be driven mostly, however, by factors other than new policies directly addressing the too-important-to-fail-problem, chiefly the difficult economic environment. Therefore, it is still too early for a final judgment on the effectiveness of such policies. Given that credit rating-based measures of systemic

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government support suggest that large German banks are still benefitting from a substantial public subsidy, it may be necessary to consider additional policy measures over the medium term.

1 The Systemic Scale of the Banking Crisis and the Regulatory Response

The events of the crisis year 2008 resulted in a broad global consensus among the relevant policymakers to reform the supervisory and regulatory framework, in particular, by addressing systemic risks more consistently. The same large, complex financial institutions that had been operating much like proud sailing vessels, travelling the market seas in a period of fair weather as the flagships of sophisticated risk management proved to be surprisingly vulnerable when their fleet navigated into the hurricane of financial turbulence. Some of them sank – their oversized sails exposed them to the storm and they had stored too little capital and liquidity as counterweights in their keel – and many came close to capsizing. During 2008 it became increasingly evident that financial institutions' risk management systems and the available liquidity and capital buffers in this sector were not adequate for preventing a disorderly downsizing of the global financial system. Private sector crisis management options, such as mooring weaker banks to stronger institutions (e.g. by takeovers), became more and more exhausted when large and complex banks themselves needed help. In order to restore confidence and contain the crisis with its negative impact on the real economy, central banks and governments implemented comprehensive stabilization measures. In addition to the significant liquidity provision of the European System of Central Banks, the German government set up a Financial Market Stabilization Fund (SoFFin) in mid-October 2008. This included government guarantees of up to €400 billion for bank liabilities, and funds for capital injections and asset purchases of up to €80 billion. The draft law on which the SoFFin was established also pointed out that the government would take care of the *Pfandbrief*, if needed, in order to avoid any defaults in this specific funding instrument in the future (Deutscher Bundestag 2008). On October 5, Chancellor Merkel and Finance Minister Steinbrück had already issued a political declaration assuring the German public that the government would not allow a crisis at one bank to become a crisis for the system as a whole, and provided a guarantee for every euro in retail deposits at German banks. In addition to the measures of the federal government, public sector resources were also committed at the level of the German states to stabilize some vulnerable *Landesbanken*.

These measures, taken all together, indicate the systemic scale on which German banks were drawn into the international banking crises, with large banks being the most exposed as well as the most interconnected. This meant that shocks hitting these banks had the potential to spread through a complex network of counterparties, creditors and markets. Against this backdrop, policymakers made it very clear from the outset that the extraordinary stabilization efforts would only be one leg of the policy response – the other leg would be a stricter regulatory framework. The internationally coordinated reform agenda would not only correct failures in

the pre-crisis framework in a backward-looking manner, it would also seek to prevent the build-up of new systemic risks in the future. Among other causes of the crisis, it would specifically address moral hazard problems, which were identified as a flaw in the originate-to-distribute-model as it was practiced in the U.S. private-label securitization market. More generally, there are strong theoretical arguments that moral hazard can be a driver of excessive risk-taking, pro-cyclical leverage in the financial system and an increasing size and complexity of financial institutions, given that these can capitalize on the perception of an implicit government guarantee (see, for example, Dam and Koetter 2011). Hence, addressing moral hazard problems more decisively than before the crisis has been motivated to a major extent by the objective of giving better protection to public finances and counteracting market participants' expectations that the extraordinary stabilization measures taken by the public sector can be relied upon as a permanent subsidy. With this in mind, the G20-Leaders' Declaration for the Pittsburgh Summit in September 2009 stated,

> We committed to act together to raise capital standards, to implement strong international compensation standards aimed at ending practices that lead to excessive risk-taking, to improve the over-the-counter derivatives market and to create more powerful tools to hold large global firms to account for the risks they take. Standards for large global financial firms should be commensurate with the cost of their failure.

2 Reducing the Probability of a SIFI Default

Since then, noticeable progress has been made in translating and operationalizing these political declarations into a concrete regulatory framework. At the international level this work has been coordinated by the Financial Stability Board (FSB). Large, complex banks are subject to the regulatory reforms that apply to all banks, such as capital requirements, liquidity standards and restrictions on large exposures. However, two strands of policy initiatives can be distinguished which specifically address the too-important-to-fail problem. One approach is primarily directed at reducing the probability of a SIFI default. Most visible has been an official list of 29 global systemically important banks, which the FSB published for the first time in November 2011. The initial list included two banks with headquarters in Germany, of which one lost its status as a global SIFI when the list was updated in November 2012. Institutions in this list are required to have additional loss absorption capacity in the form of a capital surcharge between 1 % and 2.5 % of risk-weighted assets (which could be up to 3.5 % for the hypothetical case of even more systemically important institutions). Starting in January 2016, these requirements will be phased in with full implementation by January 2019.

A reduction in the probability of default is a very practical approach with regard to large banks with cross-border activities in order to internalize potentially negative cross-border externalities and to mitigate the remaining uncertainty about the effectiveness of a joint international crisis management approach. In principle, however, it is also possible for national authorities to extend this capital based policy tool for large, complex banks with key functions in the domestic financial system, but which are not

included in the global SIFI list. While capital-based policy measures can be expected to strengthen the resilience of a SIFI, it will, of course, depend on a number of other factors whether they discourage institutions from engaging in those operations and business structures that are the main drivers of their SIFI status. Complementary to higher capital requirements, a range of supervisory activities regarding large, complex institutions are being intensified, too. This comprises international teams of supervisors (colleges), higher standards with regard to risk assessment, rigorous stress testing and more comprehensive risk-related data requirements.

3 Effective Bank Restructuring and Resolution Frameworks

The other strand of policy initiatives is directed at making possible the orderly restructuring or resolution of a failing SIFI. As a side effect, this is also having a beneficial impact on the default probability of SIFIs, given that a credible default option would tend to strengthen market discipline and moderate the risk-taking behavior of the bank management. Consequently the build-up of major vulnerabilities might be prevented. However, an effective resolution framework for financial institutions is an intermediate policy objective in itself in order to make crisis management more efficient, avoid negative externalities and to minimize contingent financial claims on the public sector. In October 2011, the FSB published the "Key Attributes of Effective Resolution Regimes for Financial Institutions". In the absence of a globally uniform insolvency law the document sets out, for the first time, essential features that are recommended to be integral parts in the resolution regimes of all jurisdictions. International implementation could lead to a gradual alignment of the diverse national legal frameworks. Among other features, the FSB's "Key Attributes" include legal powers and tools to enable creditor-financed bank recapitalization. For the group of global SIFIs, as a minimum, the document stipulates mandatory recovery and resolution planning as a means to identify overly complex banking structures and other obstacles. Furthermore, it stipulates cross-border groups comprising public authorities that would be involved in crisis management, institutions-specific international cooperation agreements and regular resolvability assessments. Another complementary measure worth mentioning in the context of restructuring and resolutions frameworks is the implementation of stricter requirements for OTC derivatives transactions. Mandatory central clearing and higher requirements for capital and collateral are expected to significantly reduce the contagion risk from counterparty exposures in the highly concentrated OTC derivate markets. Interconnectedness between banks with large, complex derivate activities is therefore likely to become less of an obstacle to effective restructuring and resolution.

Considering the vast cross-border activities of many banks over the past 20 years, it may be tempting to ask why initiatives for more international harmonization and cooperation had to wait for the crisis to act as a catalyst.[1] And yet, despite the

[1] As a paper by Völz and Wedow (2009) implies, it would have been possible – even before 2008 – to find evidence in CDS spreads suggesting that banks' size distorted market prices.

noticeable progress that has been achieved, a solution is still needed for sensitive issues such as the moderation of conflicting interests or assessments of how to deal with an internationally active bank in a specific crisis situation. The economically less than perfect practice in the past was to ring-fence the assets of banks in distress and break financial groups up according to national boundaries or to have them rescued as separate national entities by the respective home states. The current approach of national frameworks, however, cannot fully overcome such cross-border issues. National rules have limited scope with regard to the foreign legal relationships of agents.

To some extent, this is also a shortcoming of the German Bank Restructuring Act, which entered into force in January 2011, already anticipating elements of the FSB framework and preceding forthcoming EU initiatives which seek to enable coordinated crisis management action with the responsible authorities across borders. The German Bank Restructuring Act has a number of noteworthy features (see Deutsche Bundesbank 2011). First, there is greater legal certainty for German supervisory authorities to intervene early. Supervisors can order institutions to present a restructuring plan. Second, authorities are given legal clarity that, in a reorganization procedure, if necessary, there can be interventions into third party rights. For example, the institution's liabilities may be deferred or reduced and debt-equity swaps or spin-offs of some or all assets are also possible. Thus, a powerful instrument has been added to the prudential toolkit, allowing supervisors to order the transfer of systemically important assets and liabilities to another legal entity. Third, the Act is setting up a Restructuring Fund, which is owned by the federal government, but contributions are made through a banking levy on all credit institutions, which is based on a progressively rising function of simple measures of size and interconnectedness. Although it is only one element of the broader regulatory agenda to address the too-important-to-fail-problem, the German Bank Restructuring Act has had an observable impact. For example, in February 2011 the Bloomberg website reported that the credit ratings for a number of German banks' debt securities had been downgraded by Moody's, based on the expectation of materially reduced government support. From a policymaker's perspective, such a revision of market participants' perception of German banks' creditworthiness is positive, given that the policy intention of providing only temporary support to the banks amid a global financial crisis is seen as credible. The Bank Restructuring Act seems to have been a step in the right direction in terms of strengthening market discipline and incentivizing banks to substitute reduced government support by adjusting their balance sheets and business models.

The political initiative for a banking union has since opened up the way to addressing the problem of cross-border SIFI resolution in Europe even more efficiently. A European resolution authority and ex ante rules for burden sharing in Europe can be useful complements to the Single Supervisory Mechanism, which puts the ECB in a position to supervise all systemically important banks in the euro area. However, the benefits of this initiative will ultimately depend on broad political support, a sound legal basis and effective operational structures; all of this is still in a state of flux.

4 Indicators for Systemic Importance

Substantial work has been performed in identifying and measuring systemic importance at the level of individual institutions, often in the background of G20 summits and the international regulatory reform agenda. Although the too-important-to-fail problem is often categorized as being part of the structural dimension of systemic risk in the financial system, it has a time dimension, too. Monitoring the change in measures of financial institutions' systemic relevance is an essential element in the calibration of prudential policies, in the ongoing impact assessment of these policies, and in the process for identifying the build-up of new systemic risks. The up-to-date information resulting from the continuous monitoring of these indicators also provides policymakers with valuable data in an acute crisis management situation, when it is important to gauge what likely impact distress at a given firm will have on the stability of the system as a whole. For example, the FSB's list of global SIFIs – primarily used to allocate the capital surcharges – adopts an indicator-based measurement approach proposed by the Basel Committee on Banking Supervision (BCBS) and builds on earlier studies such as IMF/BIS/FSB (2009). With regard to the alternative of model-based methodologies, it is noteworthy that the BCBS came to the conclusion that

> [...] models for measuring systemic importance of banks are at a very early stage of development and there remain concerns about the robustness of the results.

Table 1 shows the five indicator categories for different dimensions of systemic importance as well as some examples of specific indicators. In the second part we illustrate how, in principle, a set of indicators like this can be used to monitor the development of banks' systemic importance over time. However, at this stage the methodology does not allow us to analyze the drivers of the indicator change in more detail, for instance, to quantify the relative contributions made by changes in the regulatory environment or by macro-economic variables. Greater differentiation would be needed in the context of a comprehensive policy impact assessment. For the time being, rigorous quantitative analysis has to be replaced with some qualitative judgment. Overall, the set of indicators suggests that the systemic importance of large German banks has declined somewhat over the past 4 years. This reflects the fact that the banks have been sailing in rough seas ever since the financial hurricane of 2008. The waves have been coming in from both sides: banks' balance sheets and some business models have been intentionally put under salutary pressure from the regulators, while, at the same time, the adverse economic environment, namely the persistent sovereign debt crisis in the euro area, has been a major dampening factor on risk-taking. But banks, too, have been benefitted from accommodative central bank policies and continued support by public emergency backstops in the form of guarantees and capital injections.

So far, the indicators of systemic importance appear to be driven mostly by factors other than new regulations directly addressing the too-important-to-fail-problem. This finding does not imply that the policies are ineffective: it should be borne in mind that not all of them have been fully implemented yet and that their

Table 1 Indicator-based measurement approach (see BCBS 2011)

Category	Examples of specific indicators
Size	Total exposures as defined for use in the Basel III leverage ratio
Cross-jurisdictional activity	Cross-jurisdictional claims
	Cross-jurisdictional liabilities
Interconnectedness	Intra-financial system assets
	Intra-financial system liabilities
	Wholesale funding ratio
Substitutability/financial institution infrastructure	Assets under custody
	Payments cleared and settled through payment systems
	Values of underwritten transactions in debt and equity markets
Complexity	OTC derivatives notional value
	Level 3 assets
	Held for trading and available for sale value

effectiveness may become more noticeable in the upswing of a financial cycle, when they dampen the resurgence of systemic risks related to SIFIs. In terms of risk-bearing capacity the group of large German banks has become more resilient (see Deutsche Bundesbank 2012). But a continuously vigilant monitoring of "systemic importance" is warranted. After all, credit rating agencies still attribute typically 2–3 notches of large German banks' issuer ratings to the expectation of systemic support provided by the government.[2] This kind of rating uplift, which is also evident for a number of banks in other jurisdictions, might be associated with a funding advantage, implying a considerable public subsidy for large banks (see, for example, Ueda and Weder di Mauro 2012). From a policy perspective, this is hard to justify in the long run.

5 Monitoring Selected Indicators for Large German Banks

5.1 Size

The ratio of bank assets-to-GDP is often used as a simple measure of financial deepening and it can be argued that there is a positive relationship between large, efficient banks and countries' economic growth over the medium term. For example, global financial deregulation in the early 1980s, together with technological progress such as computerization, allowed large banks to launch new products and diversify risks more broadly. Today, "plain vanilla" interest rate swaps, currency swaps and large, internationally diversified credit portfolios are usually not seen as

[2] Source: Company Websites.

a specific risk to financial stability, although they have contributed to the growth of banks' balance sheets.[3] However, the existence of some economies of scale does not necessarily lead to the general conclusion that size is positive, in particular, in combination with complexity, interconnectedness and low substitutability. Bearing in mind the public costs of stabilizing the large banks in Germany and the losses of confidence as well as of output that resulted from the negative spill-over to the real economy, the burden of proof has been put on the banks to show in their own restructuring and resolution planning that size is manageable.

The BCBS's preferred size indicator is "total exposures as defined for use in the Basel III leverage ratio". This indicator comprises both on-balance sheet items and off-balance sheet items, with the latter representing 30 % of some institutions' exposure. Hence, among other items it contains information about the gross value of securities financing transactions and the exposures of derivative contracts. As a proxy that is already available for a larger group of German banks and also before 2010, when the BCBS initiated the compilation of global SIFI data for the first time, we use data from the monthly reports submitted to the Bundesbank pursuant to Sect. 25 (2) of the German Banking Act (*Kreditwesengesetz* KWG).

In contrast to the increasing financial deepening of earlier decades, the data show that, after 2008, total assets of this group of 12 large banks in Germany were in a period of stalemate. Following a crisis-driven deleveraging in 2009, total asset growth has been broadly in line with domestic nominal GDP since 2010. Relative to GDP, the less volatile claims on non-banks, such as bank loans to households and businesses, have even been lagging behind. This is consistent with weak credit demand and a selective retreat from some markets, amid economic downturns in other European countries. Moreover, the European Commission, which is responsible for cross-border competition policies, required some large banks in Germany to actively shrink their balance sheet after receiving state aid.

Remarkably, the slowdown in the large German banks' claims on non-banks has been achieved in an orderly manner without overshooting to the other extreme of a "credit crunch" with severe credit supply constraints for the real economy. And yet, the overall high level of total bank assets would suggest the persistence of the SIFI problem if it were not possible to identify significant structural adjustments under this surface towards greater resilience, business models that are more sustainable and fewer potentially negative externalities. In this regard, one major element is the strengthened capital position. For the group of 12 banks, the average tier 1 ratio increased from just above 8 % of risk-weighted assets in early 2008 to over 13 % in 2012 (Deutsche Bundesbank 2012).

[3] For a deeper analysis see, for example, Düllmann and Puzanova (2011). They find some empirical evidence that size alone is not a reliable proxy for the systemic importance of a bank.

5.2 Cross-Jurisdictional Activity

Large German banks have been playing a significant role in cross-border banking activities for many years, partly reflecting the export-orientation of the German economy.[4] The marks of international integration can be found in the banks' assets and in their funding as well as in their network of foreign branches and subsidiaries. On the one hand, this has exposed them to shocks from other countries and, furthermore, accentuated the difficulty of coordinating their resolution if these banks become distressed and when crisis management by the German authorities potentially has serious economic implications for other economies, too. For example, countries where German banks hold a significant market share might suffer from an abrupt retreat of liquidity and credit supply. On the other hand, there are significant benefits stemming from international capital flows and the diversification opportunities available to German banks, which should be preserved Fig. 1.

Recently, the unwelcome fragmentation of banking activities along national borders – even within the euro area – has been dramatically highlighting what may be at stake if the financial system were to continue unwinding its cross-border activities. The preferred policy approach to the too-important-to-fail problem, therefore, would certainly not be active intervention in banks' international activities by downsizing them across the board. Rather, the preferred policy approach consists once again in a combination of reducing the default probability of banks – which might imply a review of capital requirements for the more risky cross-border activities – and greater international cooperation and harmonization among supervisors, regulators, and resolution authorities as well as within the legal framework.

The data on total foreign claims of German banks indicates a significant correction during the financial crisis in 2009. In this first global deleveraging phase, asset reductions concentrated on US dollar securities and short-term interbank loans. In contrast to this episode, German banks' claims vis-à-vis European countries with stressed sovereign bond markets have generally not been reduced via fire sales, but were instead held to maturity after the sovereign debt crisis escalated in 2010. A similar orderly declining trend is evident from the data on the securities held by the group of 12 large banks in Germany. These securities portfolios have national and international securities in them. Considering regulatory requirements and future business opportunities, banks might have been prioritizing loans and the associated customer relationship over credit exposures through securities.

Banks operate in a network with other financial institutions. The connections in the network can be interbank loans, repurchase agreements, securities lending or OTC derivatives transactions and holdings of securities issued by other banks. A default of a highly interconnected participant in the network can be difficult to manage without triggering a chain reaction in the network. There is a trade-off

[4] See Buch et al. (2010) for empirical evidence that this can be a mixed blessing for the banks themselves.

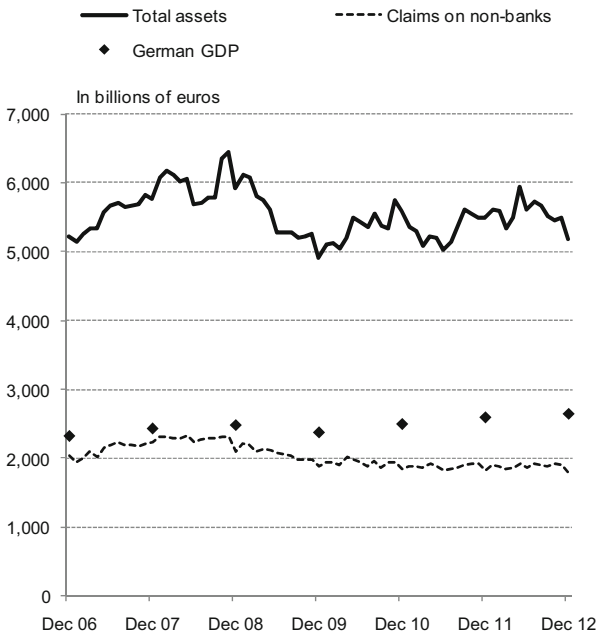

Fig. 1 *Size*. Aggregated data of 12 large banks in Germany (Source: Deutsche Bundesbank)

similar to the cross-jurisdictional activities. On the one hand, a highly interconnected network can be efficient, for example, in allocating liquidity, capital and risks. On the other hand, it can increase the risk of contagion between the participants. Counterparty risk mitigation through collateral, capital, liquidity and risk concentration limits is part of finding a practical solution in this trade-off. Moreover, compiling more detailed network data and systematically analyzing it could become an important tool for supervisors in terms of identifying systemic risks and potential second-round effects at an early stage (see IMF/BIS/FSB 2009).

In the not so distant past, international securities portfolios were purchased by some German banks as a substitute for weak domestic credit demand amid a liquidity glut (*Kreditersatzgeschäft*). For many banks, this search for yield in securitized credit products resulted in disproportionate losses. For supervisors, it would be at least a warning signal if, in the current low yield environment, banks were again chasing a particular class of securities Fig. 2.

5.3 Interconnectedness

The aggregated data of interbank loans and (reverse) repurchase agreements in Fig. 3 indicates a substantial contraction in the network in 2008 and 2009, driven by counterparty risk concerns, a substitution of interbank markets by central bank funding and deleveraging pressures. While, initially, this contraction was enforced by market mechanisms, regulatory changes will have a more permanent impact on

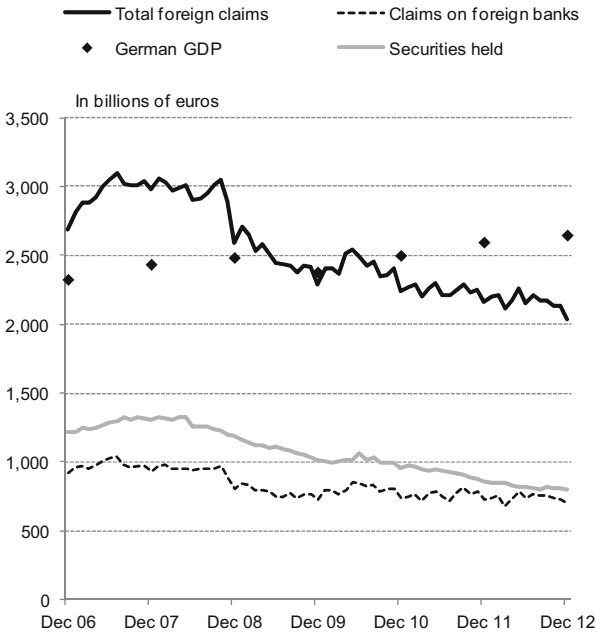

Fig. 2 *Cross-jurisdictional activity*. Aggregated data as reported by German banks to the BIS for the international consolidated banking statistics on an ultimate risk basis, and securities held by the group of 12 large banks (Source: Deutsche Bundesbank)

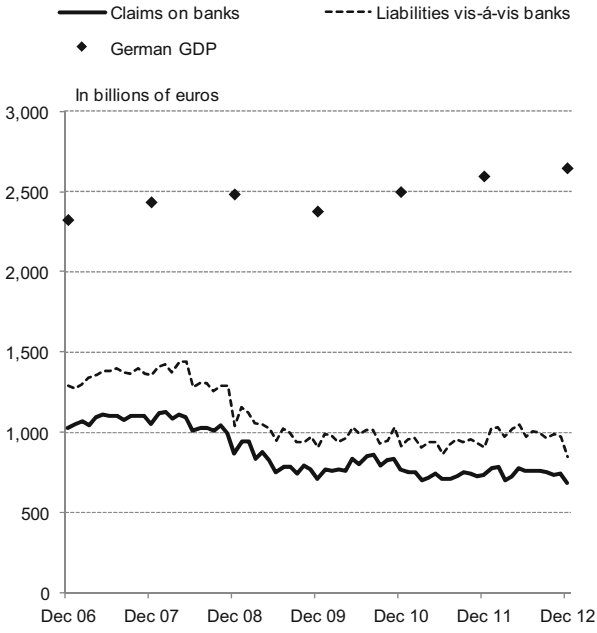

Fig. 3 *Interconnectedness*. Aggregated data of 12 large banks in Germany (Source: Deutsche Bundesbank)

the evolution of future networks. New limits on interbank exposures have been implemented (25 % of the capital base vis-à-vis a single entity) and specific capital plus liquidity requirements are making interbank loans more resilient. However, the interbank market in the euro area is persistently afflicted by counterparty risk concerns and some European banks are resorting to central bank funding in unusual amounts. The regulatory toolkit cannot cure the root causes of this problem. It is the responsibility of politicians to avoid tail events that cannot be absorbed, even after the banking network in Europe has been made more resilient.

5.4 Substitutability/Financial Institution Infrastructure

The BCBS's measurement approach to the substitutability problem explicitly refers to assets under custody, i.e. holding assets on behalf of customers, payments cleared and settled through payment systems, and values of underwritten transactions in debt and equity markets. However, the same reasoning can be applied to other market segments and client services provided by the banks, for example, lending to small and medium-sized enterprises and deposit taking. With a dominant market share, it is expected that a bank failure will be followed by disruptions and that a large number of customers will simultaneously have the cost of finding another service provider. For the assessment of these measures of systemic importance, and in order to derive the market share of a specific institution, it is necessary to define the relevant market and alternative service providers in each segment. Overall, we are not aware of major structural changes in the systemic importance of the large German banks in this regard, although, from a cyclical perspective, the value of assets under custody has increased noticeably from its trough after 2009.

5.5 Complexity

The final indicator category comprises measures of business, structural and operational complexity, potentially driving up the costs and the time needed to resolve a bank. There are three examples: first, OTC derivatives; second, "level 3" assets, whose fair value cannot be determined using observable measures; third, securities held "for trading" or "available for sale". The BCBS's rationale for using this kind of securities as indicators of systemic importance, are the potential spillovers through mark-to-market losses and fire sales.

With regard to German banks' activities in the OTC derivatives markets, the data in Fig. 4 reflect the dynamic expansion of the risk transfer markets over more than a decade. OTC derivatives are privately negotiated contracts, which can be customized. The risk management for these – sometimes complex and illiquid – products can be very challenging. Remarkably, the recent decline in notional amounts outstanding – supposedly reflecting a compression of positions with central counterparties (CCPs) as well as less hedging and trading demand – could foreshadow the implementation of a regulatory regime shift in this market.

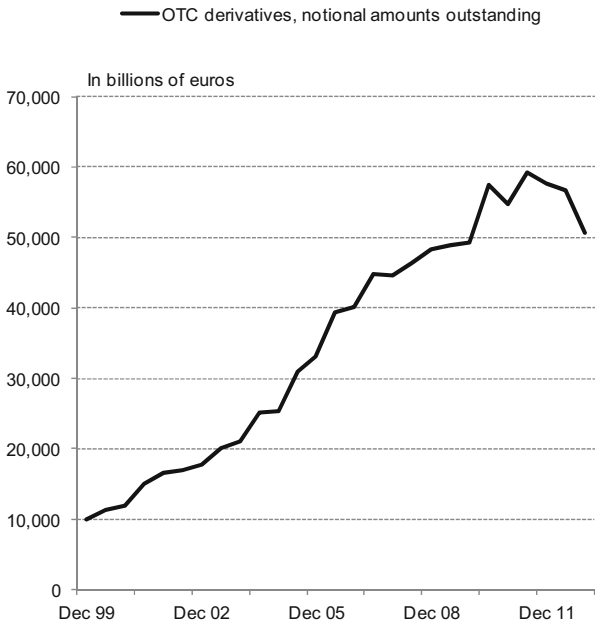

Fig. 4 *Complexity*. Aggregated data as reported by German banks to the BIS derivatives statistics (Source: Deutsche Bundesbank)

In the light of the crisis experience with the complex derivatives portfolios of institutions such as Bear Stearns, Lehman Brothers and American International Group, policymakers in the United States, in Europe and other relevant jurisdictions decided to make the central clearing of standardized derivatives mandatory. The use of CCP can effectively eliminate a key source of counterparty risk between SIFIs, and thus systemic risk, provided the CCPs risk management is sound. Moreover, capital and collateral requirements for exposures to derivatives have been increased. Reporting obligations to trade repositories will also bring more transparency to the opaque OTC derivatives markets. And yet, despite these coming fundamental changes, the future role of the SIFIs should be closely monitored. SIFIs may find ways to secure their dominant position in new networks. If the product is no longer customized OTC derivatives, it could be collateral transformation services instead, given the increasing demand for collateral extends to customers. Then, it would be the collateral transfer network that re-establishes a higher degree of interconnectedness. For regulators, there may be practical limits to reducing complexity permanently.

Conclusions

Based on the set of indicators, we find a moderate reduction in the systemic importance of large German banks since 2008. However, not all the policies addressing the too-important-to-fail problem have been fully implemented yet and their effectiveness may become more noticeable in the upswing of a financial cycle, when they dampen the resurgence of systemic risks related to SIFIs. At the same time, it is understandable that some policymakers are

pointing to the overall persistently high level of systemic importance of SIFIs and demanding further action.

In Germany, a kind of "bank-separation act" is scheduled to come into effect in January 2014, following the entry into force of German legislation to implement the EU's Capital Requirements Directive IV (Bundesfinanzministerium 2013). Separation of business activities within banks should then be carried out by July 2015. The first part of this act includes a tool that was agreed internationally at the October 2011 meeting of the FSB: mandatory "living wills" for banks. As a result, supervisors will be able to demand the elimination of obstacles to resolution which have been identified in the banks' own planning. The second part actually gives the bill its name: bank separation act. It stipulates that if certain thresholds are exceeded, deposit-taking credit institutions will have to spin off proprietary trading and prime brokerage services into a company that is legally, economically and organizationally separate. The third part introduces criminal-law provisions for the bank's management. On the positive side, this act makes bank resolution more credible by removing organizational obstacles and possibly creating smaller entities. Basically, the idea is to build banking "ships" that do not sink in a storm. Even if – in the investment banking operations – the rig is torn and the mast is broken, a robust ship hull – holding the deposits and loans – can be used as a rowing boat. In practice, it is not so easy, of course, to determine the specific banking activities that should be separated from the deposits. In particular, investment banking services for non-financial corporates can have a dual use. Moreover, even if there are clearly separated entities, pure investment banks may still be perceived as too important or too complex to fail. And there are examples of deposit-takers with seemingly simple business operations that accumulated excessive risks, typically in real estate loans or interest rate risk positions.

Against this backdrop, national bank separation acts are one regulatory tool worth considering, but, ultimately, they are not a substitute for closer international cooperation. The solution of the SIFI problem should avoid cross-border financial fragmentation and giving up the benefits of international capital flows. In other words, it is necessary to have ships that are large and robust enough to cross the seas, since otherwise, trade will be confined to inland waters.

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The Endogenous Fragility at European Periphery

A Theoretical Interpretation

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Abstract

The current crisis has revealed the co-existence of at least two quite heterogeneous parts of Europe lying hidden behind the unifying and homogenising veil of the European Union membership status. The main hypothesis exposed here is that this stylised division of the EU is largely endogenous and internal to the integration processes themselves. Given the genesis and the designed functioning of the European Union and the Euro-zone a set of centrifugal processes come into play inevitably leading to disintegration. Broadly speaking, the self-propelled breakdown processes come through the creation of "an illusory impression" of safety net and risk insurance in both sub-sets of the EU. This not only increases the overall level of risk and vulnerability but also leads to unfavourable risk redistribution directing it to the weaker links in the whole EU structure. The economic system then becomes much more vulnerable to not only external shocks but also to internal ones. This of course is usually accompanied by loss of discipline and the emergence of various forms of non-market and bandit behaviour in both core and periphery.

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1 Introduction

In the very eve of the 1929 Great Depression, the French economist and journalist Francis Delaisi published a book with the eloquent title *Les deux Europes* [*The two Europes*] (Delaisi 1929)[1] where he uses the metaphor of a traveller flying over Europe and carefully studying it. Two extremely opposite parts of Europe appear before his eyes. Europe A – as Delaisi calls it – is that of the countries at the core of the European economy, while Europe B is represented by the southern, peripheral countries. Whereas Europe A is an industrial economy, having embraced technological progress and is culturally flourishing and democratically advanced, Europe B is a backward agrarian zone remaining technically very rudimentary – not to say primitive – being averse to technical progress and ruled by corrupt and autocratic governments. Furthermore, while Europe A (E1) saves and invests, Europe B (E2) spends, lives for the day and runs into debt with E_1. Ultimately, the E2 economic agents incur huge debts, both external and internal, which put to threat the position of E2 creditor-countries.

Ever since Delaisi time, European countries and Europe as a whole have made a significant technical, economic and social progress from competing colonial powers surrounded by mediocre periphery into a set of cooperating and integrated economies with high institutional standards. Over the last two decades the pace of European integration has increased even more with the collapse of the communist bloc and the accession of most of the East European countries to EU membership. The perception of economic advancement and progress of the integration and harmonization processes in Europe however was harshly chilled with the advent of the global crisis. Hence "the ghost" of the two Europes Delaisi wrote about more than 80 years ago appears once again. Those two parts of Europe have visibly split from each other and one can easily admit that behind its strong and solid surface the European project is a rather fragile and uncertain feature. Moreover it is argued that as it presently stands the overall European project is genetically fated to divide Europe into two or more Europes and to ultimately endogenously destroy itself.

Clearly, the contemporary division of Europe has its peculiarities, but on the whole it reminds of what the French economist Delaisi once witnessed. The core E1 is basically represented by the countries from Northern Europe standing close to Germany and having "German economic way of thinking". The E1 countries follow different macroeconomic and behavioural trajectories from E2, which is composed of South-European economies and the majority of former socialist countries.

[1] At the time Delaisi wrote his book, the above mentioned division of Europe into part A and part B was popular enough (see for instance Batou (2000)). At the time of the Great Depression, possible ways of helping South Europe, i.e. Europe B, were internationally discussed as it suffered from the abrupt decline in prices of agricultural goods ruining those countries' balance of payments and jeopardizing the servicing of external debt. The so-called "Agrarian bloc" was offered different measures such as export subsidies, currency devaluation, sharp increase in money supply, etc. See Bonnet (1933) and Nenovsky (2012).

Whereas the E_1 countries (despite the general trend of deindustrialisation in Europe) try to maintain their industrial development, preserve their competitiveness, keep satisfactory rates of savings and capital accumulation, and sound public finances, in E2 economies (often called peripherals) quite the opposite can be observed – industrialisation, technologies and innovations lag behind, consumption explodes, savings are extremely low and private and public debt grow considerably. Just as in the years before the Great Depression, the E2 countries today attract savings and capitals from E1 countries. This way they are not only worsening their current accounts but are stimulating the growth of various debt bubbles, real estate credit in particular. This results in a temporary and artificial economic growth.

Also, definite parallels between the monetary regimes from the 1929 period and the ones run today can be established. In the late 1920s most countries were under a regime of partially restored gold standard (gold-exchange standard). This restoration took place in mid and late 1920. Today, most European countries share a common currency and a common European Central Bank (ECB), while the rest follow the ECB's policy either by a fixed exchange rate (or Currency boards) or inflation targeting.

At a whole, the above line of reasoning shows the existence of two archetypal and opposite models of development across Europe (E1 and E2) although an obvious number of specificities and subgroups could be identified within E1 and E2.[2] Hence, the basic task of this article is to construct a theoretical framework which highlights the mechanisms whereby the process of European integration – as is currently observed – logically leads to the emergence of sub-sets within Europe.

The main hypothesis we put forward is the following: the genesis and operation of the European Union and the Euro-zone are such that they generate internal processes, endogenous for both systems, which in turn inevitably lead to self-disintegration.[3] More generally, these self-propelled breakdown processes come through the creation of "an illusionary impression" of a safety net in the system and its risk insurance. This in turn not only raises the overall level of risk and vulnerability in the EU but also leads to unfavourable redistribution of the risk, directing it to weaker links in the system. Hence, this is accompanied by a loss of fiscal and financial discipline and the emergence of various forms of non-market and bandit behaviour in both E1 and E2. The system becomes much more vulnerable not only to external shocks, but also to its own, i.e. internal ones.[4]

The above-described processes of course are not purposely designed. Rather, they are manifestation of the law of "unintended consequences" of political and macroeconomic decisions. In this sense, the self-disintegration is a logical outcome

[2] We leave aside the discussion of the diversity of forms of capitalism, transitional economies and even economic systems which have gained high popularity in recent years, see among others Aimable (2005), Csaba (2007), and Farkas (2011).

[3] Among the few studies on disintegration theory are the old study of Röpke (1942) and more recently Slim (1997).

[4] See also De Grauwe (2011), Gros et al. (2011) and Dietrich et al. (2011).

of the rational behaviour and strategies of economic actors.[5] The purpose of this study is to show what these processes are about, what the consequences of their underestimation could be, and what would be appropriate to do under the current situation.[6]

Hereinafter the study is organized as follows: firstly, the general logic of the model is given whereby the EU and Euro-zone's institutional and political structure itself generates various forms of collateral (we could also use the terms guarantee or insurance) in different parts of the system, thereby sharply raising the risk-behaviour level in general and in some individual segments of the system in particular. The next part suggests one linear formalisation of the model. The third part analyses the forms of collateral or insurance: explicit – say evident – or implicit and presumed, virtual. The transmission channels of risk behaviour are discussed and elaborated. Finally, we suggest some ideas for possible policies to follow in the current situation and some scenarios of future revisions of the European project basically towards counteracting and safeguarding against the emergence of the insurance game and moral hazard.

2 The EU Insurance Model

The current form of integration in Europe could be brought down to the following analytical cause-consequence chain.

The starting point is the concomitant launching of the European project for enlargement and the adoption of a single currency which brings into existence the "European anchor" as a major institutional mechanism coordinating expectations and behaviour of economic and political actors. This anchor in turn leads to the sudden and imperceptible emergence of an *ex nihilo* guarantee or an insurance fund (hereinafter referred to as Φ) which diminishes the perception of risk and creates a sense of security by presenting a kind of virtual subsidy. In other words, the European project – which intends to promote a tight and sound financial discipline – becomes the initial impulse to loosen the budget constraints of economic agents.

[5] Similar behavioral self-disintegration processes were observed in the functioning of the socialist integration, as well as within the individual planned economies, especially during the last phases of breakdown of those systems.

[6] The theories of optimal monetary zones, convergence and catching up are useful and give a range of ideas; however the issue here is more about clarifying the transmission mechanisms of breakdown in a situation of misconception of the processes of integration and above all of the mechanism of growing risk behavior and loss of discipline. Of course, a number of assertions about the optimality of a given zone remain valid, be it with reference to the classical theory of optimal zones, which is static by nature, or to the theory of endogenous zones. Just as the classical theory of monetary zones fail to or insufficiently examine the breakdown processes of the zones already created and their manifestations, so too do the new trends (see recently Mongelli 2013). The model proposed below shares some features in common with the theory of internal instability of the financial system, as promoted by Minsky, and a number of elements of the Austrian theory of the economic cycle.

The risk-behaviour therefore quickly heightens deforming in turn the basic incentives for consumption investment and savings. Hence, a range of bandit and crony strategies appear. Consequently, after some latent period, the overall production structure becomes deformed and the system inevitably falls apart from within.[7] This calls for a clearer *exposé* of the dynamics of self-disintegration.

Assuming that the goal of the European project for enlargement has a strong moral and rational ground and is at least at first sight logically sound, one can summarise the task of EU-member and candidate countries as to unite into a common and integrated market and through the mechanisms of the single currency and the single monetary policy. In addition, through the set of statutory criteria of fiscal stability nominal convergence, etc. they aim to overcome the centuries-old political, economic and cultural antagonisms. It stands on the presumption that through a range of economic mechanisms described by the now classic theories of international trade and integration unions, the relatively poorer zones in E2 will catch up with the richer ones of E1. This would mainly take place through the processes of convergence and movement of production factors, goods and services. Thus, for instance, capital would move towards the zones where its marginal efficiency is higher, i.e., to E2, and labour force to E1 where salaries are higher. However the European project has never totally relied on market forces and the re-distributional processes, through the various kinds of European funds, have always been leading this integration. The role of the State and the importance and significance of the European social model have been stressed many times in all major European documents and resolutions.

