THE EFFECT OF UNCERTAINTY ON THE OCCURRENCE AND SPREAD OF FINANCIAL CRISES

Inaugural-Dissertation
zur Erlangung des Grades
Doctor oeconomiae publicae (Dr. oec. publ.)
an der Ludwig-Maximilians-Universität München

2007

vorgelegt von
Friederike Köhler-Geib
Volkswirtschaftliche Fakultät

Referentin: Prof. Dr. Monika Schnitzer
Korreferent: Prof. Jaume Ventura, Ph.D.

Datum der mündlichen Prüfung: 29. Januar 2008
Promotionsabschlussberatung: 06. Februar 2008

Acknowledgements

This research project would not have been possible without the kind support of a number of people to whom I would like to express my gratitude. First and foremost, I would like to thank my supervisor Monika Schnitzer for her excellent guidance, very helpful advice, and continuous support. Just as much, I am grateful to Jaume Ventura for hosting me twice as visiting Ph.D. student at University Pompeu Fabra, Barcelona, in spring 2006 and 2007 and for having joined in guiding, advising, and supporting my work.

Furthermore, I would especially like to thank Fernando Broner, Antonio Ciccone, Jarko Fidrmuc, Harald Fadinger, Pablo Fleiss, Georg Gebhardt, Michael Grimm, Frank Heinemann, Florian Heiss, Christian Holzner, Gerhard Illing, Francisco Peñaranda, Thijs van Reens, Stefan Schubert, Luis Serven, Andrei Sleptchenko, Frederik Udina for fruitful discussions and very helpful comments and suggestions. Then I am thankful to Jeromin Zettelmeyer for inspiring me to start working on sudden stops of capital flows. Special thanks go to Robert Holzmann for continuous, very helpful advice. My thanks extend to my colleagues at the University of Munich, the University Pompeu Fabra, the Munich Graduate School of Economics, and at the Chair of Comparative Economics at the University of Munich, who have been an important source of feedback and encouragement.

Additionally I would like to thank participants at various research seminars at the University of Munich and the University Pompeu Fabra, as well as during sessions at the LACEA Annual Meeting 2005 in Paris, the 10th International Conference on Macroeconomic Analysis and International Finance 2006 in Rethymno, the 4th Workshop on Monetary and Financial Economics 2006 in Halle, the Annual Meeting of the Verein für Socialpolitik 2006 in Bayreuth, and the Spring Meeting of Young Economists 2007, who gave me valuable comments.

Moreover, I would like to thank Gaston Gelos, Alexandro Izquierdo, Luis

Gonzalo Llosa, and Anna Stangl for sharing with me and giving information on part of the data set used in the empirical parts of this research. In addition, I am grateful to Marybeth Shea for excellent editing.

I am very thankful for the support and the provision of a great research environment by the Munich Graduate School of Economics. I would like to thank Ingeborg Buchmayr, Gabriella Szantone-Sturm, and Agnès Bierprigl for help and assistance. Special thanks go to Dirk Rösing and Peter Dumitsch for taking care of every major or minor computer problem.

I gratefully acknowledge the financial support by the German Research Foundation (DFG), the German Academic Exchange Service (DAAD), the European Commission, and the Kurt Fordan Foundation, which made this research possible.

Finally, but most importantly, I am deeply grateful for the love, encouragement, and support of my family. With all my heart I would like to thank my husband, Malte Geib, for the best company that I can imagine in a thesis endeavor. I am also particularly thankful to my mother, Gertrud Köhler, to whom I dedicate this work.

Washington DC, October 2007

Contents

Chapter 1

Introduction and Literature Overview

1.1 Introduction

1.1.1 Motivation

Most major financial crises in the past three decades entailed devastating effects on real economic activities in affected countries and markets. Examples are the Mexico crisis in 1994, the crises in South East Asia in 1997, and the Turkey crisis in 2001.[1]

In particular, financial crises that comprise a sudden stop of capital flows, i.e., a sharp negative variation in capital flows, are characterized by severe and long lasting economic effects. For example, the Mexico crisis, characterized by a sudden stop and a currency crisis, led to a fall of real equity prices in CPI units (Consumer Price Index) of 29 percent, in industrial production of 10 percent, and to a plunge of 6.5 percent in private consumption.[2] In 1995, Mexico's GDP declined 6 percent as compared to the previous year.[3]

[1] See Table 2.12 in Chapter 2 for an overview on the most severe financial crises of the last three decades and their effects on the real economic activity in the crises countries. These crises were so severe that they appeared in newspaper headlines around the world and are remembered for the accompanying turmoil. Kaminsky, Reinhart, and Vegh (2000) surveys those crises that seized several economies.

[2] Mendoza and Smith (2006) report these values comparing late January 1995 to April 1994.

[3] See Table 2.12 in Chapter 2.

Many financial crises have occurred in emerging market economies around a few initial crises, particularly around the Mexican crisis in 1994, the Thai crisis in 1997, and the Russian crisis in 1998, as well as in developed economies around the breakdown of the European Exchange Rate Mechanism in 1992. These periods of crises concentration suggest contagion effects, i.e., the transmission of crises across countries beyond what would be implied by common shocks.[4]

The high economic cost of these periods explains the effort in trying to understand the factors behind the occurrence and the spread of crises. Many researchers have analyzed factors explaining the *occurrence* of financial crises and their effects on the real economy, and have thought about possible policies that may prevent crises or mitigate their effects. Just as much effort has been exerted on exploring corresponding questions regarding the *spread* of crises. The present study seeks to contribute to this effort by analyzing one specific factor neglected so far but potentially delivering fresh insights on policies preventing the occurrence and the spread of crises: uncertainty about the fundamentals. In the present study, *uncertainty about the fundamentals* or *uncertainty* refers to the disagreement of private investors about the state of the fundamentals of an economy.[5]

Uncertainty about the fundamentals between private investors belongs to the variables only recently discovered as potential explanatory factors of currency, debt, and banking crises. Its role in the transmission of crises across countries has even been entirely neglected so far. Financial crises occurring earlier, such as currency crises of Mexico and Argentina in the 1970s, could be largely explained by inconsistent economic policies or bad fundamentals in the crises countries. Later, crises such as the breakdown of the European Exchange Rate Mechanism in 1992 appear to have been triggered by self-fulfilling beliefs of speculators or investors. However, the Mexican crisis in 1994, and to an even larger extent the Asian crisis in 1997, have shown that previous models were not sufficient to explain all crisis features. In particular, the sudden stop of capital flowing to affected countries and the spread of a financial crisis from one market to another could not be explained by previous models. Therefore, the search for crisis triggers has been extended to factors within international capital markets and investor behavior, uncertainty being one of these.

[4]See Didier, Mauro, and Schmukler (2006) for this definition.

[5]This definition is widely used in the literature of global games.

Studies modeling currency crises, debt crises, and banking crises as coordination games have contributed promising approaches to the prevention of these crises phenomena.[6] This modeling approach allows for an analysis of the effect of uncertainty. Sudden stops and contagion have not been analyzed from this angle.

Decisions underlying the occurrence of sudden stops of capital flows are similar to those underlying currency, debt, or banking crises.[7] This renders the analysis of uncertainty in the context of sudden stops possible. However, factors driving sudden stops and the crisis phenomenon itself differ profoundly from other crises phenomena. Therefore, analyzing the phenomenon of sudden stops in terms of a coordination game between private agents promises to generate new, insightful results.

While the spread of financial crises has been analyzed in the setup of a coordination game, the literature stops short of analyzing which role uncertainty plays in the transmission.[8] In addition, the spread of stock market drops has not yet been modeled in such a setting. However, such an analysis appears promising. In particular, it can help in understanding the spread of crises across countries that are unrelated in terms of their fundamentals.

Furthermore, the empirical quantification of the effect of uncertainty on the occurrence of sudden stops and on the spread of crises is missing in previous research. The goal of the empirical parts in chapter 2 on sudden stops and of chapter 3 on the spread of stock market crises address this lack.

1.1.2 Aims and Scope

The overall objective of this study is to explore the effect of one particular possible explanatory factor of financial crises and their spread: uncertainty about the fundamentals.

[6] See section 1.4 for the concrete policy implications of coordination games analyzing the effect of uncertainty such as by Heinemann and Illing (2002) in the context of currency crisis, or by Morris and Shin (2004) on debt crises.

[7] Concretely, the decision of abstaining from investment in a particular country's assets positively depends on other agents choosing the same strategy and negatively depends on the quality of the fundamentals in the respective economy. These features similarly characterize the choice of attacking a currency, of abstaining from rolling-over debt contracts, or of withdrawing bank deposits.

[8] See Goldstein and Pauzner (2004) for a prominent example.

Achieving this overall objective can be split into a number of aims with smaller scope.

A first aim is to help in understanding how sudden stops of capital flows are triggered. In particular, I want to show how coordination failure between private investors can contribute to the occurrence of sudden stops. I focus on the effect of uncertainty about the fundamentals.

The second aim is then to understand the relevance of uncertainty in explaining sudden stops. The large number of factors potentially functioning as crisis triggers requires a rigorous empirical analysis, taking into account a large number of control variables. Moreover, the potential problem of reverse causality running from a sudden stop towards uncertainty requires a careful robustness analysis.

The third aim then is to provide policy implications based on a new understanding of the occurrence of sudden stops and their relevance. The ultimate goal of these policy implications is to contribute to the prevention of sudden stops and to the mitigation of their consequences.

The fourth aim is to illustrate the mechanism through which uncertainty about fundamentals propagates financial crises across markets. In this context, I focus on contagion of stock market crises. These crises, together with banking crises, appear to be at the core of spreading crises.[9]

The fifth aim of this study is to validate empirically the effect of uncertainty on the spread of stock market crises. Again, the existing alternative factors of contagion and the risk of reverse causality call for rigorous empirical verification and careful robustness analysis.

The sixth aim is, again, to provide policy implications in the effort to prevent contagion and mitigate its consequences.

The following two points are relevant for clarifying the scope of the present study. Firstly, the present study does not claim that uncertainty about the fundamentals is the only factor either triggering or transmitting financial crises. Rather, the purpose of my study is to explore the effect of one factor neglected so far. As the empirical analysis here shows in both cases, in the occurrence of sudden stops of capital flows and the spread of stock market crises, the effect is not negligible in terms of magnitude. Additionally, analysis of uncertainty

[9]Portfolio flows and bank lending have been found to be particularly diversified across countries and volatile during crises periods. For evidence, see Levchenko and Mauro (2006).

about the fundamentals can help identify additional policy ideas that diminish the probability of a crisis or its propagation and mitigate the consequences.

Secondly, the models in this study will not explain all crisis features characterizing the recent headline crises. In particular, the models do not accommodate bank runs or debt crises. Both bank-run crises and roll-over debt crises have already been analyzed in light of coordination failure. This study focuses on phenomena shown to be especially crucial to the financial turmoil of the recent headline crises and which have the potential to generate new insights. This narrowed, strategic focus allows for concrete results and for drawing concrete policy implications.

1.1.3 Outline of the Study

This study consists of three chapters. The rest of chapter 1 briefly considers relevant threads of literature. Reviewed first is the relevant literature on financial crises. Then follows a summary of the literature on the spread of financial crises. Finally, the first chapter concludes with an overview of the existing literature on the effect of uncertainty on the occurrence and the spread of financial crises.

Chapter 2 addresses the effect of uncertainty about the fundamentals on the probability of sudden stops of capital flows, both from a theoretical and an empirical perspective. A coordination game with private information about the fundamentals is set up to show the effect of investment safety, of the international interest rate, and of uncertainty on the probability of a sudden stop of capital flows. The model predicts that the probability of a crisis decreases with an increase in investment safety. However, the crisis probability increases with an increase in the international interest rate. Moreover, the crisis probability increases with an increase in the uncertainty about the fundamentals, i.e., with the dispersion of private signals about the true value of the fundamentals. The analysis uses two data sets of Consensus Economics and WES (World Economic Survey) forecasts for 31 developed and developing countries from January 1990 to December 2001 to test the theoretical predictions. Applying probit estimations controlling for time and country effects makes the validation of the theoretical predictions possible. Additionally, results are tested for robustness across many specifications.

Chapter 3 analyzes the impact of uncertainty on the spread of stock mar-

ket crises, both theoretically and empirically. The effect of uncertainty about the fundamentals on investment decisions is an important cause of financial crises propagating across countries. Firstly, a coordination game on investment illustrates the increasing effect of a surprise crisis in one country on the probability of a crisis in a second country through higher uncertainty there. An anticipated initial crisis generates the opposite effect. Secondly, these theoretical predictions are tested empirically. Fixed effects panel estimations validate the impact of the initial crisis on uncertainty in potentially-affected countries. Subsequently, probit estimations confirm the positive impact of uncertainty on the crisis probability in the affected economy. The results are robust across various specifications.

1.2 The Occurrence of Financial Crises

The literature on financial crises is extensive. Therefore, this overview mentions only the most important studies shaping the understanding of these events. A particular emphasis lies on the literature on sudden stops of capital flows as they are at the core of interest in chapter 2 of this study. This section only briefly revisits the literature on stock market crises. As the spread of stock market crises is at the core of interest in chapter 3 of this study, readers will find more detail on this literature in the literature overview on contagion in section 1.3. In addition to reviewing relevant literature, this section puts the present study in perspective by defining its scope in the context of the literature.

This section is organized as follows: First, the most important types of crises are defined. Second, the different steps in the development of crises models are traced. Third, this section treats the literature on sudden stops of capital flows, dividing the presentation into theoretical and empirical studies.

1.2.1 Crises Phenomena

In the literature, **currency crises** that have long been considered at the core of larger financial turmoil cases are defined as substantial exchange rate devaluations. In the empirical analyses of currency crises, researchers have measured the devaluations by so-called *exchange market pressure indices*. A crisis is defined as a significant change in the index. While a few authors consider

changes in the nominal exchange rate exclusively[10], most authors, additionally, take into account either changes in foreign exchange reserves[11] or changes in foreign exchange reserves and in the interest rate[12] to accommodate possible policy responses to initial pressure on the nominal exchange rate.

Banking crises or panics have been accurately defined as events in which "bank debt holders suddenly demand that banks convert their debt claims into cash to an extent that the banks are forced to suspend the convertibility of their debt into cash" by Calomiris and Gorton (1991). Caprio and Klingebiel (2002) define systemic banking crises as "much or all of bank capital being exhausted," which is a definition more easily measured.

Most authors understand a **debt crisis** as a credit event defined as a non-repayment of pre-agreed debt service.[13] Pescatori and Sy (2004) give an extensive overview of the definitions of debt crises, categorizing the corresponding credit events as sovereign defaults, large arrears, large International Monetary Fund loans, and as distress.

Kaminsky and Reinhart (1999) introduced the term **twin crisis** to the literature. *Twin crisis* describes the simultaneous occurrence of a banking and a currency crisis. In their empirical analysis Kaminsky and Reinhart (1999) find that the banking crisis in most cases precedes the currency crisis. This observed order of events is often used to explain why the focus of a part of the literature has shifted from currency to banking crisis as the core of financial turmoil. A more recent literature also analyzes the simultaneous occurrence of debt and currency crises.[14]

The term **sudden stop** was first introduced by Dornbusch, Goldfajn, and Valdes (1995). Most authors define a sudden stop of capital flows as a sharp reversal in capital flows associated with severe economic consequences. However, authors differ in their sudden stop definitions regarding the distinction between crisis features and the consequences of the crisis. While, for example, Calvo (2003) defines a sudden stop simply as a large reduction in the flow of international capital considering the ensuing turmoil as a crisis consequence, Mendoza and Smith (2006) include three stylized facts into their definition

[10]See Frankel and Rose (1996).
[11]See, for example, Berg and Patillo (1998).
[12]See, for example, Eichengreen, Rose, and Wyplosz (1996) or Fratzscher (2003).
[13]See Sachs (1984) for this definition.
[14]See, for example, Reinhart (2002) or Bauer, Herz, and Karb (2007).

of a sudden stop: a sudden, sharp reversal in capital inflows and the current account, large declines in absorption and production, and collapses in both real asset prices and in the price of non-tradable goods relative to tradables. Henceforth, *sudden stop* in this study means the reversal in capital flows. The study will treat the consequences separately.[15]

Sudden contractions in current account deficits or even **current account reversals** are closely linked to sudden stops in capital flows. Capital inflows equal the current account deficit plus the accumulation of international reserves by national accounting, if abstracting from errors and omissions. A sudden stop in capital inflows must be met by a lower current account deficit or by reserve losses. As Calvo and Reinhart (2000) illustrate, both cases happen in reality. Edwards (2004b) demonstrates that current account reversals and sudden stops in capital inflows are highly correlated. A part of the empirical literature uses reversals in the current account to identify sudden stops of capital flows.[16]

The loss in foreign reserves is defined as a **balance of payment crisis** if it is severe: Krugman and Obstfeld (2003) define it as a sharp change in official foreign reserves sparked by a change in expectations about the future exchange rate.[17] Clearly, then, a balance of payment crisis is also closely linked to a currency crisis that occurs when depletion of reserves is not sufficient to buffer the shock: the currency, then, depreciates.

Practitioners define **stock market crises** as precipitous drops in market prices or economic conditions.[18] An academic definition is more difficult as Mishkin and White (2003) put it: "On the face of it, defining a stock market collapse is simple: when you see it, you know it. However, a precise definition is more difficult." In this study, following Broner, Gelos, and Reinhart (2006), a stock market crisis is defined as a significant drop in stock market returns.

[15] The empirical analysis in the second chapter employs two alternative measures of sudden stops. The first measure is based on the reversal in capital flows exclusively. The second measure, additionally takes negative GDP growth into account.

[16] See for example Hutchison and Noy (2006).

[17] See Krugman and Obstfeld (2003), p. 502.

[18] See *http://www.investorwords.com* for this definition.

1.2.2 Generations of Crises Models

The search for models explaining the occurrence of financial crises has evolved in several waves or generations. These generations follow the occurrence of financial crises not explained by previous models. The intellectual development is stepwise, however, and relies on prior modeling work.

In the **first generation** models, economic fundamentals and unsustainable domestic policies are at the core of financial crises.[19] These models respond to the currency crises of Mexico and Argentina in the 1970s. In these models, the combination of government deficits financed with the help of seignorage and fixed exchange rate regimes leads to a depletion of finite foreign reserves. External investors generate a *speculative attack when reserves fall below a critical level* to avoid capital losses in case of the inevitable collapse. This results in a currency crisis.

In the **second generation** models, crises occur driven by self-fulfilling beliefs. The models that were developed after the severe speculative attacks on the European Exchange Rate Mechanism in 1992 take into account that the attacked economies are mainly characterized by government surpluses and substantial foreign reserves. In Obstfeld (1994), for example, crises result from the tradeoff between a fixed exchange rate and a desire for an expansionary monetary policy to lower unemployment. The *crisis*, then, *stems from investors suspecting* that the cost of defending the peg for unemployment becomes too high for the government and that the peg may have to be abandoned. The resulting pressure on interest rates can be sufficient to force the government into devaluation.

In the **third generation** models, fragility of financial structure and institutions is at the core of the crisis. Most approaches in this generation combine features of the first and the second generation in the sense that models are fundamentals- and belief-driven at the same time. In particular, the Asian crisis in 1997-98 cannot be explained by first or second generation models because, prior to the crisis, the affected economies are seemingly characterized by sound fundamentals and, unlike the European countries prior to the 1992 crisis, by low rates of unemployment. Additionally, the 1994 Mexican as well as the 1997-98 Asian crises both involve sudden stops of capital flows and contagion. This is why the literature on financial crises broadened widely. As far

[19] See Krugmann (1979) and Flood and Garber (1984).

as crises models are concerned, the papers reviewed in the following literature overview are all part of the third generation.

1.2.3 Modeling Approaches to Sudden Stops

The theoretical literature on sudden stops of capital can be distinguished into two broad threads. One thread features dynamic, stochastic, general equilibrium (DSGE) models, which can only be solved numerically. In these models, sudden stops originate in the interaction of productivity shocks with financial market frictions such as credit restrictions and transaction costs of assets.[20]

Another thread on sudden stops features crisis models based on multiple equilibria, which are solvable analytically. In these models, the occurrence of sudden stops stems from domestic vulnerabilities interacting with exogenous shocks, such as terms of trade shocks or an increase in country risk.[21]

Dynamic, Stochastic, General Equilibrium Models

The first large thread of sudden stop literature consists of DSGE models where the sudden stop occurs as an equilibrium outcome if financial constraints bind and Fisher's debt-deflation mechanism is triggered as a result.[22]

If the economy is highly leveraged, i.e., the ratio of debt and/or working capital to asset values is sufficiently high, an adverse shock, i.e., a negative productivity shock, of standard magnitude, with financial constraints being binding, may lead agents to liquidate capital to fulfill *margin calls*.[23] The

[20]See, for example, Mendoza and Smith (2006). Mendoza (2006a) delivers a survey on this literature.

[21]The most important papers in this literature are Calvo (1998a), Calvo (2003), Calvo, Izquierdo, and Mejia (2004), Calvo, Izquierdo, and Talvi (2006), and Caballero and Krishnamurthy (2001). While the first four papers are all based on balance sheets consideration, Caballero and Krishnamurthy (2001) model a liquidity crisis from the perspective of private investors within an economy subject to domestic and foreign collateral constraints. The role of collateral constraints in the sudden models is reviewed for DSGE models. Hence, the Caballero and Krishnamurthy (2001) paper is not reviewed further here.

[22]DSGE models are a further development of small open economy business cycle models where the most prominent examples are Chari, Kehoe, and McGrattan (2005), Christiano, Gust, and Roldos (2004), and Neymeyer and Perri (2004). In these models, collateral constraints are also at the core of financial crises. The DSGE literature is the more recent one, deserving concentration here.

[23]For example, in Mendoza and Smith (2006) these constraints limit external debt to a fraction of the market value of domestic equity holdings. In Mendoza (2006b) a first

sudden high supply of assets reduces the price of capital, thereby tightening the constraint. This state sets off a spiraling collapse of investment and asset prices, which has strong real effects: The current account and domestic absorption immediately reverse. Future levels of capital, output, and factor demands fall due to the initial investment decline. In addition, the collapse of the value of collateral assets can render a collateral constraint on working capital binding, thereby inducing a decline in production and factor demands.

These types of models suggest policies aimed at preventing deflation as a good option. For example, Durdu and Mendoza (2006) study price guarantees on the emerging asset class that stop the debt-deflation process by introducing a moral hazard-like distortion affecting foreign traders. They find that welfare-improving guarantees require complex state-contingent features. The indexation of debt to GDP or to commodity prices and hard currency adoption have also been suggested as remedies against sudden stops. Another recommendation, stemming from debt-deflation models, is the build-up of foreign reserves to minimize the long-run probability of sudden stops of capital flows. However, as pointed out, for example, by Caballero and Panageas (2006), this prevention strategy is a very expensive insurance against sudden stops.

One major drawback of these types of models is that they do not deliver close form solutions. They can only be solved numerically and, therefore, do not provide strong results. Additionally, introducing private information about the fundamentals into these models is difficult. Thus, an analysis of the effect of uncertainty about the fundamentals in such a setup would be highly complicated, without the strong likelihood of producing more convincing results. Therefore, this research builds on the second thread of the literature, models based on multiple equilibria.

Models Based on Multiple Equilibria

The second large thread of literature consists of models where the occurrence of a sudden stop is based on multiple equilibria. A crisis materializes in the event of a discontinuous switch between equilibria. The mechanism through which the sudden stop occurs in these models is the following: Before the crisis, the economy displays a current account deficit. A growth collapse induced by an

collateral constraint limits debt not to exceed a fraction of the liquidation value of collateral assets; a second collateral constraint limits working capital financing to not exceed a fraction of the firms' assets.

exogenous shock displays sudden stop features:[24] The current account deficit discontinuously switches to zero because, in the non-monetary version of these models, the current account deficit equals the amount of capital inflows. As nontradable goods are normal goods, demand for them declines as net wealth declines due to the growth collapse. This implies that less tradable inputs are used for the production of nontradables. This, in turn, increases the marginal productivity of tradables such that their price increases relative to the price of nontradables, i.e., the sudden stop will be accompanied by a real depreciation. In the monetary version of these models, in which the current account deficit equals capital inflows minus the accumulation of international reserves assets, the slowdown of capital inflows associated with current account deficit could be cushioned by a drop in reserves. If the latter is high enough, this is considered a balance of payment crisis. However, in reality the reserves often do not suffice to buffer the shock. This implies that a currency crisis would ensue.

The literature on sudden stops identifies domestic vulnerabilities as well as systemic capital market forces as core explanatory factors behind a crisis. The key domestic variables are an unsustainable fiscal policy (i.e., fiscal policies that depend on high taxes, which make after-tax revenues unattractive to investors), short term foreign debt, contingent debt (i.e., government guarantees for private loans that only become apparent in bad states of nature), liability dollarization, and a high leverage of the current account deficit (i.e., low output of tradables relative to a high demand for them within the country, which makes a country vulnerable to real exchange rate fluctuations). The relevant market forces have been detected as TOT (terms of trade) shocks, fluctuations in the world market interest rates, or loss of confidence in emerging market economies as a whole. Calvo, Izquierdo, and Talvi (2005) and Calvo et al. (2006) measure the loss in confidence in emerging market economies by a significant increase in the aggregate EMBI (Emerging Market Bond Index by JP Morgan) spread and call it *substantial turmoil in global capital markets*.

The policy implications from this type of model follow from the detected vulnerabilities that economies or their governments can try to avoid. In particular, foreign-denominated short term debt is a variable that emerging market governments can influence and should reduce.[25] Governments may find them-

[24] In Calvo (2003) the exogenous shock, i.e., a TOT (terms of trade) shock, drives the economy beyond a critical level of debt that is inconsistent with a high growth equilibrium.

[25] The discussion of foreign denomination of emerging market debt has been labeled *original sin*. Various articles regarding this topic can be found in Eichengreen and Hausmann

selves facing two major difficulties: first, the vulnerability against external factors and, second, the difficulty in borrowing in their own currency. These governments should consider the following two options: In the effort of mitigating crises effects or of hedging against the probability of crises, governments can accumulate foreign reserves or they can use alternative financial instruments.

A recent discussion of reserves accumulation as policy tool in the context of sudden stops has been subject to a series of papers. Caballero and Cowan (2006) illustrate that self-insurance strategies such as reserves accumulation, public de-leveraging and export promotion are inefficient external insurance mechanisms. The authors suggest financial hedging instead. Caballero and Panageas (2005) analyze reserves accumulation and hedging mechanisms to *mitigate the consequences* of a sudden stop, whereas Caballero and Panageas (2006) analyze the role of hedging in *diminishing the probability* of a crisis.

An older policy discussion emerging from these models deals with capital controls and exchange rate management. Montiel and Reinhart (1999) discuss advantages and disadvantages of capital inflow controls. However, the authors find that the effects on the magnitude of flows are restricted. Calvo (2003) discusses the incentive of a central bank to peg its exchange rate once a crisis occurs to buffer a part of the current account adjustment. The central bank might provoke a balance of payment crisis to be able to transfer reserves to private agents of the economy.

Although these models generate numerous valuable insights, they are characterized by a number of drawbacks and shortcomings. A first drawback of this literature is that these models stop short of a framework to predict sudden stops. Although these models discuss early warning indicators and determine key vulnerabilities, they do not produce a theory that can attach a probability of a crisis to these factors. This results from the models displaying multiple equilibria without a theory-based selection procedure.

A second drawback concerns the lack of analysis of investor coordination. The introduction of a *representative agent* eludes analysis. However, especially in the context of financial crises, what other investors in the market do is paramount. Diamond and Dybvig (1983) have modeled bank runs as a coordination game. This prominent and important analysis has generated valuable insights into the occurrence of such crises and possible prevention.

(2005).

The decision to invest or not to invest in a particular country is characterized by strategic complementarity in the same way as the decision to keep or withdraw bank deposits. Therefore, analyzing issues of coordination and its failure in the context of sudden stops of capital flows is a promising research agenda.