We argue that the models of the European Union and the Euro-zone automatically trigger the appearance of a number of public and supranational guarantees and insurances which form a kind of a guarantee or insurance fund (referred to as Φ), which dulls the sense of risk and increases the illusion of safety for the various actors, thus spoiling economic discipline. This guarantee fund Φ, whose components will be discussed below (in section IV), considerably increases the level of risk in the EU and the Euro-zone while blunting the sense of risk and uncertainty through various mechanisms. Overall, the risk premium and the cost of assuming risk no longer reflect its actual level. The consequent underestimation of risk leads to the appearance of a free insurance or hidden subsidy or artificial, institutionally induced guarantee equal to $(-\varphi)$ where φ is the risk premium. This subsidy in turn increases the explicit – say perceived – real interest spread between E2 and E1. The free insurance $(-\varphi)$, through the increased perceived real interest rate, is crucially important to E2 countries which rely not only on internal, domestic

[7] Different moments of the model presented here were elaborated in Nenovsky (2010), Nenovsky and Villieu (2011) and Nenovsky et al. (2013). See also on Eastern Europe Luengnaruemitchai et al. (2007), Rugraff (2010) and Vincent (2011). The model below can be viewed as a form of the well-known mechanisms of asymmetry of information, unfavorable choice, moral hazard and incomplete contracts; here however we are striving to give a broader and, in a sense, sociological perspective to the issues of risky behavior.

bail-out mechanisms, but also on the guarantees of the European Union and hence those of E1 countries.

On the whole, in E2 the price of risk becomes considerably lower than it would have been, had the countries from that group not been members of the EU and of the Euro-zone eventually. One can call this the "EU-accession premium" as it applies to EU candidate countries whose accession is in progress or to new-member states. It justifies the flow of savings from E1 to E2 which are placed as deposits within the E_2 banking sector and in turn become external liabilities of the E2 private sector. The purpose or *raison d'être* of these flows is to take advantage of the risk subsidy (free insurance) from the EU enlargement process. The hidden subsidies or free insurances trigger substantial flows of resources and capitals – supranational, public, or private (banking, intra-firm, etc.) alike – from E1 to E2.

These funds are either E1 savings or pure bank credit (not backed by real savings) generated by the E_1 banking system.[8] This leads to a rise in external debt, be it private or public, depending on where the capitals in E2 are channelled to (hereinafter referred to as *D*). Within the E2 countries, internal debt increases as well, mainly in terms of lending to the private sector.

Therefore, we can summarise the whole story along these lines: the debt level of the E2 countries increases significantly either through an external or internal impulse, but as a rule through both channels.[9] The ECB and the governments of the leading countries from E_1 were perceived as guarantors for these riskier operations despite the numerous political and legal obstacles to such interferences. The entire system of debt accumulation in E2 was accompanied by the manifestation of crony behaviour, corruption and banditries, which are typical of such periods.

Moreover, the inflow of external savings and loans leads to looser lending conditions, higher salaries and consumption, and eventually to higher inflation (at rates higher than those in E1). With the advance of the catching-up processes in terms of prices, real interest rates in E2 would significantly decrease and even become negative because of higher inflation in E2. Domestic credit increases and is channelled either to sectors where gains from the rise in prices are expected or to investments made in inefficient projects. The growth of inflation at faster rates than those observed in E1 induces a real appreciation of the exchange rates and a loss of competitiveness. Consequently the current accounts in E2 countries deteriorate and the only way to offset this is the inflow of savings and capitals from the E_1 zone with largely positive current accounts. The economic actors from E1 also begin to take risks, especially with regard to investments in E2, believing that their governments and the European institutions would be a sufficient guarantor.

[8] The vast majority of banks in Eastern Europe (part of E2) for instance are subsidiaries of European banks.

[9] This dynamics was also encouraged by the low international interest rates which were supported by the central banks of the leading countries, including the ECB.

In somewhat different analytical scheme the inflows of capital and cash from E1 to E2 could be considered as a kind of structural deformation of the production processes, a change in the inter-temporal restriction, destroying the set of economic preferences, sending wrong signals for consumption, investment and savings, etc.[10] Moreover, similar examples of interaction between E1 and E_2 can easily be found in European history. For instance, the German expansion in Southeast Europe and the Balkan countries during the 1930s carried similar traits of an attempt at creating a common production process, i.e. complementing the E1 production process with that of E2. This entailed the periphery specialising in those production segments, which were not developed in the core-countries, namely agriculture and the production of consumer goods[11] which in turn would make it possible for the realisation of the expanded production processes in E1.[12] To prevent the breakdown of the common zone, apart from exerting political and military pressure, Germany also applied a range of administrative economic measures such as clearings, differentiated exchange rates and other technical practices.[13]

Turning to the current situation resulting from the interaction processes between E1 and E2, as was already discussed, is characterised by euphoric and artificial growth in E2. Consumption grows at high rates, just as investment in real estate aimed at profiting from the increase in price. Similar is the case of public investment in long-term projects, which are mostly inefficient and futile.[14] This accelerated economic activity creates the illusion of sustained growth of income and welfare. That in turn fuels *anew* the overall risky behaviour and accumulation of debts while falling short of generating in the same degree a growth of collateral and guarantees to match claims hereinafter denoted as Φ.

Within Φ, which is public by nature, visible and sound insurances (F) – most commonly in foreign reserves – decline considerably, as are fiscal surpluses in some countries, etc. at the expense of implicit, expected, virtual guarantees (V). However the free insurance and hidden subsidies would increasingly disappear. Finally, it becomes clear that the common guarantee fund ($\Phi = F + V$) is depleted and insufficient to cover for the liabilities (D) accumulated in E2. Then the European institutions and E1 countries prove to be a virtual anchor dangling in the air. Once free insurance has melted, the real explicit interest margin ($r_2 - r_1$) starts to decrease

[10] See for more Garrison (2001).

[11] Today, deindustrialization of E2 countries is increasingly a topic of discussion; see for example the analysis by Natixis (2011) and ECB (2012).

[12] Some allusions to this type of processes are given in the well-known book by Gottfried Haberler (1946 [1937]), as for instance in pp. 68–71. Of course, the issues of capital export, imperialism and colonialism are at the core of Marxists' theory (Rosa Luxemburg, John Hobson, *etc.*) and even of studies by non-economists like Hannah Arendt (2002 [1948]).

[13] See Fisher (1939), Guillebaud (1940), and Einzig (1941). It is interesting to note here that Hitler categorically refused to introduce the *Reichsmark* as an official currency in Southeast Europe as he believed that preserving the national currency makes the zone more resilient see Einzig (1941).

[14] This is a kind of evidence of maximal stretching of economic processes when the time horizon is extended to its maximum (long-term investments), or is maximally shortened (consumption) and destroying the middle sections of the economic process.

and to converge to the implicit margin ($r_2 - r_1 - \varphi$), where r_2 stands for real rates in E2, and r_1 in E1. The limits of this mechanism became clearly evident after the first signs of the global crisis. The private debts in several countries from E1 and E2 were nationalized and became public. The E2 public debts in turn started to be monetized by the ECB and became *de facto* E1 public debt. This logic of transforming debts has been explained on numerous occasions and will not be elaborated here.

3 Formal Presentation of the Model

The above cause-and-effect links can be represented with the following system of linear equations illustrating the relations between E1 and E2 (the model is purely illustrative, hence the linearity of relations).

$$D = \alpha_0 + \alpha_1(r_2 - r_1) + \alpha_2(-\Delta\varphi) \tag{1}$$

$$r_2 - r_1 \equiv i_2 - i_1 - \Delta\pi \tag{2}$$

$$(-\Delta\varphi) = \beta_0 + \beta_1\Phi \tag{3}$$

$$\Phi = V + F \tag{4}$$

$$V = \gamma_1\lambda_1 \tag{5}$$

$$F = \gamma_2\lambda_2 \tag{6}$$

$$\lambda_2 = \eta_0 - \eta_1\lambda_1 \tag{7}$$

Equation (1) shows the movement of resources (savings and credit) from E1 to E2 i.e. the accumulation of liabilities D in E2 as a positive function of the difference in real risk-free interest rates (r_1–r_2), and a positive function of the "EU-accession premium" (the risk-free insurance) denoted ($-\varphi$). Identity (2) shows that the real interest rate differential (r_1–r_2) presents the nominal interest rates differential (i_{1-2}), adjusted for inflation through the differential ($\Delta\pi$). Equation (3) shows the link between the insurance fund Φ and the European premium($-\varphi$). In identity (4) we can see that the guarantee fund is composed of visible guarantees, mainly foreign reserves, F, and implicit or virtual guarantees V. The relation (5) shows the virtual guarantees V as a function of the credibility of the European anchor (λ_1) and relation (6) – the real F as a function of the EU-rules compliance discipline effect (λ_1).

And finally (7) shows the relationship between the discipline effect (λ_1) and the effect of EU credibility, i.e. the insurance, (λ_1). Presumably, in time, credibility and discipline will move to opposite directions, i.e. the insurance, along with the belief that one would be saved if any problems arise, undermine the system and lead to the

accumulation of debts and bad investments.[15] In other words (and somehow paradoxically), the more credible the EU is in applying and enforcing its policy, the less capable it is of insuring individual states' discipline in the periphery. Consequently, during the "bad" part of the dynamics the robust guarantee weakens discipline, thereby deteriorating the overall condition of Φ, which can no longer cover for D, and that in turn increases risk and eliminates the free insurance, thus reducing the interest differential. Capitals start flowing out from E2 and back to E1 or elsewhere, which paralyses credit and hinders economic activities in E2.

The parameters and α_0, α_1, β_1, β_2, γ_1, γ_2, η_0, and η_1 in the above system of linear equations are positive. By simply transforming the system of equations (1, 2, 3, 4, 5, 6, and 7), we can obtain the partial derivatives, i.e. the condition (8), under which the liabilities, debts (D) in E2 grow persistently as a result of the credibility effect in the European system (λ_1), is as follows:

$$\frac{dD}{d\lambda_1} > 0, \quad \text{or} \quad \gamma_2\eta_1 < \gamma_1 \tag{8}$$

The two multipliers are different combinations of the ratios between the three elasticities: γ_1, $\gamma_2$and η_1. One should keep in mind that $\gamma_1$is the change in implicit guarantee as a reaction of the credibility in EU and γ_2 shows how the visible, explicit insurance, mainly foreign exchange reserves and budget surpluses, react to the EU disciplining influence. Also, η_1 shows the degree by which credibility destroys discipline.

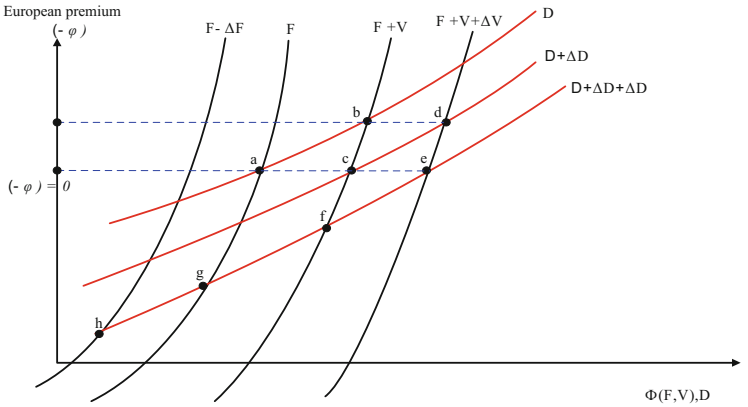
Thus, according to (8) for instance, debts and liabilities in E2, marked by D, will increase as a result of the EU credibility as long as the product of the elasticity with which discipline generates foreign reserves, and the elasticity of loosening discipline as a result of EU, is lower that the elasticity of credibility in the virtual anchor – the belief that one will be saved.

The insurance and self-disintegrating power of the European project can also be presented *graphically*.

The free European premium (or risk subsidy) in the interest rate differential is shown on the vertical axis and is equal to $(-\phi_1)$. The horizontal axis shows forex reserves F, virtual guarantees derived from EU-membership V, and liabilities that have to be insured D. All these variables are characteristic features of the peripheral E2 countries. Assuming that the European insurance game starts at point a, where V is suddenly added to forex reserves as a result of the virtual guarantees of EU (which are in most cases accompanied by real cash flows from the European integration funds) thus arriving at $(F + V)$.

The equilibrium is forthwith shifted to point b, where the European insurance appears. As mentioned above, it is not taken into account in the interest margin, but is instead a kind of a hidden subsidy. Core E1 countries' investors strive to use this

[15] This negative relationship, which can be subject to empirical validation, has been emphasized in Ialnazov and Nenovsky (2011) and Nenovsky and Villieu (2011).



Graph 1 Insurance game dynamics

insurance and so E2 liabilities towards E_1 increase ($D + \Delta D$). In point c, this premium is once again eliminated. Then one can assume that the European rhetoric and way of thinking augment the virtual guarantees up to ($F + V + \Delta V$). This again leads to the emergence of a premium in point d and again there is an inflow of foreign savings ($D + \Delta D + \Delta D$). The premium is once again eliminated in point e. At that point, a range of processes become clearly evident in the real economy of E2 which have developed slowly and imperceptibly, yet irreversibly. What is implied here is consumption and lending growth, higher incomes, loss of competitiveness and in general deterioration of current accounts. The increased consumption in E2 is offset by an inflow of savings from E1, whose current accounts are largely positive, increasing D once again. Forex reserves in E2 start diminishing quickly as part of ϕ and are increasingly replenished by virtual guarantees, i.e., within ϕ the portion of F is progressively declining and is being replaced by V.

An inflexed point is reached where the premium becomes negative, i.e. the liabilities need to cover not only F but also ($F + V$). At a moment like these virtual guarantees cannot replace the real ones, which have in turn declined and a point h is reached. That is a point of crisis, when E2 economy totally shrinks and effectively diverges from E1. The premium is negative and a run-up on deposits and outflow of capitals to E1 is observed. In order to handle this negative premium, either liabilities D have to shrink further, which translates into banking, lending and real economy failure, or create a new project, new virtual guarantees that would increase the guarantee fund. The latter is very difficult to realize. Thus, the total sequence of moves presented in Graph 1 is from point a to point b, then to c, then to d, then to e, then to f, then to g, and finally to h. The scheme presented thus far aims to illustrate the internal instability of the European project, which contains genetic processes leading to its breakdown.

4 Collateral Structure and Risk Transmissions

It is obvious that the size, strength and structure of collateral in relation to E2 are essential in putting forward the idea of the internal vulnerability of the European Union and its breaking down into at least two segments: a core E1 and a periphery E2. As was already presented in an as simple way as possible, the collateral ϕ is composed of an explicit F and a virtual V part with the boundary between them being often blurred.

F in general includes the net external assets of E_2, in particular forex reserves, public by their legal nature and shown on the asset side of the central bank's balance sheet. Such type of collateral could also include the government's fiscal surpluses and fiscal reserves held either with the central bank or with commercial banks. To various degrees, F are pooled in the form of institutions such as Deposit Insurance, Lender of Last Resort, Too Big to Fail, Too Interconnected to Fail, etc., intended to ensure guarantees to interfere in times of crisis, and which are not always backed by real funds (savings).

The implicit and virtual guarantees V extend to some oral and gentlemen commitments and non-formal promises to help E2, made by the economic agents of E1 and at a supranational level, governments and ECB in particular, as well as a number of private institutions. They are all, in a sense, guarantees for risk taking in E2. It is important to note that as the insurance game evolves over time, the F guarantees in the guarantee pool Φ smaller and smaller and eventually transform into virtual. Hypothetically, a point of time can be reached where $\Phi = V$.

Developments take an even more interesting turn if we look into the nature of explicit guarantees F of E2. F is composed for its greater part of E1 securities, internal debt of the E1 countries. If we take for example the case of Bulgaria, nearly all of the currency board assets (except gold) are invested in European securities (as the crisis evolved they were more and more restructured into German and northern Europe securities) and euro cash. These securities carry the risks of E1 debts as well as possible euro collapse. A configuration is reached whereby the E_2 currency, which is debts of their public monetary institutions, is de facto covered by other debts, those of the E1 governments. A closer and unbiased look will reveal that what is considered an external and risk-free anchor, a visible and obvious resource for the countries in E_2, is actually a guarantee, which is risky and virtual by nature. The monetary system in E_1 does not have any external anchor as becomes all the more clear when the two zones are looked upon as one whole. Even the euro banknotes, which are part of E2forex reserves, are also ECB debt. Besides, this debt of the ECB is again covered by E1 governments' debt – a process, which becomes obvious with the evolution of the crisis. An accumulation of debts takes place and a pyramid of debts is formed which does not have any external anchor.[16] Or, in summary, we could say that for its greater part, the European guarantee fund of E2

[16] Of course, the experts are aware of this, but they nevertheless keep saying that money is confidence and the banking and financial systems are confidence. This, however, does not change

is virtual, which becomes even clearer with the acceleration of the insurance game and even more so with the evolution of the crisis.

Let us look at some of the channels via which the European integration triggers the increase of risk and its wrong redistribution, leading "unexpectedly" to its collapse.

In the first place, let us look at the incentive coming from the flow of resources (savings and cash) from E1 to E2, which can take various forms. Two groups could be mainly distinguished: those of private savings from E1 and those of the European funds (pre-accession, structural or cohesion, and all others of this kind). If we look at the cohesion funds in particular (which although under-absorbed), have detrimental implications for E2's macro-economy. In the first place, these funds enter as liabilities of E2 banks, which automatically reduce the guarantee funds. Besides, they create very harmful practices of cronyism, corruption and banditism, although we are constantly assured that actions are undertaken to counteract these. Basically, these funds boost credits and through the various fraudulent schemes are most commonly channelled to sectors which rely on speculative increase in prices, such as the construction, real estate sectors, and others. Hence, the upward pressure on salaries, incomes and catching-up movement of prices in general. It is exactly this last one that leads to "eating up" free European risk subsidy ($-\Delta\phi$). As a whole, the flow of resources undermines the system of economic agents' preferences and encourages the emergence of all sorts of bandit, venal and non-market strategies.

Secondly come the channels, via which, as a rule, *institutions and rules* are mechanically transferred from E1 to E2. These institutions, being adjudicated over E2 circumstances, lead to a range of "perverse and unexpected outcomes" by often changing behaviours in a direction opposite to what was expected.[17] One such example is the pre-accession closing of chapters of the EU legislation, whereby a number of directives were imperceptibly adopted, which in an E2 context induced more risk taking. Such was, for instance, the deposit insurance directive, which required the insurance of deposits of up to 20,000 euro per individual, and later that was raised to 100,000 euro. In the case of E2, this was effectively translated into covering practically all deposits as the average deposit size is too small. This resulted in a curious guarantee of the whole banking system (much like the practice during the socialist period) with all familiar mechanisms of moral hazard and risk underestimation. This is one example of institution that leads to the emergence of the above discussed European premium (or premium for enlargement) and which becomes a major transmission channel. Furthermore, from a broader perspective, the process of adoption of E1 legislation in E2 has led to the emergence of a specific "legal illusion" according to which European integration is a process of "legal" and

things; under the gold standard money is confidence too, backed however by real worth outside the system that is nobody's debt.

[17] The transfer of institutions and their wrong utilization has been object of numerous studies, more often in the light of transitional economies see Polishchuk (2008) and less often in the context of EU enlargement.

nominal convergence with economic, real convergence following only too naturally and under the control of bureaucrats and politicians. Paradoxically, countries where Marxism prevailed have forgotten that, although important, legal and political processes cannot replace the need for structural economic changes.[18]

Thirdly, an interesting channel, although in a different context, has been examined very well by Dowd et al. (2011). Before the appearance of the E2 premium, during the initial drop in real interest rates in E1 in early 2000 the capital as a cheaper production factor began to replace labour and to expand and lengthen the production structure. An inflow of labour force from E2 to E1 was observed and a great number of delocalisations or, generally speaking, the labour in E1 was replaced by capital from E1, or by labour from E2. At the time of enlargement and the appearance of the premium in E2, the capitals from E1 began to get channelled to E2, where a process of substitution of the labour force with capitals began to be observed as well. Here, however, the substitution processes came to a standstill because the work force in E2 was depleted and there was nothing to replace it. After a period of time, a labour force shortage started to show – a fact well familiar in the E2 countries, especially in the construction and services sectors. Ultimately, a point was reached where the salaries and incomes in E_2 increased, unit labour cost and inflation went up, and productivity and competitive power declined.

Concluding Reflexions

In this paper we have presented an analytical model which we have referred to as "insurance model" allowing a relatively good explanation of the EU internal instability and of the processes that led to the current crisis. The endogenous dynamics of disintegration, to put in the simplest way, is caused by the aspiration to use a "*free insurance*" in peripheral Europe, the insurance itself being the outcome of the emergence of a large guarantee fund either explicit or virtual (promises among others). Certainly, the model holds much in common with the moral hazard models, with some of Dooley's theoretical formulations (Dooley 2000), and with a number of other models which have been increasingly making their way not only into the theory but also into the economic policy of European Union.

First, from a theoretical and empirical perspective, one of the direction for future research is to study each of the relations in the model: between the guarantee fund (collateral) and the free insurance (risk underestimation); the

[18] It should also be noted that the "state-bureaucratic" and legal way of understanding convergence has brought the E2 economic actors closer to the state and to the European civil servants and has made them dependant on these. This proximity has further intensified the sense of security and guarantees naturally boosting "bad behaviour", i.e. raising the overall risk level; hence, the conclusion that in general the presented insurance model is of stronger impact in countries with venal and bandit economic structure. Yakovlev et al. (2010) offer an interesting analysis of the behavior of Russian companies, which, due to their close relationship with the state, assumed higher risk and actively borrowed from abroad. Later, during the crisis, they were discretionarily bailed out. At the same time, Russian savings were exported.

mechanisms of formation of the insurance fund and its structure; the link between the confidence, credibility effect and the discipline effect, which can be presumed as non-linear, etc.

Second lesson and more importantly, with regard to the economic policy on a national and European level, we need to look for the *institutional mechanisms* which, in short, could prevent the emergence of the insurance game, hence the processes of internal disintegration of the European economy. Although much needs to be done both theoretically and empirically, as pointed above, the philosophy of economic measures is generally clear. It has to do with a reduced guarantee fund, less promises of assistance (bail-out), less flows towards the periphery, stricter control mechanisms over these flows, etc. A note should be made that some of these ideas, although slowly and with difficulty, have been making their way into the policy of European institutions. In this light we could see some of the measures in the fiscal policy and fiscal control. On the other hand, the efficiency of the various types of newly established guarantee institutions as regards the financial and banking system, the mechanisms of bailing out distressed and insolvent countries, the issue of a common, supranational debt, etc., is questionable (of course from the standpoint of the presented model).

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The Danger of Tax Havens for Financial Stability

Andreas Buehn and Daniel Kraaijeveld van Hemert

Abstract

The concerns about tax haven activity shown by leading nations originate not only from a sense of injustice caused by the fact that tax havens allow multi-billion dollar firms such as Google, Starbucks and Apple to pay only a few pennies in taxes but the notion that tax haven activity fuels international financial instability through various avenues. This contribution evaluates the risk of financial collapse or liquidity crisis to tax havens in general. It shows that tax havens are more exposed to the risk of a financial collapse than non-tax havens and that this risk positively depends on the amount of profits shifted to them. We find that the risk of a tax haven collapse is positively related to the corporate tax rate and MNCs are willing to make more daring investments in tax havens the higher corporate tax rates. However, MNCs take the risk of losing their investments due to a financial collapse into account and hence invest only a fraction of their profits in tax havens.

1 Introduction

During the Moscow G20 summit held in July 2013, leading nations voiced their intention of counteracting tax haven activity of multinational corporations (MNCs). Tax havens – used by MNC to reduce their tax bills – are countries with a favorable fiscal regime that MNCs use to avoid and evade taxes (Dharmapala 2008). Tax havens are typically small open economies with an insignificant real sector and scarce natural resources (Dharmapala et al. 2009). However, due to the financial activity resulting from tax avoidance by MNCs, tax havens are also some of the

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richest countries in the world in terms of GDP per capita, indicating that these activities have both highly positive effects for MNCs and the tax havens themselves.

However, the concern about tax haven activity shown by leading nations at the G20 summit in Moscow originates from another problem created by tax havens. A large part of these concerns stem from a sense of injustice caused by the fact that multi-billion dollar firms such as Google, Starbucks and Apple pay only a few percent in income taxes, while the profit taxes paid by smaller, non-multi nationals are much higher. Furthermore it is suspected that tax havens, and the economic activities they enable, harm high tax countries' economies. Slemrod et al. (2009) show several reasons why tax haven activity can be harmful to high tax countries. They describe tax havens as parasitic countries, which harm the economies of non-tax havens. In a model including both tax havens and non-tax havens they find that the existence of tax havens gives high tax countries the incentive to lower their taxes and compete with tax havens and other high tax countries to attract economic activity in the form of MNCs. They find that this competition greatly degrades high tax countries' corporate tax base due to the lowered tax rates in addition to the avoided taxes themselves. It is argued that the degradation of high tax countries' tax base has to be compensated, which means that a large part of MNCs tax burden would be shifted to other economic actors such as non-multinational corporations. Secondly Slemrod et al. (2009) find that tax haven activity causes high tax countries' governments' costs to rise as a result of the monitoring financial activities to ensure they are legal and the prevention of excessive tax avoidance. These two effects of tax havens found by Slemrod et al. (2009) lead them to a clear conclusion, namely that tax havens pose a hazard to high tax countries and that international actions taken against tax haven activity are justified and necessary.

The concerns about the economic threat that tax havens pose to high tax countries may be debatable. When considering MNC's avoidance of taxes it can simultaneously be concluded that MNC's profits will be higher due to lower costs. This leads to the employment of more workers, higher investments in non-tax havens and higher wages. This causes an expansion of high tax governments' tax bases and has widespread positive economic implications for high tax countries. Furthermore the spurring effect on tax competition is not uncontested. In a model mimicking the incentives for high and low tax governments, Johannesen (2010) finds that the existence of tax haven actually mitigates the tax competition between high tax countries. The empirical evidence with respect to the degrading effect of tax haven activity on high tax countries' tax base is not unequivocal. In an analysis of governments' income from corporate taxation in European countries, Weichenrieder (2005) found that although the corporate tax rates dropped during the period in which tax haven activity increased, the income from corporate taxation compared to the total income from taxation did not decrease. This supports Slemrod and Wilson's findings that tax haven activity spurs tax competition, however not that it degrades high tax countries tax bases. Dharmapala (2008) finds that in the US neither the proportion of income from corporate taxation nor

the corporate tax rate dropped significantly as a result of increased tax haven activity. These finding show that the expected effects of tax haven activity on the tax bases of high tax countries are not as blatant as expected by Slemrod and Wilson.

While the harmful economic effects on high tax countries' economies are not undisputed, one of the main concerns about tax haven activity is that it causes international financial instability through various avenues. This contribution inquires into a specific type of financial instability that is caused by tax haven activity. The crises of Iceland in 2008 and Cyprus in 2012 are examples of this. Originating from a bank run caused by a bank's low credibility to repay their clients and resulting in an en masse withdrawal of deposits, a bank run can spread rapidly to other banks, leading to a nation wide liquidity crisis. In particular, if a country's financial system has specific characteristics producing low confidence in banks, bank runs can happen more readily on a national level and may cause that country's whole financial system to collapse. Diamond et al. (1986) analyzed bank runs in a simple model and found that the most important method of bank run prevention is a deposit insurance scheme. Analyzing the Icelandic economy before the 2008 financial crisis, Buiter et al. (2008) found that the Icelandic banks held debts in such a large amount compared to the national economy (measured in GDP) that the government could not realistically guarantee deposits. Furthermore large parts of these debts were in foreign currency, meaning that the central bank could not supply additional currency to cover the deposits. These are characteristics that are present in many tax havens, which typically have large financial sectors compared to their real economies and deposits are often denominated in foreign currency.

This contribution evaluates the risk of financial collapse or liquidity crisis to tax havens in general. It shows that tax havens are exposed to such risk to a larger extent than non-tax havens, and that this risk positively depends on the profits shifted to them. Another hazard caused by tax haven activity comes in the form of illegal activities such as money laundering, for which we presents recent estimates. Finally an analysis is presented, which imitates MNCs decisions to export profits to tax havens, taking into account both the risk of tax haven default and the corporate tax rates in high tax countries and offers insights for tax haven as well as high tax governments with respect to how they should act in order to ensure international financial stability in the long run. The rest of the contribution is organized as follows. Section 2 discusses the risk of tax haven investments and presents estimates for money laundering, an activity often pursued in tax havens. Section 3 presents the analysis. Section 4 concludes.

2 The Risk of Investing in a Tax Haven

The basic principle of a banking crisis is quite simple. Banks play an enormously important role as they settle payments, fulfil the tasks of credit intermediation and maturity transformation and create money. In their business, banks accumulate vast

amounts of deposits, which they have to be able to pay out at any given moment. Therefore banks need to hold liquid assets in order to make such short-term payments. On the other hand, for the banks to generate profits they invest into are much longer term assets. In normal times, the amount of liquid funds banks hold is typically sufficient to pay the average short-term liabilities. However, in times of generally low credibility it may happen that at a certain moment a large number of creditors to the bank want to withdraw their money, which can cause the bank to be short on liquid funds. Even if only such fears in the economy develop, bank runs may occur and a whole financial system may collapse due to contagion effects. Diamond et al. (1986) showed that in order to prevent bank runs, it is essential to establish a deposit insurance system.

In most countries the state or some semi-public institution acts as a lender of last resort, in other words, it guarantees investments in banks at least to a certain amount (Buiter et al. 2008). This is exactly the kind of deposit insurance that if it is viable, can stabilize financial markets and prevent bank runs from occurring. In recent years however, two tax havens' financial sectors – i.e. the Icelandic in 2008 and the Cypriote in 2012 – collapsed despite their governments offering a deposit insurance in addition to that offered by the EU on deposits up to 100,000€ (Gumbel 2013).

Why was it impossible for the Icelandic government to act as a lender of last resort in order to save the banking sector? Buiter et al. (2008) mention two main reasons. The first is that the Icelandic financial sector before the collapse was disproportionately large compared to the national economy. The reason why Iceland's financial system became as large as it did might be related to it being a tax haven. The fiscal advantages of investing money in tax havens leads to high amounts of inward FDI – combined with the fact that tax havens are typically small countries with few natural resources and a small industrial sector Dharmapala et al. (2009) – means that the high levels of FDI go primarily into the financial sector explaining the overgrown banking system in e.g. Iceland. This trait can possibly be generalized to other tax havens as well. A simple bar chart as in Fig. 1 supports this. One can even see with the naked eye that tax havens on average indeed attract far larger amounts of FDI compared to GDP than non-tax haven countries, which due to their small real sectors – are usually channelled into the financial sector. This trait of tax havens may mean that they indeed carry an additional risk of financial instability due to the national government not being able to realistically act as lender of last resort. In addition, large amounts of the liabilities are typically denominated in foreign currency, a problem that Buitner and Sibert (2008) mention particularly for Iceland. This worsens the situation, as the government cannot simply use the printing press to bail out its banks.

As national governments of tax havens cannot offer realistic deposit insurance for investments when their financial sectors have outgrown their national economies, banking sectors of tax havens are especially prone to bank runs. This suggests that tax havens have an increased risk of financial collapse, a risk that grows proportionally to the overdevelopment of the financial systems and continues as long as the tax haven activity is intensive.

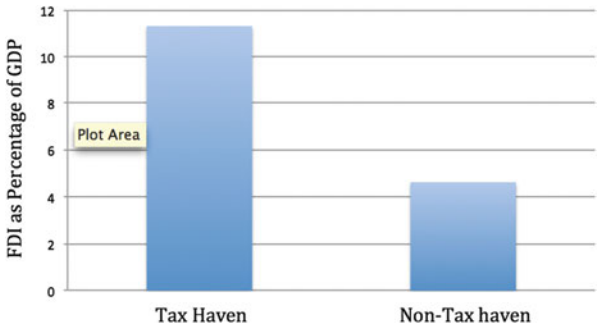

Fig. 1 FDI/GDP in tax havens and non-tax havens (Note: the data set includes 189 countries for which data on inward FDI was available for the period 2003–2011 (Worldbank 2013). The data set includes 31 tax havens from various black-/grey-lists as compiled by Gravelle (2013) and 158 - non-tax haven countries)

Tax havens are not only attractive destinations for "legal" investments but for laundering money from illegal activities such as drug trade and smuggling. Schneider (2008) estimates that money laundering and/or financial turnover from transnational crime has increased from USD 273 billion (1.33 % of the total official GDP) in 1995 to USD 603 billion (or 1.74 % of the official GDP) in 2006 in 20 OECD countries (Australia, Austria, Belgium, Canada, Denmark, Germany, Finland, France, Greece, Great Britain, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Switzerland, Spain and the United States).

Unger (2007) estimates the amount of laundered money and its top 20 destination countries; these figures are shown in Table 1 covering the time span 1997–2005. The table presents two estimates, one by Walker (1999) and one by the IMF. The Walker figure of 2,850 billion USD is much larger than the IMF figure of 1,500 billion USD (both figures are for the year 2005). Walker's figures have been criticized as being much too high, which is one reason why the IMF estimates are shown, too. Table 1 also shows that two thirds of worldwide money laundering was sent to the top 20 countries listed. One should realize that most of these countries are highly developed and have quite sizeable legal/official economies. However, amongst them are quite a few countries that are often classified as tax havens such as the Bahamas, Bermuda, the Cayman Islands, Liechtenstein, Luxembourg, the Netherlands and Switzerland. Table 1 shows that those countries are very attractive destinations for multiple reasons: firstly, they allow international investors to significantly reduce their tax bill and secondly, to launder money earned with illegal activities. However, it needs to be emphasized that it is not clear whether this money is "only" laundered in these countries or remains in these countries; it may well leave these countries after the laundering process. In general, Table 1 demonstrates how substantial the amount of laundered money is and how attractive tax havens are not only for FDI, but also as haven for illegal proceeds.

In their latest study, Walker et al. (2009, p. 821) attempt to measure global money laundering and/or the proceeds from transnational crime pumped through

Table 1 Top destinations for money laundering, year 2005

Rank	Destination	Worldwide money laundering (%)	Walker estimate of 2.85 trillion US$ (amount in billion US$)	IMF estimate of 1.5 trillion worldwide (amount in billion US$)
1	United States	18.9	538,145	283,500
2	Cayman Islands	4.9	138,329	73,500
3	Russia	4.2	120,493	63,000
4	Italy	3.7	105,688	55,500
5	China	3.3	94,726	49,500
6	Romania	3.1	89,595	46,500
7	Canada	3.0	85,444	45,000
8	Vatican City	2.8	80,596	42,000
9	Luxembourg	2.8	78,468	42,000
10	France	2.4	68,471	36,000
11	Bahamas	2.3	66,398	34,500
12	Germany	2.2	61,315	33,000
13	Switzerland	2.1	58,993	31,500
14	Bermuda	1.9	52,887	28,500
15	Netherlands	1.7	49,591	25,500
16	Liechtenstein	1.7	48,949	25,500
17	Austria	1.7	48,376	25,500
18	Hong Kong	1.6	44,519	24,000
19	United Kingdom	1.6	44,478	24,000
20	Spain	1.2	35,461	18,000
	SUM	67.1	1,910,922	1,006,500

Source: Unger (2007: 80)

the financial system worldwide. They criticize methods such as case studies, proxy variables, or models for measuring the crime economy, arguing that they all tend to under- or overestimate money laundering. They present a gravity model, which allows estimating the worldwide flows of illicit funds from and to each jurisdiction. This "Walker Model" was first developed in 1994, and was recently updated. Walker et al. (2009) demonstrate that the original Walker Model estimates are compatible with recent findings on money laundering. Once the scale of money laundering is known, its macroeconomic effects and the impact of crime prevention, regulation and law enforcement effects on money laundering and transnational crime can also be measured. Walker et al. (2009, pp. 849–850) conclude that this model seems to be the most reliable and robust method to estimate global money laundering and tax haven activities, and as such the effects of transnational crime on economic, social and political institutions.

3 Does Shifting Profits to Tax Havens Affect Financial Stability?

Shifting profits to tax havens goes hand in hand with a certain risk of losing that investment due to a banking crisis caused by a bank run in that tax haven. Using a simple analysis[1] we explore to what extent MNCs shift their profits into tax havens and how this affects the risk of a tax haven collapse. We assume two countries, a high tax country with many MNCs and a low tax country, i.e., the tax haven, into which the profits may be shifted to reduce the tax burden and/or to hide capital.

MNCs are homogeneous and minimise their tax burden and the capital they might lose due to a financial collapse of a tax haven. MNCs operating in an industrialized high tax country earn a profit P in a given year. For simplicity we normalize P to one and assume that MNCs choose to shift a fraction q of their profits into the tax haven. That is, $0 \leq q \leq 1$. The amount of capital that is not shifted to the tax haven is taxed at the corporate tax rate t in the industrialized country. No taxes apply to the fraction q of profit shifted into the tax haven. However due to the risk of a banking crisis within the tax haven's financial system, firms may lose their investment with probability π. For simplicity we assume that the full investment is lost in case of a financial collapse in the tax haven. The risk of a tax haven collapse increases as investment in the tax haven increases; therefore π is a function of q (as P is assumed to be constant). In addition, the tax haven has an exogenous marginal risk of investing in that tax haven, which is assumed to be a constant α. This setup yields the following risk function: $\pi(q) = \alpha q$. When deciding whether to export profits to tax havens MNCs take the cost from taxation C_t and the expected costs of a potential banking crisis C_c into account. Equations (1) and (2) show how these costs can be calculated as functions of q. The cost of taxation in the high tax country C_t are given by the tax rate t multiplied by the fraction of profit that remains in the high tax country, i.e., (1-q)P:

$$C_t = t(1-q)P = t - tq \tag{1}$$

The expected cost of investing in a tax haven is calculated by taking the product of the tax haven's riskiness π times the amount of capital shifted to the tax haven qP:

$$C_c = \pi qP = \alpha q^2 \tag{2}$$

The total cost C MNCs incur due to lost profits and taxes is the sum of these two types of costs as shown in (3.1) and (3.2):

$$C = C_t + C_c \tag{3.1}$$

[1] The analysis and the findings presented are adapted from Kraaijeveld van Hemert (2013).

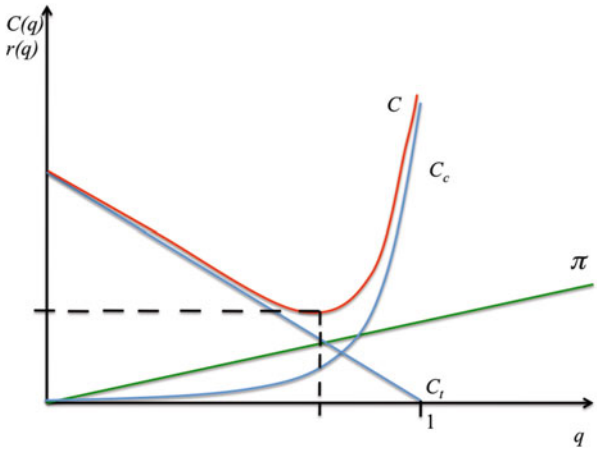

Fig. 2 The costs of a tax haven investment

$$C = \alpha q^2 - tq + t \tag{3.2}$$

Figure 2 illustrates the risk of a tax haven collapse π, showing the MNCs' cost of taxation C_t, the MNCs' expected cost of a tax haven investment C_c and the MNCs total cost C as functions of q.