A third drawback along the lines of the second criticism is that the current literature on sudden stops lacks analysis of the effect of uncertainty about the fundamentals. Based on the prominent analysis of Morris and Shin (1998) on the occurrence of speculative attacks, Heinemann and Illing (2002) show that speculative attacks become more probable with a higher dispersion of private signals about the true value of the fundamentals, i.e., the dispersion of beliefs of investors on the status of the economy. Again, the decision to invest within a country is similar to the decision to attack a currency. An analysis of the effect of uncertainty in the context of a sudden stop of capital flows thus appears promising.

1.2.4 Empirical Analyses of Sudden Stops

In the context of sudden stops of capital flows, two threads of literature are relevant: In one thread stands the literature on factors that drive capital flows in and out of emerging economies; in the second thread stands the literature that analyzes the drivers and consequences of pronounced crises events.

Empirical Analyses of Capital Flows

Lopez-Mejia (1999) provides a concise survey on the magnitude, regional destination, reversibility, and composition of large capital flows in the 1990s. The paper shows the heavy concentration of capital flows to China, Brazil, Mexico, Thailand, and Indonesia in 1990-97 and the similarities of their reversibility between the 70s and the 90s. The paper then surveys the findings of the literature on *pull* and *push* factors of capital flows into emerging markets from developed countries and vice-versa.

The literature on pull and push factors is concerned with the relative importance of domestic versus external factors in explaining capital inflows to emerging economies. The underlying concern is that large surges in inflows make countries more vulnerable to financial crises in the case that capital flows are driven primarily by factors outside the emerging markets. One of the

first papers of this literature is Calvo, Leiderman, and Reinhart (1993). In this paper, the authors examine empirical evidence for 10 Latin American countries, finding that, for the analyzed period, foreign factors, in particular the US interest rate and GDP growth, account for 30 to 60 percent of the variance in real exchange rates and reserves (two variables that directly reflect developments in the financial account) depending on the country. Chuhan, Claessen, and Mamingi (1987) find a stronger effect of domestic variables. They include Latin American and Asian countries into their analysis. They find that domestic factors in their analysis such as country credit rating, secondary bond prices, and price earning ratios in the domestic stock markets explain about half of the bond and equity flows from the United States to a panel of six Latin American countries. For Asia, they conclude that domestic factors account for about two thirds of bond and equity flows into the region. Building on this, Fernandez-Arias (1996) decomposes the improvements in creditworthiness found in Chuhan et al. (1987) into those stemming from a decline in global interest rates and those arising from improvements in the domestic environment. He finds that the interest rate accounts for around 86 percent of the increase in portfolio flows for the average emerging market during 1989-93.

In particular, the literature addresses the determinants of foreign direct investment (FDI).[26] The special interest in FDI originates from this quality: FDI is the least volatile form of capital flows as compared to portfolio equity investment, portfolio debt investment, other flows to the official sector, other flows to banks, and other flows to the non-bank private sector.[27] In particular, Levchenko and Mauro (2006) find that FDI is more stable than other types of flows during sudden stops of capital flows. Also of focus in this literature is the question of whether internal or external factors are the main drivers of FDI. On the one hand, Edwards (1991) shows that government size, political stability, and openness play an important role. On the other hand, Albuquerque, Loayza, and Serven (2005), for example, analyze the dependence of FDI on global factors or worldwide sources of risk. In a cross-country time series data set covering 94 countries and 29 years, the authors show that developing country exposure to global factors has dramatically increased. This analysis

[26]While the focus of this overview is on the literature on macro economic determinants of FDI, another literature convincingly analyzes determinants of FDI from a finance perspective. See, for example, Schnitzer (2000).

[27]See Marin and Schnitzer (2006) for an insightful analysis on the question, when FDI is counted as a capital flows at all.

delivers strong support for the hypothesis that increased market integration leads to increased worldwide sources of risk.

Literature on emerging country vulnerability has shifted focus. In the early nineties the focus of the empirical literature on capital flows was on the surge of capital inflows into emerging markets and the implied potential vulnerabilities. Later, the focus shifted to the question why the capital flows from rich to poor countries have such a low volume. This more recent literature analyzes which theoretical explanations of the Lucas paradox[28] are relevant. The theoretical literature has determined differences in fundamentals such as government policies and institutions' or international capital markets' imperfections such as sovereign risk and asymmetric information.

A prominent example of this literature is Kraay, Loayza, Serven, and Ventura (2005). The authors first contribute to the theoretical literature by modeling North-South capital flows, taking into account the interplay between diminishing returns at the country level, production risk, and sovereign risk. The authors then generate country portfolios and a world distribution of capital that resembles those portfolios actually observed in the data. In contrast to Kraay et al. (2005), Alfaro, Kalemli-Ozcan, and Volosovych (2005) focus on the empirical analysis exclusively. With the help of cross-country regressions for the period of 1971-1998, the authors show that institutional quality is the most important causal variable in explaining the low amount of flows. Additionally, they find that differences in human capital and asymmetric information play a significant role. Reinhart and Rogoff (2004) emphasize capital market imperfections. They show that serial default among debtor countries is a usual phenomenon. According to the authors, a key explanation for the low volume of capital flows from rich to poor countries is the difficulty in borrowing for countries with a history of defaults.

[28]Lucas (1990) compares the United States and India in 1988 finding that, if the neoclassical model were true, the marginal product of capital in India should be about 58 times that of the United States. In the face of such return differentials, all capital should flow from the United States to India. However, such flows are not observed. Lucas questions the validity of the assumptions that give rise to these differences in the marginal product of capital and asks which assumptions should replace these.

Empirical Analyses of Discrete Crisis Events

Although, in principal, sudden stops of capital flows are simply large negative variations of capital flows that occur in a short time period, the literature on these pronounced crises events is distinct from the literature on capital flows. Although observers see a large overlap of variables that explain continuous changes in capital flows with variables that explain sudden stops of capital flows, observations also note additional forces at work that trigger the discontinuous switch in case of a crisis.

A first branch of the empirical literature on sudden stop crises is descriptive. Apart from dating the crisis events, this literature is concerned with distinguishing sudden stops from other crises such as current account reversals or currency crises. Calvo and Reinhart (2000) are among the first to give an overview of sudden stop incidences. The authors present a selection of large reversals in net private capital flows calculated as percent of GDP in the respective countries. They further illustrate that many countries experiencing a sudden stop of capital flows in the second half of the 90s witnessed large surges in capital inflows in the first half of the decade. Furthermore, the authors assess the severity of the crises by analyzing the coincidence of currency crisis, banking crises, and financial account reversals for a sample of 20 countries from 1970 to 1994. The authors conclude that the severity, specifically the huge burden of bailing out the banks as well as the orders of magnitude of the capital account reversals, has increased during the recent crises periods. While the paper gives a good introduction into the topic, the criteria of selection of the included capital flow reversals are not evident. This absence of selection criteria renders the discussion of policy implications less convincing.

In a series of papers, Edwards (2004b), Edwards (2004a) and Edwards (2005), the author systematically analyzes the occurrence of current account reversals and sudden stops of capital flows. Using a panel data set for 157 countries, Edwards (2004a) finds that from 1970 to 2001 there is a 5.6 percent chance of sudden stops; the chance of current account reversals is 11.8 percent. The occurrence of the two crises events is highly correlated. Nevertheless, many sudden stops have not been followed by current account reversals. This indicates that, when facing a sudden stop, many countries effectively use their international reserves to avoid an abrupt current account adjustment. At the same time, a number of countries endure major current account reversals without facing a sudden stop in inflows. Most of these countries were not

subject to a large surge of inflows to begin with and had financed their large deficits by drawing down international reserves.[29]

Due to the close relation between the two crisis phenomena, many explanatory variables of current account reversals are also relevant in understanding the occurrence of sudden stops in capital flows. Analogously to the drivers of capital flows, the drivers of current account reversals can be categorized into domestic and external drivers. One of the most prominent empirical investigations on determinants of current account reversals is Milesi-Ferretti and Razin (1998). The authors run a panel probit analysis covering 86 low and middle income countries over a time span from 1974 to 1990. Milesi-Ferretti and Razin (1998) find the following major determinants of current account reversals: domestic variables such as the past current account balance, openness (share of exports and imports to GDP), and level of reserves, and external variables such as terms of trade shocks, US real interest rates, and growth in industrial countries. Using a larger data set, Edwards (2005) additionally finds the external debt to GDP ratio, domestic credit creation, and debt services crucial in explaining current account reversals.

In a series of papers Calvo et al. (2004), Calvo et al. (2006), and Calvo, Izquierdo, and Loo-Kung (2006) analyze the key explanatory factors of sudden stops of capital flows. The main focus of these papers is on the role of balance sheet effects, i.e., the interaction of the leverage of the absorption of tradables (i.e., vulnerability against real exchange rate fluctuations) and liability dollarization, which directly follows from the theoretical considerations in the theoretical models on sudden stops. All three papers use a sample of 32 developed and developing countries for the period from 1990 to 2001. Calvo et al. (2004) and Calvo et al. (2006) use random effects panel probit estimations controlling for time fixed effects.

Moreover, in addition to the significant effect of the interaction of the vulnerability against real exchange rate fluctuations with the liability dollarization, the authors find the two variables separately significant. Also important is that negative terms of trade growth increases the likelihood of a sudden stop significantly. The authors find that, controlling for dollarization, a fixed exchange rate seems to increase the probability of a sudden stop. However, this effect is not robust in all specifications. Other tested variables turn out not to be significant.

[29] See Edwards (2004b).

Policy Implications and Shortcomings of Empirical Literature

The policy implications of the empirical literature on capital flows and discrete sudden stop events are that both domestic and external factors play important roles. Strategies that lead to a stable macroeconomic environment appear to be as relevant as policies that help to respond to external shocks, as for example holding a sufficient amount of foreign reserves. One outcome of the empirical literature is that balance sheet effects should be at the core of government strategies to prevent crises, i.e., liability dollarization and vulnerability to real exchange rate fluctuations should be a major concern. Policies regarding the nominal exchange rate, i.e., questions of a floating versus a fixed exchange rate, seem to play a much less important role. Capital inflow controls are analyzed because of the observation that sudden stops are often preceded by periods of surges of capital inflows. However, Montiel and Reinhart (1999) find that these controls are only effective in altering the composition of capital flows, not their magnitude.

Although the empirical literature on sudden stops provides various valuable insights, this same literature is also subject to a number of drawbacks. The first drawback is the lack of analysis of the role of uncertainty about the fundamentals.

A second drawback of a particular part of this empirical literature is the following: Calvo et al. (2004), Calvo et al. (2006) and Calvo et al. (2006) use panel probit estimations with random effects. The estimates will be biased in the case that there are systematic differences between the countries that contribute to the explanation of the occurrence of crises. Due to the limited number of countries within the sample, justifying the use of random effects estimation is difficult. The use of pooled probit and logit estimations, controlling for country and time fixed effects by introducing country and time dummies, is a more appropriate estimation approach. A third drawback is the use of yearly data, which leads, partly, to a small number of observations.

1.2.5 Contribution of this Study

This study contributes to both the theoretical and the empirical literature on sudden stops. First, here follows a discussion of the contribution to the theoretical literature, succeeded by a description of the contribution to the

empirical literature.

The theoretical part of chapter 2 contributes to the sudden stop models based on multiple equilibria. The first contribution consists of addressing the topic of investor coordination. The model reformulates the setup in Calvo (2003) as a coordination game, thereby addressing the second criticism of the existing literature. When analyzing the problem from the angle of a coordination game, it becomes clear that, in an intermediate region of the fundamentals, a crisis can be triggered by a coordination failure in the case that the true level of the fundamentals is common knowledge, i.e., the crisis occurs merely because the investors cannot coordinate on the possible good equilibrium because each investor fears that the other investors abstain from investing.

In a further step, the model in chapter 2 introduces private information about the fundamentals. This step helps to confront the first and the third criticism of the existing sudden stop models based on multiple equilibria. The introduction of private information, i.e., the application of the global game approach, leads to a unique threshold equilibrium.[30] This, in turn, makes possible predicting the influence of the variables in the model on the probability of a crisis. In this context, both internal and external factors can be examined: the effect of internal factors such as productivity, represented by one model parameter, and the effect of external variables such as the international interest rate. Then, this work can show that within this model, an improvement in the internal factors reduces the crisis probability, while an increase in the international interest rate increases the crisis probability. The most interesting result stems from the analysis of uncertainty about the fundamentals. If this uncertainty increases, the probability of a crisis increases as well. This finding about what can drive crisis probability has policy implications for information dissemination strategies of governments. Governments should try to help private investors in receiving precise private information on the state of the economy.

Although the theory of global games has been prominently applied to various different crises phenomena, specific application of this approach is worthwhile for the problem of sudden stops. First, this modeling approach allows predictions of crisis triggers. Second, it is not clear ex ante that the effect of the uncertainty about the fundamentals on other crisis phenomena trans-

[30]The literature on global games and the analysis of uncertainty about the fundamentals is reviewed in more detail in section 1.4.

lates directly into its effect on sudden stops of capital flows. The strategic complementarity in the current model arises through a different channel, in particular a shared tax burden, than, for example, in models of speculative attacks. There, the sum of the funds put to speculation must exceed reserves that the central bank can use to defend its fixed exchange rate. From a modeling perspective, the global game approach is also interesting because, as opposed to most applications where the terms containing random variables enter the optimization of the agents in the model additively, in this present study model, the random variable terms enter as multiplicative, which leaves the solution more challenging.

The empirical part of chapter 2 contributes to the empirical sudden stop literature. The first contribution of this study is the provision of the missing empirical analysis of the effect of uncertainty on sudden stop crises. Care has been taken to ensure that this effect is distinct and present when alternative explanative factors of sudden stops are controlled for. Thereby, this study builds on the existing literature and the drivers of sudden stops that have been identified.

Second, the study improves the existing empirical analyses by Calvo et al. (2004) by dropping the assumption of random effects. Instead, this study introduces dummy variables to control for country and time fixed effects in probit and logit regressions. A rigorous robustness analysis validates the results found in the benchmark setting.

Finally, this study extends the existing literature by constructing a rich monthly data set. This allows for two improvements of the existing literature. Firstly, the small sample size objection is addressed. Secondly, monthly data allows for a better consideration of the problem of endogeneity resulting of potential causality running from the crisis to its potential triggers.

1.3 The Spread of Financial Crises

The literature on the spread of financial crises or "contagion" is as extensive as the one on financial crises.[31] Therefore, this section places particular emphasis on the literature that is relevant for chapter 3 of this study. In particular is the

[31] The terms "spread of financial crises" and "contagion" are used interchangeably throughout the study.

mention of those articles that build on the insight that common creditors are at the core of transmitting crises across countries. In addition to providing an overview of the relevant literature, this section puts this study in perspective and defines its scope in the context of the literature.

The section is organized as follows: First, the phenomenon of contagion is defined. Second, the two broad theoretical approaches to modeling contagion are presented. Third, contagion channels and mechanisms are considered. Finally, the contribution of this study is considered in light of the relevant literature.

1.3.1 The Contagion Phenomenon

The term *contagion* has been defined in a number of different ways in the literature. While a few researchers define contagion as an *increase* in the co-movement of the financial indicators of different countries during crisis periods that is unexplained by common shocks, other researchers define contagion simply as co-movement during crisis periods that is unexplained by common shocks.[32] In this analysis, following Didier et al. (2006), contagion is defined as the propagation of crises across countries beyond what would be implied by common shocks. The crises analyzed in the chapter on contagion are significant drops in stock market returns.

The spread of different crisis phenomena has been treated separately in the literature. While in the beginning the focus was on the spread of currency crises, research shifted toward questions about the spread of banking crises and stock market crises. Prominent analyses of the contagion of currency crises are Eichengreen et al. (1996), Glick and Rose (1999), Drazen (2000), and Fratzscher (2003). The spread of banking crises has been analyzed by Dasgupta (2004). The literature on the contagion of stock market crises is extensive. Prominent examples are Goldstein and Pauzner (2004) or Broner et al. (2006).

In line with, for example, Broner et al. (2006), chapter 3 of this study focuses on the spread of stock market crises. Two main considerations explain this scoping decision. First, the empirical disaggregate analysis of capital flows, reported in the balance of payments statistics, shows that in particular

[32] See Rigobon (2003), Forbes and Rigobon (2001), and Kaminsky and Reinhart (2000) for details.

portfolio investments (i.e., cross border stock market investments) and other investments (which comprise bank flows) are volatile during crisis periods.[33] Therefore, questions about how stock market crises and banking crises spread appear particularly relevant.

Second, especially with regard to an empirical analysis of contagion, the spread of stock market crises appears more promising than an analysis of the spread of banking crises. This is due to better data availability of stock market data and therefore a more reliable identification of crises events.[34]

1.3.2 Modeling Approaches to Contagion

The theoretical literature on contagion can be distinguished into two main threads from a methodological standpoint: A first thread of literature is based on portfolio optimization while the second thread uses models of sequential investment games.[35] In the first thread of literature, the optimal allocation of investments across countries is done according to considerations of the expected portfolio return versus the accompanying risks, i.e., the variance of the portfolio return.[36]

In the second thread of literature, the game-theoretical investment games begin with describing a self-fulfilling crisis in the first country. The crisis occurs due to the condition that expected returns of holding an investment until maturity depend positively on the fraction of other agents doing the same, whereas an early withdrawal generates a lower but certain payoff. If everyone expects everyone else to withdraw early, the crisis fulfills itself. Private information is introduced into this setting to be able to determine a unique threshold equilibrium dividing the fundamentals into ranges where the attack versus the non-attack equilibrium exist. In turn, the crisis in the first country influences the behavior of agents in such way that a self-fulfilling crisis in the second country becomes more probable. Goldstein and Pauzner (2004) show that investors become more risk averse in country two, because they lose part

[33] See Levchenko and Mauro (2006).

[34] See Caprio and Klingebiel (2002) for a comprehensive overview of banking crises. Even in this comprehensive and elaborate data set on banking crises, the authors refrain from stating exact crises months.

[35] The portfolio optimization literature originates from Markowitz (1959). The investment games literature is based on Diamond and Dybvig (1983).

[36] Prominent literature on portfolio optimization are, for example, Kodres and Pritsker (2002), Calvo and Mendoza (2000), and Broner et al. (2006).

of their wealth in the first country.

Both approaches of modeling generate valuable insights into how contagion functions and, hence, also into preventative policies . These policy implications will be explained in the next subsection.

The present analysis builds upon sequential coordination games. This choice stems from my interest in uncertainty about the fundamentals. The sequence of investment games is an optimal setting to introduce private information about the fundamentals and to analyze the effect of dispersion of private information on the vulnerability of a country to contagion.

1.3.3 Contagion Channels

The literature on contagion arrays a variety of explanations on how a crisis in one country can spread to other countries. Following Hernandez and Valdes (2001) and Dornbusch, Claessens, and Park (1999), this overview distinguishes three different explanations: macroeconomic similarities, trade effects, and financial linkages.

The first part of literature has identified **macroeconomic similarities** as main source of contagion. In these models, contagion either occurs because countries with bad fundamentals are subject to common negative shocks (e.g., a rise in US interest rates) or because investors treat all countries that "look alike" equally. This behavior of investors can be explained by incomplete information. Hence, if a country is hit by a crisis, information spill-overs materialize against countries in similar situations. The crisis in the first country serves as a *wake-up call* according to this view.[37]

Sachs, Tornell, and Velasco (1996) have analyzed the effect of macroeconomic similarities empirically. They identify the characteristics of countries performing worse after the Mexican crisis in 1994-95. They find that both the initial real exchange rate overvaluation and excess bank credit creation contribute largely to the after-crisis cross country performance. These results suggest that contagion is driven by initial macroeconomic fundamentals. In terms of policy implications, this means that the best way of avoiding contagion is for a country to improve on its macroeconomic fundamentals.

The second part of the literature has identified **trade linkages** as main

[37]This idea has been put forward by Goldstein (1998).

source of contagion. Direct trade linkages and trade competition have been analyzed in this context. Trade competition leads to a transmission of crises through a competitive devaluation: If a trading partner or competitor experiences a strong devaluation, the government may also devalue in order to stay competitive. Investors foreseeing this step cut demand for the second country's assets, thereby triggering a crisis, followed by a devaluation, and therein validating their own expectations. This indirect channel is particularly relevant in the spread of currency crises.[38]

Eichengreen et al. (1996) analyze contagion of currency crises in a group of 20 OECD countries. They define contagion as an increase in the likelihood of a crisis in a particular country, given a crisis in another country. They conclude that trade linkages play a more relevant role in explaining contagion than do macroeconomic similarities. In line with Sachs et al. (1996), Glick and Rose (1999) try to explain cross-country performance after particular crises. The authors find that trade linkages are more relevant than macroeconomic characteristics. If the trade channel is the most relevant in transmitting crises, the best policy for a country to avoid contagion is to diversify its trade across trading partners and sectors.

The third part of literature has identified **financial linkages** as main drivers of contagion. Apart from direct links through cross-country investments, the financial linkages occur due to common creditors. Because the most recent empirical literature supports the view that common creditors are the most relevant driver of contagion, a number of theories have been developed to explain the exact mechanism of the spread of crises through common creditors. These mechanisms are explained in the next section.

The empirical literature supporting the importance of common creditors as contagion channel started with Kaminsky and Reinhart (2000). The authors follow a similar strategy as Eichengreen et al. (1996) but use a larger sample of countries and a different crisis criterion. They analyze the effect of crises in alternative clusters of countries on the likelihood of a crisis occurring in countries of that same cluster. They conclude that financial links are potentially the more important transmission mechanism. However, the confinement is the high correlation between trade and financial links which makes an ultimate distinction difficult. Van Rijckeghem and Weder (2001) incorporate a measure of competition for bank funding between potentially-affected countries and the

[38]See Gerlach and Smets (1996) for a model of contagion through trade linkages.

initial-crisis country as explanatory variable for the probability of a crisis in a potentially-affected country. They find that competition for bank lending is a more robust indicator for incidences of contagion than trade linkages and countries' macroeconomic characteristics. Caramazza, Ricci, and R. (2004) analyze the contagion of currency crises in a panel probit analysis with 41 emerging economies. Controlling for the role of domestic and external fundamentals, trade spill-overs, and financial weaknesses, they find a strong effect of financial linkages to the initial-crisis country. Financial linkages are defined according to the same measure of competition for bank funding as in Van Rijckeghem and Weder (2001). Hernandez and Valdes (2001) show empirically the importance of financial linkages for contagion of stock market crises.

The policy implications from the common creditor channel largely depend on the exact mechanism through which the crisis is spread. Therefore, I mention them in the next section.

1.3.4 Contagion through Common Creditors

Based on the insight into the role of common investors, the theoretical literature suggests different transmission mechanisms. The most relevant are the following five: transmission of crises through financial market practices, information asymmetries, changes in risk aversion, wealth effects, and information revelation.

The transmission mechanisms based on **financial market practices** address optimization behavior of financial investors. A prominent example of this thread of literature is Calvo and Mendoza (2000). The authors show contagion as a result of the interaction between short-selling constraints, fixed costs of information acquisition, and fund managers' performance schemes. Contagion is defined as a situation in which utility-maximizing investors choose not to pay for information relevant for their portfolio decision or in which investors optimally choose to mimic arbitrary "market" portfolios. The investors become susceptible to country-specific rumors because of their lack of information. In their model of mean-variance portfolio optimization, the portfolio manager's performance is measured relative to a market portfolio. Assuming further that the marginal cost of yielding a below market return exceeds the marginal gain, in the opposite case, it can become a rational decision to mimic the market portfolio. If a rumor sets the return of a specific country to be lower than the

market portfolio, then investors might simply follow the herd.

Disyatat and Gelos (2001) empirically validate the theoretical findings by Calvo and Mendoza (2000). They show that the asset allocation of emerging market funds can be well approximated by short-sell constraints and mean variance optimization around benchmark indices.

The policy implication from these studies is the necessity to reassess the utility from short-selling constraints in the presence of fixed costs of information acquisition and the regulations regarding average returns for institutional investors.

Another article addressing contagion through financial market practices is Schinasi and Smith (2000). The authors focus on the rebalancing of portfolios within a mean variance or a value at risk (VaR) framework. In the case that the investment position of the portfolio is partly financed by debt, i.e., is leveraged, the loss in one high-risk asset can lead to a withdrawal from other high-risk assets. To reestablish the optimal portfolio weight after the loss in one high-risk asset, market participants shift from the low-risk to the high-risk asset. However, in the case of a leveraged position, the low-risk asset is a negative position. Hence, less leverage also implies less investment into the high-risk asset.

The transmission of stock market crises through **information asymmetries** has been prominently analyzed by Kodres and Pritsker (2002). In their model, differently informed market participants transmit idiosyncratic shocks across countries by optimally rebalancing their portfolios' exposure to macroeconomic risks. Contagion is defined as a price movement in a market not initially hit by the shock. The transmission of shocks is induced by rational investors who are differently informed. Price movements in the second market are exaggerated because order flows by the informed investors are misinterpreted as information-based by the uninformed investors. In terms of policy implications, Kodres and Pritsker (2002) suggest removal of informational asymmetries to diminish vulnerability to contagion.

The transmission of stock market crises through an **increase in investors risk aversion** has been analyzed by Broner et al. (2006). In a mean-variance optimization setup, the authors illustrate the effect of increased risk aversion of investors who performed relatively badly due to overexposure to a crisis country. In this setup, investors hold different portfolios due to heterogenous beliefs about expected dividends. Investor utility is a function of their own

wealth and their relative wealth to other investors, which depends on their relative performance. If an investor is overly optimistic with respect to a specific country and then under-performs there, his risk aversion increases and he will rebalance his portfolio towards the average portfolio. To do this, he withdraws from all other countries in which he was formerly overexposed. This leads to the crisis being transmitted between countries that share overexposed investors. The model is convincing and in line with empirical observations. However, the increase in the risk aversion is not explicitly modeled.

In the empirical part of the paper, the authors examine the effect of gains and losses on investor behavior in terms of portfolio choices. The authors focus on the Thai (1997), the Russian (1998), and the Brazilian (1999) crises. They show that under-performing funds do adjust portfolios in direction of the average portfolio. The presence of overexposed investors, measured by a time-varying index of financial interdependence, helps explain stock market co-movements across emerging markets above and beyond trade linkages. Also important is a negative correlation between countries' stock market performance during crises and the degree to which these countries shared overexposed funds with the original crisis country.

The analysis by Broner et al. (2006) generates an interesting policy implication. Apart from the sound analysis of the fundamentals of an economy, the authors suggest close monitoring of the micro-composition of investment positions across investment funds to detect dangers early.

A number of papers have analyzed the transmission of crises through a **wealth effect**. Prominent examples are Goldstein and Pauzner (2004), Kyle and Xiong (2001), and Yuan (2004). Goldstein and Pauzner (2004) model a sequence of self-fulfilling roll-over crises (in the sense of Diamond and Dybvig (1983)) in two countries that have independent fundamentals but are linked through common investors. The transmission functions as follows: First, a self-fulfilling roll-over crisis happens in the initial-crisis country. In this crisis, some investors loose wealth. Investors' utility function displays decreasing absolute risk aversion, which implies that investors became more risk-averse after the loss of wealth. Withdrawing early in any country is the safe action, whereas holding the investment until maturity is risky. In the latter case, the return depends on the fundamentals and the action of agents. As a result, agents in the second country will coordinate on maintaining their investments over a smaller range of fundamentals. Hence, a crisis there becomes more likely, i.e.,

there is contagion. This generates a positive correlation between the returns on investments in the two countries, reducing the benefits of diversification.

Goldstein and Pauzner (2004) deliver ambiguous policy implications. Depending on the welfare implications of portfolio diversification, on the one extreme, introducing capital controls can help the situation (when partial diversification generates a higher welfare than full diversification). On the other extreme, subsidizing diversification is the better move (when partial diversification generates a lower welfare than full diversification). A shortcoming of this approach is that determining which of the scenarios is closer to the real world is not possible.