C is a positive quadratic function of q. MNCs will always export a fraction q of their profits to the tax haven so that they incur the minimal amount of total costs, and thus maximize their expected after tax profits. Therefore in order to find the fraction of profits MNCs shift taking the risk of tax haven collapse into account, we minimize the cost function with respect to q:

$$\begin{aligned} \frac{\partial C}{\partial q}(q) &= 2\alpha q - t = 0 \\ q^* &= \frac{t}{2\alpha} \end{aligned} \tag{4}$$

All parameters on the right hand side of (4) are positive, non-zero values and q therefore takes a positive, real, non-zero value. The maximum value of q is one, in which case MNCs shift all of their profits to tax havens. Equation (4) shows that the fraction of profits shifted to tax havens q will only become smaller than one when the risk of a tax haven collapse is half the corporate tax rate. Taking US MNCs as an example, this means that the marginal risk of a tax haven investment α must exceed 0.2 in order for them to shift a less than all their profits to tax havens, given that the corporate tax rate in the US is 40 % ($t = 0.4$) (KPMG 2013). Equation (4) also shows the expected result that the fraction of profits q shifted to tax havens decreases when the exogenous riskiness α of a tax haven increases. Equation (5) below shows the cost incurred by MNCs choosing the optimal proportion of tax haven investment q *:

$$C(q^*) = t - \frac{t^2}{4\alpha} \tag{5}$$

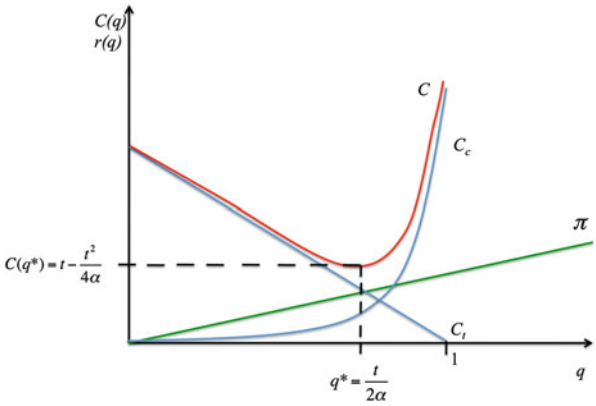

Fig. 3 The equilibrium fraction q * of profit shifting

No current estimates for the riskiness of tax havens α exist proposing an interesting avenue for future empirical research. The fraction of shifted MNC's profits q, corrected for other factors like the limitations caused by policies such as thin capitalisation laws and the arm's length principle, would have to be found. Using these estimates and the corporate tax rate, values for α could be calculated.[2]

Figure 3 illustrates the case in which the riskiness of a tax haven investment α is high and exceeds half of the corporate tax rate. The fraction of shifted profits q * then lies between 0 and 1. If the riskiness of a tax haven reduces the curve C_c shifts to the right and if it becomes lower than half of the corporate tax rate, MNCs minimize costs when q is equal to 1.

As can be seen in (4), q * is proportional to the corporate tax rate, and it is known that the risk of tax haven collapse increases with q. Equation (6) *below* shows the first derivative of the MNCs expected cost function with respect to q in order to find the equilibrium risk of tax haven collapse. The risk of tax haven collapse π linearly depends on the corporate tax rate set in the high tax country and is exactly half of that corporate tax rate. Of course, this risk is again constrained to a certain value, as q cannot exceed 1. Therefore regardless of the tax rate set by the government in the high tax country, the risk of a tax haven collapse can only be as high as the marginal risk of a tax haven investment α. Therefore only in the situation in which less than the full amount of profits is shifted to tax havens, the risk π depends on the tax rate t:

$$\begin{aligned} C(q) &= \alpha q^2 - tq + t \\ C(q) &= \alpha q^2 - tq + t \\ \pi &= \alpha q = \frac{t}{2} \end{aligned} \tag{6}$$

[2] Of course such research can only be fruitful if the riskiness of a tax haven investment exceeds half of the corporate tax rate in the high tax country, as otherwise q will be equal to *1*. This would result in a value of α being equal to half the corporate tax rate, while in reality it might be much lower.

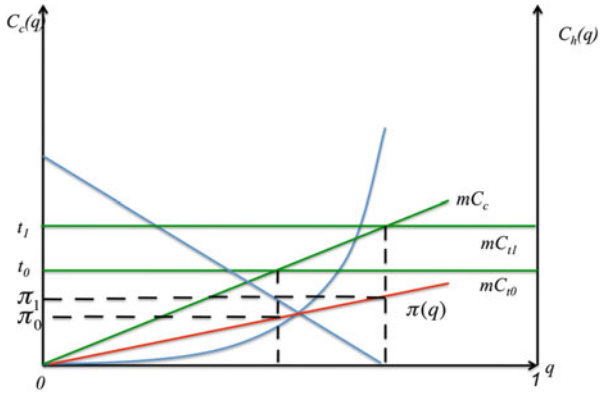

Fig. 4 The equilibrium risk of investing in tax havens

Governments of high tax countries must thus be aware that setting high corporate tax rates could increase the risk of tax haven collapse, which in turn can have a detrimental effect on other parts of the global financial sector. Lowering corporate tax rates, however, may let the financial systems of tax havens expand at a lower, more sustainable rate, which will reduce the risk of tax haven collapse and likely prevent further negative consequences.

Figure 4 illustrates the equilibrium riskiness of tax haven investments, equating the marginal costs and benefits of profit shifting as well as the equilibrium risk of a tax haven collapse. If the corporate tax rate t increases to mC_{t1} as shown in Fig. 4, the equilibrium shifts to the right, making a tax haven collapse more likely. It follows from (4) that in the case when q is lower than 1, tax haven governments can increase FDI by introducing policies, such as a higher liquidity rate of banks or more foreign currency reserves, which give the financial system more credibility. This reduces the riskiness of investment in tax havens, which will cause the fraction of exported profits to rise towards 1.

Equation (4) shows that the only case in which no profits are shifted to tax havens is when 'high tax countries' charge no corporate taxes. Only then will MNCs no longer export their profits to tax havens, which will prevent a further disproportional growth of their financial systems, leading to financial instability. Abandoning corporate taxes for MNCs altogether is not a likely policy measure taken by high tax countries. This means that the financial sectors of tax havens will become increasingly instable over time as MNCs continue to export their profits to tax havens. Hence, introducing regulations to ensure stability may be not only a reasonable measure for tax haven governments to keep inward FDI high but also essential to maintain international financial stability. If such policies are not enforced in tax havens and – like in the past – measures to counteract tax haven activity remain ineffective, governments in high tax countries may consider lowering corporate tax rates for MNCs significantly in order to avoid the frequent tumbling of tax havens' financial sectors in the future.

Conclusions

Tax havens are often seen as an imminent threat to high tax countries and the typical argument for this claim is as follows: Tax havens offer MNCs the opportunity to export their profits to countries where they pay only little or no effective taxes, which erodes the tax base in high tax countries. The other concern with respect to tax havens is its effect on high tax countries' governments' income from corporate taxes. The empirical evidence for the effect of corporate tax avoidance on government income is however scarce. Dharmapala (2008) finds that although tax haven activity by US MNCs has grown tremendously over the last decades, due to ever-increasing capital mobility, the proportion of government income from corporate tax has not fallen significantly. Weichenrieder (2005) reports similar findings regarding income from corporate taxation in Europe and argues that the reason is that corporate tax rates have dropped significantly due to increased tax haven activity. However, the proportion of government income from corporate taxes did not decrease significantly, which suggests that that these results are to some extent influenced by other factors such as economic downturns or crises. In contrast, the effect for tax havens themselves seems to be positive. Dharmapala and Hines (2009) find that compared to comparable countries tax havens have significantly higher levels of wealth, infrastructure and welfare, making the total effect of tax haven activity ambiguous.

This contribution proposes an additional risk of tax havens, namely the risk of a tax haven's financial collapse such as the ones of both Iceland in 2008 and more recently of Cyprus in 2012, which suggests that MNCs should take the riskiness of a tax haven investment into account when deciding what fraction of their profits to export to tax havens. In a simple analysis we find that if the risk of investing in a tax haven is indeed taken into account and the expected marginal costs of that investment exceeds half the corporate tax rate, MNCs will only invest a fraction of their profits in tax havens. We also find that the risk of a tax haven collapse is positively related to the corporate tax rate and MNCs are willing to make more daring investments in tax havens the higher corporate tax rates. More investments in tax havens increase the risk of a tax haven collapse. Over time and if corporate tax rates remain high, MNCs will keep exporting their profits to tax havens and the marginal risk of collapse will increase further as long as MNCs export exactly half of their profits to tax havens and the risk of a tax haven collapse becomes half of the corporate tax rate.

The higher the riskiness of a tax haven gets, the more likely it is that its financial systems collapses. This can have detrimental effects not only for the tax haven but also for the global financial system and the companies that invested in tax havens. These companies are mostly "located" in high tax countries and the tax havens' collapse may be directly mediated to the economy of those high tax countries. Looking at the big picture it might be wise for governments in those high tax countries to reduce their corporate tax rates to lessen the investments made in tax havens and thus slow down the growth of financial sectors in tax

havens. On the other hand to ensure long-term financial stability in tax havens and to maintain MNCs investments, tax haven governments should find a way to become a more credible lender of last resort, for example by holding more foreign currency. Secondly, tax haven banks should be required to hold more liquid assets, which will also make the likelihood of a bank run smaller. Basel III, requiring banks (not necessarily in tax havens) to hold larger amounts of liquid assets, is one example of restrictions placed on banks to ensure that they become more resistant (ECB 2013). The financial sectors of tax havens may also benefit from this in the long run as the risk of tax haven investment may decrease.

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The Evolution of International Geo-Political Risk 1956–2001

Ephraim Clark and Radu Tunaru

Abstract

In this paper we study the characteristics and evolution of international geo-political risk between 1956, the end of the Korean War, and 2001, the beginning of the War on Terror. To this end we propose a database of political events with global impact that substantially increased uncertainty in the international political, economic and financial environment over the period. Since the nature of the data we analyze falls outside the realm of classical statistical inferential methods that require repeated random independent experiments, we use Bayesian Hierarchical/Markov Chain Monte Carlo modeling techniques to obtain inference. We find that the average arrival rate for geo-political events is about one per year, but arrival rates are non symmetrical and vary through time. Interestingly, we also find that there is a statistically significant, negative time trend in the arrival rate, which suggests that geo-political risk was decreasing over the period.

1 Introduction

In this paper we study the characteristics and evolution of international geo-political risk from 1956 to 2001. International geo-political events have been a fact of life since the end of the Korean War. The Suez crisis of 1956, the Cuban missile crisis of 1962, the oil embargo of 1973, and the debt crisis of 1982 are some of the most obvious examples. Combined with the ongoing "globalization" process, more recent events, such as September 11, 2001 and the war in Iraq, are powerful

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reminders of the importance of the international aspect of political risk and the effect it can have on individual countries around the world.[1] However, despite the consequences that international events can have on the political, economic and social conditions in individual countries, the political risk literature either ignores this aspect or treats it indirectly. Root (1973), for example, focuses on country specific characteristics that he divides into transfer risks (potential restrictions on transfer of funds, products, technology and people), operational risks (uncertainty about policies, regulations, governmental administrative procedures which would hinder results and management of operations in the foreign country), and, finally, risks on control of capital (discrimination against foreign firms, expropriation, forced local shareholding, etc.). Robbock and Simmonds (1973) look at country specific political events that cause unanticipated discontinuities in the business environment. Brewer (1981) refers to political risk as miscellaneous risks from doing business abroad. The expropriation literature is country specific by definition (see, for example, Eaton and Gersovitz 1984; Andersson 1989; Raff 1992) and the contagion literature, which might be expected to consider international political risk, is also country focused.[2] Valdes (1997), for example, defines contagion as excess co-movement in asset returns across countries and Eichengreen et al. (1996) define it as a situation where knowledge of a crisis in one country increases the probability of a crisis in another country above that warranted by the fundamentals. Meldrum (2000) summarizes the definition of political risk as additional risks not present in domestic transactions that typically include risks arising from a variety of national differences in economic structures, policies, socio-political institutions, geography and currencies.[3]

There are at least two steps to integrating international political risk into the overall process of political risk analysis. The first step involves identifying and analyzing the international political events that generate the risk. The second step

[1] For example, Clark and Kassimatis (2012) have shown that a global macroeconomic index contains significant incremental information for the pricing of international commodities (energy, precious metals, industrial metals, real estate and livestock) as well as for stocks, bonds, and money market instruments in a large sample of countries.

[2] The thrust of the contagion literature is on how a crisis is transmitted from one country to another. Calvo (1998), for example, explains contagion as a result of liquidity and asymmetric information, whereby a leveraged investor facing margin calls must sell his assets to uninformed investors who cannot distinguish between good assets and bad (lemons problem). A variant of this scenario is leveraged investors facing margin calls who sell assets whose price has not yet collapsed, thereby causing the collapse of these prices and spreading from market to market. Kaminsky and Reinhart (2000) emphasize the role of common lenders, such as commercial banks. In this explanation, the banks' need to rebalance their portfolios and recapitalize after initial losses causes an overall reduction in credit to most or all countries that rely on them for credit. The most plausible family of contagion models focuses on the role of trade in financial assets and information asymmetries. Calvo and Mendoza (2000), for example, show how the costs of gathering and processing country risk information can cause herding behavior even among rational investors.

[3] For a comprehensive, in-depth presentation of political risk and an extensive bibliography, see Bouchet et al. (2003).

involves measuring their effects on the individual countries. In this paper we deal with step 1.

The first contribution of this paper is that it proposes a database of international geo-political events, which we define as political events with global impact that substantially increase uncertainty in the international political, economic and financial environment as opposed to political events whose political, economic and financial consequences are limited primarily to a specific country or region. The geopolitical events that form the database for this study were determined in a two step process. First, we went year by year and gathered a list of political events that could potentially be considered as substantially increasing uncertainty in the international political, economic and financial environment. They include standard event types common to the political risk literature, such as wars, currency crises, social conflict and government decrees as well as aggressive actions taken by governments, individuals and groups. We then proposed the list to a panel of experts. Those events deemed to have consequences broad enough and severe enough were retained for the data base. This methodology is analogous to the rating process that subjectively determines the relevant variables and then estimates their severity on a case by case basis.

Treating political risk as a loss causing event is clearly in the spirit of authors such as Root (1973), Simon (1982), Howell and Chaddick (1994), Roy and Roy (1994), Clark (1997) and Meldrum (2000), who analyse political risk as an explicit negative event that causes an actual loss or a reduction of the investment's expected return. This stands in contrast to other authors such as Robock (1971) and Haendel et al. (1975), Kobrin (1979) or more recently Feils and Sabac (2000), who focus on political risk as it affects the volatility of an investment's overall profitability both negatively and positively. Tests of political risk on investment outcomes reflect these two approaches. Kim and Mei (2001), Chan and Wei (1996), Cutler et al. (1989) and Bittlingmayer (1988) consider political risk with respect to stock market volatility. Other papers, such as Erb et al. (1995, 1996), Cosset and Suret (1995), Bekaert (1995), and Bekaert et al. (1997) focus on losses and test political risk with respect to stock market performance. We choose the negative slant on political risk because we find it more intuitive and more in line with what investors generally understand by political risk.

In the second contribution of this study we use Bayesian Hierarchical modelling and Markov Chain Monte Carlo (MCMC) simulation techniques to measure the level and evolution of international geo-political risk over the period 1956–2001. This methodology is particularly suited to the analysis of phenomena, such as political events, that are relatively rare with irregular arrival rates and that arise from a wide range of sources, which are often mutually dependent.[4]

Traditional methods for assessing political risk are generally country specific and range from the comparative techniques of rating and mapping systems to the

[4] Clark and Tunaru (2003), for example, modelled this aspect of political risk as a conditional Poisson process.

analytical techniques of special reports, dynamic segmentation, expert systems, and probability determination to the econometric techniques of model building and discriminant and logit analysis.[5] The non-econometric techniques are generally very timely but have the shortcoming of also being very subjective. Rating systems, for example, reflect the latest information but the different factors and factor weights are generally subjective in the sense that they have no comprehensive statistical or theoretical underpinning. The econometric techniques are less subjective but have the shortcoming of not being very timely. For example, when conditions change, it can take a long time and many observations before the change is fully reflected in the estimated coefficients. MCMC simulation based on Bayesian hierarchical models has the advantage of being both timely and less subjective. Innovations are incorporated immediately in the analysis and the major subjective input is limited to choosing the prior probability distributions.

By looking specifically at international geo-political risk, we deal with a timely topic and fill a major hole in the literature. We find that the average arrival rate for geo-political events is about one per year on average. More importantly, we find that the arrival rate varies from year to year. We also find that there is a statistically significant, negative time trend in the arrival rate, which suggests that geo-political risk was decreasing over the period.

The rest of the paper is organized as follows. Section 2 presents the data. Section 3 contains an overview of Bayesian hierarchical modelling, a presentation of the three models considered in this paper and a discussion of the empirical results. The last section summarizes and concludes.

2 Data

The data presented in Table 1 is organized annually and comprises international geo-political events between 1956 and 2001, which we defined as political events with global impact that substantially increase uncertainty in the international political, economic and financial environment as opposed to political events whose political, economic and financial consequences are primarily limited to a specific country or region. To compile the list we started with a web search where we identified 49 potential events. The problem that we had in compiling the event list is that the variables relevant to the crisis events are not known in advance and many that are relevant are not countable.[6] For example, many of the variables

[5] See Bouchet et al. (2003) for a comprehensive presentation and analysis of assessment techniques.

[6] When the variables relevant to a crisis event are countable and known in advance, one way forward is to define a crisis event as a number of standard deviations away from the mean change in a variable. In the case of currency crises, for example, Goldstein et al. (2000), define a crisis event as a change more than three standard deviations from the mean change of the variables they consider. Another way forward is to determine hurdle rates and define a crisis event as a change that exceeds the hurdle rate.

Table 1 International political events 1956–2001

1956	Suez Crisis
1960	Run on gold causes creation of London gold pool
1960	Soviets shoot down American spy plane
1960	France tests its first atomic weapon
1961	Berlin Wall is constructed
1962	Cuban missile crisis
1962	France begins selling dollars for gold
1963	Kennedy assassinated
1963	Interest equalization tax
1964	Turkey planes attack Cyprus (UN peace force takes over in Cyprus)
1965	Indo-Pakistan War
1966	B-52 bomb North Vietnam
1967	Devaluation of British pound followed by world monetary crisis
1967	Middle East War
1968	Tet offensive
1968	Czechoslovakia invaded by Warsaw Pact troops
1968	Martin Luther King assassinated
1968	Robert Kennedy assassinated
1968	Upheaval at democratic convention
1968	Mandatory controls on foreign investment by US residents
1969	Massive antiwar demonstration in DC
1970	Kent State incident troops fire on students
1971	Gold convertibility suspended
1971	War between Bengali rebels and Pakistan
1972	Arab terrorist attack at Munich Olympics
1973	Dollar devalued
1973	Oil embargo/Yom Kippur War
1974	Turks invade Cyprus
1975	Ethiopian-Eritrean War
1976	New international monetary system (gold demonetized, floating exchange rates agreed)
1979	Iranian Revolution
1980	Iran-Iraq War
1982	Mexico defaults
1983	Star Wars initiative by US government
1985	Group of 5 announce policies to push down the dollar's value
1987	Stockmarket crash
1990	Iraq invades Kuwait
1991	Operation desert storm
1994	Peso crisis
1997	Asian crisis
1998	India and Pakistan conduct nuclear tests
1998	Clinton impeached
2000	Contested election
2001	September 11

affected by the 9/11 terrorist attack on the United States differ from those affected by the 1973 oil crisis. Many variables that are affected are not countable, such as time, stress, resources and personal freedom lost to increased security requirements after 9/11 or loss of health or even lives in the subsistence sectors of poor oil importing countries after the 1973 oil crisis. Furthermore, the consequences of individual events can take different forms depending on the country. For example, in a country with a convertible currency and a functioning stock market an oil price shock might manifest itself in immediately observable variables like the exchange rate and stock prices, whereas in a country with a non-convertible currency and no stock market the consequences might show up in variables such as inflation, capital flight, foreign debt, resource reallocation and the like.

Thus, the initial selection of potential events is largely subjective, based on personal analysis. We submitted this list to three political scientists anonymous to each other for suggested additions or deletions. None of the suggested additions were supported by another expert so none were added. For reasons explained below, consensus was reached for eliminating the Bay of Pigs, the Soviet invasions of Hungary and Afghanistan and the US invasions of Grenada and Panama.

Although this subjective element is a potential weakness, it is in the spirit of traditional political risk analysis reflected in ratings, mappings and special reports and we feel that the majority of events included in the study are non-controversial. These include events such as the Suez Crisis of 1956, the Cuban Missile Crisis of 1962, the stock market crash of 1987,[7] the September 11 terrorist attack, the international debt crisis of 1982,[8] the 1994 Mexican peso crisis, the 1997 Southeast Asian economic meltdown, the reorganization of the world monetary system in 1976 and the runs on gold and the international monetary crises of 1960, 1962, 1967, 1971, 1973, and 1985.

Nuclearization is also clearly an aggressive, world shaking event. Thus, we include France's first nuclear tests in 1960 and those of India and Pakistan in 1998. Other events that would normally be consigned to the regional event category are international events because of the oil factor. These include the 1967 Middle East War, the 1972 Arab terrorist attack at the Munich Olympic Games, the 1973 Middle East War that provoked the oil embargo, the 1979 Iranian Revolution, the 1980 Iran-Iraq war, and the 1990 Iraqi invasion of Kuwait followed by Operation Desert Storm in 1991.

The Cold War is the direct source of other international events such as the U2 spy plane incident in 1960, the construction of the Berlin Wall in 1961, the 1968

[7] Although some of the decline in prices can be ascribed to pure market risk, political elements contributed to the magnitude of the decline and its spread worldwide. They include regulatory shortcomings, worsening relations with Iran reflected in a US attack on an Iranian offshore oil platform over the previous weekend, statements by the US Treasury secretary Baker undermining the recently agreed currency accords, an unanticipated tax proposal by the House Ways and Means committee, budget deficits, etc.

[8] This was the result of sovereign borrowers deciding to default.

invasion of Czechoslovakia by Warsaw Pact troops, and the US government's Star Wars Initiative in 1983. It is also an indirect source for regional conflicts that would otherwise have been purely regional affairs. This is true for the Indo-Pakistan war of 1965, the Turkey-Cyprus wars of 1964 and 1974, the war between the Bengali rebels and Pakistan in 1971, and the Ethiopian-Eritrean war of 1975. Combined with the economic, military and political power of the United States in the world, it was also an important element in incidents such as Kennedy's assassination in 1963, and incidents in the Vietnam war, such as the US bombing of North Vietnam in 1966, and the Tet offensive of 1968. The Vietnam war itself is responsible for a series of US political events that rocked the country and, because of the US position of overwhelming international power, the world as well: the assassinations of Martin Luther King and Robert Kennedy and the upheaval at the Democratic convention in 1968, the massive anti-war demonstration in Washington, DC in 1969 and the Kent State incident where US troops fired on and killed protesting students. Again, the importance of the US in the world makes any threat to its political stability a threat to stability in the world. Thus we include Clinton's impeachment in 1998 and the contested presidential election in 2000. We include the interest equalization tax of 1963 and the mandatory controls on foreign investment in 1968 because of their effects on the international financial system and world capital flows.

To get a better feel for what we have included as international political events, it is instructive to consider some events that were not included. For example, why did we exclude the Hungarian invasion by the Soviet Union in 1956 while including the invasion of Czechoslovakia in 1968 or why did we exclude the Bay of Pigs in 1961 but include the Cuban missile crisis of 1962? The invasion of Hungary was aimed at putting down a revolution, seen from the eyes of the recognized government, basically an internal affair, and treated as such by the US and the rest of the free world. The invasion of Czechoslovakia was aimed at toppling the recognized government, basically an act of war, and treated as such by the free world. The Bay of Pigs did not involve the superpowers directly while the missile crisis did. The same reasoning went for excluding the Soviet invasion of Afghanistan and the US invasions of Grenada and Pa**nama.**

3 Bayesian Hierarchical Modelling with Markov Chain Monte Carlo Simulations

Our data is relatively rare and irregular and lacks repeated measurements. The data generation process also undergoes major changes from time to time. Classical statistical tools such as maximum likelihood inference or the least-squares class of methods or the more empirical methods-of-moments approach require repeated measurements and are not flexible enough to handle sudden parameter changes. The Bayesian view of statistics states that the only way to deal with uncertainty is via

probability. This implies that statistical inferences should be made using probability statements. By treating uncertainty about parameters probabilistically, Bayesian Hierarchical Modelling provides a coherent solution for data like ours that lacks repeated measurements and that undergoes sudden parameter changes. It has been widely applied in other areas such as biostatistics, marketing, business, and epidemiology (see Gilks et al. (1996) for a wide range of applications).

The concept of Bayesian hierarchical modelling is very simple. The model is specified on several layers. For example, denoting generically the vector of all data by y, the vector of all parameters by φ[9] and a probability density function by p, we first provide a likelihood distribution $p(y|\varphi)$ and an a priori distribution for the parameters $p(\varphi)$. Then, using Bayes' law it is true that

$$p(\varphi|y) \propto p(y|\varphi)p(\varphi) \tag{1}$$

where the symbol $\propto$ signifies up to a proportionality constant. This process may continue hierarchically with further prior parameters associated with φ. The models in this paper are all hierarchical.

For example, in the first model that we present in this paper we assume that the rate at which political events occur follows a conditional Poisson process, which has one parameter that must be estimated.[10] This is the first layer. In the second layer, we recognize that the arrival rate of the Poisson process can also be a random variable. We assume that this latter variable has a Gamma distribution.[11] A Gamma distribution has two parameters that must be estimated. In the third layer we recognize that the two parameters of the Gamma distribution can also be random variables. We assume that each of these parameters has a Gamma distribution. This is the last layer and requires the estimation of four parameters (two for each of the two Gamma distributions), which are constants and not random variables. Once the model has been specified MCMC can be used to estimate posterior distributions and obtain inference. More specifically, the MCMC methodology makes it possible to draw from posterior distributions whose exact forms are not known to develop Bayesian inference.

Our testing involves three models. We start with a simple model (henceforth Model 1) to demonstrate the methodology and to get a feel for the data. We then present a model that allows the arrival rate of political events to vary over time (Model 2). In model 3 we test whether there is a time trend in the arrival rate.

[9] A missing data observation can be considered as a parameter in the context of Bayesian modelling

[10] It is conventional in the finance literature to model discrete events as Poisson processes.

[11] The Gamma distribution has the advantage of being flexible with respect to shape and can capture effects such as skewness. It also has the technical advantage that when combined with a Poisson distribution, the result is another Gamma.

3.1 Model 1: A Gamma Distributed Poisson Process

In Model 1 geo-political events follow a conditional Poisson process with an arrival rate that is Gamma distributed.[12] This gives

$$\begin{aligned} &Y_i|\theta \sim Pois(\theta) \\ &\theta|\alpha,\beta \sim Gamma(\alpha,\beta) \\ &\alpha \sim Gamma(a_1,a_2) \quad \beta \sim Gamma(b_1,b_2) \end{aligned} \tag{2}$$

where a_1, a_2, b_1, b_2 are constants that are chosen in order to specify the degree of information that the analyst has about the parameters α and β. Since we have no precise information on these parameters, we choose them such that the resulting Gamma distribution has a wide range of likely values. The model postulates that the number of events in each year are conditionally independent draws from the same Poisson distribution with arrival rate θ which is also a random draw from a Gamma distribution with parameters α and β.

For this model the joint posterior distribution of all parameters is

$$\begin{aligned} p(\theta,\alpha,\beta|y) &\propto p(y|\theta)p(\theta|\alpha,\beta)p(\alpha)p(\beta) \\ &\propto \left[\prod_{i=1}^{N}\frac{\theta^{y_i}e^{-\theta}}{y_i!}\right]\left[\frac{\beta^{\alpha}}{\Gamma(\alpha)}\theta^{\alpha-1}e^{-\theta\beta}\right]\left[\alpha^{a_1-1}e^{-\alpha a_2}\right]\left[\beta^{b_1}e^{-\beta b_2}\right] \end{aligned} \tag{3}$$

The marginal posterior distribution for each parameter (or group of parameters) of interest can be identified by collecting all factors containing that parameter from the joint posterior distribution. Thus

$$\begin{aligned} &p(\theta\,|\,y,\alpha,\beta) \propto \theta^{\sum_{i=1}^{N}y_i+\alpha-1}e^{-\theta(\beta+1)} \propto Gamma\left(\sum_{i=1}^{N}y_i+\alpha,\beta+1\right) \\ &p(\alpha\,|\,y) \propto \frac{(\beta\theta)^{\alpha}}{\Gamma(\alpha)}\alpha^{a_1-1}e^{-\alpha a_2} \\ &p(\beta\,|\,y) \propto \beta^{\alpha+b_1-1}e^{-\beta(\theta+b_2)} \propto Gamma(\alpha+b_1,\theta+b_2) \end{aligned} \tag{4}$$

In order to obtain inference, we sample from values from the posterior distributions.[13] The inference is easily obtained via MCMC simulations. We start

[12] It is conventional in the finance literature to model discrete events as Poisson processes. The Gamma distribution has the advantage of being flexible with respect to shape and can capture effects such as skewness. It also has the technical advantage that when combined with a Poisson distribution, the result is another Gamma.

[13] Inference for model 1 can also be obtained using rejection sampling and straight Monte Carlo.

Table 2 Summary statistics for the Poisson model with a single rate of arrival

Node	Mean	Sd	MC error	2.50 %	Median	97.50 %
alpha	10.02	3.143	0.040	4.847	9.709	17.06
beta	10.68	5.075	0.066	3.132	9.886	22.73
theta	0.956	0.145	0.001	0.694	0.951	1.261
y.new	0.947	0.976	0.007	0.0	1.0	3.0
Deviance	118.0	1.443	0.010	117.0	117.4	122.1

by verifying that the simulated chain or chains are stationary.[14] The results reported below for the models we use were obtained after a burn-in period of 30,000 MCMC iterations. To check for convergence we used the trace plots of the simulated values, then the autocorrelation plots and then the Gelman-Rubin statistics. Two chains were used starting from overdispersed values and the inference sample was sometimes thinned (taking every 5th value from the sample) so that more independent values from the posterior densities were employed for calculations. Once a sample for the joint posterior distribution of all parameters and data has been estimated, then it is straightforward to calculate any function statistic.[15]

Model 1 is fitted for $a_1 = 10$, $a_2 = 1$, $b_1 = 0.001$, $b_2 = 0.001$, both sets of values ensuring a very wide spread Gamma distribution. In Table 2 we can see that geo-political events arrived at the rate of about one per year on average based on the mean for theta (0.956) and the median (0.951). Figure 1 shows that the distribution for the arrival rate is quite symmetric around 1. We can also see that the mode of the posterior distribution for *y_new*, the forecast future number of events, is very close to 0.

The estimated quantities are obtained from two chains with over-dispersed initial values, after a burn-in period of 20,000 iterations, from a thinned sample of 4,000 iterations, that is every 5th value from the 10,000 values part of the stationary Markov chains; the model is fitted with 46 data points and prediction is made by drawing a new value from the fitted hierarchical Poisson model.

3.2 Model 2: A Time Varying Poisson Process with a Gamma Distribution

We now consider the possibility that each year the number of geo-political events comes from a different Poisson distribution or that the arrival rate has a time trend.

[14] Although it is theoretically impossible to be 100 % sure that the chain has converged, a series of tests, measures and exploratory graphical investigations are conducted prior to any inferential calculations.

[15] Note that this sample is made of values that are correlated. Nonetheless the sample is large enough to cover the whole density range and the lack of independence does not affect in any way the inference. If some sort of independence in the sample is desired then the sample can be thinned by retaining from the sample every k-th value.

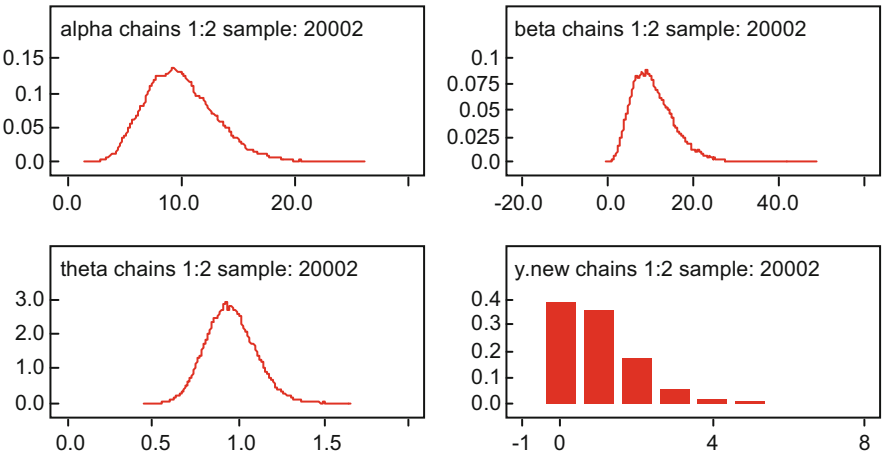

Fig. 1 Posterior density functions and histogram for the main parameters of interest of the Poisson model with a single arrival rate that is gamma distributed

In Model 2 we assume that every year the number of events comes from a Poisson distribution with individual arrival rate θ_i and all those rates are independent random draws from a Gamma distribution. Note that although here we have more parameters (θ's and other hyper-prior parameters) than data points, inference can be obtained because of the hierarchical structuring of the model on several layers. Model 2 is given by

$$\begin{aligned} &Y_i|\theta_i \sim Pois(\theta_i) \\ &\theta_i|\alpha,\beta \sim Gamma(\alpha,\beta) \\ &\alpha \sim Gamma(3,1) \quad \beta \sim Gamma(3,1) \end{aligned} \tag{5}$$

The last line specification of the Gamma distribution is not very restrictive. There is still quite a wide spread distribution and it leads to conditional distributions that are easier to follow. The joint posterior distribution of all parameters is

$$\begin{aligned} p(\theta_1,\ldots,\theta_N,\alpha,\beta|y) &\propto p(y|\theta_1,\ldots,\theta_N)\,p(\theta_1,\ldots,\theta_N|\alpha,\beta)\,p(\alpha)\,p(\beta) \\ &\propto \left[\prod_{i=1}^{N}\frac{\theta_i^{y_i}e^{-\theta_i}}{y_i!}\right]\left[\frac{\beta^{\alpha}}{\Gamma(\alpha)}\theta_i^{\alpha-1}e^{-\theta_i\beta}\right]\left[\alpha^2e^{-\alpha}\right]\left[\beta^2e^{-\beta}\right] \end{aligned} \tag{6}$$

and the conditional distributions needed for the MCMC simulations are

$$
\begin{aligned}
p(\theta_i|y,\alpha,\beta) &\propto \theta_i^{y_i+\alpha-1} e^{-\theta_i(\beta+1)} \propto Gamma(y_i+\alpha,\beta+1)\\
p(\alpha|y) &\propto \frac{(\beta)^{N\alpha}}{\Gamma(\alpha)^N}\left[\prod_{i=1}^{N}\theta_i\right]^{\alpha}\alpha^2 e^{-\alpha}\\
p(\beta|y) &\propto \beta^{N\alpha} e^{-\beta\left(\sum_{i=1}^{N}\theta_i+1\right)} \propto Gamma\left(N\alpha+3,\sum_{i=1}^{N}\theta_i+1\right)
\end{aligned}
\tag{7}
$$

The two chains become stationary quite rapidly. The autocorrelation plots, not provided here for lack of space, show no problems with convergence. The Gelman Rubin statistics[16] are also very good, all being between 0.98 and 1.01. Various MCMC output that is taken into consideration when extracting inference is presented in the Appendix.

The inference is summarised in Table 3 where we see that the mean and the median of parameter theta vary through time. To determine the forecast for the number of events for the next year, first a new arrival rate θ_{new} is simulated and then a Poisson draw is made from this distribution. The median of the forecast number of events is the same as for Model 1 and the mean is very close. Based on the median in Models 1 and 2, a good estimate for the future number of events is 1 with a credibility interval [0, 3] for model 1 and [0, 4] for Model 2. The kernel mass density (histogram) of the future value of y in Fig. 2 shows that the most likely outcome is zero as it was in Model 1.

Thus, there is evidence that the level of political risk as measured by θ varies from year to year.[17] The difference between the posterior mean estimate and posterior median estimate indicates that the distribution of the random arrival rate of political events is skewed. This can be seen in Fig. 2 where the distribution of the parameter theta is skewed with a long right tail. The histogram of the future number of events for the year 2002 shows that the most likely outcome is zero events with 40 % chance but the chance to have one, two or three events is about 50 %.

3.3 Model 3: Testing for a Time Trend

Given that model 2 suggests that theta varies through time, in Model 3 we test whether there is a time trend for the arrival rate of events.

[16] For this measure, m parallel chains are started with overdispersed starting values and n iterations are retained from the assumed stationary part. These m chains are then compared to the chain obtained by mixing together the mn values from all sequences. This is done by calculating a potential scale reduction factor, in fact comparing the variances within and between the chains. A large value of this factor indicates that further simulations are needed, while a value close to 1 indicates that each of the m sets of n values is close to the target distribution. See Brooks (1998) and Brooks and Gelman (1998) for more technical description.

[17] In preliminary results not reported here theta lagged one period is a significant explanatory variable World GDP.

Table 3 Summary statistics for the Poisson model with independent gamma rates of arrival. The estimated quantities are obtained from two chains with overdispersed initial values. After a burn-in period of 20,000 from a thinned sample of 4,000, that is every 5th value from the 10,000 values part of the stationary Markov chains

Node	Mean	SD	MC error	2.50 %	Median	97.50 %
alpha	2.821	1.272	0.030	1.13	2.581	5.963
beta	3.017	1.459	0.036	1.072	2.727	6.555
theta[1]	0.984	0.543	0.009	0.230	0.883	2.312
theta[2]	0.695	0.447	0.007	0.083	0.605	1.837
theta[3]	0.688	0.453	0.008	0.088	0.596	1.868
theta[4]	0.682	0.443	0.006	0.081	0.597	1.772
theta[5]	1.51	0.709	0.011	0.506	1.38	3.263
theta[6]	0.973	0.552	0.007	0.221	0.859	2.347
theta[7]	1.244	0.608	0.010	0.383	1.125	2.726
theta[8]	1.246	0.624	0.009	0.370	1.139	2.713
theta[9]	0.967	0.533	0.008	0.219	0.871	2.268
theta[10]	0.978	0.546	0.007	0.216	0.877	2.351
theta[11]	0.982	0.540	0.009	0.227	0.879	2.246
theta[12]	1.234	0.598	0.010	0.378	1.137	2.687
theta[13]	2.375	0.982	0.018	0.967	2.199	4.655
theta[14]	0.954	0.521	0.008	0.215	0.864	2.208
theta[15]	0.978	0.537	0.008	0.225	0.886	2.253
theta[16]	1.248	0.630	0.010	0.355	1.135	2.834
theta[17]	0.951	0.515	0.008	0.212	0.857	2.149
theta[18]	1.246	0.622	0.009	0.356	1.135	2.771
theta[19]	0.964	0.525	0.007	0.223	0.867	2.233
theta[20]	0.963	0.524	0.007	0.216	0.871	2.226
theta[21]	0.961	0.545	0.008	0.202	0.856	2.342
theta[22]	0.682	0.434	0.006	0.077	0.602	1.73
theta[23]	0.691	0.449	0.007	0.081	0.610	1.763
theta[24]	0.974	0.540	0.007	0.232	0.869	2.322
theta[25]	0.966	0.536	0.007	0.217	0.866	2.306
theta[26]	0.690	0.453	0.007	0.087	0.607	1.798
theta[27]	0.963	0.550	0.008	0.213	0.875	2.313
theta[28]	0.963	0.528	0.009	0.228	0.868	2.276
theta[29]	0.694	0.464	0.007	0.075	0.601	1.824
theta[30]	0.958	0.538	0.009	0.221	0.855	2.294
theta[31]	0.678	0.453	0.007	0.077	0.591	1.818
theta[32]	0.967	0.532	0.008	0.222	0.862	2.265
theta[33]	0.688	0.449	0.007	0.079	0.599	1.835
theta[34]	0.691	0.458	0.006	0.084	0.599	1.816
theta[35]	0.973	0.538	0.008	0.225	0.886	2.223
theta[36]	0.965	0.549	0.009	0.222	0.863	2.277
theta[37]	0.697	0.461	0.007	0.072	0.607	1.821
theta[38]	0.677	0.449	0.007	0.083	0.585	1.783

(continued)

Table 3 (continued)

Node	Mean	SD	MC error	2.50 %	Median	97.50 %
theta[39]	0.958	0.537	0.008	0.203	0.861	2.236
theta[40]	0.689	0.447	0.006	0.079	0.611	1.802
theta[41]	0.689	0.451	0.006	0.077	0.604	1.798
theta[42]	0.950	0.515	0.008	0.216	0.864	2.218
theta[43]	1.251	0.630	0.010	0.367	1.13	2.84
theta[44]	0.687	0.446	0.007	0.083	0.603	1.801
theta[45]	0.962	0.528	0.007	0.218	0.868	2.225
theta[46]	0.961	0.538	0.009	0.217	0.867	2.335
theta.new	0.961	0.657	0.012	0.133	0.813	2.651
y.new	0.971	1.175	0.017	0	1	4

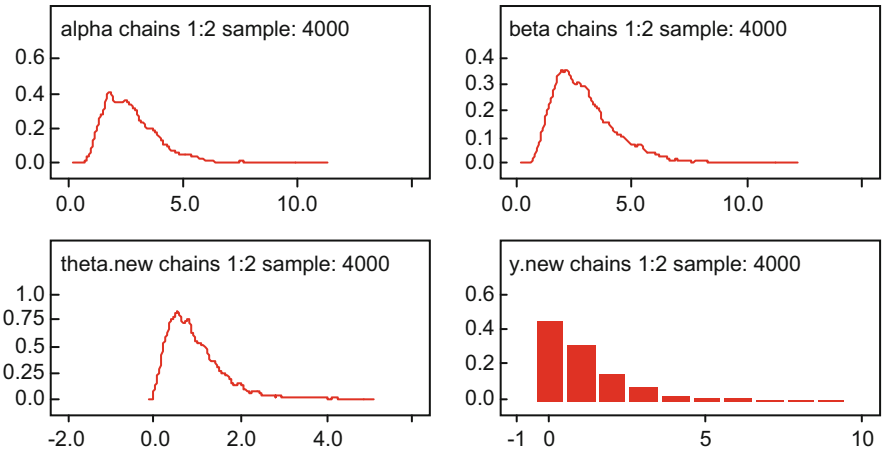

Fig. 2 Posterior density functions and histogram for the main parameters of interest of the Poisson model with independent rates of arrival gamma distributed

$$\begin{aligned} &Y_i|\theta_i \sim Pois(\theta_i) \\ &\theta_i = a + bi \\ &a \sim N(0, 0.0001) \quad \text{b} \sim N\left(0, 0.0001\right) \end{aligned} \tag{8}$$

The second line of the model assumes a deterministic ordering of the thetas. The last line of the model specification acknowledges our lack of any prior information about the regression coefficients that are treated as random variables.[18] The parameterization of the normal distribution is in terms of precision, which is the inverse of variance. Therefore a very small precision means a very large variance leading to a

[18] Given the normal priors on a and b, we also work with the log of Theta as a robustness check. The results, not reported here, are qualitatively similar to those in Table 4.

Table 4 Summary statistics for the Poisson model with rates of arrival regressed on time

Node	Mean	SD	MC error	2.50 %	Median	97.50 %
(a)						
a	0.455	0.274	0.0046	−0.112	0.463	0.971
b	−0.024	0.012	1.94E-04	−0.047	−0.024	−0.001
mu_a	0.450	0.756	0.0073	−1.058	0.452	1.945
mu_b	−0.024	0.692	0.0046	−1.423	−0.021	1.352
V_a	2.993	1.714	0.0134	0.627	2.683	7.193
V_b	3.006	1.738	0.0125	0.627	2.669	7.307
Deviance	114.7	1.97	0.0244	112.8	114.1	120.1
(b)						
a	0.451	0.274	0.00439	−0.108	0.460	0.964
b	−0.024	0.011	1.88E-04	−0.047	−0.024	−0.0013
Deviance	114.7	2.022	0.02235	112.8	114.1	120.1

The entire posterior distributions of the parameters of interest are illustrated in Fig. 3

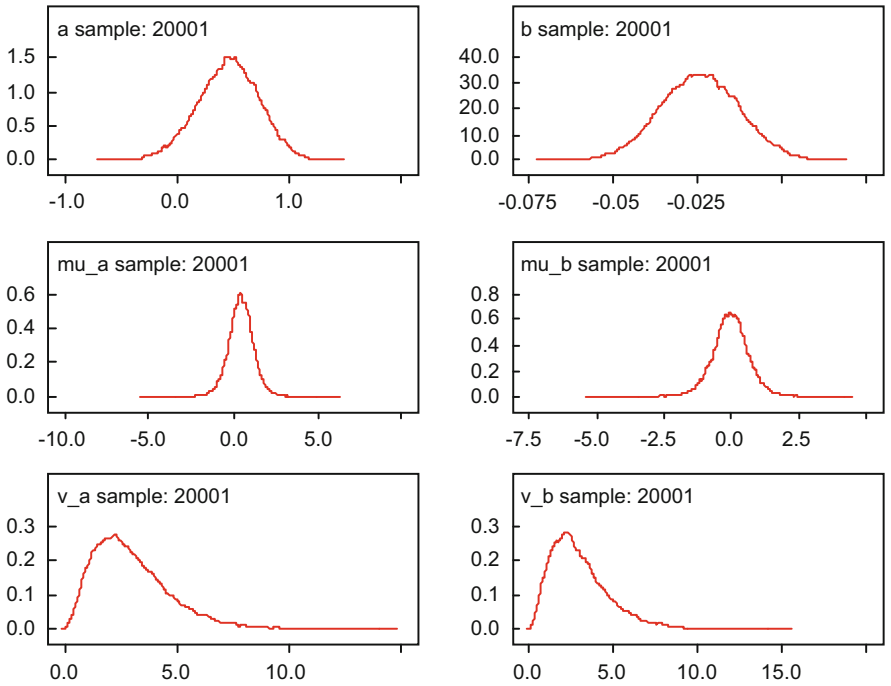

Fig. 3 Posterior densities for the parameters of the Poisson model with rates of arrival regressed on time

very flat normal distribution similar to a uniform distribution over a very large range. The joint posterior distribution of the parameters of interest, the regression coefficients *a* and *b* here, is

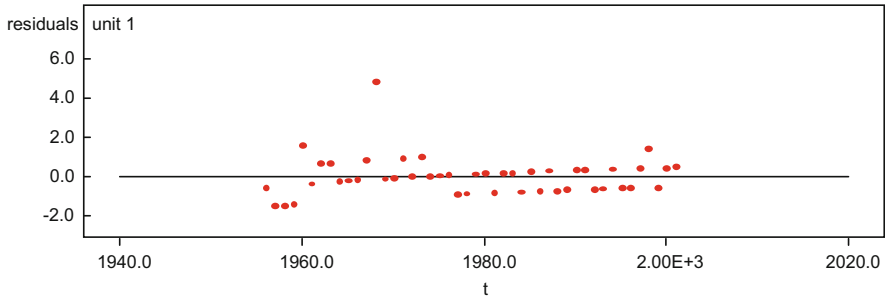

Fig. 4 Residuals versus time for the hierarchical Poisson model with rates of arrival regressed on time and noninformative priors for the regression coefficients

$$\begin{aligned} p(a,b|y) &\propto p(y|a,b)\,p(a)\,p(b) \\ &\propto \left[\prod_{i=1}^{N}\frac{(a+bi)^{y_i}\,e^{-a+bi}}{y_i!}\right]\left[e^{-\frac{0.0001}{2}a^2}\right]\left[e^{-\frac{0.0001}{2}b^2}\right] \end{aligned} \tag{9}$$

For MCMC sampling the conditional distributions are required. These are

$$\begin{aligned} p(a|y,b) &\propto \left[\prod_{i=1}^{N}(a+bi)^{y_i}\,e^{-a+bi}\right]\left[e^{-\frac{0.0001}{2}a^2}\right] \\ p(b|y,a) &\propto \left[\prod_{i=1}^{N}(a+bi)^{y_i}\,e^{-a+bi}\right]\left[e^{-\frac{0.0001}{2}b^2}\right] \end{aligned} \tag{10}$$

After checking that the simulated Markov chain looks stationary, a large sample is used for inference. From Table 4b it can be seen that an *a posteriori* estimate is $a = 0.451$ and $b = -0.024$. Testing whether there is a time trend can be done by looking at the 95 % credibility interval constructed from the 2.5 % percentile and 97.5 % percentiles. This is $[-0.047, -0.0013]$ and it just misses out the zero value.[19] Thus we can say that there is a negative time trend for the arrival of global political events.

The residual analysis in Figs. 4 and 5 points to a possible outlier for the year 1968 when six events were observed. Maybe this was just a signal for the troubles to come in the financial markets of the 1970s. Apart from this data point the fit looks good and it seems that there are no problems with the (conditional) independence assumption or the distributional assumptions we made.

[19] A zero in the interval would suggest no trend.

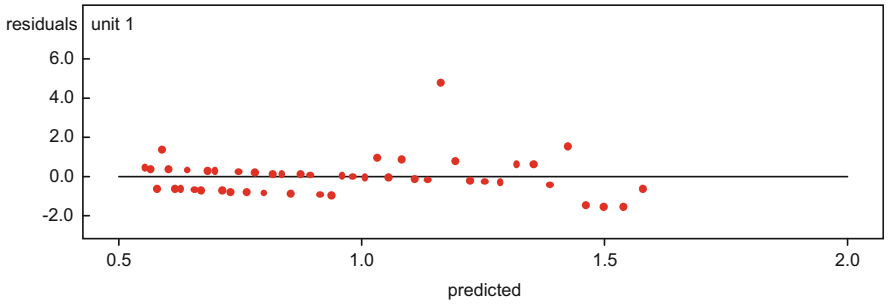

Fig. 5 Residuals versus the expected values of observed data for the hierarchical Poisson model with rates of arrival regressed on time and noninformative priors for the regression coefficients

Conclusions

In this paper we analyzed international geo-political risk over the period 1956–2001. We started with an analysis designed to identify the geo-political events that caused a substantial increase in uncertainty in the international economic and financial environment. Since the nature of the data we analyse falls outside the realm of classical statistical inferential methods that require repeated random independent experiments, we used Bayesian Hierarchical/Markov Chain Monte Carlo modelling techniques to measure the level of international geo-political risk and its evolution over the period. We find that the average arrival rate for geo-political events is about one per year and that the most likely outcome is zero events with a probability mass of about 40 %. This result is robust in that it is basically unchanged whether we assume that the arrival rate comes from the same Gamma distribution or from independent Gamma distributions that change from year to year. An average arrival rate of one per year is very high. Combined with the mode of zero, it shows that we have captured the clustering caused by the fact that geo-political events can arise from a wide range of sources, which are often mutually dependent. Although the arrival rate of geo-political events is relatively high, it seems to be declining. The time trend in the arrival rate is negative and statistically significant.

4 Appendix

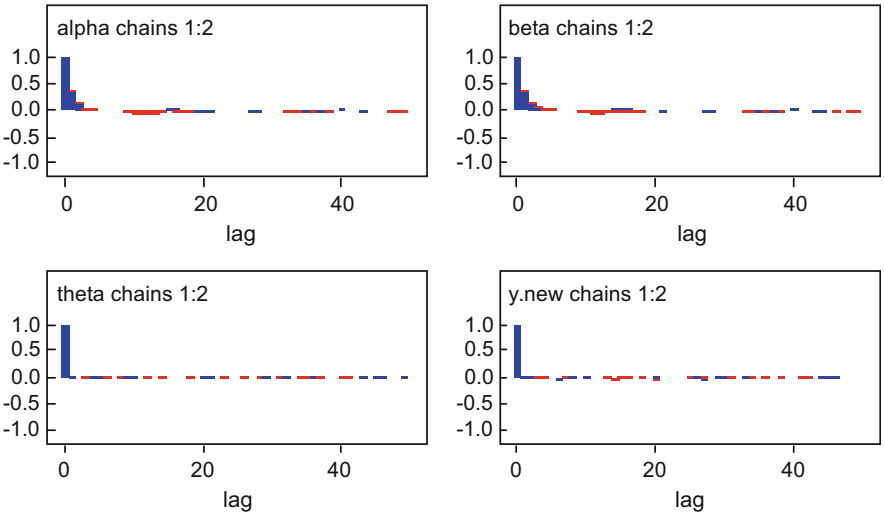

Fig. 6 Autocorrelation plots for the main parameters of interest of the Poisson model with a single rate of arrival gamma distributed

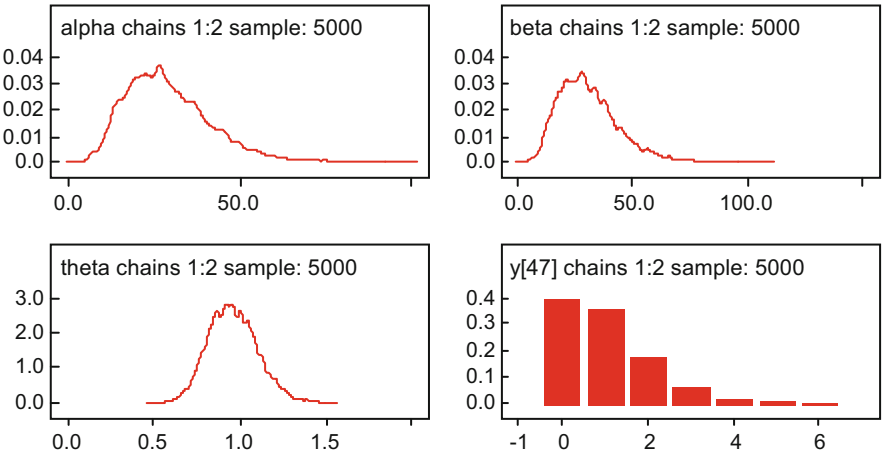

Fig. 7 Posterior density functions and histogram for the main parameters of interest of the Poisson model with a single rate of arrival gamma distributed

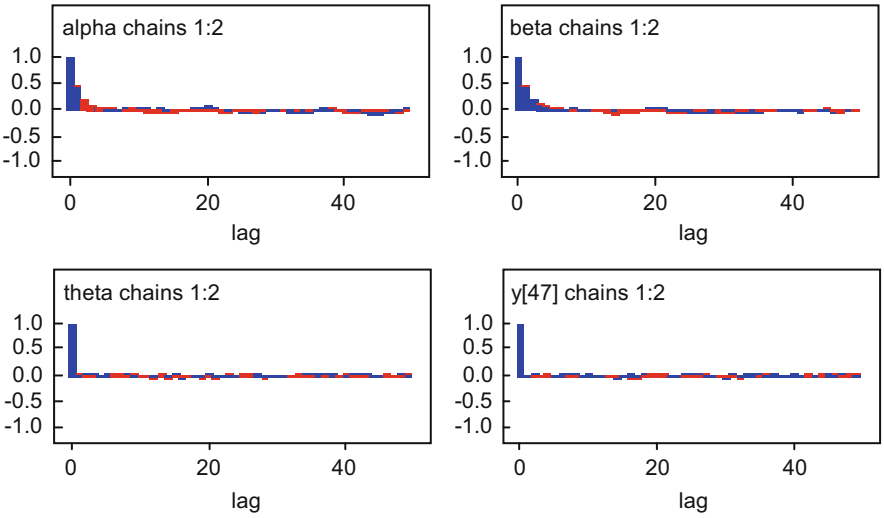

Fig. 8 Autocorrelation plots for all parameters of interest of the Poisson model with a single rate of arrival gamma distributed

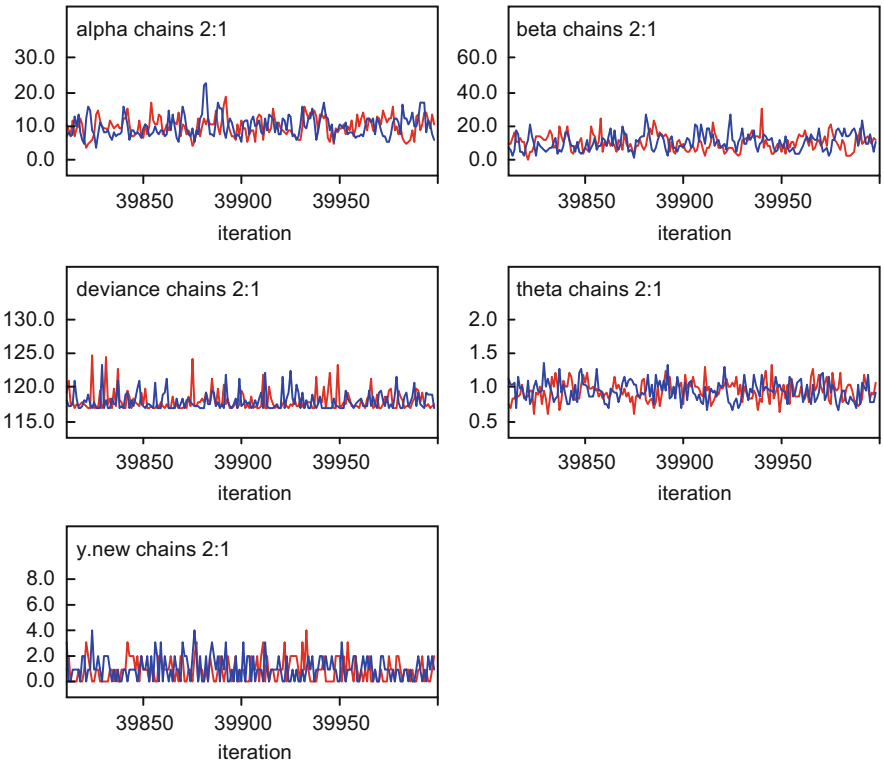

Fig. 9 Trace plots of the simulated Markov chain for all parameters of interest and the deviance of the Poisson model with a single arrival rate that is gamma distributed

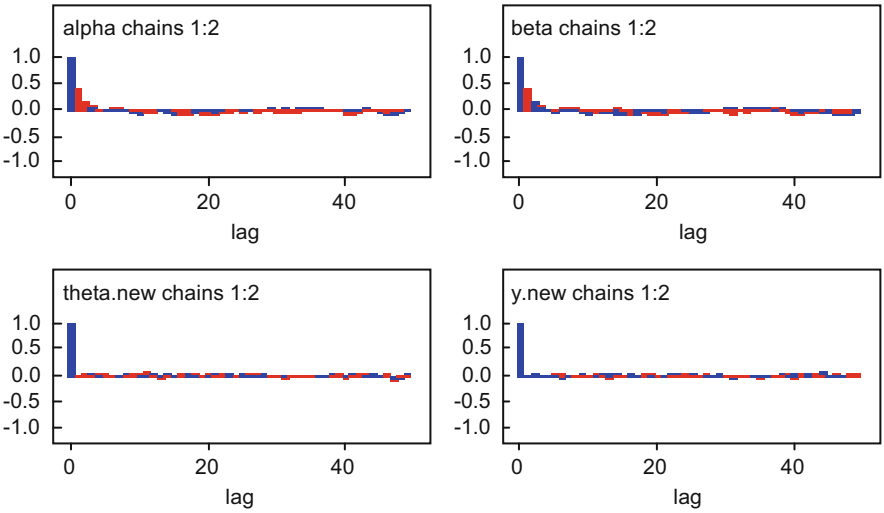

Fig. 10 Autocorrelation plots for the parameters of interest of the Poisson model with independent gamma rates of arrival showing that the simulated Markov chain is stationary

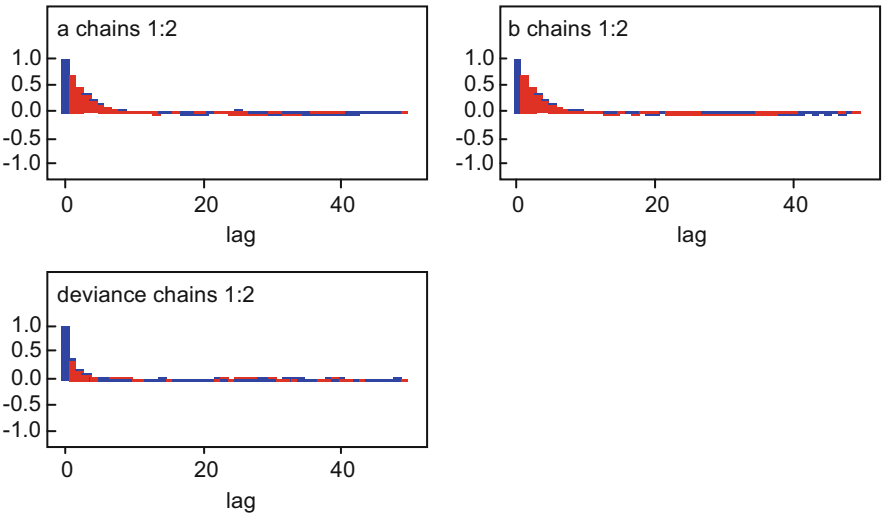

Fig. 11 Autocorrelation plots for the parameters of the hierarchical Poisson model with rates of arrival regressed on time and noninformative priors for the regression coefficients

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Financial Crises and Sovereign Default: Dependencies, Timing and Uncertainty in a Stochastic Framework

Dominik Maltritz

Abstract

I discuss how the influence of outstanding debt on financial crises occurrence and the relationship between different types of crises can be modeled using a stochastic and dynamic framework in continuous time and (compound-) option theory. This approach especially enables us to consider the influence of the debt's maturity and the uncertainty about the amount of funds the government is able and willing to spend for crisis avoidance. It can be shown that this uncertainty increases crisis risk in most situations. The risk of a financial crisis is higher with (higher) outstanding debt repayments. A shorter maturity of debt increases crisis risk.

1 Introduction

The recent global financial crisis with its vast impact on the world economy shows very plainly the relevance of a proper analysis of the causes and determinants of financial crises. Of special importance here is the indebtedness of countries and the relationship between country defaults and financial crises. This became obvious during the recent world economic crises since in many countries financial crisis occurred jointly with a default or quasi-default[1] on debt service payments. However, also during the most recent major financial crises in emerging markets, e.g., the Russian crisis of 1998/1999 and the Argentine crisis of 2001/2002, a financial

[1] The term "quasi-default" refers to a situation where a country required international help to fulfill its debt service obligations.

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crisis of the banking sector and the exchange markets was accompanied by a sovereign default.[2]

In this paper I discuss a stochastic approach to model the interrelation between financial crisis and defaults in a dynamic framework with continuous time based on (compound) option theory (see, Geske 1977, 1979). This approach contributes to the literature by paying special attention to two very important aspects of dependencies between crises and defaults: First, it considers how uncertainty about a country's ability and willingness to pay to avoid a crisis influences crisis risk and the dependencies between different types of crises. Second, it enables to analyze how the maturity of debt influences crisis risk.

The idea of using the compound option approach to model the relation between different types of crises was firstly formulated for the case of currency crisis and debt crises in Maltritz (2008). In Maltritz (2010) it has been applied to model and analyze the crises in Hungary of 2008. In Karmann and Maltritz (2012) the compound option approach was used to analyze the debt crises in Greece be differentiating between short-and long-term debt. Eichler, Karmann and Maltritz (2010) apply the compound option approach to derive banking crises risk in the US. While those papers have a clear empirical focus, the present paper contributes to the literature by analyzing the features of the model on a rather theoretical level. In particular, it discusses in detail how certain model parameters influence crises risk and how the model parameters interact with each other.

The compound option approach to model interactions between different types of crisis is inspired by two strands of the literature where a stochastic framework has successfully been applied to model *either* distress in the banking sector *or* country default. In the latter case, e.g., the application of structural credit risk models to country default risk by Clark (1991), Claessens and van Wijnbergen (1993), Claessens and Pennacchi (1996), Keswani (2000), and Huschens et al. (2007) is to mention.[3] Financial distress in the banking sector can also be analyzed in a stochastic setting by applying structural credit risk models to predict banking failures or to value insurance contracts of bank deposits. This was firstly proposed by Merton (1977). More recent examples include Duan (1994), Duan et al. (1995), Gunther et al. (2001), Duan and Simonato (2002), Gropp et al. (2002), and Chan-Lau et al. (2004).

Inspired by these approaches, we develop a general framework to analyze the relationship between (defaults on) outstanding debt and crises in the banking sector. This framework enables us to specify closed-form formulas to calculate the probability of the respective crises. Based on these formulas we explore the influence of several determinants of financial crises and sovereign default in detail.

[2] For an analysis of the frequency of the joint occurrence of financial crises and defaults see e.g. Reinhart (2002) or Herz and Tong (2008).

[3] An important deterministic and theoretic approach to country default risk analyzes the determinants of a country's willingness to pay, i.e. the pros and cons of debt repayment or default. See Eaton et al. (1986) or Eaton and Fernandez (1995) for an overview. Another strand of the theoretical debt crisis literature focuses on a country's ability to pay, i.e. the amount of funds a country is able to spend for debt servicing. Examples are Avramovic et al. (1964) and Diaz-Alejandro (1984).

We show that higher debt service payments increase not only the probability of default, but also the probability of a banking crisis. The continuous time framework used here enables us to demonstrate the influence of timing – which is not possible in models with discrete time. Thus, we can prove that a shorter time span between dates at which payments for crisis avoidance are required – resulting from short maturities of debt – increases the risk of a financial crisis. The uncertainty about the amount of funds the government is able and willing to spend to avoid a crisis also influences crisis risk: in typical constellations, a higher uncertainty increases the risk of a crisis.

The remainder of the paper is organized as follows. Section 2 presents the model. Section 3 discusses in detail the influence of certain determinants on crisis risk. Section 4 concludes.

2 The Model

In the derivation of our stochastic continuous time framework for the analysis of crisis occurrence and crises dependencies we start in Sect. 2.1 with the basic model, which considers a situation where only two payments are required for crisis avoidance. In Sect. 2.2 we derive closed form solutions for crises probabilities in this basic case. In Sect. 2.3 we generalize our model to situations where more than two payments are required for crisis avoidance.

2.1 The Basic Model

2.1.1 The Stochastic State Variable

Our model is based on the consideration that a government needs to spend money to avoid a financial crisis, for example, in order to bail-out troubled banks. The government must also spend funds to avoid a default on its debt. There is a high degree of uncertainty about the funds the government is able and willing to spend to avoid a crisis. This is because it is difficult to predict which part of its revenues, or more generally of the country's GDP, the government will be able to provide to avoid a crisis. On the other hand, the government can refuse to make payments even if it has enough funds, as discussed in the willingness-to-pay debt crisis literature.

To capture the uncertainty about the funds the government is able and willing to spend for crises avoidance we assume that these funds can be described by a stochastic state variable. This state variable is modeled using the following stochastic (Ito-) process:

$$dW = \mu_W W dt + \sigma_W W dZ, \tag{1}$$

where μ_W and σ_W are constant, and Z follows a standard Wiener process. We choose a model with continuous time since this enables us to consider timing better than with discrete time.

2.1.2 The Occurrence of Crises

In our model, a crisis or default occurs if the stochastic state variable describing the amount of funds the government is able and willing to spend to avoid a crisis falls below a certain crisis threshold at any date when it becomes necessary to spend funds to avoid a crisis. The threshold is easy to determine in the simplest case – where only one payment is required to avoid a crisis. As an example, we may consider the (rather unrealistic) case of a country with no outstanding debt where the government has to spend some amount, B_1, to bail out the banking system.[4] In this case, the threshold equals the amount of the single payment, B_1. The government avoids a banking crisis if the state variable, i.e., the amount of funds the government is able and willing to spend, is higher than the amount required to avoid the crisis, i.e., $W_{T_1} \geq B_1$. If the state variable is lower, the government does not help the banks and a banking crisis occurs at T_1.[5]

The crucial point of our model is that this simple reasoning does not apply if the government must meet debt service payments to avoid a default at later dates. In this case, the threshold for avoiding a banking crisis at T_1 changes. To explain this, we consider an indebted country with a simple debt structure where the entire debt must be repaid at a future date, T_2, in the amount of B_2.[6] If the government has to take into account the possibility of a debt crisis at this future date, T_2, the situation at the date T_1 (before T_2), when the bail-out of the banking system is required, is different to the situation without debt: it would be pointless to sacrifice all funds to avoid a banking crisis in the short run if the remaining funds are very low or even zero and, thus, there is a high probability of a (debt) crisis in the long run.[7] Hence, the threshold is not the amount of funds B_1 the country is able and willing to spend for the bail-out at T_1. Rather the funds the country is able and willing to spend for crisis avoidance have to be higher than a new threshold: $W_{T_1} \geq W_Q = B_1 + X$. In

[4] The explanations also hold true for the occurrence of a default, if we consider an indebted country with outstanding debt obligations payable at only one point in time where the banking system is sound. This is the typical situation considered in the default risk models mentioned in the introduction.

[5] Whereas we focus on banking crises also currency crises could be considered in our framework: for a country without outstanding debt service payments B_1 describes the amount of funds required to fend off an attack on the currency (plus the funds required to bail-out the banking sector – as the case may be). The government avoids a financial crisis by exchanging foreign currency (and/or bailing out the banking sector), if the state variable W is higher than the required funds; otherwise, it faces a financial crisis. If the payments for avoiding the currency crisis and the banking crisis are required at different dates, this could be captured by the general (multi-payment) framework developed in Sect. 2.3.

[6] We make this assumption to simplify the explanations. We later generalize our model, allowing an arbitrary number of later payment dates.

[7] If, for example, the amount of funds required for the bailout is USD 10 billion and USD 10.01 billion is available but USD 5 billion is due at the next payment date, the government may refuse to bail out the banking system since it will face a financial crisis no matter what and can save the USD 10 billion.

the following, we present an approach to quantify this new threshold W_Q, i.e. the minimum amount of funds to avoid a crisis at T_1.

2.1.3 The Short-Term Crisis Threshold

To derive the threshold at T_1, we first consider the situation at T_2 when the debt becomes due. The situation at T_2 is similar to the situation described for T_1 above when the country was assumed to have no outstanding debt. Since no payments are due after T_2, the crisis threshold equals the required debt service payments. If the payments the country is able and willing to make to avoid a crisis are equal to or higher than the payments due, $W_{T_2} \geq B_2$, the government pays its creditors B_2 and no default occurs. Otherwise, the amount the government is able and willing to pay is lower than the amount required to avoid a default, and a default occurs. In the first case, the country retains funds in the amount of $W_{T_2} - B_2$. In the second, the difference between the amount the government is able or willing to pay and the payment it actually makes equals zero. Since it is not possible to force the government to pay more than it is able or willing to pay, the value will never be a negative, however. Thus, the debt service payments resemble the payment function at maturity of a call option, Y, where W is the underlying and B_2 is the strike price, i.e., $Y_{T_2} = \max(W_{T_2} - B_2, 0)$. In fact, by making the payment B_2, i.e., by paying the strike price, the government can exercise the option to avoid a default at T_2.

Based on these considerations, we are able to derive the crisis threshold at date T_1 when the bailout is required for a country with outstanding debt. By spending the required funds, B_1, at T_1, the government avoids a banking crisis at T_1 and buys the option Y that enables the government to avoid a crisis at all, i.e. also the potential default in T_2 (which can be achieved by making the debt service payments required at T_2.). The government buys this option at T_1 only if the option value at T_1, Y_{T_1}, is greater than or equal to the required payment, B_1. Otherwise, the country would be worse off if it spends the required funds. This is because the value of the option to avoid a debt crisis at T_2 (and thus a crisis at all) is lower than the value of this possibility. The condition for avoiding a crisis at T_1 is thus:

$$Y_{T_1} \geq B_1. \tag{2}$$

The option Y can be valued for any date t before the expiry date of the option, T_2, using the Black-Scholes formula for a call option (see Black and Scholes 1973):

$$Y_t = W_t N_1\left(d + \sigma_W \sqrt{T_2 - t}\right) - B_2 e^{-r_s(T_2 - t)} N_1(d), \tag{3}$$

$$\text{with :} \quad d = \frac{\ln(W_t/B_2) + \left(r_s - \sigma_W^2/2\right)(T_2 - t)}{\sigma_W \sqrt{T_2 - t}}.$$

$N_1(\ldots)$ describes the value of the (one-dimensional) cumulative standard normal distribution for the value in parentheses. The use of (3) implies that the assumptions of the Black-Scholes model are valid here. Besides the assumption concerning the stochastic nature of the underlying (see (1)) this means, in particular, that there is

one constant risk-less interest rate, r_s, valid for borrowing and lending and that crisis risk is diversifiable since securities are traded on perfect markets without arbitrage opportunities. Though idealized, these assumptions are widely accepted in the literature.[8]

To determine the threshold, we insert the Black-Scholes formula for Y_{T_1} in (2). The threshold, W_Q, is the value of W for which the resulting formula becomes an equation:

$$B_1 = W_Q N_1\left(d + \sigma_W\sqrt{T_2 - T_1}\right) - B_2 e^{-r_s(T_2-T_1)} N_1(d), \tag{4}$$

$$\text{with}: \quad d = \frac{\ln(W_Q/B_2) + \left(r_s - \sigma_W^2/2\right)(T_2 - T_1)}{\sigma_W\sqrt{T_2 - T_1}}.$$

If at T_1 the amount of funds the government is able and willing to spend to avoid a crisis is lower than this threshold, $W_{T_1} < W_Q$, the option's value is lower than the amount of funds required to bail out the banking system, B_1. This means that the value of the option is lower than its price and the government does not buy the option. It refuses to spend the required funds, and a (banking) crisis occurs. If, by contrast, W_{T_1} is greater than or equal to W_Q, the option value is higher than its price, i.e., the required payment, and the government avoids a crisis by spending the required funds, B_1.

It should be mentioned that the value of the underlying of an option (here, W_Q) is always greater than or equal to the option value (B_1). Thus, the existence of later (debt service) payments yields a higher threshold at T_1 than when no later payments are due and the threshold equals the actual payments, B_1. By calculating the crisis threshold valid at T_1 in this way, we incorporate the dependency between a banking crisis at T_1 and a debt crisis at T_2. This is because the threshold value depends not only on the actual payments, B_1, but also on later payments, B_2 and the time span between the dates at which payments become necessary to avoid a crisis, $T_2 - T_1$. Section 3 discusses this in more detail.

Condition (2) is equivalent to the statement that the government avoids a crisis at the first date, T_1, at which payments are required to avoid a crisis if and only if the stochastic state variable is higher than the value of *all*(!) outstanding payments (and not just the current payments, B_1), which is the sum of the payments, B_1, required at T_1 and the current value of the default risky (!) later payments, F_{2,T_1}:

$$W_{T_1} \geq B_1 + F_{2,T_1}. \tag{5}$$

The equivalence of (2) and (5) is justified because – as explained above – the value of the option at T_2 equals the difference between the state variable and the

[8] All papers that use structural credit risk models to analyze country default risk or bank failures and bank deposit insurance rely on these assumptions (see the discussion in the introduction). Certain default risky debt instruments, such as government bonds, can be combined with corresponding credit default swaps to diversify default risk.

payments required at this date, i.e., $Y_{T_2} = W_{T_2} - B_2$. Under the non-arbitrage assumption, the option value also equals the difference between the state variable and the current value of the (default risky) payments, $F_{2,t}$, at any date t before T_2. Hence, it follows for T_1: $Y_{T_1} = W_{T_1} - F_{2,T_1}$. By inserting this into condition (2) we obtain (5).

In the framework considered here, the current value of the default risky later payments in the amount of B_2 at any date t before T_2 (and thus also for T_1) is given by (see, e.g., Merton 1974):

$$F_{2,t} = W_t - W_t N_1\left(d + \sigma_W\sqrt{T_2 - t,}\right) - B_2 e^{-r_s(T_B - t)} N_1(d), \tag{6}$$

$$\text{where } d = \frac{\ln(W_t/B_2) + \left(r_s - \sigma_W^2/2\right)(T_2 - t)}{\sigma_W\sqrt{T_2 - t}}.$$

2.2 Crises Probabilities in the Basic Model

As explained in the last section, a crisis occurs if the state variable describing the funds the government is able and willing to spend to avoid a crisis is below the crisis threshold at a date when payments are required to avoid a (banking or a debt) crisis, i.e., at T_1 or T_2. The occurrence of a crisis at T_1 or T_2 is an uncertain event since the amount of funds available is not known with certainty. This uncertainty is modeled by assuming the state variable is a stochastic variable. Using our framework, we can derive closed-form solutions for the crisis probabilities, i.e., the probability that the state variable is below the respective crisis threshold at T_1 or T_2. In our (basic) example, we distinguish between three different crisis probabilities: the probability of a (banking) crisis at the first date, T_1, the probability of a (debt) crisis at the second date, T_2, and the overall crisis probability, i.e., the probability that a crisis occurs either at T_1 or at T_2.

At any point in time t ($<T_1$), the probability of a (banking) crisis at T_1 can be calculated by (see Delianedis and Geske 1998):

$$P_{T_1,t} = N\left(\frac{\overbrace{\ln(W_Q/W_t)}^{W_{min}} - \overbrace{\left(\mu_W - \sigma_W^2/2\right)(T_1 - t)}^{\text{mean}}}{\underbrace{\sigma_W\sqrt{T_1 - t}}_{\text{standard deviation}}}\right). \tag{7}$$

To interpret (7) we consider log-changes of the state variable between t and T_1, $\ln(W_{T_1}/W_t)$. Since a crisis occurs if the state variable at T_1 is below W_Q, the minimum change of the state variable between t and T_1 to avoid a crisis has to be equal to or greater than $\ln(W_Q/W_t)$. If it is less than this, a crisis occurs. We can calculate the probability that the actual changes is lower than the minimum change, $\ln(W_{T_1}/W_t) \leq \ln(W_Q/W_t)$, using the assumptions about the stochastic nature of the state variable. Equation (1) implies that log-changes are independent identically normally distributed. Thus, the probability that the actual change is below the

minimum change can be estimated by calculating the standardized minimum log-change and inserting it into the standard normal distribution function. The standardized minimum log-change is determined by subtracting the mean of log-changes and dividing the difference by their standard deviation, as shown in (7). The probability that no (banking) crisis will occur at T_1, i.e., that the state variable is greater than W_Q, is given by $1 - P_{T_1,t}$. It follows then that:

$$\begin{aligned} 1 - P_{T_1,t} &= 1 - N\left(\frac{\overbrace{\ln(W_Q/W_t)}^{W_{min}} - \overbrace{\left(\mu_W - \sigma_W^2/2\right)(T_1 - t)}^{mean}}{\underbrace{\sigma_W\sqrt{T_1 - t}}_{standard\ \ deviation}} \right). \\ &= N\left(\frac{\ln(W_t/W_Q) + \left(\mu_W - \sigma_W^2/2\right)(T_1 - t)}{\sigma_W\sqrt{T_1 - t}} \right). \end{aligned} \tag{8}$$

In the same manner, $N_2(m_0,m_1;\rho)$ in (9) describes the probability that a crisis occurs neither at T_1 nor at T_2. In our framework, this equals the probability that the state variable is higher than the respective thresholds at the possible crises dates, i.e., higher than W_Q at T_1 and higher than B_2 at T_2. Thus, the overall crisis probability, i.e., the probability of either a banking or a debt crisis can be calculated by (see Delianedis and Geske 1998):

$$P_{T_1,T_2,t} = 1 - N_2(m_0, m_1; \rho), \tag{9}$$

$$\text{where :} \quad m_0 = \frac{\ln(W_t/W_Q) + \left(\mu_W - \sigma_W^2/2\right)(T_1 - t)}{\sigma_W\sqrt{T_1 - t}},$$

$$m_1 = \frac{\ln(W_t/B_2) + \left(\mu_W - \sigma_W^2/2\right)(T_2 - t)}{\sigma_W\sqrt{T_2 - t}}, \quad \text{and} \quad \rho = \sqrt{\frac{T_1 - t}{T_2 - t}}.$$

Here, $N_2(\ldots)$ describes the value of the two-dimensional cumulative standard normal distribution for the value in parentheses.

At any date t (before T_1), the probability that a (debt) crisis will occur at T_2, given that no (banking) crisis has previously occurred, can be determined by (see Delianedis and Geske 1998):

$$P_{T_2,t} = 1 - \frac{N_2(m_0, m_1; \rho)}{N_1(m_0)}. \tag{10}$$

In the following discussions of crisis determinants, we consider also the *unconditional long-term crisis risk*, i.e., the probability that the state variable falls below the long-term threshold at the second date, estimated at date t before T_1 with the values observable at t. The *unconditional long-term crisis risk* is given by:

$$\widetilde{P}_{T_2,t} = N\left(\frac{\ln(B_2/W_t) - \left(\mu_W - \sigma_W^2/2\right)(T_2 - t)}{\sigma_W\sqrt{T_2 - t}}\right). \tag{11}$$

At any date between T_1 and T_2, the debt crisis probability can be calculated using (11).