One example of the transmission of currency crises through the **revelation of information** in the initial crisis is the model by Taketa (2004). The author models crises of speculative attacks a la Morris and Shin (1998) in two countries having independent fundamentals but being linked through common investors. In the model, two types of investors are characterized by different costs of attacking the currency. The investor type is private information. If a crisis reveals other investors' types, this case will lead each investor to update his beliefs and thereby change his optimal behavior, which can lead to a crisis in another unrelated country. Namely, if the fundamentals in the country of the original crisis country were good, the occurrence reveals the presence of many investors with low costs of attacking. Hence, the crisis makes investors revise their beliefs, leading them to attack the second country already in better state of fundamentals than without the crisis in the first country. This implies that crises can be the more contagious the better the fundamentals of the crisis country are.

Although this literature has generated a good understanding of the mechanisms through which financial crises spread and many plausible and helpful policy implications, analysis of uncertainty about the fundamentals is missing. Additionally, in terms of the empirical analysis, the main channels have been tested, i.e., whether it is macroeconomic similarities, trade linkages, or financial linkages that are at the core of contagion. However, only few studies take on a specific mechanism.

1.3.5 Contribution of this Study

The contribution of this study to contagion literature is the illustration of an additional mechanism through which financial crises spread in a simple model. The idea that the dispersion of private signals in potentially-affected countries increases after a surprise crisis in an initial-crisis country and decreases after an anticipated crisis has not been modeled so far.

The focus of chapter 3 is on the empirical analysis. The present analysis contributes to the empirical contagion literature by examining one additional mechanism through which a stock market crisis can spread.

Additionally, the construction of a rich, monthly data set, spanning from beginning of 1993 until the end of 2005, allows for improvement on the existing literature. Firstly, the long time span and cross-sectional dimension allows for covering the crises in Thailand (1997), Russia (1998), Brazil (1999), Turkey (2001), and Argentina (2001). Most of the above mentioned papers work with a collection of only three of these crises. Secondly, this study controls for a large range of alternative contagion channels adapting the existing measures of linkages to the specific needs in the context of the spread of stock market crises.[39]

1.4 The Effect of uncertainty about the fundamentals

The effect of uncertainty about the fundamentals in the context of financial crises is interesting from two perspectives. From one vantage, observers can study how far uncertainty is a factor in explaining the occurrence of a crisis within a country. From another vantage, observers can examine which role uncertainty about the fundamentals plays in the transmission of financial crises across countries. A first brief section explains the concept of uncertainty used in this study while the two subsequent sections mirror these two perspectives. The first subsection clarifies the concept of uncertainty, while the second subsection reviews the literature on the effect of uncertainty on the occurrence of financial crises. Finally, the third subsection reviews the literature on the

[39]For example, Broner et al. (2006) among others use the exact same measures of common creditors to control for this channel as other authors use for currency crises, thereby underestimating the real effect of those alternative channels.

effect of uncertainty on the spread of crises. This entire section is brief, because many of the relevant papers have already been reviewed in the sections on financial crises and on the spread of crises and, therefore, are not repeated here.

1.4.1 The Concept of Uncertainty

The term *uncertainty* in the present study refers to the **uncertainty about the fundamentals**, which is relevant in the literature of global games. Global games are coordination games, in which the fundamentals and the information that agents in the model receive about the fundamentals are random variables with specific distributions. Following, for example, Morris and Shin (1998), Heinemann and Illing (2002), or Prati and Sbracia (2002), this study defines uncertainty about the fundamentals as the dispersion of private signals around the true value of the fundamentals. In models using global game theory, a crucial assumption is that the true value of the fundamentals is not observable by agents and that, therefore, its realization is not part of the common knowledge of the game. Instead, each agent in the game receives a private signal about this true value of the fundamentals. The dispersion or the noise of the private signals around the true value of the fundamentals is called uncertainty about the fundamentals. An increase in the dispersion of private signals is equal to a decrease in the precision of private signals. In this study, uncertainty about the fundamentals is interpreted as the dispersion of the agents' private opinions or agents' disagreement about the state of the economic fundamentals. In chapter 2, these economic fundamentals refer to the level of government debt, while in chapter 3 to the investment environment.

Achieving clarity in this study requires distinguishing the concept of uncertainty about the fundamentals from related concepts. As stated in Heinemann and Illing (2002), in general, economists identify two kinds of uncertainty: uncertainty about the fundamentals of the economy and **strategic uncertainty**. Strategic uncertainty refers to uncertainty about the behavior of other agents. While these concepts are closely related, the present study focuses on the uncertainty about the fundamentals.

A concept closely linked to uncertainty about the fundamentals is **transparency**. Transparency refers to the precision and timeliness of information

disclosure by public authorities.[40] In most analyses transparency is modeled such that, in all states, increased transparency reduces the dispersion of private signals around the true value of the fundamentals.[41]

A number of papers assume that, in addition to private signals about the fundamentals, **public signals** exist.[42] Public signals are not equal to information disseminated by public authorities but are signals observed by all agents in the model in exactly the same way (they are therefore common knowledge). Public signals represent the true value of the fundamentals plus a noise term. In this study, public signals are abstracted from, following the argument that private interpretation of available information ultimately determines the actions of investors.

Moreover, readers should distinguish uncertainty about the fundamentals referred to in this study from **volatility** over time, which is partly subsumed under the notion of uncertainty.[43]

1.4.2 Uncertainty, Crises and their Spread

Carlsson and van Damme (1993) developed the theory of global games by first introducing private, noisy information into the setup of a coordination game on investment. This type of model is a natural framework for studying the role of uncertainty in the occurrence of financial crises because global game models allow consideration of the effect of changes in the precision of private and public information on the likelihood of a crisis. Morris and Shin (2003) provide a concise summary of the global games approach.

This approach has been applied to various setups of crisis models. The particular appeal here is the following: Applying the global games approach to models characterized by a multiplicity of equilibria under complete information serves as an equilibrium selection mechanism; under certain assumptions, the approach allows removal of the indeterminacy of equilibria completely.

[40] See Morris and Shin (2004) for this definition.

[41] See, for example, Cukiermann and Meltzer (1986) or Heinemann and Illing (2002).

[42] See, for example, Metz (2002).

[43] See, for example, Mondria (2006b) for a paper closely linked to this study but, among other differences, uses this different notion of uncertainty. Additionally, much of the finance literature, for example, uses macroeconomic uncertainty as a synonym for macroeconomic volatility, a time series based concept. In this context, only recently has the value of survey data been discovered. See, for example, Giordani and Soederlind (2003) or Arnold and Vrugt (2006).

Additionally, models using the global games approach combine features of first and second generation models. The equilibrium outcomes result from of the interaction of levels of the fundamentals and the behavior of agents. Agent-behavior, in turn, is a function of the expectations of the agents regarding the fundamentals and the actions of all other agents. In this sense, these models of crises are both belief- and fundamental-driven at the same time. They belong to the third generation of crises models. This study benefits especially from the global games approach, allowing the study of the likelihood of a crisis as a function of the precision of private signals. Recall that the purpose of this study is the evaluation of the effect of uncertainty on the occurrence and the spread of financial crises from a theoretical and an empirical angle.

Theoretical Analyses of Uncertainty

The literature of crisis models applying the global games approach to a setup where initially multiple equilibria exist is large. This literature starts with Morris and Shin (1998) who model the occurrence of a currency crisis induced by a speculative attack. They assume uniformly distributed fundamentals and uniformly distributed private signals. Finding a unique threshold equilibrium in terms of the fundamentals, the authors can conduct a comparative static analysis with respect to the parameters in the model. They show that for small enough noise of private signals, an increase in transaction costs renders a currency crisis less probable. Additionally, they show that a higher aggregate wealth of investors, or simply a higher number of investors, increases the probability of a crisis. However, the authors stop short of analyzing the effect of uncertainty, despite providing interesting policy implications with regard to the imposition of transaction costs and capital controls.

Heinemann and Illing (2002) provide a good analysis of the uncertainty effect in the Morris and Shin (1998) setup. The authors find that a higher precision of the private signals around the true value of the fundamentals reduces the likelihood of a speculative attack. In their model, higher transparency leads to a higher precision of private signals. Hence, the policy implication of their paper is that governments should provide the best possible private information but avoid common knowledge in the effort to reduce the risk of currency crises.

Morris and Shin (2004) apply the global games approach to a model similar to the Diamond and Dybvig (1983) bank-run model. Assuming normally distributed fundamentals and private signals, they find that greater precision of information does not always mitigate the coordination problem.[44] Extending the model used by Morris and Shin (2004), Metz (2002) analyzes the effect of changes in the noisiness of private and public information on the occurrence of a currency crisis. She finds that an increase in dispersion of private signals increases the probability of a currency crisis if the fundamentals of the economy are sufficiently bad. In this range of fundamentals, an increase of the dispersion of public information would generate the opposite effect because then public information serves investors less as a coordination device. The additional policy implication from this paper is that policy makers must consider that information disseminated to all agents not only affects the outcome through content but also by functioning as a coordination device.

Papers on the spread of crises, using either the global games approach or being important for this study because they are linked to uncertainty, have already been reviewed in section 1.3.1. These are Goldstein and Pauzner (2004), Taketa (2004), and Mondria (2006a). Global games papers exist on the spread of banking crises, as for example Dasgupta (2004). However, discussion of these papers is left to studies dealing with the spread of banking crises.

Empirical Analyses of Uncertainty

Only a few empirical papers explore the effect of uncertainty on the occurrence of crises. The existing studies examine the effect of uncertainty on the occurrence of currency crises. Prati and Sbracia (2002) analyze the effect of uncertainty on the occurrence of speculative currency crises in the presence of public and private information about the fundamentals. Bannier (2006) interprets the Mexican crisis as a currency crisis, analyzing the effect of uncertainty in this context. Both these analyses are based on the theoretical model in Metz (2002) and assume the presence of public and private information.

Prati and Sbracia (2002) use dispersion of GDP growth forecasts as a measure combining the effects of public and private signal precision. In their analysis of seemingly unrelated regressions (SUR) for six Asian countries with

[44] In this informational setup, the variance of private signals has to be small enough relative to the variance of the fundamentals in order to be able to find a unique equilibrium.

a monthly data set from 1995 to 2001, they find that dispersion of GDP growth forecasts has a significant and independent effect from the level of mean GDP expectations on the exchange rate pressure index. They find a higher dispersion of GDP growth forecasts increasing exchange rate pressures when expected GDP growth is above an estimated country-specific threshold, and forecasts reducing exchange rate pressure when expected GDP growth is below the threshold.

Some doubts about generality, however, remain about these studies. Questions on Prati and Sbracia (2002) cluster around the small sample of countries, application of time series estimations to testing a static global game model, and finally, estimation of the threshold level to distinguish good from bad fundamentals within the main estimation equation. Using the same estimation method Bannier (2006) is subject to the same criticism.

Tillmann (2004) analyzes the effect of uncertainty on the occurrence of currency crises in a Markov-switching framework for the French franc and the Italian lira in 1992. In a framework assuming private information only, he finds that an increase in the dispersion of private signals renders a speculative attack more likely. The measure of uncertainty in his analysis consists of country fund discounts. This is the difference between the price of closed-end country funds and their underlying net asset value. The results support the theoretical predictions of Heinemann and Illing (2002), thus enforcing the policy implications of that paper. One drawback of this analysis is, however, again, that time series techniques are applied to test a static model.

Based on a model of portfolio optimization, Gelos and Wei (2005) analyze the effect of different measures of transparency on portfolio holdings. The authors conduct a convincing analysis of the country weights of 137 investment funds over a time period from January 1996 until December 2000. They show that both government and corporate transparency have separate and distinct positive effects on investment flows from international funds into a particular country. Additionally, they show that during the Thai and the Russian crises capital flight is greater in the less transparent countries. Hence, as a policy implication the authors suggest that becoming more transparent is an effective strategy for countries to benefit from international integration, thereby avoiding increased volatility.

While including public information in the setup of a global game appears interesting from a theoretical perspective, keeping track of the empirical rele-

vance renders this concept much less attractive.

Firstly, conveying the meaning of public information is difficult, in particular if admitting the existence of private information. How does information emerge that is understood in exactly the same way by all agents of the model (i.e., information that is common knowledge)? In particular, in the context of information provided by public authorities, how achievable is a situation in which all agents understand an announcement in exactly the same way?

Secondly, from a practical view point, available data does not allow for a reliable distinction between private and public information.

And thirdly, apart from Prati and Sbracia (2002) and Bannier (2006), first empirical analyses on the effect of uncertainty in the context of financial crises appear to tend towards a clear-cut effect. This finding seems to contradict the predictions of a global games setting with public and private information, where direction of the effect also depend on the level of the fundamentals.

Summing up, these criticisms appear to favor an analysis abstracting from public information as is done in this study.

To my best knowledge, chapter 3 of this study is the first analysis to test the effect of uncertainty about the fundamentals on the spread of financial crises.

1.4.3 Contribution of this Study

The theoretical model in chapter 2 of this study is the first analysis that applies the global games approach to the question of sudden stops of capital flows. Much of the literature on global games focuses on currency crisis models a la Morris and Shin (1998) or on bank-run models of the Diamond and Dybvig (1983) type. From a theoretical viewpoint, the fact that the strategic complementarity enters into the model through the shared tax burden is interesting. Additionally, the multiplicative payoff function is interesting.

The empirical part of chapter 2 contributes to the empirical literature on the effect of uncertainty on the occurrence of crises by analyzing the effect of a different type of crisis. The analysis in this study is more rigorous than the existing literature due to a larger data set. This large data set makes the exploitation of the cross-sectional dimension of the data possible, which is more consistent with a static model than the time series analyses mostly done

in the literature.

While the idea of an uncertainty channel of contagion is new, the model in chapter 3 rather serves illustrative purposes. The focus is on the empirical part. Again, here, chapter 3 of this study explores a new effect of uncertainty. Especially, this study accomplishes a rigorous empirical analysis of the existence and the relevance of the effect of uncertainty on the spread of crises.

Chapter 2

Uncertainty About the Fundamentals and the Occurrence of Sudden Stops of Capital Flows: Theory and Empirics

2.1 Introduction

Most major financial crises involve a sudden stop of capital inflows.[1] Examples are the Latin American debt crises during the 1980s, the crisis experienced in South East Asia in 1997, and the Russian crisis in 1998.

Recall the example of the Tequila crisis hitting Mexico at the end of 1994 and the beginning of 1995. During this crisis net private capital flows fell by almost 4 percent relative to GDP in 1994 and a drop of more than 5 percent in 1995.[2] The sudden stop was followed by further financial turmoil and severe consequences in the real economy.