2.3 Extension of the Basic Model

So far we have explained the basic idea of modeling the dependency between different types of crises at different dates using the simplest possible case where just two payments are required to avoid a financial crisis. In reality, more than two payments are usually required to avoid a crisis. So, typically several debt servicing payments have to be made instead of just one. In the following, we consider the case where *I* payments are required to avoid a crisis. The generalized framework relies on the same ideas as the basic two-payment model, but instead of the simple option and the Black-Scholes model we consider compound options and compound option theory.

Firstly, we consider a situation with three different payments required to avoid a crisis: B_0, B_1, and B_2. B_0 may now represent, e.g., the amount of payments required to bail-out the banking system and B_1 and B_2 may now represent two debt service payments required at two different dates. For B_1 and B_2 the situation is similar to that explained above for the two payment case: At T_1, the government can buy the option that expires at T_2 by spending the required funds, B_1, for debt servicing. Or, the government can choose not to spend the funds and face a (debt) crisis at T_1. Thus, as at T_2 the government owns an option right at T_1. This is the option to buy another option – the one which expires at T_2. For any date before T_1 this option can be valued using the pricing formula for compound (call) options (see Geske 1979). To derive the threshold for a crisis at T_0 we can – as we did in (4) – set this formula equal to the payments required to avoid a crisis at T_0: B_0. This is because the government will also only buy the (compound) option at T_0 if its value is greater than or at least equal to the required payments.

Based on these ideas we can model situations where *I* rather than two or three payments are required to avoid a financial crisis. Here, the government owns a compound option with multiple expiration dates. At T_I, when no payments are due at later dates, the simple call option described above expires. At T_{I-1}, the government can buy this option or not, which equals the compound option described above. At T_{I-2}, the government can buy the compound option or not. At T_{I-3}, the government can buy this option, and so on. For $i = 1,\ldots, I$ payments, B_i, required at I payment dates, T_i, the value of the compound option at any date t before T_1 is given by (see Geske 1977):

$$Y_t = W_t N_I\left(d_1 + \sigma_W\sqrt{T_1 - t}, \ldots, d_i + \sigma_W\sqrt{T_i - t}, \ldots, d_I + \sigma_W\sqrt{T_I - t}; \left\{\rho_{ij}\right\}\right) - \sum_{i=1}^{I} B_i e^{-r_s(T_i - t)} N_i\left(d_1, \ldots, d_i; \left\{\rho_{ij}\right\}\right), \tag{12}$$

$$\text{where: } d_i = \frac{\ln(W_t/W_{Q,i}) + \left(r_s - \sigma_W^2/2\right)(T_i - t)}{\sigma_W\sqrt{T_i - t}},$$

$$d_I = \frac{\ln(W_t/B_I) + \left(r_s - \sigma_W^2/2\right)(T_I - t)}{\sigma_W\sqrt{T_I - t}}, \text{ and } \rho_{ij} = \sqrt{\frac{T_i - t}{T_j - t}} \text{ (for } i < j).$$

$N_i(\ldots)$ describes the value of the i-dimensional cumulative standard normal distribution for arguments in parentheses. $W_{Q,i}$ are the threshold values at payment dates T_i (with $i = 1,.., I-1$).

These thresholds can be derived in a recursive manner starting from the last date, for which the threshold is B_I. At any payment date before T_I, the government buys a compound option by making debt service payments to its creditors, provided the value of this option is positive. If we consider the first payment date, T_0, where payments in the amount of B_0 are required, and $i = 1,\ldots I$ payments in the amount of B_i have to be made at later dates, T_i, the threshold at T_0 can be determined by:

$$B_0 = W_Q N_I\left(d_1 + \sigma_W\sqrt{T_1 - t}, \ldots, d_i + \sigma_W\sqrt{T_i - t}, \ldots, d_I + \sigma_W\sqrt{T_I - t}; \left\{\rho_{ij}\right\}\right) - \sum_{i=1}^{I} B_i e^{-r_s(T_i - t)} N_i\left(d_1, \ldots, d_i; \left\{\rho_{ij}\right\}\right), \tag{13}$$

where:

$$d_i = \frac{\ln(W_Q/W_{Q,i}) + \left(r_s - \sigma_W^2/2\right)(T_i - t)}{\sigma_W\sqrt{T_i - t}},$$

$$d_I = \frac{\ln(W_Q/B_I) + \left(r_s - \sigma_W^2/2\right)(T_I - t)}{\sigma_W\sqrt{T_I - t}},$$

$$\text{and } \rho_{ij} = \sqrt{\frac{T_i - t}{T_j - t}} \text{ (for } i < j).$$

For all dates, T_ϑ, after T_0 (except T_I), the respective threshold can be calculated by replacing B_0 with B_{T_ϑ} and the first value of the index $i = 1$ with $i = T_{\vartheta+i}$.

Using the threshold W_Q, the (short-term) probability that a financial crisis occurs at T_0 can be calculated by applying (7) (and by replacing T_1 with T_0). The overall crisis probability is given by:

$$P_{T_0,\ldots,T_i,\ldots,T_I,t} = 1 - N_I\left(m_0,\ldots,m_I,\left\{\rho_{i,j}\right\}\right) \tag{14}$$

$$\text{where } m_i = \frac{\ln(W_t/W_{Q,i}) + \left(\mu_W - \sigma_W^2/2\right)(T_i - t)}{\sigma_W\sqrt{T_i - t}},\ (\text{for } i = 0,\ldots,I-1),$$

$$m_I = \frac{\ln(W_t/B_I) + \left(\mu_W - \sigma_I^2/2\right)(T_I - t)}{\sigma_W\sqrt{T_I - t}},\ \text{and}\ \rho_{ij} = \sqrt{\frac{T_i - t}{T_j - t}}\quad (\text{for } i < j).$$

$N_I(m_0, \ldots, m_I, \{\rho_{i,j}\})$ describes the probability that a crisis occurs neither at T_0 nor at any other date T_i, i.e., the probability that at any date the amount of funds the government is able and willing to pay to avoid a crisis is higher than the amount required.

The probability that a crisis occurs before a specific date T_ϑ is given by:

$$P_{T_0,\ldots,T_\vartheta,t} = 1 - N_\vartheta\left(m_0,\ldots,m_\vartheta\left\{\rho_{i,j}\right\}\right). \tag{15}$$

The probability that a crisis occurs exactly at date T_ϑ (and not before or thereafter) is given by:

$$P_{T_\vartheta,t} = 1 - \frac{N_\vartheta\left(m_0,\ldots,m_\vartheta;\left\{\rho_{i,j}\right\}\right)}{N_{\vartheta-1}\left(m_0,\ldots,m_{\vartheta-1};\left\{\rho_{i,j}\right\}\right)}. \tag{16}$$

Here $N_\vartheta(m_0, \ldots, m_\vartheta; \{\rho_{i,j}\})$ is the probability that no crisis occurs up to T_ϑ, and $N_{\vartheta-1}(m_0, \ldots, m_{i-1}; \{\rho_{i,j}\})$ is the probability that no crisis occurs up to $T_{\vartheta-1}$.

3 The Determinants of Financial Crisis Risk

Using the framework developed in the last section, we now analyze the impact of several determinants on crisis risk. We focus on the basic model with two payment dates since this is sufficient to infer the main results and avoids unnecessary complexity. The situation is sketched in Fig. 1. A financial crisis occurs if, either at the first or at the second date at which payments to avoid a crisis or a default are required, the state variable, i.e., the amount of funds the country is able and willing to spend to avoid a crisis, falls below the respective crisis threshold. Thus, the risk of a financial crisis in the short run is described by the probability that the state variable falls below the short-term threshold W_Q (as derived by (4)), The risk of a default (debt crisis) can be calculated by (10) and (11). The overall crisis risk is described by the probability that the state variable falls either below the short-term threshold at the first date or below the long-term threshold, given by the (debt service) payments, at the second date (see (9)). In the following, we discuss the quantification of crisis risk at an arbitrary date t before T_1 with the information known at t.

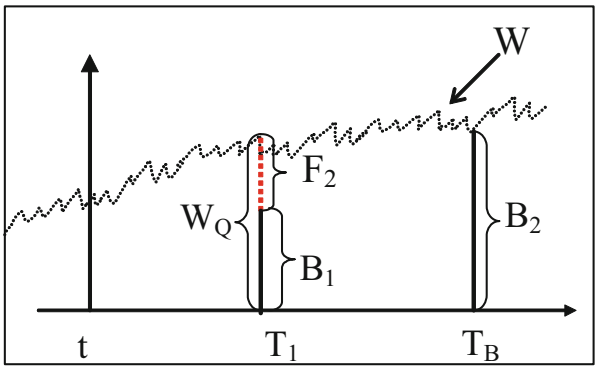

Fig. 1 The situation with two payments required to avoid a crisis

3.1 The Payment Requirements, the State Variable, and Its Drift

The crisis risk depends on the relationship between the (expected) value(s) of the state variable (describing the amount of funds the country is able and willing to spend to avoid a crisis) at dates T_1 and T_2, when payments are required to avoid a crisis, and the respective thresholds, W_Q and B_2. Based on this, we can first derive some rather intuitive results, which we discuss here. A *higher* current value of the state variable, W_t, as well as a higher drift, μ_W, increases the expected value for the payment dates, which is given by:

$$E_t[W_{T_i}] = W_t e^{\mu_W (T_i - t)}. \tag{17}$$

Thus, c.p., higher values of the state variable and its drift decrease the short-term crisis probability, i.e., the probability that the state variable is below W_Q at the first payment date. They also decrease the long-term crisis probability, i.e., the probability that the state variable is lower than the debt service payments at the second date. Thus, the overall crisis probability depends negatively on the current value of the state variable and its drift.

Higher threshold values, by contrast, increase crisis risk, since the thresholds positively depend on the payments required for crisis avoidance: Higher short-term payment requirements (to bail out the banking sector) increase the short-term crisis threshold and, thus, the short-term risk of a banking crisis. Since the overall crisis risk depends positively on the short-term crisis risk, the overall crisis risk is c.p. higher when higher short-term payments are required. The long-term threshold is equal to the long-term payment requirements (for debt service). Thus, the higher the (debt service) payments required to avoid a (debt) crisis at the second date, the higher the long-term and the overall crisis risk.

While these results are rather obvious, our model also shows that the long-term payment requirements (for debt service) influence the short-term threshold and thus the short-term crisis risk. This dependency is discussed in detail in the next section.

3.2 Dependencies Between Payment Requirements at Different Crisis Dates

3.2.1 The Influence of Later Payments

One of the main goals of this paper is to analyze how the occurrence of a financial crisis at a certain date is influenced by the payments required to avoid a default at a later date. Although the amount of later (debt service) payments does not directly enter into the formula for the short-term crisis probability (see (7)), it influences the crisis risk because the short-term crisis threshold, W_Q, depends on the debt service payments due at later dates (see (4)).

If no later payments are required, the short-term threshold equals the funds required to avoid a crisis at T_1. If the government has to make later payments, the threshold is higher, as shown in (4) (see also the discussion following this equation). By determining the threshold in this way, we model the connection between potential crisis dates and the payments required at these dates. The later payments enter into (4) with a negative sign whereas the relationship between current payments and the threshold W_Q is positive. Thus, it follows that for higher later payments, the threshold increases for a given amount of current payments.

We illustrate the influence of later payments on the current threshold in Fig. 2. The numbers displayed by the curves are calculated using (4). We set the actual payment, B_1, equal to one and vary the values of later (debt service) payments, B_2, between zero and three. The risk-less interest rate is assumed to be 5 %. For the time span between the current payment and the second payment we consider values of 1 month, 1 year, and 3 years. For the volatility we assume values of 0.3 and 0.7.

As mentioned above, if no later payments are due, i.e., $B_2 = 0$, the current threshold value is equal to the current payments, i.e., $W_Q = B_1 = 1$. If later payments are due, the threshold is higher than B_1. The threshold increases with the amount of later payments and, c.p., decreases with a longer time span between payments and for a higher volatility, as discussed in the next subsections.

Having considered the effects of later payments on the current threshold, we can now discuss the implications for crisis risk. The *short-term probability* of a financial crisis is positively influenced by outstanding (debt service) payments due at later dates, i.e., it increases with higher later payment requirements, since higher payment requirements at the second date increase the short-term threshold. Since the long-term payments equal the threshold at the second date, the probability of a (debt) crisis at T_2 depends positively on the long-term debt service payments. Thus, the overall crisis risk increases when the long-term payments increase and all other quantities, the short-term payments especially, stay the same.

3.2.2 The Ratio Between Short-Term and Long-Term Payments

So far we have considered the effects of (changes in) the amount of long-term (debt service) payment requirements for a given amount of short-term payments required to bail-out the banking system. We now discuss how the composition of payments, i.e., a change in the ratio between short-term and long-term payment requirements for a given total amount of payments, influences crisis risk. At first glance this

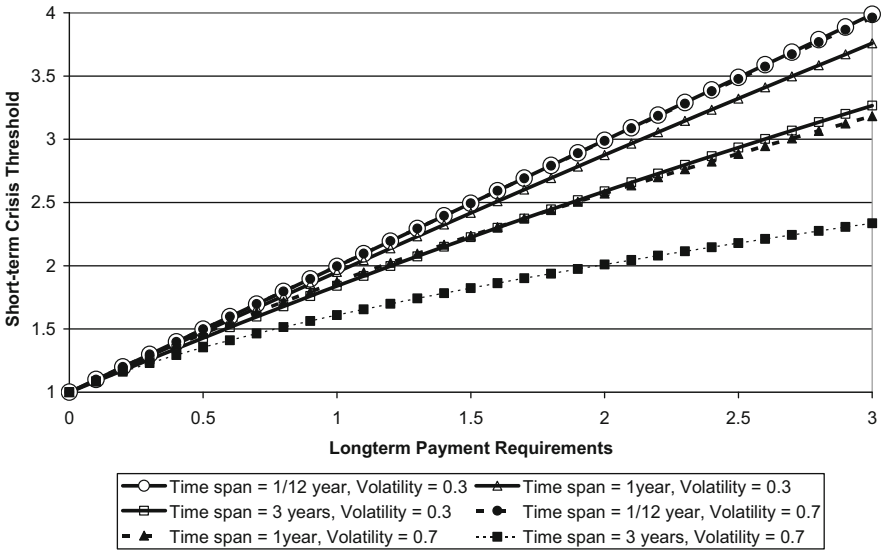

Fig. 2 Short-term crisis thresholds for different scenarios

question may seem somewhat artificial since there is no such functional relationship between the amount of payments required at the first date (e.g., to bail out the banking system) and the (debt service) payments due at a later date per se. Nevertheless, the discussion of this issue gives us further insight into the relationship between payments to avoid a crisis at different dates and their influence on crisis risk.

An increase in long-term payments accompanied by a decrease of the same amount in short-term payments *lowers the short-term crisis risk* since the short-term threshold decreases. This is because the decrease of the short-term payments outweighs the corresponding increase in the long-term payment requirements: The lowering of the short-term payment requirements by a specific amount, for example, by one dollar, decreases the short-term threshold by the same amount while a corresponding increase in the long-term payments increases the short-term threshold by less than one dollar (for all situations where the time span and the volatility are greater than zero). This can be proved by considering (5) and (6): a decrease in B_1 lowers the threshold by the amount of the change whereas an increases in B_2 increases F_{2,T_1}, but the change is smaller since the first derivative of F with respect to B_2 is smaller than one. This is illustrated in Fig. 2 where an increase in the long-term payments of one unit increases the threshold by less than one unit.

Because the short-term threshold decreases when the ratio of long-term to short-term payments required (for a given total amount of payments required) increases, the *probability of a crisis at the first crisis date*, T_1, decreases. By contrast, the *risk* that a default occurs at the *second date* increases since higher later payments imply a higher threshold for the second date. Whether the *overall crisis risk* decreases or

increases, i.e., whether the effect of the decrease in the short-term risk or the effect of the increase in the long-term risk is higher, depends on the other quantities.

3.3 Crisis Timing and the Debt's Maturity

3.3.1 The Tim Span's Influence on Short-Term Crisis Risk

In addition to the amount of payments, the maturity of debt and the resulting time structure of payments, i.e., the time span between the dates T_1 and T_2, at which payments are required to avoid a crisis, influences the crisis risk. The influence on the short-term risk results because the time span affects the short-term crisis threshold. A longer time span leads to a lower threshold. This can be seen in Fig. 2. If the time span between the two payments converges to zero, the threshold equals the sum of all payments. So, for a short time span of half a year, represented by the dotted lines, the threshold is virtually equal to the sum of all payments. For longer time spans, the threshold is lower for a given amount of later payments.

The negative influence of the time span on the short-term crisis threshold follows from the features of the government's option (see (3) and (4)), that is, a longer time to maturity increases the value of the option. For a given option price, i.e., B_1 in (4), and fixed values for the other parameters, the specific value of the underlying, i.e. the threshold, W_Q, must be lower in order to compensate for the increase in the time span.[9]

Like the threshold, the short-term crisis risk depends negatively on the time span between required payments, i.e., the risk decreases for longer time spans. This is because the time span only enters into the formula for short-term crisis risk via the threshold, which depends negatively on the time span. Since, the short-term crisis risk depends positively on the threshold it must be negatively influenced by the time span.

3.3.2 The Time Span and the Long-Term and Overall Crisis Risk

The overall and the long-term crisis risk also do not directly depend on the time span $T_2 - T_1$ since this parameter does not enter into the respective formulas. However, the time span between payment dates does influence the long-term and overall crisis risk indirectly. This is because for a given date of prognosis, t, the time span between T_1 and T_2 determines the time span $T_2 - t$, i.e., the time to maturity of the (debt service) payments. The time span between t and T_2 influences the long-term (and the overall) crisis risk.

Whether this influence on long-term crisis risk is positive or negative depends on the other parameters. On the one hand, the time span's influence depends on the *ratio* between the payments B_2 required to avoid a crisis at T_2 and the funds the country is currently able and willing to spend to avoid a crisis, W_t. On the other

[9] As can be seen in Fig. 2, the influence of the time span depends on the volatility. The influence of volatility is discussed in detail in Sect. 3.4.

hand, the relationship between volatility, σ_W, and drift, μ_W, determines the influence of the time span on long-term crisis risk. For a more detailed analysis we rearrange (11):

$$\begin{aligned}\widetilde{P}_{T_1,t} &= N\left(\frac{\overbrace{\ln(B_2/W_t)}^{W_{\min}} - \overbrace{\left(\mu_W - \sigma_W^2/2\right)(T_2-t)}^{mean}}{\underbrace{\sigma_W\sqrt{T_2-t}}_{standard\ \ deviation}}\right) \\ &= N\left(\frac{\ln(B_2/W_t)}{\sigma_W\sqrt{T_2-t}} - \frac{\left(\mu_W - \sigma_W^2/2\right)(T_2-t)}{\sigma_W}\right).\end{aligned} \tag{18}$$

The long-term crisis risk decreases with a longer time span, i.e., the influence of the time span is negative if $B_2 > W_t$ and additionally $\mu > \sigma^2/2$. If $B_2 < W_t$ and $\mu < \sigma^2/2$, a longer time span increases the long-term crisis risk. If the direction of both signs differs, we cannot make a general statement.

It is not possible also to make a general statement about the time span's influence on the *overall* crisis risk. If the time span negatively influences the long-term crisis risk, it also negatively influences the overall crisis risk since a longer time span decreases the short-term risk in all situations. If, by contrast, the influence on long-term risk is positive, i.e., the long-term risk increases with longer time to T_2, it can – depending on the other parameters – outweigh the negative influence on (the short-term threshold and) the short-term crisis risk. Thus, the overall crisis risk can increase as well as decrease for longer time spans between payment dates.

3.4 The Influence of the Volatility

In addition to the relationship between different payment requirements and their timing, we are interested in how uncertainty about the amount of funds the government is able and willing to spend influences the occurrence of financial crises. This uncertainty is parameterized by the volatility of the state variable. The volatility has several, partly contradictory effects, which require a detailed discussion. Again, we first discuss the short-term risk and later the long-term and overall crisis risk.

In contrast to the time span, the volatility may affect the short-term risk both negatively and positively depending on the combination of other parameters. As can be seen in (4), for example, the volatility affects the short-term threshold. This is not the volatility's only effect, however. For a given threshold (and a given current value of the state variable), the volatility also influences the probability that the state variable will exceed the threshold at T_1.

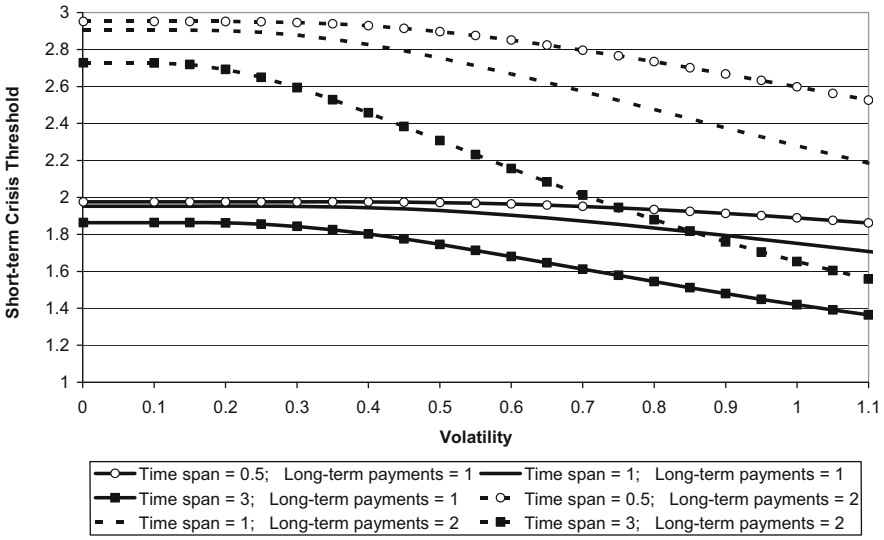

Fig. 3 Short-term crisis threshold for different scenarios with later payments

3.4.1 The Volatility's Influence on Short-Term Crisis Threshold

The volatility influences the short-term threshold negatively. The reasoning is similar to that for the time span (see (4)): a higher volatility leads to a higher value of the government's option. For a fixed option price (given by the value of the short-term payments required, B_1) and fixed values of the other parameters, the value of the underlying, i.e. the threshold, must be lower in order to compensate the higher volatility.

Figure 3 gives an impression of the influence of the volatility on the short-term crisis threshold. Again, we assume short-term payment requirements of 1 and a risk-less interest rate of 5 %. The respective values for the long-term payment requirements and the time spans are shown in the figure.

Figure 3 indicates that the volatility's effect on the threshold depends on the time span between the payment dates[10]: For longer time spans, the influence of the volatility on the threshold increases, which can be seen by the steeper (negative) slope of the curves for the longer time spans. The amount of outstanding long-term (debt service) payments (in relation to the short-term payments) also influences how strong the volatility affects the threshold, whereby the higher the values of the later payments, the higher the influence of the volatility.[11]

[10] The influence of the time span on the threshold can be seen in Fig. 3 when comparing the three solid lines (or the dashed lines) with each other.

[11] In addition to the short-term payments required to avoid a crisis, B_1, the threshold also depends on the current value, F_2, of the long-term payments, B_2 (see Eq. 5). The value of F_2 depends on the volatility (see Eq. 6). For higher long-term payments, the volatility has a stronger impact on the threshold W_Q, ceteris paribus.

3.4.2 The Volatility's Influence on Short-Term Risk for a Given Threshold

A decrease in the short-term crisis threshold decreases the short-term crisis probability. Thus, one may expect that an increase in the volatility, which leads to a decrease of the threshold, decreases the short-term crisis risk. This, however, is not necessarily the case. In reality, the opposite usually happens (as explained below). This is because the volatility influences crisis risk not only via the threshold but also via the probability that the state variable jumps over a given threshold: As described in Sect. 2.2, the short-term crisis risk is the probability that the state variable will not exceed the short-term threshold, W_Q, at T_1. This probability also is affected by the volatility. Depending on the other parameters, an increase in the volatility may either increase or decrease the short-term crisis risk (for a fixed threshold). The relationship between the stochastic state variable and the threshold is especially critical. For a given threshold, the volatility influences (short-term) crisis risk positively in all situations if the value of the state variable (that is expected for the crisis date, T_1) exceeds the threshold:

$$E_t[W_{T_1}] = W_t e^{\mu_W (T_1 - t)} \geq W_Q. \tag{19}$$

Otherwise, the influence of the volatility can be either positive or negative. This is easy to see when we rearrange (7):

$$\begin{aligned} P_{T_1,t} &= N\left(\frac{\overbrace{\ln(W_Q/W_t)}^{W_{\min}} - \overbrace{(\mu_W - \sigma_W^2/2)(T_1 - t)}^{mean}}{\underbrace{\sigma_W \sqrt{T_1 - t}}_{standard\ deviation}} \right) \\ &= N\left(\frac{\ln(W_Q/W_t) - \mu_W (T_1 - t)}{\sigma_W \sqrt{T_1 - t}} + \frac{0.5 \cdot \sigma_W (T_1 - t)}{\sqrt{T_1 - t}} \right). \end{aligned} \tag{20}$$

In the second term in parentheses, the influence of the volatility on the crisis probability is strictly positive whereas in the first term, the volatility's influence depends on the configuration of the numerator. If (19) holds, the numerator is negative and a higher volatility increases the first term in parentheses and, thus, the whole argument in parentheses. Hence, the influence of the volatility on the crisis probability is strictly positive if (19) holds. Otherwise, it depends on the other parameters.

It is important to note that – for a given threshold – the influence of the volatility can only be negative if the crisis probability is greater than or equal to 50 %. This follows because the standard normal distribution is symmetrical around its mean, zero. Thus, the probability is above 50 % if the argument in parentheses is positive. The second term in parentheses is positive in all situations. The volatility can have a negative influence only, if also the first term in parentheses is positive. Thus, the

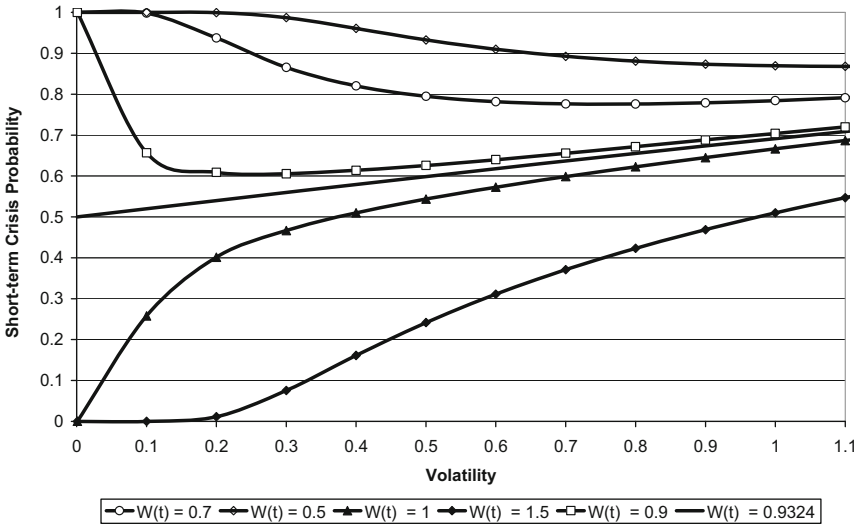

Fig. 4 Short-term crisis risk and volatility for different values of the state variable

whole argument must be positive and the probability above 50 % in order for the volatility to have a negative influence.

Figure 4 illustrates our findings for short-term crisis probabilities at different volatility values. In this example, the threshold W_Q is given exogenously (independent of the volatility especially) and set to 1. The time of prognosis, $T_1 - t$, is also set to 1. The drift is assumed to be $\mu_W = 7\,\%$. In this case, the critical value for the current payments is about 0.93 (since it follows from (19): $W_t^{crit} \geq W_Q e^{-\mu_W(T_1-t)} = 1 \cdot e^{-0.07.1} \approx 0.93$). For any positive value of the volatility, the critical crisis probability – above which the volatility can have a negative influence – is higher than 50 %. This can be seen on the unmarked curve showing the short-term crisis probabilities corresponding to the critical value W_t^{crit}. These critical crisis probabilities increase with the volatility. For all values of the state variable (e.g., $W_t = 1$ and $W_t = 1.5$) above the critical value of the state variable W_t^{crit}, the volatility's influence is strictly positive, i.e., the curves have a positive slope. For lower values of the state variable (e.g., $W_t = 0.5$, $W_t = 0.7$ and $W_t = 0.9$), the volatility can influence the crisis risk either positively or negatively depending on the other parameters. For higher volatility values, its influence on short-term risk is rather positive – even when (19) does not hold.

3.4.3 The Combined Effect of Volatility on Short-Term Crisis Risk

The last subsections considered the two isolated effects of the volatility: the negative influence on the short-term threshold, on the one hand, and, on the other, the influence on the crisis risk for a given threshold, which can be positive or negative. In combination of both effects the volatility can influence the short-term

crisis risk negatively as well as positively. If the volatility has a positive impact on the crisis risk for a given threshold, this effect can outweigh its negative effect on the threshold.

In Sect. 3.4.2 we stated that the volatility has a negative influence only if the short-term crisis risk is above 50 %. If we include the volatility's negative influence on the threshold, this result no longer holds. Because of the volatility's negative influence on the crisis threshold, a higher volatility can lower the short-term crisis risk – even when the short-term crisis probability is below 50 %. This occurs especially for configurations of other parameters where the volatility's influence on the threshold is very high in relation to its isolated effect on the probability of exceeding the given threshold. As discussed in Sect. 3.4.1, the volatility's influence on the threshold is high for longer time spans between payments, $T_2 - T_1$, and also for higher values of the later payments (in relation to short-term payments).

In sum, the volatility influences short-term crisis risk by affecting both the crisis threshold and the probability of exceeding a given threshold. The influence on the latter can be positive or negative. If it is positive, it can outweigh the effect on the threshold – which is always negative. An overall negative influence will rather prevail when the short-term crisis risk is high and/or if the volatility has a high impact on the threshold, e.g. for long time spans between payments and high long-term payments.

3.4.4 Volatility's Influence on the Long-Term Crisis Risk

For the long-term (default) risk, the volatility's influence also may be either positive or negative. In the simple case considered here, where all (debt service) payments become due at one date, T_2, the long-term threshold is equal to the long-term payments, B_2, i.e., in contrast to the short-term threshold, the long-term threshold is independent of the volatility. The volatility does, however, affect the long-term crisis risk. This is because the probability that the state variable will exceed the second threshold depends on the volatility. For the influence of the volatility on the unconditional long-term risk, our findings for the isolated influence on the short-term risk for a given threshold (see Sect. 3.4.2) apply mutatis mutandis. For combinations of the other quantities, where the value of the state variable expected for date T_2 is above the threshold B_2, i.e.:

$$W_t e^{\mu_w (T_2 - t)} \geq B_2, \tag{21}$$

the volatility's influence is positive. Otherwise, the influence can be either positive or negative.

Again, a negative influence is possible only if the unconditional long-term probability is above 50 %. Here, a similar explanation for the volatility's influence on short-term crisis risk for a given threshold applies since the threshold for long-term risk is independent of the volatility given (by B_2).

The volatility can influence the long-term risk in a different direction than the short-term risk, whereby the influence can be positive on short-term risk and negative on long-term risk, or vice versa. As already explained, the volatility's

influence on each of these probabilities is determined by the relationship between the threshold and the expected value of the state variable (see Eqs. 19 and 21), whereby the short-term threshold, W_Q, also depends on the volatility. It is possible that the expected value for the state variable is below the threshold, W_Q, for the first date, T_1, and above the threshold, B_2, for the second date, T_2.[12] This means the volatilities influence on short-term risk can be negative whereas its influence on long-term risk is positive. We can also observe a situation where the expected value of the state variable is above the threshold for the first date and below it for the second date. In this case, the volatility may have a positive influence on short-term risk and a negative influence on long-term risk.[13]

3.4.5 Volatility's Influence on the Overall Crisis Risk

Whether the volatility's impact on the short-term risk or that on the long-term risk dominates with respect to the *overall risk* (if the direction of influence differs) also depends on the configuration of the other parameters. It is not possible to make a general statement on this subject. This is illustrated in Fig. 5, which displays the short-term crisis risk (the dashed lines) and the overall crisis risk (the solid lines) for several combinations of parameters.[14] The differences between the (marked and unmarked) lines result from the different values for the state variable at date t, W_t, and its drift, μ_W. The lines marked with circles follow from a current state variable of $W_t = 1$ and a drift of $\mu_W = 0.1$, whereas the unmarked lines result from a state variable of $W_t = 2.6$ and a drift of $\mu_W = -0.3$.

The former combination of input parameters yields a negative influence of the volatility on *short-term crisis risk*, as can be seen by the negative slope of the dashed line marked with circles. The influence on the unconditional *long-term risk* is positive since $W_t e^{\mu_W (T_2 - t)} (\approx 1.49)$ is above B_2 $(= 1)$. For lower values of the volatility (up to 80 % in our case), the *overall crisis risk* (represented by the solid line marked with circles) depends negatively on the volatility. This means that the volatility's negative influence on short-term risk outweighs its positive influence on long-term risk. For higher values of the volatility, by contrast, the volatility's positive influence on long-term risk outweighs its negative influence on short-term risk – which results in a net positive influence on overall crisis risk. For the second combination of state variable and drift values, the volatility's influence on short-term risk is positive, as can be seen by the dashed, unmarked line. When the

[12] Such a situation may occur especially when the state variable at the date of prognosis is comparatively low and the drift high. Situations where the short-term payments are high compared to the long-term payments also lead by tendency to these differences in the influence on short-term and long-term risk.

[13] Such a situation prevails, for example, when the current value of the state variable is high and the drift is negative or when short-term payments are low and long-term payments are high.

[14] Both the short-term and long-term payments are set to one, and the time span between payments is assumed to be three years. The risk-less interest rate is 5 %. The resulting (volatility depending) short-term thresholds are shown in Fig. 3 by the solid line market with squares. The day of prognosis, t, is one year before the first crisis date, T_1.

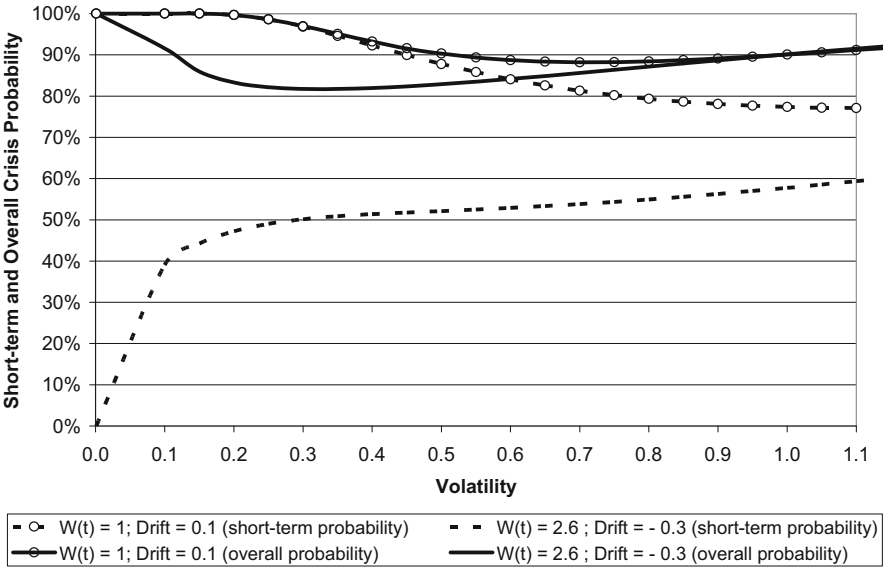

Fig. 5 Short-term and overall crisis risk and the volatility for different scenarios of the state variable and its drift

volatility is comparatively low (below 20 %), however, the overall crisis risk decreases as the volatility increases. This means that the volatility's negative influence on long-term risk outweighs the volatility's positive influence on short-term risk. If the volatility is above 20 %, its net influence on the overall risk is positive.

Situations in which the volatility affects both short-term and the long-term risk in the same direction are more straight forward than situations in which the volatility has an opposite influence on the short-term and long-term crisis risk, which, thus, require a more detailed discussion. We want to point out that situations where the volatility affects short-term and long-term risk in the same direction are, however, more realistic – whereby the influence is typically positive. This is discussed in the next section.

3.4.6 Some Thoughts About Reality

Our paper focuses on a theoretical framework for the analysis of important determinants of financial crises rather than empirical application to quantify these parameters. A discussion of empirical application of our framework would break the mould and should be the topic of subsequent research.[15] Yet, even without

[15] An empirical application could quantify the model's parameters based on observable market data, such as prices of financial instruments, as is done, e.g., in some of the single-crisis stochastic models mentioned in the introduction.

concrete quantities for the parameters we can use findings of previous papers to discuss some features in a qualitative manner.

Our discussion is based on the observation that in reality the risk of a financial crisis or a country default is rather low (i.e. well-below 50 %) for most countries at most observation dates. So, although a number of financial crises were recorded during the past decades the relative frequency, which may give a first glance approximation of the probability, shows rather small values. Reinhart (2002), for example, report for a sample of 59 countries observed over 30 years (1970–1999) 151 currency crises and 113 defaults (which often occur together). Similar results are reported by Herz and Tong (2008). Although these numbers seem high, the ratio to the total number of observations is fairly low. Beers and Chambers (2002) report between 1 and 7 sovereign defaults (on debt lent by commercial creditors) per year for all existing countries from 1990 to 2002.

What does these rather low crises probabilities mean for the influence of the volatility on crises risk? As explained above, for a given threshold, the volatility only influences short-term crisis risk negatively if the probability is above 50 %. The additional impact of the volatility on the *short-term threshold* may lead to a negative net influence on the short-term crisis risk even for *short-term probabilities* below 50 %. Nevertheless a negative influence on short-term risk rather results for high short-term probabilities. A negative influence on the *overall crisis* risk only can prevail for even higher probabilities since the risk of suffering a crisis either in short-term or in long-term is, of course, (at least slightly) higher than the short-term crisis risk. For the unconditional *long-term risk*, a negative influence prevails only for probabilities above 50 % since the volatility does not influence the threshold. On the whole, the volatility has a negative influence on crisis risk only in rare (pre crisis) situations where the risk is already very high. In normal situations, by contrast, higher volatility increases the risk of a crisis.

Conclusion and Policy Implications

Our paper is concerned with the interrelation between banking crises and (defaults on) sovereign debt. We use a stochastic framework and (compound) option theory to model the dependency between several payments required to avoid a crisis at different dates. Our stochastic continuous time framework enables us to analyze the influence of the debt's maturity and the resulting time span between payments, on the one hand, and of uncertainty about the payments the government is able and willing to make to avoid a crisis, on the other. Thus, we can provide interesting insights about the impact of determinants of financial crises and their implications for policymakers.

With respect to the amount of foreign exchange a government is able or willing to spend to avoid a crisis, we can confirm in our stochastic framework the expectation that a higher value lowers the crisis probability. The drift, which describes the expected development of these funds, also influences the crisis risk negatively. These results may justify the accumulation of high amounts of foreign exchange reserves, a policy followed by many developing countries in recent years. Investing these reserves in sovereign wealth funds, where it is

invested mostly in (foreign) stocks – which provide higher expected returns than US treasury bonds – also seems justified in this context. A strengthening of the tax revenues or of export industries, which helps to accumulate the funds needed for avoiding crisis, also decreases crisis risk.

The crisis probability for a certain date increases when higher payments are required to avoid a crisis at this date. Naturally, the more funds needed to bail out the banking sector, the higher the banking crisis risk and higher indebtedness increases the default risk. Our model shows, however, that higher indebtedness also increases the risk of a banking crisis since the probability of such a financial crisis also depends (positively) on (debt service) payments due at later dates. Thus, reducing a country's indebtedness not only reduces the default risk but also the risk of a banking crisis.

Our model further demonstrates that not only the amount of required payments but also their timing, i.e., the time span between dates at which payments are required to avoid a crisis, affect crisis risk. Here, a shorter time span increases the (short-term) risk of a financial crisis. For example, a banking crisis is more likely to occur if the debt repayments are soon due. Thus, a government can reduce the risk of a financial crisis by limiting short-term debt.