This chapter contributes to the discussion about causes and prevention of sudden stops in two ways. The first contribution is a model that explains how

[1]For a list of headline financial crises, see Table 2.12 in Appendix 2.10. These financial crisis incidents were so severe that they were in the newspaper headlines around the world and are remembered by most for the associated financial turmoil.

[2]These percentages correspond to a drop in capital flows of 15.5 billion current US dollars in 1994 and further 15.2 billion in 1995 in absolute values.

private investors' uncertainty about the fundamentals increases the probability of a sudden stop. Uncertainty is interpreted as the disagreement between the private investors about the quality of the fundamentals.[3] The second contribution of this chapter is to test the predictions of the theoretical model empirically.

The current theoretical and empirical literature on sudden stops ignores the effect of uncertainty about the fundamentals, leaving room for a contribution. It is surprising that the uncertainty about the fundamentals has not been analyzed in the context of sudden stops of capital flows. In most models, investors are assumed to take their investment decisions in a forward-looking manner. They are assumed to base their decisions on expectations about future returns, which in turn depend on other investor behavior and the future fundamentals in an economy.[4]

Whether uncertainty about the fundamentals has an effect on the occurrence of sudden stops of capital flows has important policy implications: If, for example, an increase in uncertainty about the fundamentals increases the probability of a sudden stop of capital flows, then an economy will be more vulnerable in times when uncertainty is higher. Hence, policy makers should take this fact into consideration. Additionally, to the extent that public authorities can influence the degree of investors' uncertainty about the fundamentals, policymakers should adjust their policies on information dissemination to reduce uncertainty.

The basic model is an extension of a model by Calvo (2003). As a first extension, I introduce infinitely many investors of mass one. Then, I set up a coordination game. In this basic model, investors maximize the value of their firm, which is the net present value of their after-tax returns net of investments. The government mechanically sets the tax rate that is necessary to cover the exogenously given amount of debt. However, the tax lowers the after-tax productivity of capital, which is the crucial variable in the investment decision of the investors.

For sufficiently low levels of debt, the government sets output taxes so low

[3]This interpretation is in line with the global games literature, reviewed in section 1.4.

[4]In the present model, sudden stops of capital flows are assumed to be unexpected to private investors. In this sense, investors are still not forward looking. Nevertheless, it can be shown that the results of the analysis also hold for an expected sudden stop, see Calvo (2003).

that investing is attractive. In this model, the level of investment directly determines the economic growth of the economy. Hence, a high level of investment induces high growth. On the other extreme, if the debt is high, only low growth can be observed due to the negative impact of the high taxes.

However, for intermediate levels of the government debt, the optimal action of a firm depends on the actions of the other firms. If a firm expects all other firms to invest, it is optimal for this firm to invest as well. This is due to the debt burden being shared by a large number of other firms. Hence the government can choose a low tax rate and the after-tax returns of the investing firms are high. Otherwise, if a firm expects that few other firms will invest, it is optimal for this firm to abstain from investing. Otherwise the firm will have to pay high taxes because the debt burden is shared by few investors. The strategic complementarity between investments that results from the tax burden being shared among investors explains a multiplicity of equilibria in the intermediate debt region. High (low) growth induces low (high) output taxes, which in turn generates high (low) economic growth.

A sudden stop occurs if growth discontinuously switches from high to low growth. With the help of the methodology of global games, it is possible to show that there is a threshold level of the government debt, below which everyone invests and above which no one does. Specifically, the assumption of private information on the level of debt allows for finding the unique threshold level. This assumption means that the true value of the government debt is no longer common knowledge but that every investor receives a private signal on the level of debt.[5]

This results in a new equilibrium condition, which permits the determination of a unique threshold in terms of the debt level: At the threshold signal, each investor is indifferent between investing and not investing. This is because at this level of debt the expected payoff of investing, given that each other investor invests weighted with the conditional probability that each other investor receives a better signal and hence invests, equals the expected loss of an investment in the case that each other investor does not invest weighted with the conditional probability of this event. The probabilities are conditional on the private signal that the investor receives about the value of the debt.

[5]It is a plausible assumption that investors interpret published information about the state of the fundamentals differently. In the current model, it is assumed that government debt and private signals are uniformly distributed.

Due to the monotonicity of the payoff function in the private signal, clearly, each investor invests if he receives a smaller signal than the threshold signal and does not invest above. Hence, above the threshold, the economy drops to the low growth equilibrium due to a lack of investment, although the state of the fundamentals would still support the high growth equilibrium. The reason for the switch is a coordination failure between private investors.

Analyzing the threshold equilibrium yields a set of interesting comparative static results. In the present setup, the change in the value of the threshold translates into a change in the probability of a sudden stop crisis. The first result is that the probability of a sudden stop increases with the dispersion of the private signals on fiscal burden. The second result is that the crisis probability decreases with the parameter of technological progress. This parameter can also be understood as an indication of how safe an investment is. The third result is that the probability of sudden stops increases with the international interest rate. Finally, the fourth result is that technological progress and international interest rate influence the scope of government policies.

The policy implications of these findings on sudden stop conditions are that governments should take uncertainty about the fundamentals into account because the uncertainty condition has real effects. Two kinds of advice can be given to governments based on this study. First, governments should help private investors obtain precise private information on the fundamentals. A government could achieve this by allowing unrestricted access to government data for independent institutions. These institutions could then sell the data to other market participants. One could argue that it would not make a difference if the government itself sold this information. However, a government could have incentives to understate the true value of the debt and then ask for higher taxes ex post. This credibility problem could be alleviated with the help of an independent institution. As a second policy advice, the results of the study suggest that governments should care for investment safety in their country and foster technological progress.

How relevant are the described effects in reality? Do the model and policy prescriptions apply to real sudden stop cases? Answering these questions requires empirical verification of technological progress, the international interest rate, and most importantly, uncertainty about the fundamentals influencing the probability of a sudden stop.

Three hypotheses can be derived from the theoretical model. They build

the basis for the empirical analysis. The first hypothesis is that sudden stops are less likely if internal factors of an emerging market country become more favorable, e.g., if the government adopts technology-enhancing policies or takes measures to ensure investment safety. The second hypothesis is that more sudden stops occur if the international interest rate increases. The third hypothesis is that a sudden stop is more likely to occur with more uncertainty on a government's fiscal policy (less precise private information).

Take the third hypothesis. In the empirical analysis, I focus on the effect of uncertainty on the probability of a sudden stop. The dependent variable in the regressions is a dummy variable that takes a value of one in a sudden stop period and of zero otherwise. In line with Calvo et al. (2004), Cavallo and Frankel (2004), and Eichengreen, Gupta, and Mody (2006), I identify sudden stops of capital flows by considering both the first and the second moments of a measure of capital flows. Provided that in a particular period the capital flows drop as low as two standard deviations below the sample mean, a sudden stop crisis period starts when the flows drop lower than one standard deviation below the sample mean. For symmetry, the crisis period stops when the flows exceed this limit again. The most important explanatory variable in the analysis is a measure of uncertainty about the fundamentals: the variance of investor' expectations about the fundamentals. The base data are expectations about GDP growth of the current and following year. These data are collected by Consensus Economics and the IFO Institute for Economic Research. I select these growth forecasts because they are available for a sufficiently large sample of countries.

As a benchmark regression, I use a pooled probit estimation controlling for country and time fixed effects. The data set contains 31 developing and developed countries. The sample size is dictated by data availability. The analyzed period extends from 1990 to 2001, including yearly and monthly data.

The search for determinants of a sudden stop quickly leads to a problem of potentially omitted variables and endogeneity. To tackle these difficulties, I run various robustness checks. Specifically, to address the first problem of omitted variables, I include a large variety of control variables. To address the endogeneity problem, I estimate the model with an increasing order of lags of the explanatory variables. Additionally, I employ two-step estimation where I instrument the uncertainty in the current period with its own lag.

Furthermore, I check the robustness of my results by conducting the analysis for the full sample and an emerging market sample by making use of a yearly and a monthly data set and by using various different estimation methods. The positive effect of the uncertainty on the occurrence of a sudden stop is robust across these tests.

Calculating the marginal effects of a one unit increase in uncertainty suggests that an increase of the uncertainty by one standard deviation increases the crisis probability by up to nine percent.[6] These results, indeed, suggest that the uncertainty about the fundamentals has a non-negligible effect on the probability of a sudden stop in reality and should thus be incorporated in the considerations on economic policies.

This study is connected to the following threads of economic literature. Calvo et al. (2004) analyze drivers of sudden stops, finding that the vulnerability to real exchange rate fluctuations and domestic liability dollarization increase the probability of a crisis. Edwards (2005) focuses on capital mobility and disputes its link to increased crisis probability. Furthermore, the question whether internal or external (global) factors drive capital flows into and out of emerging markets has been extensively studied. Calvo et al. (1993), Calvo, Leiderman, and Reinhart (1996), Fernandez-Arias (1996), and Montiel and Reinhart (1999) examine internal factors such as, for example, the price of debt on the secondary market, country credit ratings, and the domestic rate of inflation versus external ones such as the interest rates and the economic activity in highly developed countries. These analyses attribute a higher importance to external factors. In the more recent literature with a focus on FDI (foreign direct investment), Albuquerque et al. (2005) find that the most important driver of capital flows is a synthetic global factor, which they interpret as a globalization measure. Broner and Rigobon (2005) detect regional patterns in capital flows and emphasize the role of contagion in determining capital movements to a country.

However, the literature ignores the effect of uncertainty about the fundamentals on the occurrence of sudden stops. The issue has been addressed so far only in the context of currency crises. Prati and Sbracia (2002) analyze the effect of uncertainty on the occurrence of a currency crisis. With their seemingly unrelated time series regressions (SUR) for six Asian economies, they show that higher dispersion of GDP growth forecasts (their proxy for the

[6] See Table 2.8 in section 2.7.2.

fundamentals) tends to have an additional independent effect apart from the effect exercised by the lagged level of the fundamentals.

The analysis by Prati and Sbracia (2002) suffers from two shortcomings. The first shortcoming is its application to a small sample of countries all affected by the East Asian financial crisis in 1997-98. Second, given that Prati and Sbracia (2002) model a static global game, an analysis emphasizing the cross sectional variation between countries seems more appropriate than the time series analysis conducted. To overcome these shortcomings in the present analysis, I work with a much larger set of countries, emphasizing the cross-sectional variation between countries by estimating pooled probit regressions controlling for time effects.

2.2 Theoretical Background

This section presents a coordination game model on the occurrence of sudden stops. The model is based on the framework presented in Calvo (1998b) and Calvo (2003). I extend the original Calvo setup by introducing a continuum of infinitely many identical firms of mass one. In a first step, I set up a coordination game with common knowledge. In a second step, in section 2.4 I extend the setup further by introducing private signals on the fundamentals.

2.2.1 The Firms

Following Calvo (1998b) and Calvo (2003), each of the infinitely many firms produces tradable output with a linear homogeneous production function, in which tradable capital is the only production factor. Capital is fully internationally mobile ex ante but immobile after investment.

The firms maximize their value by choosing between constant growth paths. The value of a firm is defined as the sum of discounted future cash flows until infinity. Due to the linear production function, the rate of investment or capital accumulation equals the rate of output growth. In their optimization, firms consider the technology parameter, the tax rate, and the international interest rate as given. Thereby, the following representation of the value of a firm i

can be found.[7]

$$V^i = \frac{\alpha(1-\tau) - z^i}{(r - z^i)} \tag{2.1}$$

V^i represents the firm value, α is the productivity factor, τ is the constant output tax rate, z^i is the investment rate that the firm can choose. r represents the constant international interest rate. Optimizing the value of the firm with respect to the rate of investment or capital accumulation leads to:

$$\frac{\partial V^i}{\partial z^i} = \frac{\alpha(1-\tau) - r}{(r - z^i)^2}$$

The model delivers corner solutions. If the after-tax return on capital, $\alpha(1-\tau)$ exceeds the international interest rate r, it is optimal for a firm to invest as much as possible and thus grow as fast as possible. If the return on capital is lower than the interest rate, the firm does not accumulate capital at all. Such a firm would even borrow as much capital as possible and invest it abroad. For the model to deliver a sensible outcome, the parameter z^i must be restrained to finite 'corners'. Following Calvo (2003), the value of z^i is restricted to an interval $[0, \overline{z}]$ with $\overline{z} < r$, in which the lower bound ensures that capital cannot be unbolted. The upper bound stands for reasonable outcomes with respect to the valuation of the firms. In particular, as z^i signifies the constant growth path of the firm, by bounding it, I rule out the possibility that the firm can outgrow the world market in the infinite horizon.

A firm would never invest if this investment had a negative effect on the value of the firm. Hence, it suffices to consider the sign of the derivative of V^i with respect to z^i. If the sign is positive, the agent invests as much as possible (restricted to $\overline{z} < r$ in this model); if negative, investment equals zero.

$$\operatorname{sgn}\frac{\partial V^i}{\partial z^i} = \operatorname{sgn}[\alpha(1-\tau) - r] \tag{2.2}$$

[7]For a detailed derivation, please see Appendix 2.10. The firms expect the tax rate to be constant, because a sudden stop is unexpected to them. In the light of possible growth collapses and ensuing sudden stops, a different tax policy τ_t might be optimal for the government. Therefore, firms would expect the tax rate to change once a crisis occurs. Calvo (2003) shows that growth collapse and sudden stops also occur in the case when they are foreseen by the firm. Therefore, I do not consider the case of an anticipated crisis here.

2.2.2 The Government

The government inherits a stock of debt D, which must be financed by an output tax. The tax rate is set so that the future discounted tax revenues cover the amount of debt. This is possible, assuming full capital market access by the government.

$$D = \alpha\tau \int_0^\infty K_t^{econ} e^{-rt} dt = \frac{\alpha\tau}{r - z^{econ}} \tag{2.3}$$

with

$$z^{econ} = \frac{\int_0^1 \dot{K}^i di}{\int_0^1 K^i di} = \frac{\dot{K}^{econ}}{K^{econ}}$$

The superscript ^{econ} indicates that a variable refers to the economy and not to an individual i.