Whether the volatility of the state variable, which represents uncertainty about the amount of funds the government is able and willing to spend, affects the crisis risk positively or negatively depends on the other parameters. In situations typically observed, where the crisis risk is comparatively low (i.e. well-below 50 %), higher volatility increases the risk of a crisis. If, however, the crisis risk is already high, – for example, if the funds available to avoid a crisis are much lower than the required payments – higher volatility may actually lower the crisis risk. In tranquil times, by contrast, more certainty about the country's available funds lowers crisis risk. So, smoothing tax revenues or export surpluses (through diversification, for example) can lower the probability of a financial crisis. On the whole, sustainability, credibility, and stability of the government's economic policy will lower the risk of a financial crisis.

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The Risk of Withdrawals from the EMU and the Foreign Exchange Market

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Abstract

We study whether foreign exchange market investors perceive the risk that vulnerable countries, such as Greece, Ireland, Italy, Portugal, or Spain, could leave the EMU to cope with the financial turmoil produced by the financial crisis in the eurozone. We find that since the aggravation of the financial crisis, after the collapse of Lehman Brothers in September 2008, the euro depreciates against the U.S. dollar when the incentive for vulnerable countries to leave the EMU is increased, i.e. when sovereign default risk increases (i.e. if sovereign credit default swap (CDS) spreads rise) and when bank crisis risk increases (i.e. if banks' CDS premiums rise).

1 Introduction

The financial crisis has produced severe financial vulnerabilities for banks and governments in most EMU member countries. While most other industrialized countries' central banks (such as the Federal Reserve or the Bank of England) have implemented expansionary monetary policies relatively early after the outbreak of the crisis and at a relatively large scale, monetary easing of the European Central Bank (ECB) started relatively late during the recent crisis. One possible explanation for the relatively late quantitative easing of the ECB may be that the stabilization needs in the currency union are too heterogeneous. Since the ECB implements its monetary policy for all EMU members, the one size fits all problem of monetary policy may produce the risk of withdrawals from the Eurozone.

Sovereign states can choose to withdraw from the EMU (Cohen 1993; Scott 1998; Buiter 1999; Eichengreen 2007) and there is evidence that financial markets anticipate such a risk (Eichler 2011). The new Treaty of Lisbon includes a new

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provision indicating that a member country may "withdraw from the Union".[1] We argue that the financial crisis produced financial vulnerabilities that rapidly increased national stabilization needs, particularly in vulnerable countries such as Greece, Ireland, Italy, Portugal, and Spain. Firstly, the financial crisis produced severe solvency and liquidity problems of banks. Secondly, poor economic performance, high debt levels and the costs of national bank bailout plans feed speculations about sovereign debt defaults in the most vulnerable EMU member countries.

If the central banks of the most vulnerable EMU member countries would leave the eurozone, they could ease their monetary policies at national discretion. Bank bailouts may be financed using national monetary policy. Sovereign bond yields may be effectively reduced by a national central bank. Moreover, by increasing inflation (expectations) a national central bank may be more effective in stimulating the economy. Being a member of the EMU, however, reduces the ability of member countries to cope with financial problems in this politically attractive way by using national monetary policy. Although the ECB has implementing more expansionary monetary policies to address the financial problems associated with the current crisis (Eichler and Hielscher 2012), autonomous national central banks of the vulnerable eurozone countries would probably pursue more expansionary monetary policies. Given the political costs of the current bailout regimes (the EFSF and ESM bailout packages), withdrawals from the eurozone may therefore not be a purely hypothetical scenario. As the crisis of the European Monetary System in 1992 illustrates, opportunistic governments may rationally decide to reassert national authority over monetary policy if the benefits of dropping out exceed the benefits of remaining in a fixed-rate regime (Obstfeld 1994).

We contribute to the literature by testing whether foreign exchange market investors anticipate the risk that vulnerable member countries may withdraw from the EMU. Of course, withdrawal from the EMU is a political decision. Although our analysis cannot explain the actual choice of policymakers to withdraw from or to remain in the EMU, we can evaluate whether foreign exchange market investors perceive a risk of withdrawal from the EMU and the vulnerability factors that drive such a risk. If investors perceive a higher risk of withdrawals from the EMU *in the future*, they will let the euro depreciate against the U.S. dollar *today* since a break-up of the EMU would probably lead to sustained downward pressure on the euro. We hypothesize that the exchange rate risk is driven by two vulnerability factors that influence a government's incentives to leave/remain in the EMU: (1) the risk of a banking crisis and (2) the risk of a sovereign debt default. If foreign exchange market investors consider withdrawals from the EMU possible, we would expect that the euro depreciates against the U.S. dollar when the risk of a banking

[1] Art. 50(1) of the Treaty of Lisbon specifies that a withdrawal agreement must be made that defines a member's "future relationship with the Union." This suggests that a country may leave the EMU and can remain a EU member (Dougan 2008). Art. 50(3) of the Treaty of Lisbon even provides for automatic withdrawal in the case that a withdrawal agreement between the remaining EMU members and the withdrawing member fails.

crisis and the risk of sovereign default in the vulnerable EMU member countries increases.

To test our hypotheses, we use daily data from March 1, 2006 to March 1, 2010. Our results largely confirm the hypotheses. We find that the euro significantly depreciates against the U.S. dollar when the risk of banking crisis increases (i.e. when CDS premiums of domestic banks rise) and when sovereign default risk increases (i.e. when sovereign CDS spreads rise) in the five vulnerable EMU member countries. To determine since when the euro/U.S. dollar exchange rate significantly responded to changes in the risk measures (i.e. since when investors considered withdrawals from the EMU possible), we apply the regime switching approach of Bai et al. (1998). The results of the regime switching model indicate that the euro/U.S. dollar exchange rate significantly responded to changes in the risk measures in the crisis period from October 3, 2008 to March 1, 2010 while in the pre-crisis period from March 1, 2006 to October 2, 2008 it did not. Thus, foreign exchange market investors seem to have considered withdrawals of vulnerable member countries from the EMU possible since the beginning of October 2008, i.e. since the financial crisis aggravated and spread over to Europe after Lehman Brothers filed for bankruptcy, the interbank market dried out, bank runs occurred, and sovereign debt levels rapidly increased due to multi-billion euro bank bailout plans.

The rest of the paper is organized as follows. Section 2 derives the hypotheses on the supposed incentives to withdraw from the EMU. Section 3 outlines the empirical model. Section 4 presents the results. Section 5 concludes.

2 Incentives to Withdraw from the EMU

Withdrawing from the EMU is a political choice that involves both costs and benefits. While the costs of leaving the EMU (such as transaction costs and currency risk vis à vis EMU members) should be relatively stable over time, the benefits depend on the time-varying severity of the banking and sovereign debt crisis. Thus, assessing whether foreign exchange market investors perceive the risk of withdrawals from the EMU requires finding proxies for the benefits of leaving the EMU.

The following derives two hypotheses regarding the correlation between the risk of a currency crisis (i.e. the risk of withdrawal from the EMU) and the vulnerabilities stemming from the risk of a banking crisis and the risk of a sovereign debt crisis. We expect that the incentive to withdraw from the EMU is higher, when the risk of banking crisis and sovereign default are higher. If foreign exchange market investors take these vulnerabilities into account when evaluating the risk of withdrawals from the EMU, the euro/U.S. dollar exchange rate should be affected by empirical measures capturing these vulnerabilities. In the following two sub-sections we first derive the theoretical hypothesis from the literature and then explain how we measure the vulnerability factors empirically.

2.1 Withdraw from the EMU to Address a Banking Crisis

Several studies show that currency pegs can break down if the national central bank tries to avert/address a banking crisis. The central bank may be forced to bail out illiquid/insolvent banks by printing national money which, in turn, produces inflationary pressure that can lead to a currency crisis (Diaz-Alejandro 1985; Velasco 1987; Calvo 1998; Miller 2000). Kaminsky and Reinhart (1999) and Glick and Hutchison (2001) find empirical evidence that banking crises often precede currency crises. We argue that governments may choose to leave the eurozone and reassert sovereignty over national monetary policy in order to address a national banking crisis (i.e., finance bank bailouts, support illiquid banks). We therefore expect that higher banking crisis risk is associated with a higher risk of withdrawal from the EMU.

To measure the risk of a banking crisis, we employ data on credit default swap (CDS) premiums on domestic banks' liabilities. A CDS is a financial instrument to hedge against the risk that a borrower (such as a bank) will default on its debt. Rising CDS premiums indicate a higher bank default risk. In order to measure the risk of a country-wide banking crisis, we calculate the weighted average of CDS basis points for all domestic banks DATASTREAM provides data for, by using the market capitalization as the weighting scheme. We use CDS with maturities of 1 year. Table 4 in the Appendix lists the domestic banks included in the calculation of the average CDS premium index of each country. To obtain an aggregate measure of banking crisis risk in the five vulnerable EMU member countries, we aggregate the country-specific CDS premium indices using real GDP weights.

Hypothesis 1: If foreign exchange market investors perceive the risk that vulnerable EMU member countries may leave the EMU in order to avert a domestic banking crisis, we expect that the euro will depreciate against the U.S. dollar when the CDS premiums of the five vulnerable countries' banks (which indicate banking crisis risk) rise.

2.2 Withdraw from the EMU to Address a Sovereign Debt Crisis

Governments of vulnerable member countries may also leave the EMU in order to avert/address the outbreak of a sovereign debt crisis. By leaving the EMU and reasserting sovereignty over national monetary policy, the central bank may effectively reduce sovereign bond yields or reduce the real sovereign debt burden by increasing the inflation tax. Several empirical studies confirm that currency and debt crises often occur together (Reinhart 2002; Dreher et al. 2006; Herz and Tong 2008). Several theoretical studies show that such twin crises may be self-fulfilling (Bauer et al. 2003; Benigno and Missale 2004). As both types of crisis are interrelated, we expect that a higher sovereign default risk increases the risk of withdrawals from the EMU as perceived by foreign exchange market investors and thus leads to a depreciation of the euro against the U.S. dollar.

We employ sovereign CDS spreads to measure sovereign debt crisis risk in the five vulnerable EMU member countries. Sovereign CDS spreads are calculated as the difference between the domestic sovereign CDS premium and the German sovereign CDS premium. We use data on sovereign CDS with a maturity of 10 years provided by DATASTREAM. To obtain an aggregate measure of sovereign default risk we aggregate the country-specific sovereign CDS spreads using real GDP weights. Higher CDS spreads indicate higher sovereign default risk of the five vulnerable EMU member countries.

Hypothesis 2: If foreign exchange market investors perceive the risk that vulnerable EMU member countries may leave the EMU in order to avert a sovereign debt crisis, we expect that the euro will depreciate against the U.S. dollar when sovereign CDS spreads of the five vulnerable countries (which indicate sovereign default risk) rise.

3 Methodology

To test our hypothesis that foreign exchange market investors take the risk of withdrawals from the EMU into account when setting the euro/U.S. dollar exchange rate we apply a simple model as outlined in (1):

$$e_t = \mu + B_1 VUL_t^{Bank} + B_2 VUL_t^{Sov} + B_3 i_t^{EUR} + B_4 i_t^{USD} + \upsilon_t, \tag{1}$$

where

$$\upsilon_t = \rho \upsilon_{t-1} + u_t,$$

where the euro/U.S. dollar exchange rate (defined as the amount of U.S. dollars one must pay for one euro[2]), e_t, is regressed on a constant, μ, the CDS premiums of the five vulnerable EMU member countries' banks (our banking crisis risk measure), VUL_t^{Bank}, and the sovereign CDS spreads of the five vulnerable EMU member countries (our sovereign default risk measure), VUL_t^{Sov}. In order to control for the interest parity condition we also include the 1-year nominal interest rates for euro funds, i_t^{EUR}, and for U.S. dollar funds, i_t^{USD}, taken from Garban Information Services. B_1 to B_4 are the corresponding coefficients and υ_t is the error term, which is assumed to follow an AR(1) process.

To estimate our model we use a regime switching approach. The reason for this is explained in the following. Our observation period includes the relatively tranquil pre-crisis period 2006 to summer 2008 as well as the crisis period autumn 2008–2010. Until the collapse of Lehman Brothers on September 15 2008, the subprime crisis was largely considered to be confined mainly to the U.S. economy and its impact on European banks was perceived as relatively small. Since the

[2] A rising exchange rate indicates an appreciation of the euro against the U.S. dollar.

Lehman collapse, however, counterparty risk in interbank lending rapidly increased and interbank markets dried out. As depositors realized the refinancing problems of banks, bank runs occurred also in Europe and multi-billion euro bank bailout plans had to be set up which now question the sustainability of public finances in many vulnerable EMU member countries. We expect that prior to the aggravation of the subprime crisis (triggered by the Lehman Brothers collapse) the risk of withdrawals from the EMU was rather low as financial vulnerabilities were too small to justify reasserting sovereignty over national monetary policy. Since the aggravation of the subprime crisis in mid September 2008 foreign exchange market investors may perceive a realistic risk that vulnerable countries may withdraw from the EMU in order to cope with banking and sovereign debt crises. Thus, we expect that foreign exchange market investors have taken financial vulnerabilities into account when setting the euro/U.S. dollar exchange rate only since the aggravation of the subprime crisis, which has increased the financial vulnerabilities of the vulnerable countries and thus the potential benefits to withdraw from the EMU.

In order to detect if and since when the euro/U.S. dollar exchange rate has significantly responded to the financial problems of the five vulnerable EMU countries, we apply the regime switching approach of Bai et al. (1998). The regime switching methodology of Bai et al. (1998), allows us to determine the most significant date of the regime change, i.e., the date when the correlation between the Euro/U.S. dollar exchange rate and the financial vulnerabilities changes significantly, as well as the confidence interval at this break date.[3]

To do so we estimate the linear time series model outlined in (2):

$$e_t = \mu + \sum_p B_p x_{pt} + d_t(k)\left[\Delta\mu + \sum_p \Delta B_p x_{pt}\right] + \upsilon_t, \tag{2}$$

where

$$\upsilon_t = \rho\upsilon_{t-1} + u_t.$$

The first part of the right-hand side of (2) shows the determination of the euro/U.S. dollar exchange rate, e_t, in the first regime (the pre-crisis period), where e_t is regressed on a constant, μ, and a set of $p = 1,..., 4$ exogenous variables, x_{pt}, including the financial vulnerability measures, i.e. VUL_t^{Bamk} and VUL_t^{Sov}, and the interest rates, i.e. i_t^{EUR} and i_t^{USD}, with the corresponding coefficients of the first regime, B_p. The second part of the equation shows the change in the coefficients in the second regime (the crisis period), where $d_t(k)$ is a dummy equal to one if t is greater than or equal to the potential break date k and otherwise equal to zero, $\Delta\mu$ and ΔB_p denote the change in the value of the constant and the

[3] This methodology has, for example, also been applied to date the financial integration of emerging economies (Bekaert et al. 2002) or to test for regime changes in capital market integration after the outbreak of financial crises (Pasquariello 2008).

coefficients in the second regime, respectively, and υ_t is the error term. In matrix form, (2) reads:

$$e_t = V_t'\theta + d_t(k)V_t'S'S\delta + \upsilon_t, \tag{3}$$

where

$$V_t' = [1, x_{1t}, \ldots, x_{4t}], \quad \theta = [\mu, B_1, \ldots, B_4]', \quad \delta = [\Delta\mu, \Delta B_1, \ldots, \Delta B_4]',$$

and S is a selection matrix with ones on the diagonal for parameters of the variables in V_t' that are allowed to change, and zeros otherwise. Rewriting (3) yields:

$$e_t = Z_t'(k)\beta + \upsilon_t, \tag{4}$$

$$\text{with } Z_t'(k) = \left[V_t', d_t(k)V_t'S'\right] \text{ and } \beta = [\theta', (S\delta)']'.$$

In order to find the optimal date of the regime change, k, we estimate (4) for each possible value of k, i.e., for a time sample of $t = 1,..., T$, this implies $k = 2,..., T - 1$. As Bai et al. (1998, p. 398) we consider the maximum of the Wald F-statistic outlined in (5), which tests the null hypothesis that the second-regime coefficient changes of the variables allowed to break are jointly equal to zero, i.e. $S\delta = 0$:

$$\hat{F}(k) = T\left\{R\hat{\beta}(k)\right\}'\left\{R\left(T^{-1}\sum_{t=1}^{T} Z_t\hat{\Sigma}_k^{-1}Z_t'\right)^{-1}R'\right\}^{-1}\left\{R\hat{\beta}(k)\right\}, \tag{5}$$

where T is the length of the time sample, $R = [0,I]$ is such that $R\beta = S\delta$, and $\hat{\beta}(k)$ and $\hat{\Sigma}_k$ are the estimators for β and the error variance, ${\sigma_\upsilon}^2$, respectively, for a given value of $\hat{k}$.[4] If the maximum of the F-statistic for a $\hat{k}$ is significant at least at the 10 % level, we conclude that a regime switch occurred on this day. The asymptotic-confidence interval at this break date that covers at least $100(1 - \pi)\%$ is given by (Bai et al. (1998, p. 402)):

$$\hat{k} \pm c_{(1/2\pi)}\left[\left(S\hat{\delta}\right)'S\left(\hat{\Sigma}_k^{-1}T^{-1}\sum_{t=1}^{T} V_tV_t'\right)S'\left(S\hat{\delta}\right)\right]^{-1}, \tag{6}$$

where $c_{(1/2\pi)}$ is the $100(1 - \pi)th$ quantile of the Picard (1985) distribution.

We apply the Bai et al. (1998) estimation approach to search for the most significant regime switch in the determination of the euro/U.S. dollar exchange rate. Equation (4) is estimated for each possible break date, k. We allow the coefficients of the two financial vulnerability measures – banking crisis risk (VUL_t^{Bank}) and sovereign default risk (VUL_t^{Sov}) –, B_1 and B_2 to change. The binary

[4] The critical values for the test statistic $\hat{F}(k)$ can be found in Bekaert et al. (2002, pp. 244–245).

selection matrix, S, thus has two ones on the diagonal, which correspond to the matrix position of the two financial vulnerability measures, and zeros otherwise. For each day k, the estimators for the regression coefficients and the error variance are used to compute the Wald F-statistic as outlined in (5). The day of the regime switch with the maximum value of the Wald F-statistic is considered as the most significant break date.

4 Results

We use daily data from March 1, 2006 to March 1, 2010. We start our analysis in 2006 as data on CDS premiums of most banks of the five considered vulnerable EMU members are only available since 2006. Before estimating the model, we check for unit roots in the variables using the augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. The results of the unit root tests are presented in Table 5 in the Appendix. The test results indicate that the variables contain a unit root in levels and are consequently used in first differences.

Table 1 reports the results for the date of regime switch in the determination of the euro/U.S. dollar exchange rate. We report the median date of the regime switch, the maximum value of the Wald F-statistic, and the corresponding 5 % confidence interval.

We find a significant regime switch on October 3, 2008 with a Wald F-statistic of 14.2. This finding means that the estimated changes in the coefficients of the two financial vulnerability measures in the second regime are jointly different from zero at the 5 % significance level. Taking the 2.5th and 97.5th percentiles into account, we conclude that foreign exchange market investors have significantly altered the modus of determination of the euro/U.S. dollar exchange rate between August 4, 2008 and December 4, 2008. The median date of the regime change is October 3, 2008. During the start of the subprime crisis many investors obviously believed that the financial crisis would affect mainly American banks. After the failure of Lehman Brother it became clear that the subprime mortgage crisis would spread over to Europe. Following the bankruptcy of Lehman Brothers and the bailout of AIG, counterparty risk increased and the interbank market subsequently dried out worldwide. The write-offs on bad assets and liquidity shortages increased the vulnerabilities in EMU banking systems, which led to increasing CDS premiums, particularly of the most vulnerable EMU countries' banks. Following rising bank bailout costs, the disastrous impact of the banking crises on economic activity, and the loss of investor confidence, sovereign CDS spreads of Greece, Ireland, Italy, Portugal, and Spain began to rise as investors anticipated that the public expenditures associated with the financial crisis would overtax the fiscal capacities of these countries. In the light of rising banking and debt crisis risk in the vulnerable EMU member countries, the regime break during the beginning of October 2008

Table 1 Regime switch in the determination of the euro/U.S. dollar exchange rate

Maximum wald F-statistic	2.5th percentile	Median	97.5th percentile
14.201**	August 4, 2008	October 3, 2008	December 4, 2008

Note: This table reports the median structural break date $\hat{k}$ determined using the maximum Wald F-statistic outlined in (5), which tests the null that the second-regime coefficient changes of the banks' CDS premiums and the sovereign CDS spread are jointly equal to zero, i.e. $S\delta = 0$. The reported optimal break date is determined using the coefficients of the regime switching regressions outlined in (2). The critical values for the Wald F-statistic are taken from Bekaert et al. (2002, pp. 244–245): 10.226, 11.780, and 16.366 correspond to the 10 %, 5 %, and 1 % significance level, where two coefficients are allowed to break. ** denotes 10 %, 5 %, and 1 % level of significance respectively. The 2.5th and the 97.5th percentiles around the break date are computed using (6)

may be interpreted as evidence that foreign exchange market investors consider withdrawals from the EMU increasingly possible.

In order to illustrate test how the crisis indicators of the five vulnerable eurozone member countries (Greece, Ireland, Italy, Portugal, and Spain) affect the euro/U.S. dollar exchange rate before/after the regime change, we estimate the benchmark model (see (1)) using the pre-crisis regime observations (March 1, 2006 to October 2, 2008) and the crisis regime observations (October 3, 2008 to March 1, 2010). Table 2 presents the estimation results.[5]

The results indicate that the euro/U.S. dollar exchange rate is not significantly affected by the financial vulnerability measures during the pre-crisis regime (March 1, 2006 to October 2, 2008) where the financial vulnerabilities of the considered EMU member countries were low and the incentive to withdraw from the EMU was low. This suggests that during the pre-crisis regime foreign exchange market investors did not anticipate that vulnerable EMU members might consider withdrawing from the EMU and that vulnerability measures consequently played no role in determining the fair value of the euro/U.S. dollar exchange rate. We find however some evidence for the validity of the uncovered interest parity since the U.S. dollar and the euro interest rates have a significantly negative and positive effect on the euro/U.S. dollar exchange rate. During the crisis regime (October 3, 2008 to March 1, 2010) the euro/U.S. dollar exchange rate is significantly negatively correlated with the vulnerability variables. This result means that the euro depreciates significantly against the U.S. dollar when banks' CDS premiums (indicating banking crisis risk) or sovereign CDS premiums (indicating sovereign default risk) increase in the five vulnerable EMU members. This result confirms our

[5] Before estimating the models we check for unit roots in the variables for the pre-crisis and the crisis period. The results of the unit root tests are reported in Table 5 in the Appendix. All variables contain unit roots in levels and are therefore used in first differences, except for the euro and U.S. dollar interest rates which are stationary in levels during the crisis period. However, to make the results of the crisis-period comparable to the results of the pre-crisis period, we also use the interest rates in first differences in the crisis regime regression. As a robustness check we use the interest rates in levels in the crisis regression but the results (which are available upon request) change only marginally.

Table 2 Pre-crisis and crisis regime estimations

	Pre-crisis regime	Crisis regime
Euro interest rate	0.027***	0.002
	(2.917)	(0.385)
U.S. dollar interest rate	−0.006**	0.003
	(−2.102)	(0.787)
CDS premiums of domestic banks	4.27E-05 (0.537)	−4.11E-04*** (−4.800)
Sovereign CDS spread	−3.72E-04 (−1.631)	−2.23E-04* (−1.757)
C	1.37E-04	8.96E-05
	(0.682)	(0.198)
AR(1)	0.020	0.007
	(0.516)	(0.132)
Adj. R2	0.013	0.099
F-statistic	2.757**	9.013***
No. of obs	677	367

Note: t-statistics in parentheses. *, **, *** denotes significance at the 10 %, 5 %, and 1 % level

hypothesis that foreign exchange market investors consider withdrawals from the EMU possible since the regime break on October 3, 2008 thereby taking banking and sovereign debt crisis risk into account when pricing the euro/U.S. dollar exchange rate. The coefficient of the CDS premiums of domestic banks is −4.11E-04 which means that a two standard deviation increase in banks' CDS premiums (11.748) would lead to a 0.5% depreciation of the euro against the U.S. dollar on average. Thus, foreign exchange market investors seem to perceive the risk of a twin currency and banking crisis, where governments of vulnerable countries could leave the EMU in order to bail out domestic banks by printing large amounts of new national currency. The coefficient of the sovereign CDS spread is −2.23E-04 which means that an increase of the vulnerable countries' sovereign CDS spreads by two standard deviations (7.977) would lead to a 0.2 % depreciation of the euro against the U.S. dollar. This result implies that foreign exchange market investors perceive the risk of a twin currency and debt crisis in which highly indebted governments could leave the EMU and introduce a new national currency to reduce the real value of public debt via the inflation tax.

In order to test if the countries' crisis indicators differ with respect to their impact on the euro/U.S. dollar exchange rate, we estimate (1) for each of the considered EMU countries for the crisis period (October 3, 2008 to March 1, 2010). The results are presented in Table 3.[6]

[6] Before estimating the models we check for unit roots in the variables. The results of the unit root tests are reported in Table 6 in the Appendix. All variables contain unit roots in levels and are consequently used in first differences.

Table 3 Country-specific regressions

	Greece	Ireland	Italy	Portugal	Spain
Euro interest rate	−0.002	0.003	0.003	0.004	0.001
	(−0.292)	(0.397)	(0.435)	(0.553)	(0.189)
U.S. dollar	1.60E-04	0.003	0.003	0.002	0.002
interest rate	(0.032)	(0.858)	(0.910)	(0.660)	(0.567)
CDS premiums of	1.08E-05	−4.05E-05	−4.05E-04***	−2.58E-04***	−3.60E-04***
Domestic banks	(0.391)	(−1.227)	(−5.462)	(−3.283)	(−4.227)
Sovereign CDS spread	−7.57E-05**	−2.80E-04***	−2.01E-04*	−1.99E-04*	−2.15E-04*
	(−2.072)	(−4.260)	(−1.731)	(−1.802)	(−1.682)
C	−6.66E-04	6.98E-05	4.38E-05	1.23E-04	3.98E-05
	(−1.503)	(0.153)	(0.096)	(0.263)	(0.087)
AR(1)	−0.187 *	−0.010	0.016	0.009	0.001
	(−1.938)	(−0.195)	(0.307)	(0.167)	(0.011)
Adj. R2	0.021	0.048	0.108	0.046	0.071
F-statistic	1.48	4.735***	9.893***	4.516***	6.574***
No. of obs	114	367	367	367	367

Note: t-statistics in parentheses. *, **, *** denotes significance at the 10 %, 5 %, and 1 % level. The observation period for Greece spans only from September 22, 2009 to March 1, 2010 since data on CDS premiums of Greek banks are only available thru September 22, 2009

Overall, the country-specific regressions confirm our previous findings. For most of the five vulnerable EMU member countries the Euro/U.S. dollar exchange rate significantly responds to changes in the financial crisis measures in the hypothesized direction. We find that the coefficient of CDS premiums of domestic banks is significantly negative for Italy, Portugal, and Spain while it is insignificant for Greece and Ireland.[7] One possible explanation for this result may be that the Greek and Irish banking systems are relatively small compared to Italy and Spain. Thus, foreign exchange market investors seem to expect that a possible withdrawal of Greece or Ireland from the EMU in order to rescue the domestic banking sector would have a less severe impact on the euro than would a withdrawal of EMU countries with large banking sectors such as Italy or Spain. For sovereign CDS spreads we find significantly negative coefficients of all countries, indicating that higher sovereign default risk of each of the considered countries leads to a significant depreciation of the euro against the U.S. dollar.

[7] Please note that the observation period for Greece spans only from September 22, 2009 to March 1, 2010 since data on CDS premiums of Greek banks are only available from September 22, 2009.

Conclusions

In this paper we studied whether foreign exchange market investors perceive the risk that vulnerable countries such as Greece, Ireland, Italy, Portugal, or Spain could withdraw from the EMUin order to address financial difficulties produced by the subprime crisis. We hypothesized that these vulnerable countries could use the opportunity to withdraw from the EMU provided by the new Treaty of Lisbon and to introduce a new national currency in order to finance bank bailouts by printing national money or to reduce the real value of sovereign debt by raising the inflation tax.

Our results indicate that the euro significantly depreciates against the U.S. dollar when banking crisis risk increases (i.e. when CDS premiums of domestic banks rise) and sovereign debt crisis risk increases (i.e. when sovereign CDS spreads rise) in these vulnerable EMU member countries. Using the regime switching approach of Bai et al. (1998) we found that the euro/U.S. dollar exchange rate significantly responded to changes in the financial crisis risk measures in the crisis period from October 3, 2008 to March 1, 2010 while in the pre-crisis period from March 1, 2006 to October 2, 2008 it did not. Our results indicate that foreign exchange market investors have considered withdrawals of vulnerable member countries from the EMU possible since the beginning of October 2008, i.e. since the subprime mortgage crisis spread over to Europe after Lehman Brothers filed for bankruptcy, interbank markets dried out, bank runs occurred, and sovereign debt levels of many vulnerable EMU member countries rapidly increased due to multi-billion euro bank bailout plans.

Although our results imply that foreign exchange market investors perceive a certain risk of withdrawals from the EMU, the development of a European bailout framework (EFSF, ESM, the crisis measures of the ECB) during the last years may reduce the attractiveness of leaving the EMU. However, it is an open question if these bailout instruments are robust enough to rescue large member countries such as Italy and Spain. At some point, such as a default of the Spanish or Italian government, the limits of European solidarity may have reached. In such an event, leaving the EMU may be a politically opportune way to solve financial distress without having to fear open-ended negotiations on bailout packages with the other EMU countries that could result in an unfortunate consensus.

5 Appendix

Table 4 Domestic banks included in the national CDS premiums indices

Country	Included domestic banks
Greece	EFG Eurobank Ergas[a], National Bank of Greece[a]
Ireland	Allied Irish Banks, Anglo Irish Bank, Bank of Ireland
Italy	Banca Italease, Banca Siena, Banca PPO Italiana, Banca PPO Di Milano, Unicredito Italiano
Portugal	Banco Commercial Portugues, Banco Espirito Santo
Spain	Banco Intl. Finance, Banco Bilbao Vizcaya Argentaria, Banco Popular Espaniol, Banco Sabadell, Banco Santander, La Caja de Ahorros

[a]Included thru September 22, 2009

Table 5 Results of the unit root tests for the aggregated variables sample

	Whole sample		Pre-crisis sample		Crisis sample	
	Mar 1, 2006 to Mar 1, 2010		Mar 1, 2006 to Oct 2, 2008		Oct 3, 2008 to Mar 1, 2010	
	ADF	PP	ADF	PP	ADF	PP
Log euro/ U.S. dollar exchange rate	−2.181	−2.213	−1.818	−1.812	−1.588	−1.565
	$(-31.130)^{***}$	$(-31.130)^{***}$	$(-24.895)^{***}$	$(-24.952)^{***}$	$(-18.503)^{***}$	$(-18.504)^{***}$
Euro interest rate	0.020	0.455	−0.762	−0.784	-5.660^{***}	-6.353^{***}
	$(-6.581)^{***}$	$(-41.688)^{***}$	$(-22.385)^{***}$	$(-22.626)^{***}$	$(-28.451)^{***}$	$(-27.224)^{***}$
U.S. dollar interest rate	−0.259	−0.169	−1.006	−1.099	-3.573^{***}	-3.370^{**}
	$(-37.050)^{***}$	$(-37.701)^{***}$	$(-24.296)^{***}$	$(-24.350)^{***}$	$(-24.362)^{***}$	$(-27.039)^{***}$
CDS premiums of domestic banks	−1.313	−1.243	−0.032	−0.197	−1.392	−1.348
	$(-25.900)^{***}$	$(-25.818)^{***}$	$(-16.655)^{***}$	$(-22.707)^{***}$	$(-14.851)^{***}$	$(-14.842)^{***}$
Sovereign CDS spread	−0.876	−0.709	0.476	0.586	−2.558	−2.256
	$(-22.997)^{***}$	$(-25.936)^{***}$	$(-27.186)^{***}$	$(-27.186)^{***}$	$(-13.636)^{***}$	$(-14.933)^{***}$

Note: Test statistics for variables in levels and first differences (in parenthesis); **, *** denotes significance at the 10 %, 5 %, and 1 % level. For theorder of the autoregressive correction for the ADF test, we use the modified Akaike Information Criterion (AIC)

Table 6 Results of the unit root tests for the country specific financial crisis indicators

	CDS premiums of banks		Sovereign CDS spread	
	ADF	PP	ADF	PP
Greece	3.409	2.372	−1.339	−1.080
	$(-8.858)^{***}$	$(-8.712)^{***}$	$(-15.346)^{***}$	$(-15.090)^{***}$
Ireland	−1.588	−1.429	−2.489	−2.384
	$(-8.375)^{***}$	$(-15.626)^{***}$	$(-14.398)^{***}$	$(-14.411)^{***}$
Italy	−1.258	−1.238	−2.201	−2.038
	$(-15.943)^{***}$	$(-15.979)^{***}$	$(-16.058)^{***}$	$(-15.836)^{***}$
Portugal	−1.757	−1.627	−1.039	−1.163
	$(-15.632)^{***}$	$(-15.541)^{***}$	$(-17.569)^{***}$	$(-17.569)^{***}$
Spain	−1.317	−1.228	$-.2681^{*}$	−2.291
	$(-15.782)^{***}$	$(-15.798)^{***}$	$(-14.064)^{***}$	$(-16.232)^{***}$

Note: Test statistics for variables in levels and first differences (in parenthesis); *, *** denotes significance at the 10 %, 5 %, and 1 % level. For the order of the autoregressive correction for the ADF test, we use the modified Akaike Information Criterion (AIC)

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An Economic Approach to Market Risk

Christian Hott

Abstract

Value at Risk models are often employed for the purpose of evaluating market risk as a basis for determining capital requirements of financial intermediaries. We argue that this type of model delivers highly pro-cyclical results. As a result, capital requirements are rather low at the peak of an asset price bubble, right before the losses occur. In addition, the pro-cyclicality of regulation provides an incentive for banks to buy assets when prices go up and to sell them when prices go down, thereby amplifying price fluctuations. Against this background this paper delivers two important contributions. First, we evaluate minimum standards for Value at Risk that should help to reduce its weaknesses. Second, we develop a capital add-on for market risk that is, in contrast to Value at Risk, linked to economic fundamentals.

1 Introduction

Banks suffered substantial trading losses over the past decade. At the same time, capital requirements for their trading books were rather low. This indicates that not only banks but also regulation underestimated the risks associated with trading activities. One reason for this is that since the 1996 market risk amendment to the Basel Capital Accord,[1] banks were allowed to use their own risk models to calculate the capital requirements for their trading book.

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[1] See Basel Committee on Banking Supervision (1996).

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The risk model that is usually used to assess market risks is Value at Risk. A problem with this method is that it is very pro-cyclical, meaning it indicates low risks when prices go up and high risk when prices go down. As a result, capital requirements are rather low at the peak of an asset price bubble, right before the losses occur. In addition, the pro-cyclicality of regulation provides an incentive for banks to buy assets when prices go up and to sell them when prices go down. Thereby, they amplify price fluctuations.

The aim of this paper is to develop a proposal for capital requirements that reduces the pro-cyclicality of regulation and that limits the risk that banks hold too little capital to cover their trading losses. On the one hand we evaluate minimum standards for Value at Risk that should help to reduce its weaknesses. On the other hand, we develop a capital add-on for market risk that is, in contrast to Value at Risk, linked to economic fundamentals.

The paper is organized at follows. First we will evaluate the weaknesses of Value at Risk models and illustrate these weaknesses by looking at stock market prices. Then we estimate imbalances on stock markets. These imbalances are then used to estimate additional capital requirements for market risk. The final section offers some concluding remarks.

2 Value at Risk

Value at Risk (VaR) is a widely used method to assess risks and, since the introduction of the 1996 market risk amendment by the Basel Committee on Banking Supervision, also an important instrument for capital regulation of banks. It provides an estimate of trading losses over a certain holding period that are not exceeded with a certain probability.

As for all approaches to assess risks, there are pros and cons for the usage of VaR. One positive feature is, for example, that it can easily be used. However, we will argue that some characteristics of VaR lead to a systematic miscalculation of risks and to wrong incentives for banks. First, VaR is completely atheoretical and lacks any link to economic fundamentals like earnings or interest rates that might cause price changes. Hence, VaR can only work when markets are efficient and prices always reflect all information on the relevant fundamentals in an efficient way. However, under this assumption it is questionable whether we would need any regulation. Second, banks have a significant freedom to design their VaR models. Some differentiation might be welcomed to diversify model risk. However, different models can lead to very different estimates of risks and capital requirements. Hence, banks have the possibility to manipulate their capital requirements and have incentives to do so.[2]

In the following, we will evaluate the effects of some critical assumptions of VaR calculations: the length of the holding period, the confidence level and the estimation of the underlying loss distribution.

[2] See Basel Committee on Banking Supervision (2013).

2.1 Length of the Holding Period

The assumed length of holding period that is relevant for VaR calculations is usually rather short. For internal purposes, banks often only look at a holding period of 1 day, meaning that they are interested in the potential trading loss within 1 day.

One reason for the relatively short assumed holding period is that banks often trade their trading assets with a high frequency. In fact, assets are often sold on the same day as they were bought. Another reason is that banks assume that they can sell an asset entirely within a few days when prices are falling. A more technical (although not an economic) reason for the use of a short holding period is that it allows to use more data points which makes the results more significant even if the history of data is rather short.[3] Finally, most asset prices are mean reverting and have a positive trend. As a result, short term losses are usually higher than losses over a longer period.

There are however problems with these arguments. First, the development of asset prices is often highly correlated, especially in crises times. When a bank exchanges one asset after a short period of time for another asset, it could continue to make losses with a different asset. Second, it is not clear that a bank really sells an asset if its price is falling. The reduced price can be interpreted as an increased risk but also as a buying opportunity. Based on anecdotal evidence, when prices of some US mortgage backed securities started to fall slightly in early 2007, some banks tried to get out of the market while others even increased their exposure.

Third, using high frequency data might provide a false signal for accuracy. If we would measure, for example, outside temperature every 5 min for an entire month, we would get very significant results for the temperature fluctuation in this location. However, the results measured in January would be very different from the results in July. The same happens if we use a VaR model to evaluate the riskiness of a mortgage back security that has existed for 5 years. If we use daily data we might get significant results. However, given that real estate and mortgage cycles have a length of 20 years, we have to aware that we have only the results for summer times.

Forth, even with mean reversion and a positive trend, it is unclear whether the assumed short holding period reflects the maximum loss for all assets and at all times. Especially when greater imbalances have to be reduced or are reversed, losses can appear over longer periods of time, leading to higher aggregated losses. This is illustrated in Fig. 1 which shows the market losses of the US DatastreamMarket – Price Index over 1 month, 6 months and 12 months.[4] As we can see, losses over a shorter period of time occur more often than losses over a longer period of time and in many cases losses over 1 month are higher than losses over 6 or 12 months. However, there are some episodes where losses over a longer period of time are substantially higher than the 1 month losses. This is especially the case after the burst of the internet bubble in 2002 and after the recent crash in 2009.

[3] See for example Danielsson (2011, p. 89).

[4] Monthly data from 1975 to 2010.

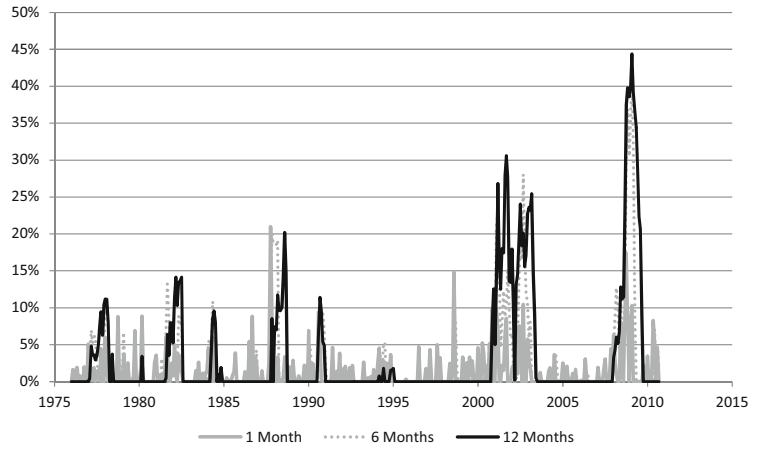

Fig. 1 Stock market losses for different holding periods (Sources: Datastream and own calculations)

The Basel Capital Accord requires using a holding period of 10 days.[5] As mentioned above, there are some reasons for using a short holding period. However, it is important to keep in mind the negative implications: the losses from the correction of greater imbalances will be missed.

2.2 Confidence Level

Another problem with VaR is that it does not consider the extent of the losses that are suffered with lower probability than the confidence level demands. The losses that are not exceeded with a probability of 99.5 % could be very similar to the losses that are not exceeded with a probability of 99 %. However, they could also be much higher than the 99 % losses. This is illustrated in Fig. 2. As we can see, the results for VaR calculation with a confidence interval of 99.5 %, 99 % and 95 % are often very similar. However, especially after the stronger market crashes in 1987, 1998 and 2008, there were substantial differences.

There is always a trade-off between safety and efficiency. We do not want banks that constantly fail and we don't want to make sure that a bank never fails. The capital that would be needed to provide complete safety would make it difficult for the bank to fulfill its main role: channeling savings into investments. The Basel Capital Accord requires using the 99 % confidence interval.[6] In spite of the described difficulties, this seems reasonable.

[5] See Basel Committee on Banking Supervision (1996, p. 44).

[6] See Basel Committee on Banking Supervision (1996, p. 44).

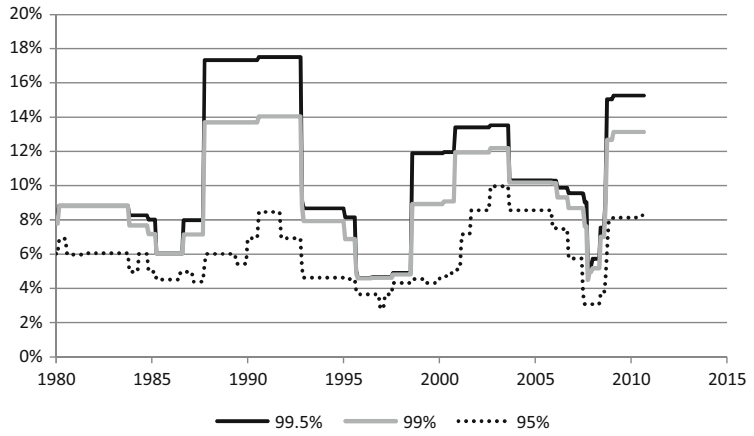

Fig. 2 Different percintiles of monthly stock market losses within a 5 year moving data window (Sources: Datastream and own calculations)

2.3 Loss Distribution

The development of asset prices does not follow natural laws. Hence, it is ex ante not possible to derive the exact probability distribution of losses. For VaR calculations the probability distribution is usually estimated by looking at past losses. The quality of the risk assessment depends therefore on the representativeness of the data sample for future losses.

For some asset classes there are relatively long time series available. However, not for all and in addition, regulation does not require banks to use the entire data sample that is available. In many cases banks used data series with a history of only 2 years. This is half the length of a normal business cycle and by far shorter than a real estate cycle, which has a length of about 20 years.

This has two negative consequences for the VaR calculation. First, when the VaR calculation only considers data from one phase of the cycle, it substantially underestimates risks in upswing phases and capital reserves might be too low to cover the losses when the cycle turns. Second, when the risk assessment and capital requirements are low in upswing phases and high in downswing phases, VaR provides an incentive for pro-cyclical behavior. As a result VaR can cause a behavior of banks that lead to an amplification of cycles. Hott (2011), for example, demonstrates how risk models that are based on data with a short history can lead to cyclical mortgage lending behavior of banks, which in turn results in fluctuations of real estate prices.

Figure 3 illustrates that the length of the used data sample can have a substantial impact on the risk assessment. Every time there is a stronger price decline, the VaR jumps up and it declines again if prices increase for a while without any price drops.

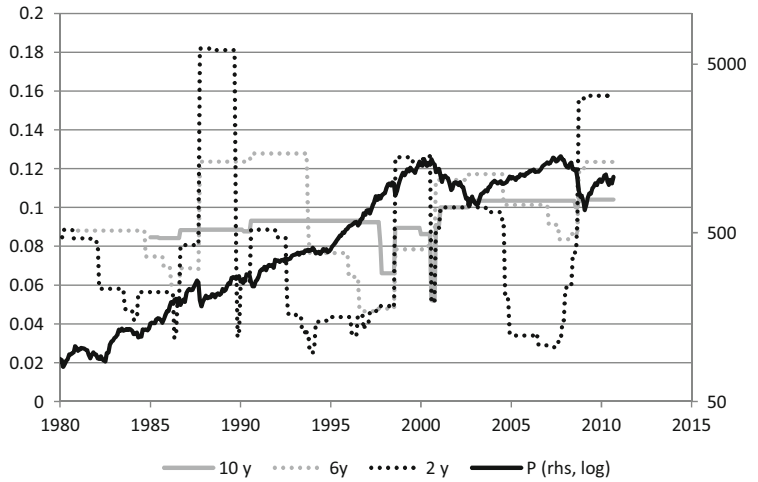

Fig. 3 Stock prices versus 99 % percentile of monthly stock market losses using different moving data windows (Sources: Datastream and own calculations)

Hence, the risk measure and the capital requirements based on it are very pro-cyclical and the increase of the capital requirements always comes too late. This is especially the case when we only use the previous 2 years of data. When using a 10 year window, the pro-cyclical effect almost disappears.

A regulatory requirement for VaR models of banks should be that the data history has to cover at least one cycle of the asset price or the underlying driving fundamental factors. The Basel Capital Accord requires that "observation period must be at least 1 year".[7] For most asset classes this seems far too short. We recommend using at least 10 years for stock prices. For real estate related assets like mortgage backed securities it should be at least 20 years. If such a long time series is not available and couldn't be derived from other indicators (e.g. write-down rates on mortgages for mortgage backed securities), VaR should not be used to calculate risks and capital requirements.

3 Estimating Market Imbalances

Expectations about future developments are the driving factors behind market prices. If expectations suddenly worsen substantially, prices fall and the owners of the assets suffer losses (at least on a mark-to-market base). Some triggers of such changes cannot be predicted. An example is the 9–11 attack from 2001, which was impossible to predict, at least for an economist. This changes, when it comes to deviations of market prices from their fundamental values. It is difficult to predict

[7] See Basel Committee on Banking Supervision (1996, p. 44).

when imbalances are corrected. However, imbalances will not persist forever and the extent of the correction will likely depend on the extent of the imbalance. Hence, as a first step, we need to calculate imbalances on financial markets.

Following the efficient market hypothesis, market prices should reflect all available information in a rational way. However, already in 1981 Shiller (1981) as well as LeRoy and Porter (1981) have demonstrated that stock prices fluctuate much more than fundamentally justified. There are various possible explanations for the emergence of such deviations from fundamentals (or imbalances), including speculation (e.g. Froot and Obstfeld 1991), herding behavior (e.g. Hott 2009), and disaster myopia (e.g. Herring and Wachter 1999). In this paper, we will focus on the link between imbalances on financial markets and potential losses rather than on explaining the imbalances.

3.1 Methodology

In order to estimate imbalances on stock markets we compare actual prices to their fundamental value. The fundamental value of a stock in period t (P_t^*) is given by the sum of the discounted expected fundamental value $E(P_{t+1}^*)$ and earnings $E(D_{t+1})$ in period t + 1. As the discount factor we take a risk free interest rate (r_t) plus a constant risk premium (ρ):

$$P_t^* = \frac{E(D_{t+1}) + E(P_{t+1}^*)}{1 + \rho + r_t} \tag{1}$$

To calculate the fundamental value of stocks it is reasonable to assume that investors have rational expectations. This implies that:

$$P_t^* = \frac{E(D_{t+1})}{1 + \rho + r_t} + \frac{E(D_{t+2})}{(1 + \rho + r_t)(1 + \rho + E(r_{t+1}))} + \ldots \tag{2}$$

As we can see, the fundamental stock price is given by the sum of all future discounted expected earnings. Since we do not know future earnings and interest rates we simply assume that earnings grow with a constant rate *w* and interest rates stay constant at the level *r*. As a result, we get the following equation for the fundamental value of a stock:

$$P_t^* = \frac{(1 + w)D_t}{\rho + r - w} \tag{3}$$

Following our assumptions, the price-earnings ratio should equal a constant that is given by the risk premium, growth rate and interest rate. To get an estimate of this constant we assume that the interest rate is equal to the growth rate ($r = w$). Although we know that this golden rule is not always fulfilled, over the long run it might still be a reasonable assumption. If we assume a risk premium of 6 %, the

resulting constant of the price-earnings ratio would be around 17. This implies that the fundamental value of a stock should be around 17 times the current earnings per share.

As highlighted by Campbell and Shiller (2001) and others, using the price-earnings ratio to estimate the accuracy of stock prices can be problematic. The main reason for this is that earnings are simply too volatile. To overcome this problem, Campbell and Shiller (2001) propose to look at the average of earnings over the past 10 years (D_t^*). We follow this proposal in order to calculate imbalances.

3.2 Estimation Results

For illustration we estimate stock market imbalances by using the US Datastream Market – Price Index as the relevant stock price P_t. For this price index Datastream also provides corresponding price-earnings ratios. By dividing P_t by this price-earnings ratio we get a time series for earnings (D_t). From these earnings we calculate the average of earnings over the past 10 years (D_t^*). The time series are monthly, start in 1975 and end in 2010. Hence, we can calculate the adjusted price-earnings ratio (P_t/D_t^*) from 1985 to 2010.

The results are displayed in Fig. 4. We can easily spot the price bubble around 2000. Interestingly, our indicator does not show a strong imbalance before the stock market crash in 2009. This crisis, however, was triggered outside the stock market world in the real estate market. For our small model this is a surprise like the 9–11 attacks. However, if we would have looked at real estate prices we would have predicted that a shock from this market is about to come. Hott and Monnin (2008), for example, have shown that imbalances on the real estate market could have been revealed before the crisis. The difficulty to estimate the spillover effects remains but goes beyond the scope of this paper.

Another noticeable point about Fig. 4 is that the calculated adjusted price-earnings ratios are relatively high compared to our estimated fundamental value of around 17. On average (P_t/D_t^*) is almost 26. However, when we calculate (P_t/D_t^*) we compare prices with the average earnings over the past 10 years. If trend earnings would develop linear, we would look at trend earnings from 5 years ago. Today's trend earnings are much higher. By adjusting for this, we get an average price-earnings ratio of around 19, which is much closer to our estimate of 17. The remaining positive difference might be explained by the enormous overvaluations around 2000.

In order to get an out of sample estimate of the fundamental adjusted price-earnings ratio, we multiply 17 with the average growth rate of (D_t^*) over the past 5 years. By dividing (P_t/D_t^*) from Fig. 4 by the resulting fundamental adjusted price-earnings ratio, we get an out of sample estimate of the stock market imbalance.

Figure 5 shows the result of the estimate. The results indicate that the buildup of the 2000 bubble started around 1996. There are many possible reasons for the

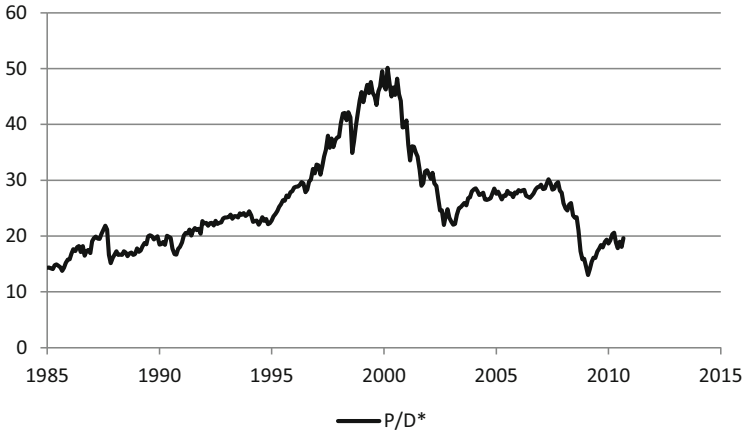

Fig. 4 Development of the adjusted price-earnings ratio for the US stock market (Sources: Datastream and own calculations)

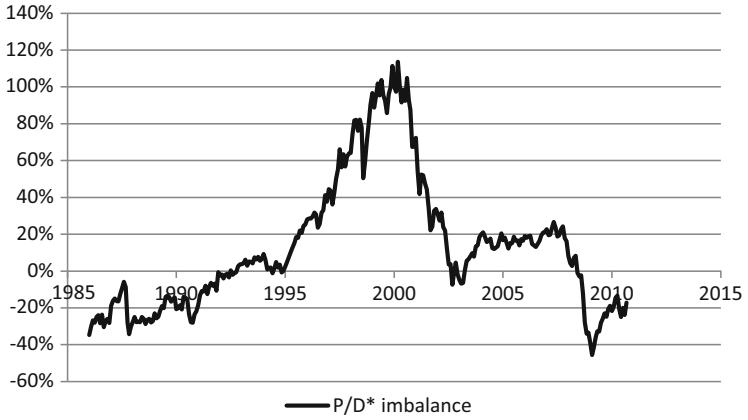

Fig. 5 Development of in-and out of sample imbalances on the US stock market (Sources: Datastream and own calculations)

emergence of this bubble. However, given the timing and the incentives created by the 1996 market risk amendment, it seems reasonable to assume the changed regulatory treatment of the trading book had an influence.

4 Capital Add-on for Market Risks

As we have seen, VaR approaches underestimates losses especially when greater imbalances are reversed over a longer period. As a result, capital requirements are too low to cover the losses in the downturn. We have already made suggestions of

how to improve the requirements for VaR models. In particular we recommend using data with a history of at least one cycle for any VaR calculations in order to get rid of its pro-cyclicality. In this section we propose to use our estimate of market imbalances, to calculate an add-on for capital requirements.

This approach is very similar to the proposal of the Basel Committee on Banking Supervision (2010) to introduce a countercyclical capital buffer that is based on a measure of imbalances. In reflection to the recent credit and mortgage crises in several countries, the proposal of the Basel Committee focuses on the banking book and is taking an adjusted credit to GDP ratio as a main indicator for imbalances. This is certainly a step in the right direction. However, given the described problems in the regulatory treatment of the trading book, it seems urgent to develop something that is focused on market risks as well.

In order to calculate the capital add-on for market risk we focus on price declines on the stock market over the 12 months ahead and compare them to our VaR results. For our VaR calculation we look at the 99 % percentile of monthly losses and consider a data history of 10 years. The results are displayed in Fig. 6. As we can see, as the VaR calculation focuses on the shorter time price fluctuations, most of the time the risk estimate is higher than the loss over 12 months. However, there are some episodes where losses exceed capital requirements substantially. This is especially the case during the dot com crisis and the price drop in the recent crisis. In fact, capital requirements reached their lowest level of around 5 % in 2000, right before the crisis started and led to annual losses of 30 %.

As the capital requirements that are based on VaR only cover "normal" price fluctuations our capital add-on should be able to cover the losses from the reversal of imbalances. To get an estimate of these losses, we look at our estimate of imbalances on this market (see Fig. 5). For simplicity we assume that a stock market correction leads to a balanced market within 12 months.

The resulting capital add-ons are displayed in Fig. 7. In addition, Fig. 7 shows the 12 month losses from Fig. 6 that are not covered by the capital requirement according to the VaR model (positive difference between the black and the grey line in Fig. 6). As we can see, banks would be required to build up capital during the boom phase and before the losses come.

Summary and Conclusions

The usage of Value at Risk models to estimate market risks is very common. Nevertheless, the approach has several drawbacks that could lead to a substantial underestimation of risks and give an incentive for pro-cyclical behavior. This is especially dangerous since the models are used by banks and their regulators.

In the present paper we analyze the different drawbacks of VaR models and present a way to overcome the problems. In particular we suggest that a requirement for the usage of a VaR model should be that its calculation is based on data that covers at least one cycle. While the minimum requirement by the Basel Capital Accord is 1 year, we propose 10 years of data for stock markets. This should reduce the pro-cyclicality of the approach.

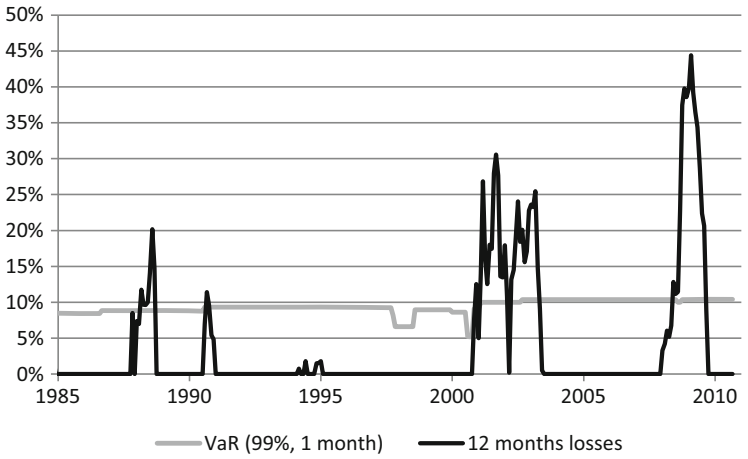

Fig. 6 Development of VaR versus stock market losses (Sources: Datastream and own calculations)

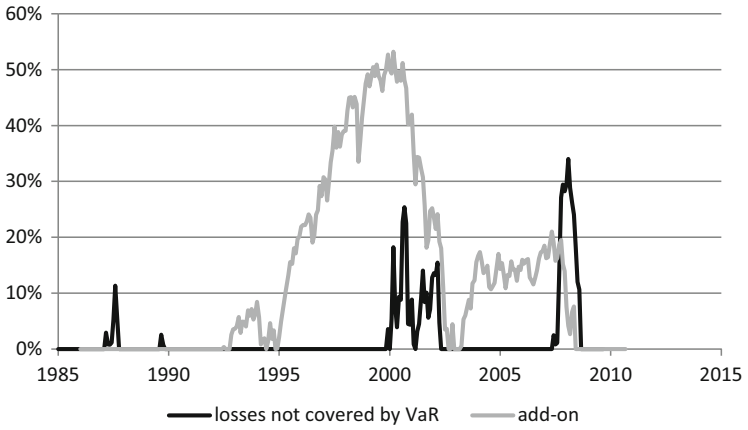

Fig. 7 Stock market losses not covered by the VaR versus proposed capital add-on for stock market risk (Sources: Datastream and own calculations)

In addition and in order to cover losses that are not captured by VaR we propose to introduce a capital add-on for market risks. This add-on should be based on an economically founded indicator for imbalances on the corresponding asset market. Our estimate indicates that this would have helped to better cover market losses. This statement is of course subject to the Lucas critique. However, as the proposed capital add-on provides a disincentive to buy an asset in the buildup phase of a price bubble, it is likely that it would have let to lower imbalances and trading losses after the 1996 market risk amendment to the Basel Capital Accord.

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The Quantity Theory of Money in Year Six After the Subprime Mortgage Crisis

Michael Graff

Abstract

This contribution traces the origins of the quantity theory of money and its applications. It is shown that the theory was flexible enough to adapt to institutional change and thus succeeded in maintaining its relevance. To this day, it is useful as an analytical framework, although it now has only limited potential to guide monetary policy and has consequently been abandoned by most central banks. Yet, it is still passionately discussed by both followers and sceptics. Lately, the measures taken by central banks to mitigate the effects of the 'Great Recession' triggered by the 2007 subprime mortgage crises in the US have led to a spectacular increase in the stock of money, but the following price inflation that is predicted by the quantity theory cannot be observed anywhere. Is inflation in the pipeline, inevitably to emerge soon or later, as the critics of 'monetary easing' keep claiming? Does the failure of inflation to materialise finally falsify the quantity theory? To answer this question, we first highlight the most important characteristics of the latest economic slump. Then, an empirical analysis drawing on data on 109 countries from 1991 to the present confirms that the theory still has predictive power. While the classical proportionality theorem does not hold, excess money growth is a significant predictor of inflation. At the same time, the effect, although positive, is now so low that the fears regarding inflation as a consequence of the recent monetary easing do not appear warranted.

1 Introduction

The quantity theory of money (hereafter: 'quantity theory') is the only economic theory dating back from before the establishment of classical national economics around the end of the eighteenth century, which still features prominently in

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economics. Its relevance reveals itself in historical perspective, but up to this date, it is being called upon as a theoretical basis of economic policies and strategies.[1]

The ancestry of its classical version, referring to changes in the money supply, can be traced to the early modern era. It emerged in times of then unfamiliar price fluctuations in mediaeval Europe. Many generations later, in the 1970s, when prices in the capitalist world rose across the board, Milton Friedman's reformulation of the quantity theory (Friedman 1956) achieved highest standing amongst economists. Apart from providing the theoretical basis of monetarism, with significant influence on academic discussion, it became highly influential in shaping the conduct of monetary policy in central banks around the globe.

The theory's recent heyday, however, did not last long. In the US, monetary targeting was abandoned in the early 1980s, and in the English-speaking world, monetary aggregates are nowadays generally considered inappropriate as intermediate targets. However, other countries, particularly in Central Europe, were not so quick to dismiss the theory. The German Bundesbank communicated the control of the money supply as its theoretical foundation for the conduct of monetary policy for over a quarter of a century to the very end of the DM era, i.e. until the establishment of the European Monetary Union (EMU) in 1999,[2] and the Swiss National Bank (SNB) adhered to monetary targeting as long as the Bundesbank.[3] Furthermore, at the time when the SNB abandoned monetary targeting in 1999, the European Central Bank (ECB), as a legacy from the Bundesbank, adopted the quantity theory as one of its two official pillars for monetary policy. A reason for this was certainly to transfer some of the reputation from the old to the new Frankfurt monetary authority. A few years later, in May 2003, the ECB, in what appeared to be a rather low-key press release, significantly downgraded the theory as a practical guidance for its conduct of monetary policy.[4] Nevertheless, the ECB's monetary analysis persists up to this date. Arguably, on the operational level, monetary policy in Frankfurt never truly targeted the quantity of money, but rather

[1] This contribution summarises the latest results of a continuous research programme; earlier publications that I liberally refer to are Graff (2000), Graff and Müller (2006) and Graff et al. (2013). My interest in this topic goes back to the years 2004-2010, when I had the privilege to work as a Senior Lecturer at Alexander Karmann's Chair for Money, Credit and Banking at TU Dresden. The first of the above mentioned publications documents my research conducted at Alexander's Chair.

[2] For an authoritative representation of Bundesbank's monetary policy since 1994, see Issing (1997).

[3] Monetary targeting in Switzerland lasted from 1974 to 1999, with a suspension in 1978-1979; see Rich (1997, 2007).

[4] Titled 'The ECB's monetary policy strategy', the 8 May 2003 press release states: '... the Governing Council of the ECB has undertaken a thorough evaluation of the ECB's monetary policy strategy ... [T]he monetary analysis mainly serves as a means of cross-checking, from a medium to long-term perspective, the short to medium-term indications coming from economic analysis. To underscore the longer-term nature of the reference value for monetary growth as a benchmark for the assessment of monetary developments, the Governing Council also decided to no longer conduct a review of the reference value on an annual basis.'

inter-bank interest rates.[5] Indeed, the fact that the Bundesbank's track shows significant and repeated deviations from its official monetary targets, suggests that it may have referred to the quantity theory and the money supply calculus on a communications level, while it actually tried to target inflation. Nevertheless, the change in emphasis that the ECB devotes to its two pillars is now leaving no doubt that also in Frankfurt the money supply is de facto no longer an intermediate target. Thus, all major central banks now, at least in practical terms, have shelved the quantity theory.[6]

While the theory's practical influence has recently faded, it is still a subject of passionate discussions by both followers and sceptics. Lately, the measures taken by central banks across the curb to mitigate the effects of the 'Great Recession' triggered by the 2007 subprime mortgage crises in the US have led to a spectacular increase in the stock of money, but the following price inflation that is predicted by the quantity theory cannot be observed anywhere. Is this inflation in the pipeline, inevitably to emerge soon or later, as the critics of 'monetary easing' keep claiming? Does the failure of inflation to materialise finally falsify the quantity theory? Or is the current situation after all reconcilable with the theory? The present contribution will try to provide some answers to these questions. To this end, let us first look at the most important characteristics of the latest economic slump.

2 The 'Great Recession'

After 1989, the collapse of what some had perceived as a 'communist' alternative to capitalism lifted all previous restraints on the liberal free markets ideology.[7] The roll-back of the welfare state that had started with the extreme pro business 'laissez-faire' governments under Margret Thatcher in the United Kingdom (1979–1790) and Ronald Reagan in the United States (1981–1989) gained momentum. Reformist left wing parties (Labour, or Social Democrats, as some of them are also calling themselves) completed the job. Unemployment benefits, old age and health care provisions were cut with cynical reference to individual freedom and responsibility. Progressive taxation, which had been the moral backbone of the 'social market economy' and provided the revenue for the welfare state in the golden age up to 1973, were deemed inefficient. Marginal tax rates were cut, and 'simple' – a euphemism for less progressive or completely flat – income tax schedules were embraced. The second long-standing principle of taxation, stating that all income should be taxed independent of the source and at the same marginal rate, was abandoned as a response to increasing international capital mobility. With an

[5] See von Hagen (1911). The same is claimed regarding the SNB (Mishkin 1999).

[6] See e.g. Berger et al. (2006), who analyse the ECB's statements and press conferences from 1999 to 2004 and find that the relative amount of space devoted to monetary analysis has decreased; implying that role of money has indeed been downgraded since 1999.

[7] See Graff et al. (2013, Chap. 23).

increasing number offshore tax havens offering minimal taxation coupled with secrecy, a race to the bottom of capital income taxation set in.[8] While many regarded this as a lamentable but inevitable side effect of globalisation, more radical market fundamentalists greeted it as a healthy move toward 'slim' government. The absolute minimum of taxes required to ensure the institutional framework for the rule of law and to sustain the police and other armed forces that are perceived as indispensible would ideally be levied on consumption. Thus, along with income tax cuts, indirect taxes were increased along the board. And expenditure taxes are mostly flat; they in fact tend to be regressive as the marginal propensity to consume declines with income and wealth. At the same time, structural reforms created new financial markets for which there had previously simply been no necessity; student loans as a result of newly introduced or increased tuition fees and abolition of educational government grants, and pension funds to accumulate mandatory savings on private retirement accounts, where previously or tax funded or pay-as-you-go pension schemes had provided reliable and crisis-prone retirement incomes. As desired, financial markets grew, and along with them the incomes earned in the financial industry. At the same time, liberalisation got rid of precautionary regulation; and innovative 'products' were presented to the admiring public. Banks widely promoted loans to fund financial investments and willingly accepted these assets as collateral. Yet, an important lesson from the Great Depression of the 1930s is that speculative investment based on credit had triggered massive 'margin calls' as the banks watched the collateral prices sliding. Asset prices then plunged, as illiquid speculators were forced to sell. It remains a miracle how this could be overlooked in the beginning of the new millennium: In the bubble economies ordinary people took out loans in order to 'invest' in shares or 'property'. Whatever interest they were charged, they were told that they could only gain, as the increase in asset prices was promised to outweigh the costs by far. Tax deductibility for such 'investments' in many countries added to the boom. The fact that interest rates for liabilities are higher than for assets, so that it is wise to pay off any loan as quickly as possible was declared invalid. And indeed, as long as the bubble inflated, those who stood aside appeared foolish.

For those who were left behind, easily available credit was offered as compensation. Thus, the new economic order of mass consumption coupled with increasing inequality relied in fact on a structural asset bubble (Frank et al. 2010). Of course, this 'neo-liberal growth model' (Palley 2009) could not last, as it was based on a continuous reduction of saving rates by lower-income households coupled with increasing borrowing, backed by ever rising asset prices as collateral. Eventually, saving rates hit zero; for some time, they may become negative, turning the country

[8] Apart from the immediate effect to raise the tax bills for those who cannot or do not want to resort to tax havens – the majority of ordinary tax payers – the deliberate opacity created by tax havens undermines supervision, regulation and early warning and thus increases the likelihood and severity of financial crises, which again implies that the burden is borne by the ordinary people.

into a net importer of capital, goods and services, but at some stage the inevitable must happen and the bubble will burst.

The correction of 2001 was still taken as contained within an obviously speculative niche of the otherwise fundamentally healthy economy, and while people had become more sceptical about the promise of huge and practically risk-free profits in the stock market, they quickly tuned back to normal business. From then onward, the asset price boom mainly affected the housing market. The trust in permanent asset price inflation above the general inflation was re-established, and the neo-liberal growth model could continue for another couple of years. As we now know now, the end came in 2007, and the scope of the correction by far exceeded the 2001 crises. But most importantly, this time the stability of the entire financial system had been undermined, as it held huge amounts of assets secured by collateralised household debt. US banks had too generously approved mortgages for people who could not afford to service them – the so-called no income, no job and no assets ('NINJA') loans or 'sub-prime' mortgages. Also, the banks had securitised the sub-prime mortgage debt and sold the resulting asset-backed securities world-wide. With the stream of mortgage interest payments ebbing, these securities – and the derivatives based on them - dramatically devaluated. Banks thus suddenly faced severe balance sheet problems. In September 2008, Lehman Brothers was allowed to go bankrupt. The Great Recession thus began at the turn of the year 2007/2008 in the US. By the following quarter it had spread to the rest of the world. In other countries with asset bubbles or excessively large banking sectors, it was triggered by asset prices collapses, which in turn led banking crises. Economies that were not vulnerable in these respects nevertheless experienced plunges in demand for their exports, which made them likewise slide into recession or periods of depressed growth.

The world economy thus slipped into the most severe recession since the slump of the 1930s, and it is still recovering from it. Remarkably, most economies found themselves in a 'liquidity trap', which makes stimulation through monetary policy practically impossible. Central banks across the globe swiftly lowered their interest rates to historical lows in the vicinity of zero, and as this proved without perceivable effects on final demand, they moved to 'quantitative easing' – unconventional policies with the objective to stimulate demand, or at least to prevent a slide into deflation, by flooding the economy with central bank money. At the same time, the 'investment trap' prevented firms from demanding credit despite low interest rates, as genuine uncertainty or pessimistic expectations concerning the business situation in the foreseeable future induced them to postpone most, if not all, investment projects until the situation would perceivably improve. Therefore, governments in most developed countries took refuge to fiscal policy, although the dimension of the stimulation packages varied widely across countries. Last but not least, central banks were bailing out governments, firstly, via purchases of government bonds, secondly, by deliberately inflationary policy which would erode the real value of government debt. Critics keep raising their concerns up to this date, but so far, there is no sign that their worries are warranted; inflation is low across the board.

How could such a situation have evolved? According to Rajan (2010), the causal factor was the increase in income inequality after the 'golden age' of capitalism had ended in the 1970s. Initially predominantly in the United States and Britain, income inequality started to rise, making it increasingly difficult for workers at the lower bands of the wage scale to secure their part in the ongoing growth of their economies from labour income. At the same time, consumption was increasingly financed through credit. Politically, this served two goals simultaneously; firstly, to appease those who otherwise would have been left behind and could have started to doubt the wisdom of the prevailing order and turn rebellious. Secondly, it secured that aggregate demand would be sustained and thus ensured that the economy could keep growing. It seemed an almost perfect way of combining wage depression with less redistribution, steadily increasing mass consumption and real estate related wealth. It was admired as an 'ownership economy' and cheerfully copied in economies like Ireland (the 'Celtic tiger') and Spain (the 'Iberian tiger') which are now at the core of the euro crisis. The deleveraging was violent. The requirement to save the financial systems from collapsing led to sharp increases in government debt levels. At the same time, financial investors reconsidered their previous assessment of sovereign debt risk, which in addition to increasing interest rates on new debt made all existing debt far more expensive to service as soon as it had to be rolled over. Thus, even governments with sound budgets and otherwise sustainable debt levels came under budgetary pressure. In this context it is most irritating that the direct way to address the problems that caused the current problems, a reversal of the increasing income inequality, is out of the reach of governments, which instead are under pressure to follow austerity policies in order to maintain or re-gain the confidence of the players in the world's financial markets.

3 The Quantity Theory

To ease the following elaborations, we first give a brief summary of the twentieth century formalisation of the quantity theory.[9] Let M denote the amount of money in the hands of the public, T the economic transactions paid for with M within a given period, P the price level of T, and V the velocity of the circulation of M. We can then write down the following identity

$$M\,V = P\,T, \tag{1}$$

which is the textbook version of the equation of exchange associated with Irving Fisher (1911). The right hand of the equation denotes the volume of transactions paid for, quantified in terms of their prices. With M defined as the stock of means of payments at hand to settle the volume of payments given by $P\,T$, V is the number of times per period that the stock of money has to pass from payer to payee to satisfy

[9] See Graff et al. (2013, Chap. 7, Appendix 2).

the equality condition, which is another way to look at the concept of the velocity of money.

M, V, P and T all have empirical correlates that in principle can be quantified. In practice, however, measurement of any of the four variables is fraught with difficulties. Regarding M, for periods before the advent of bank money, the stock of bullion and full-bodied coins may serve as a useful approximation. After liquid bank liabilities have become the major means of payments, measurement is not as straightforward, which is illustrated by the fact that applied economics nowadays refers to various definitions such as M1, M2, M3 (occasionally M4), where a higher ordinal number indicates a wider aggregate. The textbook definition for M1 is legal tender (notes and coins) plus demand deposits with banks in the hands of the public. Aggregates with higher ordinal numbers consecutively add bank liabilities of lesser liquidity, implying that money's core function as a means of payments, which is the focus of M1, is amended by its quality to serve as a means for storage of wealth and financial investment. Hence, M1 is most in line with M in the equation of exchange. Yet, not even the narrow aggregate M1 consists of homogenous elements, and in fact, Irving Fisher's original equation of exchange

$$M\,V + M'V' = P\,T \tag{2}$$

takes account of this, where M signifies the quantity of money in circulation; V, its velocity of circulation, or rate of turnover per annum; M', the volume of deposits subject to check; and V', its velocity of circulation, or rate of turnover per annum. The distinction between two categories of means of payments, with the possibility of different velocities, adds realism to the equation, and monetary statistics nowadays allow distinguishing between cash and demand deposits; so let us consider the measurement issues regarding M as manageable. However, the same does not hold for T, which includes intermediary products and services. Since the commonly available measure of aggregate economic activity like gross domestic product (GDP, or Y) exclude intermediary products and services, $Y < T$. Referring to Y, for which useful approximations are usually available, rather than to T, hence requires us to define a modified identity given by

$$M\,V^Y = P\,Y^r. \tag{3}$$

Equation 3, the GDP version of the equation of exchange, is the norm today. Y^r denotes real GDP and V^Y the velocity of money related to GDP. At first glance, the difference between the transaction and GDP versions seems minor, but it should be noted that in (1) and (2), money is strictly referred to as a means of transactions, whereas in the GDP version, V^Y cannot readily be interpreted as the velocity of money. Yet, as long as the fraction Y^r/T is constant, the growth rate of V^Y will be the same as that of V, and with estimates of Y^r/T, we could actually compute V^Y from V. In other words, V^Y is essentially representing the same concept as V, implying that it is characterised by the same benefits or drawbacks.

4 The Historical Contingency of the Quantity Theory

Economic history, and in particular the history of money is crucial for a critical assessment of the theory and its relevance for economic policy, since along with money came inflation, a phenomenon known since antiquity.[10] The earliest systematic debasements of coinage indeed go back to the Greek city-states. Performed as reductions of the share of gold or silver in the alloy, or by hiding cores of low value metal within the coin, debasements were initially carried out with caution and probably only in wartime, so that they would not be permanent threat to acceptance of the money as a means of payments (Burns 1927, 339 ff.; Schwartz 1973, 244). In Rome, when the Punic wars were stressing the state finances, debasement was more common, and the first long-term inflation in history is due to systematic coin debasement in the Roman Empire, when in the course of roughly a century the price level increased by a factor of 50 (Burns 1927, 407 ff., Friedman 1994, 190).

In the European 'Dark Ages' after the fall of the Western Roman Empire in 476, the ancient monetary standards largely disappeared. Coinage crumbled away and money vanished from circulation, but from the eleventh to the thirteenth century money re-emerged, and the 'Commercial Revolution' shaped the prototype of the modern financial system. Its driving factor was the international trade that had started to recommence on a large scale with Northern Italy as its hub. Merchants in Genoa, Venice, Florence and the cities of Lombardy experienced an urgent need for finance and liquidity and created constant demand for financial services such as currency exchange and naval insurance. With the return to the regular minting of money based on full-bodied coins, the related problems do not fail to re-emerge. In addition to wear and tear, the clipping of coins (by the public) and periodic debasements (by the authority) regularly contributed to reducing the bullion content of the coinage, which soon or later inevitably would result in devaluation (Lopez 1976; Sussman and Zeira 2003). The history of money, which for the most part is the history of full-bodied money, is hence mostly a chronology of debasements and subsequent monetary reforms to restore the old standard or to establish a new one with modified mint parity. The ancient monetary system thus quite effectively ensured that money as a unit of measurement would correspond to a well-defined quantity of bullion. Significant deviations from the official parity would soon or later be detected and not tolerated, hence resulting in monetary reform. Inevitably, the authority at some stage would feel that its coffers were unduly depleted and again be tempted to debase the coinage, so that the cycle of debasement and reform would continue. Though coined money as a rule would conform rather closely to the mint parity, the risk to receive underweight coins was certainly too high to be neglected. Accordingly, for *large* payments settled in cash, the requirement to verify purity and weight persisted. This inconvenience triggered the path-breaking innovation of credit money (Lopez 1976, 71 ff.). The most straightforward was to grant customers trade credit for later settlement. By

[10] This paragraph is mostly based on Graff et al. (2013, Chap. 7, Appendix 1).

softening the liquidity constraint of the cash economy, this contributed to make investment and consumption decision less dependent on current liquidity (Cipolla 1993, 160 ff.). Another innovation was the private cash account ('giro di partita'). Apart from the peace of mind from knowing that coins or bullion was stored securely in the coffers of a bank, this innovation soon delivered a new kind of payments service, as payments from one customer of the bank to another – usually members of the local merchant community – could be performed as transfers between accounts. Initially both payer and payee had to appear at the bank in person, but soon, a written order by the payer, stating the payee and the sum to be transferred, would be sufficient. Thus, the earliest known cheque was issued in 1368. This innovation made the settlement of payments safer and at the same time markedly reduced transaction cost.

Since the early cheques represented intrapersonal transfers of an existing claim on coins or bullion in the coffers of the bank, they did not increase the quantity of money, at least as long as the banks held 100 % reserves, as their statutes required. It would not take long, however, until some banks silently began to breach the rules and offer standing overdraft facilities to their most trustworthy customers, which marks the beginning of fractional reserve banking (Cipolla 1993, 181; Spufford 1988, 256 ff.). The most important implication for money and banking was that fractional reserve banking allowed expanding the means of payments – i.e. the quantity of money – beyond the rigid limits previously set by the quantity of bullion. Yet, during the Commercial Revolution, bank money, important as it was to the merchant community, occupied a relatively small niche. Hence, despite its potential, the effect that this innovation had on the quantity of money initially remained very limited. In fact, it was not before the twentieth century that it became common for payments affecting the wider public.

Though the Commercial Revolution took place in the centres of trade, i.e. the town, money and credit soon and increasingly affected also the rural population of mediaeval Europe. Initially this was because the growing population in the towns would buy victuals from the surrounding countryside for money, with the result that using money became common amongst rural people. Moreover, while serfdom prevailed, from the tenth century, an increasing part of the rural population was employed as wage-labourers (Cameron 1993, 50). Moreover, mediaeval lords of feudal properties were increasingly being paid in money instead of feudal service or payment in kind. They too hence started to measure profit in money (Duby 1978, 132 f.; Lopez 1976, 155 ff.). Thus, throughout the medieval society, economic activity was directed more and more at the realisation of money revenue, and prototypes of the capitalistic enterprise emerged (Weber 1924, 86). In addition to this, the way of life of the aristocracy further promoted monetisation and credit. On the one hand, there were the expenses related to taking up public office. On the other hand, gambling was endemic and almost obligatory in aristocratic circles and resulted in huge gains and losses. As the bourgeoisie copied the habits of the aristocracy, gambling spread beyond the nobility (Dewald 1993). As a result of these developments, within a few centuries, the largely cash-free society of the 'Dark Ages' was transformed into an economy that was monetised 'from head to

toe' (Spufford 1988, 378). Yet, though the Commercial Revolution successfully developed credit money and clearing soon became common practice, liquidity was ultimately restricted and depended on access to gold and silver: Unbalanced accounts – at the bank or with a trading partner – would finally require settlement in full-bodied coins or bullion.