2.2.3 The Reduced Form Game Between Firms

The mechanical way in which the government sets the tax rate introduces strategic complementarity between the firms into the model. The profit of investment for an individual company positively depends on the rate of investment of all other firms. This can be shown by solving Equation (2.3) for τ and plugging it into Equation (2.2):

$$\text{sgn}\frac{\partial V^i}{\partial z^i} = \text{sgn}[\alpha - D(r - z^{econ}) - r] \tag{2.4}$$

The return on investment is a positive function of z^{econ}. This results from the burden of debt repayment being carried by more firms. Through the tax-setting mechanism, the investment decision of each firm depends negatively on the state of the fundamentals.

The main mechanism underlying the interaction of firms is therefore: If growth is high, the government sets a low tax rate, which in turn sustains high growth. Similarly, if growth is low, the government sets a high tax rate, holding firms off investing, which in turn further induces low growth.

2.3 The Common Knowledge Game

First, it is assumed that all the firms and the government know the true values of the relevant variables. Recalling that firms either do not invest or invest $\overline{z}$, a strategy π^i is defined as $\pi^i : [\breve{D}, \hat{D}] \rightarrow [0, 1]$, in which $\breve{D}$ is the lower and $\hat{D}$ is the upper bound of the support of the debt level. This means that firm i invests in state D with probability $\pi^i(D)$. Because of the mass of agents being 1, the fraction of agents that invest at a particular state of fundamentals can be expressed as $\pi^{-i}(D) = \int_0^1 \pi^j(D)dj$ for $j \neq i$. This makes it possible to express the investment rate of the economy as the product of upper limit of investment and the fraction of agents that invest in the economy.

$$z^{econ}(D) = \overline{z}\pi^{-i}(D) \tag{2.5}$$

2.3.1 High Growth and Low Growth Equilibrium

Equation (2.4) can be used to illustrate the parameter range for which the low growth and the high growth equilibrium exist. On the one hand, the low growth equilibrium can exist if a firm does not have an incentive to deviate from its strategy not to invest, given that all the other firms do not invest. This is the case if Equation (2.4) displays a negative value in the case that $z^{econ} = \overline{z} * 0 = 0$. Solving for the debt level yields that the low growth equilibrium exists in the case that the debt is higher than a threshold:

$$D > \underline{D} = \frac{\alpha - r}{r} \tag{2.6}$$

On the other hand, the high growth equilibrium exists if a firm does not have an incentive to deviate from the strategy to invest, given that the other firms do also invest. In terms of Equation (2.4), this means that the high growth equilibrium exists if the signum of the equation is positive for $z^{econ} = \overline{z} * 1 = \overline{z}$. Thereby one finds that the high growth equilibrium exists below a threshold:

$$D < \overline{D} = \frac{\alpha - r}{r - \overline{z}} \tag{2.7}$$

2.3.2 The Tripartite Classification of Fundamentals

The level of debt can be classified into three ranges. By definition $0 < \overline{z} < r$ and $\alpha > r$. Therefore, clearly, from the two equations in section 2.3.1 follows

that $\overline{D}$ is greater than $\underline{D}$. Between the two threshold values, $\overline{D}$ and $\underline{D}$, the two equilibria coexist. Above $\overline{D}$, only the low growth equilibrium exists, and below $\underline{D}$, only the high growth equilibrium exists.

If D is smaller than $\underline{D}$, there exists a dominance region of investment. Consequently, the economy will be in high growth equilibrium. If D lies between $\underline{D}$ and $\overline{D}$, it is not clear if firms can coordinate on the high growth equilibrium or if a coordination failure occurs and the economy is captured in the low growth equilibrium. If D exceeds $\overline{D}$, there is a dominance region of no investment and the economy displays low growth with certainty.[8] The tripartite classification of fundamentals is illustrated in Figure 2.1.

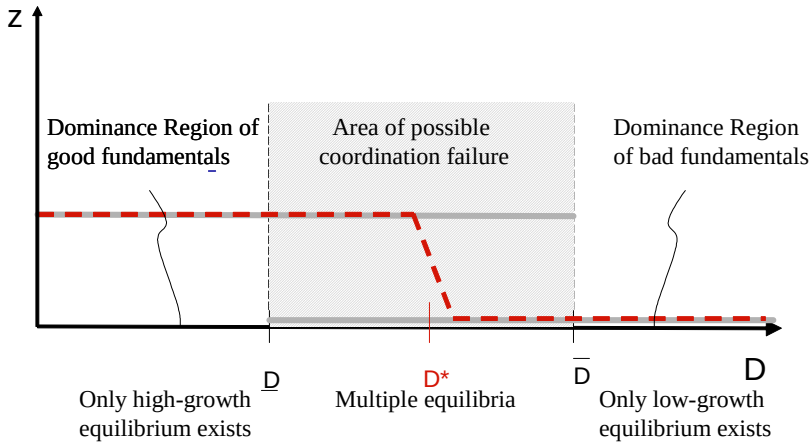

Figure 2.1: Model Setup

Figure 2.1 shows the existence of the high growth and the low growth equilibrium as a function of the government debt level. In case of common knowledge of the true value of government debt, the model displays indeterminacy between the high growth and the low growth equilibrium for those debt levels, where both equilibria coexist.

[8]The threshold cases, in which $D = \underline{D}$ and $D = \overline{D}$, are not of interest and will therefore not be discussed.

2.4 The Private Information Game

Introducing private, slightly noisy information on the state of the fundamentals makes eliminating the range of multiplicity between $\underline{D}$ and $\overline{D}$ possible. Instead, there is a threshold value of the debt level, below which all agents coordinate on the high growth equilibrium and above which no agent invests. The dotted line in Figure 2.1 represents the equilibrium that is realized in the private information game.

This section explains, first, the informational structure of the model with private information, second, the optimization of the firms, and third, the proof of uniqueness of the threshold equilibrium. The next section, then, shows how the threshold equilibrium is influenced by changes in the technology parameter, by changes in the international interest rate, and by changes in the precision of the private signal.

2.4.1 Informational Structure

The agents cannot observe the true debt value but receive noisy signals D^i on the state of the debt. The true debt level is uniformly distributed over the interval $[\breve{D}, \hat{D}]$. The signals are privately observable and uniformly distributed in an ϵ surrounding of the true debt value $D^i \sim U[D-\epsilon, D+\epsilon]$. The agents know the distribution and the support of D and of the private signals. All agents know that all other agents also receive private signals.

The fact that the signal on the state of the debt is private reflects that agents interpret officially announced values of the government debt differently. In addition, debt levels are often revised ex post by public authorities. This enforces the importance of the interpretation of information and justifies the signals on debt being private.

Deriving a unique equilibrium requires care that the signal is informative about the true level of debt. Otherwise, the agents would not have any idea about the true value of debt and about the possible signals that the other agents receive, given their own signal. As shown in Heinemann and Illing (2002), the distributional assumptions in the current setup ensure that this requirement is fulfilled.

2.4.2 Object of Optimization

The firms cannot observe the true value of D in the private information setup but only have an expectation about it, given the private signal that they receive.

Because a firm's expectations of D and of z^{econ} depend on the private signal, the firm has an expectation about the tax rate that the government will set, given its private signal:

$$E(\tau|D^i) = E\left(\frac{D(r - z^{econ})}{\alpha}|D^i\right) \tag{2.8}$$

Therefore, the expectation of the value of the firm depending on the level of investment can be expressed as:

$$E(V|D^i) = E\left(\frac{\alpha - D(r - z^{econ}) - z^i}{r - z^i}|D^i\right) \tag{2.9}$$

The optimizing behavior in the private information game is analogous to the behavior under common knowledge. Agents maximize the expected difference in payoffs resulting from alternative strategies: investing versus non-investing.[9] However, the expectations of an agent are now conditional on the signal that he receives. Each agent weighs the expected payoff of investing: for the case that each other agent invests and for the case that no one else invests, with the conditional probability given his private signal that the other agents choose the respective strategies, i.e., investing versus not investing.

Assuming private information, a firm's strategy is a function of the private signal instead of being a function of the true value of the fundamentals: $\pi^i(D^i) : [\breve{D}, \hat{D}] \rightarrow [0, 1]$. As shown before, the extreme strategies of maximum investment versus not investing at all dominate all intermediate strategies. Therefore, when calculating the payoff difference, comparing the expected payoffs of these two strategies suffices.

The investment rate of the economy can be expressed as the product of the maximum investment $\overline{z}$ times the fraction of other firms investing, which depends on their respective signals D^j:

$$z^{econ} = \overline{z}\pi^{-i}(D^j) = \overline{z}\int_0^1 \pi^j(D^j)dj \tag{2.10}$$

[9] In the following, this will simply be referred to as payoff difference. As in Doenges and Heinemann (2001), in the present model also, the payoff of the alternative action depends on the state of the fundamentals and is not fixed to a constant value.

The expected payoff difference $\widetilde{P}$, given the private signal D^i, is then

$$\widetilde{P}(D^i) = E\big(\frac{\alpha - D(r - \overline{z}\pi^{-i}(D^j)) - \overline{z}}{r - \overline{z}} - \frac{\alpha - D(r - \overline{z}\pi^{-i}(D^j)) - 0}{r - 0}|D^i\big)$$

In the case of unbiased signals around the true value, the expectation of the true value of a variable, given the private signal that individual firm i receives, is the signal itself: $E(D|D^i) = D^i$. Therefore, the above expression can be simplified to:

$$\widetilde{P}(D^i) = \overline{z}\frac{\alpha - r - rD^i + \overline{z}E(D\pi^{-i}(D^j)|D^i)}{(r - \overline{z})r} \tag{2.11}$$

2.4.3 Unique Equilibrium

This section shows the existence and the uniqueness of the equilibrium. The analysis proceeds in several steps. First, it is assumed that all agents follow a simple switching strategy. Second, the starting points for the iterative elimination of dominated strategies are determined. In this process, dominated strategies are excluded from the set of possible strategies until the unique threshold equilibrium is found. Third, the monotonicity of the expected payoff difference in the private signal is proved. Steps one through three enable the fourth step, the iterative elimination of dominated strategies beginning at borders of the dominance regions. Finally, in the fifth step, it is shown that there is only one unique value of the level of debt for which the payoff difference given the private signal equals zero. This level of debt is the threshold value below which all agents invest and above which, no one does.

In the first step it is assumed that each firm follows a simple switching I_T. This means that a firm invests with probability one, if and only if, the signal it receives is below a threshold T and abstains from investing with probability one, if the signal is above the threshold: [10]

$$I_T = \begin{cases} 1 & \text{if } D^i < T \\ 0 & \text{if } D^i \geq T \end{cases} \quad [11] \tag{2.12}$$

[10] By continuity arguments, it is possible to show that such a simple switching strategy is optimal. So generality is not lost when imposing it in the first place.

[11] In terms of the payoff, the behavior of the firms in a single event is irrelevant. Therefore, it is also irrelevant whether firms invest at $D_i = T$ or not.

At this point, assuming a simple switching strategy, the fraction of other agents investing can be expressed as the probability that one agent receives a smaller signal than the threshold signal.

Lemma 2.1 *Under the assumption that, in the game with infinitely many agents of mass one, all follow the same switching strategy I_T, the fraction of agents investing, $\pi^{-i}(D^j)$, can be replaced by the probability that one agent receives a signal smaller than the threshold signal T, prob$(D^j < T|D)$, in Equation (2.11).*

Proof. See Appendix 2.10. ∎

Given Lemma 2.1, the payoff difference can be expressed in the following way:[12]

$$\widetilde{P}(D^i, I_T) = \overline{z}\frac{\alpha - r - rD^i + \overline{z}E(D\text{prob}(D^j < T|D)|D^i)}{(r - \overline{z})r} \tag{2.13}$$

The second step is determining the starting points of the elimination of dominated strategies.

Lemma 2.2 *The starting points for the iterative elimination of dominated strategies are $\underline{D}$ and $\overline{D}$.*

Proof. See Appendix 2.10. ∎

The third step shows proof of the monotonicity of the payoff difference needed as one further ingredient to apply the iterative elimination of dominated strategies.

Lemma 2.3 *$\widetilde{P}(D^i, I_T)$ is strictly monotonically decreasing in the private signal D^i.*

Proof. See Appendix 2.10. ∎

Given Lemma 2.2 and Lemma 2.3, the lowest possible threshold for a switching strategy of all the firms is $\underline{D}$. Similarly, the highest possible threshold is $\overline{D}$. For all $D^i < \underline{D}$, the payoff difference is positive, irrespective of the

[12]This probability (and the fraction of firms investing) depends on the realization of D. Hence, given private information, firm i's expectation of the probability is a function of the realization of the private signal D^i.

actions of all other firms. As the rationality of the agents is common knowledge, not to invest is a dominated strategy for signals below $\underline{D}$. And, at the other extreme, for all signals $D^i > \overline{D}$ the payoff difference is negative.

Due to the strategic complementarity between investments, the worst scenario that a firm has to consider is the case where $I_T = I_{\underline{D}}$. This means that for all values of debt in the range of multiplicity, firms choose not to invest, although the levels of debt would in case of coordination on the high growth equilibrium also allow for this. The best scenario would be a switching strategy of $I_T = I_{\overline{D}}$.

Steps one through three provide all ingredients to begin the fourth step, which iteratively eliminates all dominated strategies. This process works as follows: If a firm i receives a signal that is very close to the border of the dominance region, the probability that other firms receive signals within the dominance region and thus have a dominant strategy is very high. Due to the strict monotonicity, this suffices to induce firm i to have a dominant strategy as well. This is true for all firms. Therefore, the range between the signal of firm i and the former border of the dominance region can be added to the dominance region. The iterative elimination starts at both borders of the multiplicity range. Starting at the low [high] end of the multiplicity range, the iterative process continues until finding the maximum [minimum] signal, at which firm i is indifferent between investing and not investing and which is at the same time the threshold of the switching strategy of all other firms.[13]

Milgrom and Roberts (1990) have shown that in all games with strategic complementarity, the set of strategies that resist the iterative elimination of dominated strategies is limited by Nash equilibria. Nash equilibria are not eliminated through this process. Thus $I_{\underline{D}^\star}$ and $I_{\overline{D}^\star}$ are the most extreme Nash equilibria of the game. There is no Nash equilibrium below $\underline{D}^\star$ in which the firms do not invest. On the other hand, there is also no Nash equilibrium above $\overline{D}^\star$ in which the firms invest.