From a quantity theory perspective, an important fact from the economic history of mediaeval Europe is that apart from all innovations brought about by the Commercial Revolution, the stock of money grew rather smoothly, without sudden increases or decreases that would have led contemporary observers to speculate about possible links between the quantity of money and the level of prices. Yet, when the bubonic plague swept over Europe from 1347, this had an impact on prices that did not escape the attention of a thoughtful observer: Nicolai de Oresmius (1325–1382). Oresmius was the bishop of Lisieux, an astronomer, mathematician, and last but not least, advisor to Charles V on financial matters. In his tracts on economics, he mainly argued against coinage debasement (even if ordered by Charles V). In today's terminology, Oresmius' opinion was that reducing the bullion content of coins that maintained the same face value had led to a corresponding increase in prices, so that in the end, the king had not gained anything by the debasement.[11] Oresmius' tract 'De Origine, Natura, Jure, et Mutationibus Monetarum' of 1355 is probably the first statement of the quantity theory. Now it is important to notice that this publication came 3 years after Europe's first plague epidemic (1347–1352), This was an epidemic of horrendous impact. It is estimated that in these 5 years, the population of Europe was reduced by a third (Pirenne 1986, 186). The resulting decline of aggregate economic activity economic was – in today's terminology – a dramatic negative supply shock. Accordingly, the price increases that attracted Oresmius' attention were only partly due to coinage debasement; the supply shock was probably the major factor. Though it may seem an anachronism to discuss earlier contributions in terms of the equation of exchange, the effect of the plague on the price level can easily be captured by the GDP version of the equation of exchange (3) with time subscripts

$$M_t V^Y{}_t = P_t Y^r{}_t. \tag{3'}$$

Let t–1 denote the time before the outbreak of the plague, so that $Y^r{}_t < Y^r{}_{t-1}$. Now, in a currency system where money is bullion, the stock of money M is practically constant in the short term. Hence, without a dramatic decline in V, it follows that $P_t > P_{t-1}$. While we can speculate that some hidden money was permanently lost when people fell victim to the plague, and that the survivors tended to hoard money more then previously (leading to a decline in V), the decline

[11] For this, see Gordon (1987), and others. According to Mundell's (1998, 3) judgment, Oresmius' 'De Moneta' (written during the reign of Charles V, when no less than 86 coin devaluations took place) is the first version of *Gresham's* (1519–1579) *Law,* and the most important work on the theory of money in the period prior to the sixteenth century.

of Y to appears to have outweighed the declines of M and V. The price increases that Oresmius observed were then caused by a sharp decline in transactions that had to be settled in cash in an economy that had inherited a stock of money from a far more numerous population. Of course, this does not contradict the debasement story. As can be seen from the equation of exchange, without a decline of V, both an increase in the *nominal* supply of money M and a decrease of Y will result in a higher price level P.

After recovery from the first devastating pandemics of the plague, the demand for money gradually started to outstrip supply in late mediaeval Europe, so that in relative terms, currency became scarcer than in the preceding centuries. The mining and refining of bullion failed to keep pace with the increase in economic activity that was settled in cash. In addition, money in circulation was depleted through normal wear and tear as well as through hoarding, which, in times of unrest often meant that coins were buried in depots and abandoned when their possessors lost their lives. Furthermore, the world economy at that stage required a constant flow of gold and silver to the East. While Oriental goods were sought-after in Europe, in the East there was little interest in European commodities. Hence, the European balance of trade with the East was constantly negative and bullion has to be shipped to the East for settlement (Day 1978; Parker 1979). The 'Great Bullion Famine' that resulted from these developments formed the empirical basis for European Mercantilism, and particularly the doctrine of 'bullionism' (Day 1978, 49). Indeed, for an economy in which the means of payments was predominantly restricted to full-bodied coins, bullionism was a well-founded strategy to counter a downward pressure on prices and hence to avert deflation and depression. However, with a production of bullion that was minor relative to the stock inherited from the past, so that the supply of money was practically exogenous, bullionism, once adopted by all relevant European Countries, was effectively a zero-sum game. Consequently, the economic policy of mercantilism could offer no remedy to the scarcity of money and the 'hunger' for bullion in Europe as a whole. The only promising strategy for Europe was to find substitutes for bullion that were not subjected to the same inherent scarcity and yet suitable to serve as money.[12] It took centuries for solution to this problem – currency that circulated below a parity corresponding to its commodity price – to gain widespread acceptance. In fact, the final dissociation of money from bullion did not take place before the 1970s, when the convertibility of the US dollar into gold was suspended.[13]

[12] We note in passing that, given the knowledge of the nature of chemical elements at that time, *alchemy* was a rational attempt to fight the 'bullion famine', although – as we know now – it was doomed to fail.

[13] Yet, let us recall that economic history provides a host of examples of monetary decay and disintegration, illustrating that organisational and institutional progress is reversible, as during regressions to a barter economy or a commodity money standard. Frequently cited in the economic literature are the 'cigarette standards' in Sicily, Germany and in the Pacific after 1944, see e.g. Radford (1945).

Apart from institutional inertia, the most important retarding factor in the spread of credit money was that as a result of what has been called the 'Age of Discovery', the European expansion. It was driven by the hunger for bullion as much as – if not more than – by the desire to spread the gospel and succeeded to establish a continuous and sizeable flow of bullion from the New World to the Old, thus increasing the supply of bullion based money and alleviating the scarcity of currency. Thus, '[t]he famine of precious metal that had strangled the European Economy during the Middle Ages was over' (Cipolla 1993, 214), implying that monetary innovation became far less urgent. In fact, scarcity of money was followed by abundance, and hence, towards the end of the sixteenth century, people could witness the beginning of a new kind of inflation, subsequently called the 'Price Revolution', that lasted some 150 years and provided the quantity theory with a sound empirical basis. Europe's stock of bullion increased modestly between 1500 and 1580, then rapidly between 1580 and 1620. Before silver mining collapsed and shipments from America fell strongly during the first 20 years of the seventeenth century, the influx of precious metal from the New World had elevated the price level in Europe by some 300–400 % (Cameron 1993, 107; Cipolla 1993, 215). This historical account of an obvious correlation between the stock of money and the price level for centuries constituted the empirical basis for the quantity theory, and the scholarly work that is credited to have inferred the classical quantity theory from this first is Jean Bodin's (1530–1596) treatise 'Réponse aux paradoxes de Monsieur de Malestroicttouchantl'enchérissement de toutes choses' (Bodin 1566). Malestroict had blamed the widespread practice of coin clipping, i.e. debasing of coins by the public, for the general acceleration in prices 'de toutes choses', which had become noticeable by the middle of the sixteenth century. Bodin took a different stance. He argued that the price level had risen together with the stock of money, or more precisely, with the amount of bullion available for monetary purposes. Having witnessed the results of the early shipments of bullion from the Americas to Europe, he drew the right conclusion about the link between the two. The origin of the quantity theory of money is thus a reflection of the history of money in the early modern era. It preceded the advent of classical economics by two centuries: The classic's version of the quantity theory is the proportionality theorem, which postulates that the price level reacts proportional to changes to the stock of money. Formally, this theorem can be derived from the equation of exchange (3) as follows:

$$M\,V^{Y} = P\,Y^{r} \Leftrightarrow P = \left(V^{Y}/Y^{r}\right)M, \tag{4}$$

where V^{Y} and Y^{r} are regarded as constant.

The relief to the European 'bullion famine' though influx of specie from the New World was temporary. When the shipments started to decline, innovation was back on the agenda. By this time, it was not only triggered by the scarcity of money but also by the inconvenience of full-bodied coins for the settlement of large payments, as the early prototypes of credit money that had been developed in Italy during the Commercial Revolution had not yet diffused from their niches. This now started to

change. When the mediaeval trade with the East, taking the Silk Road to the Levantine Coast, then by ship across the Mediterranean to the trade centres of Northern Italy, was replaced by the Africa route, new centres of trade and commerce emerged in the European ports of the Atlantic. By the seventeenth century, the financial instruments developed during the Commercial Revolution had been adopted in the Northwest (Sombart 1916, Vol. II, De Roover 1942). From that time, until 1914, the world's centres of money, banking and finance were found in North Western Europe; first in Antwerp, then in Amsterdam and Hamburg, and, after the Napoleonic wars, in London (Glamann 1979, 323 ff.) Now financial development gained momentum, and various local variants of secured and unsecured credit were added to the Italian prototypes, including different types of negotiable debt instruments. In particular, the mediaeval letter of exchange underwent important modifications and its successor, the bill of exchange, became a negotiable instrument for credit and payment. An essential prerequisite for negotiability was that personal trust in the ability and willingness of the issuer to meet his obligations had to be substituted for by some more formal – institutional – guarantee. The solution found was bill discounting. For this purpose, in the larger centres of trade and commerce municipal discount houses were chartered. The first of these was in 1609 the AmsterdamscheWisselbank, and here as elsewhere, credit and payment for regional as well as international trade was considerably facilitated.

Yet, the bill of exchange never became a local means of payments. In Amsterdam, this function was eventually taken by the Wisselbank's guilder (florin), which was credited to personal accounts for discounted bills as well as against deposits of full-bodied coins or bullion. The Wisselbank's guilder soon became the dominant currency for trade and commerce in Amsterdam and far beyond. The opportunity to settle payments by transfers denominated in a widely accepted bank deposit currency was much safer and more convenient than shipments of coinage or bullion, particularly in the face of the 'dreadful coinage mayhem' of the sixteenth and seventeenth centuries (Sombart 1916, Vol. I: 424).

As others, Adam Smith was impressed by convenience that the Wisselbank meant to trade and commerce (Smith 1776, Book 4, Chap. 3).[14] In fact, although the statutes of the Wisselbank required the bank's guilder to be backed by 100 % reserves, in practice, credit-worthy customers could transfer guilder in excess of their deposits. In other words, the Wisselbank engaged in fractional reserve banking and made personal loans. As the beginnings of fractional reserve banking can be traced back to the Commercial Revolution and to the early goldsmith bankers of London, the Wisselbank's practice was not strictly an innovation. But now fractional reserve banking was performed by a public bank that was supervised by the authorities, and at a much larger scale than ever before. Hence, economic historians tend to identify the Wisselbank as the starting point of credit money (Galbraith

[14] See also Sombart (1916, Vol. I: 424 ff.), who cites a considerable number of observers, reflecting how contemporary merchants greeted the improvement that the new money meant to trade and commerce.

1995, 8). In the seventeenth century, more than twenty public banks were chartered, modelled on the Amsterdam example, e.g. in Barcelona (1609), Hamburg (1619), Delft (1621), Nuremberg (1621), Rotterdam (1635), Stockholm (1656) as well as 1694 in London. Although the creation of money through fractional reserve banking was not covered by any of these bank's charters, it became soon accepted practice. Bank money had thus become a reality.

Another type of credit money that emerged in the modern era is the bank note, or paper money, an impersonal means of payments, which is characterised by the fact that, whatever is its face value, its commodity price is practically zero. In Europe,[15] paper money was first issued in 1661 by the Swedish Riksbank, followed by the Bank of England in 1694 and the Bank of Scotland in 1695. From 1690, paper money was issued in New England, and in the early eighteenth century in France as well as in various Italian and German States.

From a quantity theory perspective, the numerous innovations in money, finance and the payments system during this period can be summarised as a gradual substitution of credit for commodity as a means of payments. This process had started during the Commercial Revolution, but it gained momentum in modern times. Still, until recently, credit money was confined to a relatively narrow range of economic activities, and bank money was not common in everyday life until well into the twentieth century. The move towards credit money freed the monetary system from the material restrictions of the past. However, the downside of removing the natural and technical constraints that the antique system of full-bodied money minted from bullion had laid on the quantity of money is that without these restraints, the potential for inflation is infinite. And indeed, while moderate inflations and tinkering with coinage have been recorded since the first coins were minted, hyperinflation has exclusively affected credit money.[16] Due to this imminent danger, opposition to uncovered paper money ('fiat money') has been fierce well into the twentieth century, both among the public and among those responsible for the stability of the monetary system.

For the nineteenth century, Peel's Bank Act of 1844 is revealing in illustrating the dilemma.[17] It declared the notes of England as legal tender, which could be perceived as a decreed 'fiat money'. However, at the same time the Act included the

[15] See e.g. Born (1972) and Rittmann (1975, 483 ff.). The oldest known paper money circulated in China from the seventh century. However, at the end of the Ming Dynasty in the seventeenth century, it perished.

[16] Initially, governments issued uncovered paper money in times of crisis, war or revolution. The first European issue of government paper money occurred in pre-revolutionary France; where after the revolution the notorious 'assignats' were emitted. Other early examples are the paper monies in North America during the War of Independence, in England during the Napoleonic Wars, and the greenbacks from the US Civil War. As Friedman (1994, 45) remarks, these emergency measures without exception quickly resulted in inflation and ultimately disruption of the paper currency, after which stability had to be restored under a bullion standard.

[17] See Born (1976, 20 ff.). Robert Peel was Prime Minister of Great Britain from 1834 to 1835 and from 1841 to 1846.

obligation that two thirds of the notes in circulation had to be covered by gold in the Bank's coffers. This effectively allowed supplying liquidity to the economy in excess of the stock of bullion. But with mandatory reserves of two thirds, the public could trust that the notes were indeed convertible into gold, at least in the absence of circumstances that might trigger a run on the coffers of the Bank. Other European countries soon followed this example, which indeed proved reasonably flexible in supplying money and liquidity for the fast growing economies of that time.

With the onset of hostilities in 1914, the situation to cause a flight from paper into gold had arrived and consequently, convertibility into gold was suspended in all belligerent nations. During the interwar period, many countries attempted to or indeed restored their pre-war gold parities. However, these moves eventually proved futile when the gold standard was again largely abandoned during the Great Depression. After World War II, a modified gold standard was introduced as the basis for currencies taking part in the international monetary regime that had been approved at Bretton Woods in 1944. The US dollar was fixed to gold at a parity of 1/35 oz and, since no other currency was convertible into gold, it became the 'anchor currency' of the Bretton Woods system, where the other participating currencies were pegged to the dollar within a relatively narrow band of ± 1 %. Consequently, as soon as a currency was made convertible into US dollar, it was de facto indirectly pegged to and convertible into gold. Hence, a link from paper to gold, albeit indirectly via the US dollar, was re-established for another three decades. The end of the Bretton Woods system came in 1971, when the US government suspended convertibility of the dollar into gold. Consequently, not only the dollar, but all currencies that were pegged to it, suddenly were stripped of the provision – as hypothetical as it may have been – to redeem paper into gold at a fixed rate.

The link between money and bullion, which had been established thousands of years ago, was suddenly cut and world's currencies turned into uncovered paper money. Understandably, the public – as far as people were interested in the nature of money – was concerned. At the same time, central banks were urgently looking for an alternative to 'anchor' potentially worthless 'fiat money' to a solid base. The quantity theory of money, at that time widely discussed and forcefully promoted by the influential monetarist school, delivered this device. Assuming an exogenously given level of potential output and full employment, in the short term, Y^r can be treated as a constant. Assuming further that the income velocity of money V^Y is exogenous and constant, (4) can be specified as $P = a\ M$, where a is the proportionality constant. Notice that under these assumptions, money is 'neutral' in the sense that real output is completely independent of the stock or changes to the stock of money. Money affects the price level, and nothing else. To derive a theory of the price level (4') from the identity stated by the equation of exchange (3), the following conditions must be met:

1. M is an exogenous variable and independent of P, Y^r and V^Y. (Otherwise, there is no conclusive causality.)
2. V^Y is an exogenous variable; in particular, it is independent of P, M, and Y^r. (Otherwise, the link between money and prices is indeterminate.)

3. Y^r is independent of M, i.e. neutrality of money holds. (To the degree to which real output is a positive function of the money supply, extra money would raise output but not prices.)

The equation of exchange can serve to derive a simple money demand function. Let us define $k \equiv 1/V^Y$ and $Y \equiv PY^r$. Equation 3 can than be rearranged into the 'Cambridge Equation'

$$M = kY \Rightarrow M^d = f(Y) \tag{5}$$

The Cambridge Equation is a money demand function, a behavioural equation, where M is interpreted as the demand for money M^d and the 'Cambridge constant' k shows the proportion of real income that individuals want to hold in liquid form. As k is the inverse of V, stability of V^Y in (3) implies a stable money demand function (5).

The success of the monetarist liquidity preference theory among economic theorists and practitioners around 1970 reflects the political and economic situation of these days. With the end of the Bretton Woods system, monetary policy suddenly had to take on new functions, so a revised theoretical foundation the monetary policy became the order of the day. Under these circumstances, Friedman's version of quantity theory was readily accepted as the appropriate paradigm. What made this approach so attractive? It offered clear guidance to monetary policy by directly addressing the main weaknesses of the classical quantity theory, namely ignorance of the velocity of money and its determinants. Let us hence look at his seminal work in some detail. Friedman (1956) approached the demand for money like the demand for any good would be analysed in a microeconomics textbook. M^d is then a function f of (a) the price of the relevant good; here the price level, (b) the prices of substitutive goods; here interpreted as the real return of other financial claims, such as yields from fixed-interest bonds or shares as well as the yield from holding real assets, (c) the budget constraint; here represented by Friedman's famous *permanent income*Y, (d) preferences; here Friedman remains vague, so that this should be regarded as a catch-all term to make sure that the money demand function lists all arguments. Friedman's money demand function hence reads as follows:

$$M^d = f(a, b, c, d)Y. \tag{6}$$

A comparison between equation (6) and the Cambridge Equation (5) reveals that the function f (a, b, c, d) is as an elaboration of the Cambridge k. Now, if f can empirically be handled as a stable function of traceable macroeconomic variables, Friedman's *neo-quantity theory* can be called upon as the basis for an economic policy that is focussing on control of the money supply: Solving (6) for Y and referring to the equilibrium condition $M^d = M^s$, we get

$$Y = M^s/[f(a, b, c, d)]. \tag{7}$$

With a stable money demand function f and the money supply M^s exogenously

set by the monetary authority, nominal output Y can be directly controlled. Hence, from the monetarist point of view, the money supply is, or should be, the central variable of economic policy.

Yet another approach to derive a positive theory from the equation of exchange is to transform it into growth rates and to solve for the growth rate of the price level, i.e. inflation. Taking logarithms and time derivates of (3) results in

$$g(M) + g\left(V^Y\right) = g(P) + g(Y^r) \tag{8}$$

$$\Leftrightarrow$$

$$\pi = g(M) + g\left(V^Y\right) - g(Y^r) \tag{9}$$

where $g(X)$ represents the growth rate of a variable X and $\pi \equiv g(P)$. As can be inferred from (9), if the velocity of money is a constant, hence $g(V^Y) = 0$, any growth rate of the money supply exceeding that of real output, leads to inflation. This is the basis of perhaps the most famous, and most often quoted of Milton Friedman's statements:

> '[I]nflation is always and everywhere a monetary phenomenon in the sense that it is and can be produced only by a more rapid increase in the quantity of money than in output.' (Friedman 1994, 49).

Empirically the quantity theoretical explanation of inflation can refer to a firmly established long-term correlation between growth of the money supply and increases in the price level.[18] Apart from this, proponents of the theory point to evidence that this correlation not only holds in longitudinal studies but also for cross sections of countries.[19]

It is in order to note that the observed correlation between π and $g(M)$ does not prove that causality runs from $g(M)$ to $g(M)$; π could also be the cause and $g(M)$ the consequence, especially in hyper-inflationary situations. Moreover, this inflation theory has to assume super-neutrality of money, i.e. the independence of the growth rate $g(Y^r)$ from $g(M)$. The question of the super-neutrality of money in the inflation process has not as yet been empirically clarified.[20] But if $g(Y^r)$ reacts positively to a change in $g(M)$, the correlation between $g(M)$ and π is not as narrow as the equation of exchange suggests.

[18] See e.g. Friedman (1994, 47 and 195 ff.) and Hallman et al. (1991).

[19] Schwartz (1973, 267) e.g. reports a correlation between π and $g(M/Y)$ from 1952 to 1969 in a sample of 40 countries as high as 0.94. Notice however, that recent studies find that this result in mainly driven by a limited number of high inflation countries. We shall come back to this point below.

[20] Traditionally, economics would not usually assume super-neutrality of money, as individuals easily err about the rate of inflation. Contrary to this view, 'Neoclassical Macroeconomics' today frequently refers to rational expectations of the expected rate of inflation, and money is therefore not only neutral, but also super-neutral; see McCallum (1990).

Let us now briefly turn to a practical implication of the quantity theory in monetary policy: From 1974 until the end of its responsibility for monetary policy in Germany in the end of 1998, the German Bundesbank referred to a monetary target that can readily be derived by solving (9) for g(M), which results in

$$\mathrm{g}(M) = \pi + \mathrm{g}(Y^r) - \mathrm{g}\left(V^Y\right). \tag{10}$$

Let us take as an example the Bundesbank's last monetary target, i.e. for 1998. To arrive at a number for g(M), it referred to a forecast for the real GDP growth rate of 2.0 %, a 'medium-term price target' (implicitly an inflation target) of 1.5–2.0 %, and a decline of 1.0 % in the velocity of money.[21] This gives a target growth rate of 4.75 %. While the Bundesbank had initially communicated a point target, it later switched to a target band that was 3 % points wide. For 1998, this would have resulted in a target ranging from 3.25 % to 6.25 % for the growth rate of M3, which was the Bundesbank's preferred monetary aggregate in the later years. In 1998, the belief in the accuracy of this arithmetic, that had previously been followed exactly, obviously had slightly faded, so that the Bundesbank left the 1997 target corridor of 3.0–6.0 unchanged instead of adjusting it by 25 % points, as (10) had given 4.5 % for 1997.

The ECB, which took up its responsibilities in 1999, initially closely stuck to the practice of the Bundesbank and performed yearly calculations according to (10). When it downgraded its second pillar – 'monetary analysis' – in 2003, it decided to abandon the yearly review of the reference value. Since then, the calculus that results in its reference value of g(M) = 4.5 % refers to g(Y^r) = 2.25 % and g (V^Y) = −0.75 %. According to (10), the ECB's implicit inflation target is thus centred on 1.5 %.

While the ECB continues to declare monetary analysis as its second pillar, it certainly did not restrict the growth of monetary aggregates in line with the reference value of 4.5 % that results from the quantity theory. The reality looks different. As Fig. 1 shows, apart from a trough in the beginning of 2001, the annual growth rates M3 up to the Great Depression was always – and at times considerably – above this target. Clearly, the ECB does not conduct monetary targeting. In 2008, it plunged to zero, and it is now lingering around 3 %.[22] Rule-based monetary policy according to (10) has been abandoned in Frankfurt, too.

[21] The latter conjecture is consistent with Friedman's 'luxury goods hypothesis', according to which the preference to hold money is increasing disproportionately with income. Based on a meta-analysis of some 500 studies on money demand, Knell and Stix (2005) conclude that money is indeed a superior good. First estimates for the euro area (Brand et al. 2002) arrive substantially at the same conclusion, namely a trend towards moderate decline in the velocity of M3 around 0.5–1.0 %.

[22] The latest figure is for June 2013, when the annual growth rate of M3 was as high 2.3 %.

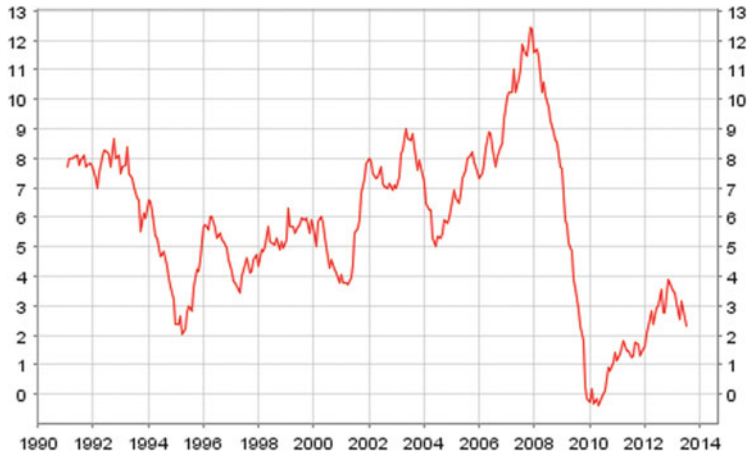

Fig. 1 Annual growth rate of M3, euro area (Source: ECB, http://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=BSI.M.U2.Y.V.M30.X.I.U2.2300.Z01.A&, accessed on 16/08/2013)

5 Is the Quantity Theory Obsolete? An Empirical Assessment

According to the quantity theory, as long as the velocity of money remains stable, the rate of inflation should equal the difference between the growth rates of money and real GDP. Is this still an adequate tool to explain the relationship between money and inflation in recent times? To confront this hypothesis with the data, we refer to a panel comprising yearly data from 1991 to 2012 across 109 countries, so that (9) is amended by time and country subscripts:

$$\pi_{it} = \mathrm{g}(M)_{it} - \mathrm{g}(Y^r)_{it} + \mathrm{g}\left(V^Y\right)_{it}. \tag{11}$$

Moreover, we specify our reduced form as a fixed-effects model, allowing for year-specific as well as country-specific effects, including particularities of $\mathrm{g}(V^Y)_{it}$, for which we do not have any direct measure. The regression that follows from this is hence

$$\pi_{it} = \beta_i + \beta_t + \beta_1 \mathrm{g}(M/Y^r)_{it} + \varepsilon_{it}. \tag{12}$$

Our data are taken from the World Bank's World Development Indicators (WDI), which include adequate specifications of all variables needed to estimate this model.[23]

The endogenous variable π is represented by inflation, defined as the annual growth rate of the GDP deflator in per cent, and excess money growth $\mathrm{g}(M/Y^r)$ is the

[23] The data are taken from the online version, assessed on 16 August 2013. Some missing values could be filled with corresponding data and estimates from the April 2013 International Monetary Fund World Economic Outlook Database.

difference between the annual growth rate of M2 in per cent of money and the annual percentage growth rate of real GDP, quantified at market prices based on constant local currencies. The sample selection is based on data availability. The WDI comprise yearly series, starting in 1960. At the time of conducting this analysis, the last year reported was 2012. As can be expected for large samples of countries, the series are affected by missing values, where a balanced sample with complete time series for all countries will include more countries when we chose a shorter time period. Regarding the variables required to estimate (12), the number of countries with complete series monotonically increases from 1971 as starting date to 109 with 1991 as the first year.[24] Fortunately, four our purpose, which is to assess the performance of the quantity theory when confronted with recent data, the missing values for the 1970s and the 1980s are not particularly troublesome, so that we choose broad coverage rather than longer time series. With yearly observations from 1991 to 2012 and 109 countries, we refer to a balanced panel that covers 2,398 observations for π and $\mathrm{g}(M/Y^r)$.

Before we turn to our analysis, let us take a brief look at the core variable: inflation. The evolution of inflation rates from 1960 to 2012 as reflected by mean inflation across the increasing sample of countries covered by the WDI is shown in Fig. 2. The most striking finding from this figure is the very high mean inflation rates above 150 % in the second half of the 1980s, which result from hyper-inflation in a number of countries. Somewhat harder to detect, as hyper-inflation dominates the picture, is the general acceleration of inflation around the mid-1970s, which in world-wide perspective lasted well up to the mid-1990s. The Great Recession year 2009, when many economies actually faced deflation, exhibits the lowest average inflation rate of the entire sample period.

Inflation is now regressed on excess money growth as specified in the reduced form. The results are as follows:

$$\pi_{it} = \beta_i + \beta_t + 1.004\mathrm{g}(M/Y^r)_{it} \tag{13}$$

The country and year fixed effects are jointly significant, so that they indeed belong into the regression. $R^2 = 0.60$, which means that 60 % of the variance in inflation can be attributed to excess money growth. The coefficient of interest, β_1, is very close to unity, and there is no significant support for the hypothesis $\beta_1 \neq 1$. Obviously, these results are perfectly consistent with the proportionality theorem. This seems too good to be true. Therefore, let us consider whether these results are driven by a limited number of influential observations. Different heuristics and ad hoc procedures are suggested for this. A method to ensure inter-subjectivity is to look at the studentised residuals (STRES), which are asymptotically t-distributed. Taking a low significance level of $\mathrm{p} = 0.1$, the tabulation in Kleinbaum et al. (1988,

[24] After 1991, a limited number of transition and emerging market economies could be added to the sample, but the increase in country coverage is more than outweighed be the decrease in the years considered, so that our balanced sample of 109 countries from 1991-2012 maximises the number of observations in the panel.

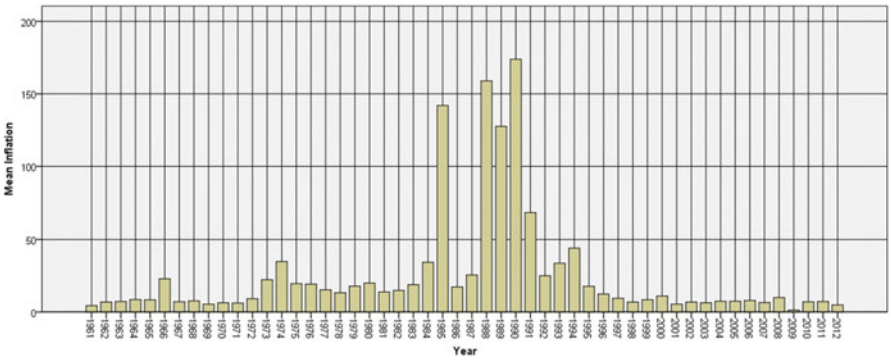

Fig. 2 World inflation since 1960, mean inflation rate across countries, $80 \leq n \leq 10$

661) gives a critical value of $|STRES| \geq 3.58$, which implies that four observations should be dropped from the fixed effects regression.[25] The result is now changed to:

$$\pi_{it} = \beta_i + \beta_t + 0.71 g(M/Y^r)_{it} \tag{13}$$

Compared to the reference model, we observe an increase in R^2 from 0.60 to 0.70 and a decline in the point estimate of β_1 from 1.004 to 0.701, which is now significantly lower than unity. We thus see a pronounced decline in β_1 as we drop high inflation observations from the sample. Is this a clue to some structural regularity? To investigate whether this is the case, we now run a number of regressions where we progressively reduce the sample by eliminating all observations that exceed a certain inflation cut-off value. To this end, we set the cut-off values at $\pi \leq 4{,}000$ %, $\pi \leq 3{,}000$ %, $\pi \leq 2{,}000$ %, $\pi \leq 1{,}000$ % and $\pi \leq 500$ %, and after this we shall lower the threshold stepwise by 1 % point. With these cut-off values, we repeatedly run the fixed effects regression according to (12), while the observations with the highest inflation rates are one by one removed from the sample, which will allow us to trace the effect of these observations on the pooled sample estimations.

Figure 3 plots the point estimates for β_1 as the cut-off value for π is lowered to 4,500, 4,000, 3,500, 3,000, 2,500, 2,000, 1,500, 1,000, 500, 499, .. 1, 0,−1,−2, . . . to−5 % annual inflation.

The point estimates illustrate the dramatic decline as a few hyper-inflation observations are removed from the sample, which is followed by a more gradual decline as the cut-off is lowered from 500 % to some 20 %. Beyond this, i.e. in the territory of moderate to low inflation as well as mild deflation, the point estimate for β_1 is getting higher, so that we end up with a U-shaped curve. Below a cut-off of zero, the point estimates are again decreasing, but the results are no longer

[25] The four outliers are Nicaragua 1991 and Brazil 1992-1994.

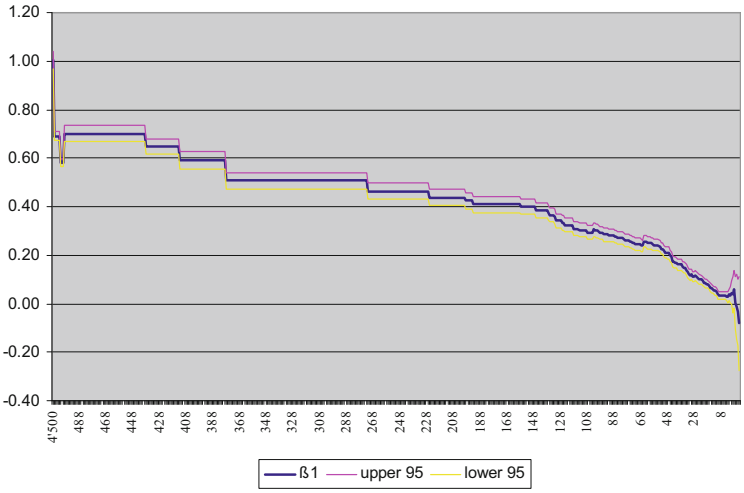

Fig. 3 $ß_1$ and 95 % confidence interval for decreasing cut-off level of inflation

significant. Either, the number of observations is getting too low, or the quantity theory is not a goof predictor of deflation.

Finally, we run the inflation regression with the sample restricted to the years 2008-2012. The result is:

$$\pi_{it} = \beta_i + \beta_t + 0.064\mathrm{g}(M/Y^r)_{it} \tag{13}$$

The country and year fixed effects are again jointly significant, and $R^2 = 0.45$. But now, the coefficient of interest, β_1, is very close to zero, although with $t = 2.30$ it is still significantly positive at the 5 %-level. Accordingly, even in the aftermath of the Great Recession, the quantity theory has not entirely lost its predictive power, although it is quite far from the proportionality theorem. Taken literally, the point estimate would imply that an increase in the money supply above GDP growth by factor x would trigger inflation, measured by an increase in the GDP deflator of 0.064 x.

Taken together, these analyses leave no doubt that for our sample period, i.e. the years since 1991, the classical proportionality theorem does not hold, as β_1 is far from stable. At the same time, this analysis confirms that the quantity theory continues to have explanatory power. $P = f(M)$ with $f' >= 0$ is confirmed for all cut-off values above zero. Moreover, the effect of excess money growth, although positive, is no so low that the fears regarding inflation as a consequence of the recent monetary easing do not appear warranted. Obviously, velocity has plunged as the excess liquidity is hoarded.

6 The Present Status of the Theory

As the basis of monetarism in the 1970s, the quantity theory had significant influence on academic theory as well as on the practice of monetary policy. Since then, we have seen a continuing reduction in its relevance. In the USA money targeting was abandoned in the early 1980s, when the correlation between the excess supply of money and inflation had apparently collapsed. Ever since, this has characterised the dominant point of view, at least in the English-speaking world: monetary aggregates are inappropriate as intermediate targets.

After monetary targeting was given up by the SNB in 1999, and markedly downgraded by the ECB in 2003, the last prominent central banks finally dismissed the quantity theory as a basis to implement money policy.

In addition to this, particularly in the English-speaking world,[26] not even monetary analysis, i.e. taking money as an indicator rather than an intermediate target, is any longer considered worthwhile as guidance for monetary policy. This practice is based on two main points that question the practical usefulness of the quantity theory:

1. Problems with measurement and definition of monetary aggregates: the appropriate monetary aggregate cannot be measured with sufficient accuracy;
2. Goodhart's law: the correlation between the stock of money and nominal output breaks down as soon monetary policy relies on it to achieve its goals.

Regarding the first point, there are indeed numerous examples that demonstrate the difficulty in defining and measuring monetary aggregates. We just mention two recent cases, the far-reaching revision of Swiss monetary aggregates by the Swiss National Bank in 1995 and the re-booking of German savings balances from M3 to M2 after the EMU came into effect. Yet, in our view, problems with definitions and measurement are in principle manageable; and the frequent revisions of monetary statistics around the world show that the problem is recognised and endeavours are being made to cope with it. From this perspective, the quantity theory will continue to produce predictions with empirical content as long as payments are customarily settled with money. Now, are we witnessing that economic transactions are decoupled from what we would in economic terms define as money, i.e. a financial stock variable that delivers convenience rather than return and is characterised by inelastic supply? We do not know what tomorrow will bring, but presently, conventional liquid assets still clearly prevail, and 'electronic money' is advancing slowly (OECD 2002). Surely, as liquid assets are getting less tied to the monetary base, the quantity theory will continue to lose significance for the conduct of monetary policy.[27] However, in as much as the stock of money can be considered to be exogenous, it would in our view clearly be premature to consign the quantity theory into the realm of historical dogma.

[26] Collins et al. (1999, 7) explicitly mention New Zealand, the US, Canada and the UK.

[27] See Dalziel (2000).

The second point is the in our view more substantive argument against the quantity theory: Goodhart's law[28] states that a statistical regularity falls apart, when a policy maker tries to exploit it. In the case of monetary targeting, this could be because the financial sector and/or the public undermine effective implementation of a money supply rule through financial innovation that facilitates substitution of illiquid and liquid financial assets. This is reflected by the observation that monetary targeting, when it was introduced in the 1970s, usually referred to a narrow monetary aggregate (the Bundesbank e.g. first targeted the monetary base), which was then widened, and in the end the target was usually broad money (M3). Apart from that, the public is to some degree free to adapt its demand for money to the conditions set by monetary policy, so that, in technical terms, V^Y will turn into an endogenous variable, which jeopardises a policy that builds on endogeneity of V^Y in (10).[29] In the end, central bank money could be avoided altogether, which would drive the money multiplier towards zero and thus deprive the monetary authority of its traditional means to manage the quantity of money held by the public.[30]

Goodhart's law makes a strong argument against *application* of the quantity theory with M as an exogenous control parameter, in predicting that the observed relationship between M and π is weakened or collapses as soon as the policy maker refers to it. At the same time, it follows that as long as M is *not* used as a control variable, it will continue to reflect information about π. In this sense, abandoning monetary targeting was a precondition for re-establishment of a stable relationship $P = f(M)$. Ironically, the progressive dismissal of the quantity theory since the 1980s may have contributed to the fact that it now appears alive as ever. And indeed, it seems that there is a new consensus emerging, where money is disregarded as a control variable but continues to be – or is resurrected – as a valuable indicator of inflationary pressure.[31]

To conclude, we hence shall not suggest an epilogue. The quantity theory may be the oldest theory that still features prominently in economics, but in the history of science, the observation 'the older you are, the sooner you die' does not always hold. As we have argued, the vitality of the quantity theory lies in the fact that it has

[28] See Goodhart (1981, 5): 'Any observed statistical regularity will tend to collapse once pressure is placed upon it for control purposes.' For an in-depth discussion of Goodhart's law, see Evans (1985).

[29] Greenspan (2003) summarises: '... in the past two decades, what constitutes money has been obscured by the introduction of technologies that have facilitated the proliferation of financial products and have altered the empirical relationship between economic activity and what we define as money, and in doing so has inhibited the keying of monetary policy to the control of measured money stock.' See also Gomme (1998), who relates the failure of monetary targeting in Canada to this issue.

[30] Notice that without demand for central bank money, not only would the foundation for monetary targeting be stripped from the central bank, but the bank rate policy would be obsolete too, so that this argument can also be brought forward against inflation targeting via the central bank rate.

[31] See e.g. Svensson (2003).

been able – explicitly or implicitly – to apply an identity, the equation of exchange, to ever changing historical circumstances and institutional change. It emerged as mediaeval rulers manipulated the coinage, and as the Black Death was followed by price increases. In early modern times it contributed to understand the price revolution. Later it was the theoretical basis for controversies about the links between bank money, paper money and bullion. When the last remainders of the gold standard vanished in the last century, it was referred to as a theory that advocated monetary targeting, but it was then quickly (in historical terms) abandoned. Nowadays, it continues mainly as a theory of inflation. It is presently challenged by the fact that financial innovation appears to make it increasingly difficult to define and measure monetary aggregates that are appropriate representations for M in the equation of exchange. Yet, as the history of money shows, the quantity theory has survived profound changes to the currency system, so that we are confident that it will also cope with the next one and continue to produce predictions with empirical content.

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