Given this argument and due to the strict monotonicity of the payoff from Lemma 2.3, it suffices to show that equation

$$\widetilde{P}(D^i = D^\star) = \overline{z}\frac{\alpha - r - rD^\star + \overline{z}E(D\text{prob}(D^j < D^\star)|D^i = D^\star)}{(r - \overline{z})r} = 0 \quad (2.14)$$

[13]For a more formal consideration of the iterative elimination, please refer to Appendix 2.10.

has a unique solution. This can be expressed in the following Lemma.

Lemma 2.4 *There exists only one value, for which the expected payoff difference equals 0 given that firm i receives exactly the threshold signal $D^\star$ as private signal and given that all other firms have a switching strategy where the switching signal equals exactly $D^\star$.*

Proof. See Appendix 2.10. ∎

The unique solution is

$$D^\star = \frac{\alpha - r - \frac{\epsilon}{6}\overline{z}}{(r - \frac{1}{2}\overline{z})} \tag{2.15}$$

$D^\star$ determined by Equation (2.15) is the unique threshold equilibrium of the game with private information. This can be summarized in the following proposition:

Proposition 2.1 *There exists a unique threshold equilibrium $D^\star$ of the game with private information, such that each firm invests if and only if $D^i \leq D^\star$ and does not invest if $D^i > D^\star$.*

Applying the methodology of global games allows for elimination of the multiplicity range. This, in turn, allows the prediction of the levels of fundamentals, at which a growth collapse occurs. In the Calvo setup, a growth collapse automatically entails a sudden stop of capital flows. So the above analysis not only lays bare how the economy will plunge into a growth collapse but, at the same time, explains the onset of a sudden stop of capital flows. It is of interest to know how the change of economic variables alters the threshold and, thereby, the probability of a sudden stop.

2.5 Comparative Statics

This section analyzes how a change in the productivity of the country, a change in the international interest rate, and a change in the noise in the information on the debt influence the value of the threshold equilibrium at which the growth collapse and, therefore, the sudden stop take place.

2.5.1 Changes in the Technology Parameter α

First, consider the technology parameter, which in the model is equivalent to the productivity of capital.

Proposition 2.2 *If the technology parameter α increases, the threshold equilibrium is shifted to a higher debt level, i.e., a growth collapse and, therefore, a sudden stop occurs at higher debt levels only.*

Proof. Differentiating Equation (2.15) with respect to α delivers:

$$\frac{\partial D^\star}{\partial \alpha} = \frac{1}{(r - \frac{1}{2}\overline{z})} > 0 \tag{2.16}$$

The above expression must always be positive because $\overline{z} < r$. This implies that an increase in α shifts the threshold level to a higher debt level. ■

Considering the finite support of the distribution of the debt, Proposition 2.2 implies that the probability of a growth collapse decreases and with it the probability of a sudden stop. In Figure 2.2 this is mirrored by $D'^\star$ lying right of $D^\star$ with α' being bigger than α.

Another interesting result emerges when looking at the change of the borders of the multiplicity range with a change in the technology parameter.

Proposition 2.3 *If the technology parameter α increases, the range of debt levels, for which the multiplicity of equilibria prevails, widens in the common knowledge game.*

Proof. The derivative of the lower bound of the multiplicity range, $\underline{D}$, with respect to α is smaller than the derivative of $\overline{D}$.

$$0 \quad < \quad \frac{\partial \underline{D}}{\partial \alpha} = \frac{1}{r} \quad < \quad \frac{\partial D^\star}{\partial \alpha} = \frac{1}{(r - \frac{1}{2}\overline{z})} \quad < \quad \frac{\partial \overline{D}}{\partial \alpha} = \frac{1}{r - \overline{z}} \tag{2.17}$$

■

As illustrated in Figure 2.2, the range of multiplicity enlarges with bigger α. Between $D^\star$ and $\overline{D}$ lies the range, where the low growth equilibrium prevails due to coordination failure, although in terms of the fundamentals, still, the high growth equilibrium is possible. One interpretation of this range is to see it as a measure of inefficiency of the economy. According to this interpretation,

an increasing α implies an increase in the inefficiency of the economy. However, this view is incorrect. Simultaneous to the increase of the range between $D^\star$ and $\overline{D}$, also, the range between $\underline{D}$ and $D^\star$ increases by the same amount. For these debt levels, investors coordinate to the high growth equilibrium although, also, the low growth equilibrium exists. Therefore, a more convincing interpretation of the range between $D^\star$ and $\overline{D}$ is the following: It is a range where the government can improve the situation by helping investors to coordinate. This suggests that technological progress has two positive effects. Firstly, it directly decreases the probability of a sudden stop and secondly it accords a larger scope to government policy to enhance coordination.

Note further, that the effect of α decreases in r.[14] This can be explained by the fact that the scope of action for the government is reduced, when external factors change in an unfavorable way. One example of such a change is an increase in the international interest rate.

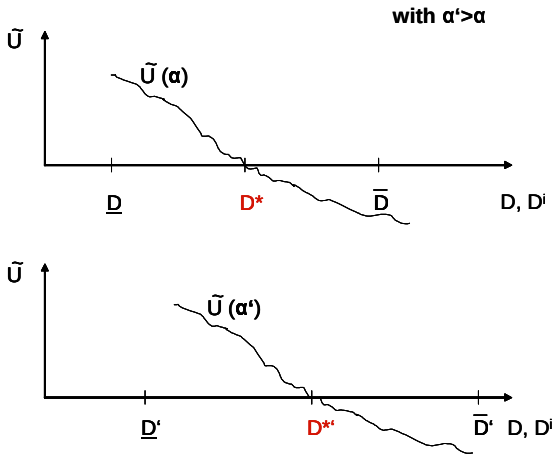

Figure 2.2: Changes in $D^\star$ and the borders of the multiplicity area due to changes in α

2.5.2 Changes in the International Interest Rate r

First, I show the direct effect of the international interest rate on the threshold equilibrium. Next, I show the effect of the international interest rate on the borders of the multiplicity range in the common knowledge game.

[14] To see this, differentiate the right hand side of Equation (2.16) with respect to r.

Proposition 2.4 *If the international interest rate r increases, the threshold equilibrium is shifted to a lower level of debt, i.e., a growth collapse and thereby a sudden stop occurs already at lower levels of debt.*

Proof. A change in the international interest rate produces the following effect:

$$\frac{\partial D^\star}{\partial r} = \frac{(3+\epsilon)\overline{z} - 6\alpha}{6(r - \frac{1}{2}\overline{z})^2} < 0 \tag{2.18}$$

The denominator of the fraction in Equation (2.18) is always positive. The numerator could, in principle, be positive or negative. However, given the assumptions on α and ϵ, it is always negative. Recall that α exceeds r, which in turn exceeds $\overline{z}$. ϵ is restricted to be a small positive number. In the limiting case that $\alpha = \overline{z}$, ϵ has to be smaller than 3 for $\frac{\partial D^\star}{\partial r}$ to be negative. Given the assumption on the possible size of ϵ, this restriction is not binding. Hence, the effect of a change of r on $D^\star$ is negative. This means, if the international interest rate increases, $D^\star$ moves to lower levels of debt, i.e., a growth collapse already happens at better states of the fundamentals. ■

In Figure 2.2, this translates into a shift of the threshold to the left if the international interest rate increases. In terms of the real economy this implies that, with higher international interest rates, a sudden stop becomes more probable.

Proposition 2.5 *If the international interest rate r increases, the range of multiplicity of equilibria shrinks in the common knowledge game.*

Proof. The derivative of the lower bound of the multiplicity range, $\underline{D}$, with respect to r is bigger than the derivative of $\overline{D}$.

$$0 \quad > \quad \frac{\partial \underline{D}}{\partial r} = -\frac{\alpha}{r^2} \quad > \quad \frac{\partial \overline{D}}{\partial r} = -\frac{\alpha - \overline{z}}{(r - \overline{z})^2} \tag{2.19}$$

This inequality can be reformulated to:

$$2\alpha r - \alpha\overline{z} - r^2 > 0$$

which must hold because $\alpha > r > \overline{z} > 0$ by assumption, and hence, $\alpha r > r^2$ and $\alpha r > \alpha\overline{z}$. ■

The comparative static analysis lays bare that the derivative of $\overline{D}$ with respect to r is more negative than the one of $\underline{D}$. This result implies that the

range of multiplicity shrinks with increasing r. This implies that the scope of government policies is diminished by an increase in the international interest rate.

Again, this comparative static result reveals the opposing effects of α, a parameter determined in the respective country, and r, a parameter, which is independent of the situation in the particular country.

These opposing effects of α and r are fully in line with the empirical literature on pull and push factors with respect to capital flows.[15] As a large part of the relevant literature tries to explain the surge of capital inflows into developing countries, *pull* refers to the factors that lie inside the economy and attract capital inflows. Montiel and Reinhart (1999) define these capital attracting factors as the ones operating through an improvement in the risk-return characteristics of assets issued by the developing country debtors. Such an improvement could result from productivity-enhancing economic reforms.[16] So in the present setup, these would translate into policies that increase the technology parameter α.

The most prominent of the *push* factors (which lie in the industrialized countries) is the world interest rate.[17] In their paper on inflows of capital to developing countries in the 1990s, Calvo et al. (1996) mention that low interest rates in developed countries attracted investors to the high investment yields and improving economic prospects of economies in Asia and Latin America in the beginning of the 1990s. For example, the short term interest rate in the United States reached its lowest point since the early 1960s in 1992. Fernandez-Arias (1996) contributes an interesting twist to the question of the influence of external factors on capital flows to emerging markets. He shows the positive effect of lower world interest rates on the creditworthiness of debtor countries borrowing at these rates. This is a further channel through which low world interest rates may induce capital to flow into emerging markets.

[15] See, for example, Calvo et al. (1993), Calvo et al. (1996), Diaz-Alejandro (1983), Fernandez-Arias (1996), and Montiel and Reinhart (1999).

[16] In addition, Calvo et al. (1993) mention introduction of institutional reforms such as liberalization of the domestic capital market, opening of the trade account, and policies that result in credible increases in the rate of return on investment.

[17] As stated in Calvo et al. (1996), additional external factors include terms-of-trade developments, the international business cycle, and regulatory changes that affect the international diversification of investment portfolios at the main financial centers.

The relevant literature disputes whether external or internal factors are more important in determining the direction and composition of these flows. In the present model it is indeterminate whether the derivative of the threshold with respect to α is smaller or bigger than the derivative with respect to r in absolute values.[18] So the model does not reveal, which factors, external or internal, are more important. However, the present model can illustrate that the scope of government policies dealing with possible coordination failures changes as a function of external factors. If the international interest rate increases, governments of developing countries lose scope, whereas they gain scope if the interest rate falls. This study finds that the government can buy scope for its policies by, for example, productivity enhancing reforms. But, at the same time, governments lose scope if the productivity is decreased. This means that the relative importance of internal versus external factors varies over time. As governments lose scope when the international interest rate increases, i.e., when the economic surrounding turns unfavorable, governments are even in a worse position because their effort in preventing a crisis would even have less effect.

2.5.3 Changes in the Degree of Uncertainty ϵ

Finally, the comparative static analysis with respect to the precision of private information ϵ reveals interesting insights.

Proposition 2.6 *If the degree of uncertainty about the fundamentals ϵ increases, the threshold equilibrium is shifted to a lower level of debt, i.e., a growth collapse and, thereby, a sudden stop occurs already at lower levels of debt.*

Proof. Proving 2.6 requires calculating the derivative of the threshold $D^\star$ with respect to the variance of the private signal around the true value of debt.

$$\frac{\partial D^\star}{\partial \epsilon} = -\frac{\overline{z}}{6(r - \frac{1}{2}\overline{z})} < 0 \tag{2.20}$$

Recall that $r > \overline{z}$. Hence, the derivative is always negative. This means that $D^\star$ decreases with increasing uncertainty. ■

[18] This depends on the relative magnitudes of α, $\overline{z}$, and r.

As argued before, this finding implies that the probability of a sudden stop increases with an increase in uncertainty. Formulated differently, this means that the more precise the information, the lower the probability of a bad equilibrium. This result contrasts the findings of the "game of refinancing."[19] In terms of government policies, these results mean that governments should aim for an information dissemination policy that entails small variation in the value of private signals, i.e. that entails little uncertainty about the fundamentals.[20]

2.6 Testable Hypotheses

In this section, predictions of the theoretical model are translated into a set of testable hypotheses. In particular, I formulate testable hypotheses regarding the influence of technological progress, the international interest rate, and the uncertainty about the fundamentals on the probability of a sudden stop.

Hypothesis 1 *Sudden stops become less likely if internal factors of emerging market countries become more favorable, e.g., if the investment safety increases or if governments adopt technology enhancing policies (derived from Proposition 2.2).*

Hypothesis 2 *Sudden stops become more likely if the international interest rate increases (see Proposition 2.18).*

Hypothesis 3 *Sudden stops become more probable with more uncertainty on the fundamentals of the economy (see Proposition 2.6).*

2.7 Empirical Analysis

The purpose of this section is to validate the predictions of the theoretical model, and evaluate these three hypotheses. Particular attention will be paid to showing the effect of uncertainty about the fundamentals on the occurrence of sudden stops of capital flows.

[19] See Morris and Shin (2004).

[20] For an extensive analysis of transparency, see Heinemann and Illing (2002).

2.7.1 The Data

I work with two data sets: a yearly data set of 14 emerging and 17 industrialized countries and a monthly data set of 11 emerging and 14 industrialized countries. Both sets run from January 1990 to December 2001. I work with these two data sets because the yearly data does not allow me to tackle the potential problem of endogeneity in a convincing manner because there are too few observations. However, the results of the analysis with yearly data are displayed, because a part of the time series of control variables are only available in yearly frequency. In the analysis with monthly data, those series are interpolated.

The selection of countries reflects those emerging countries tracked by JP Morgan's Emerging Market Outlook, i.e., countries that significantly show in the world capital markets. The developed countries in the sample are OECD members. However, some of the countries that fulfill those criteria are dropped due to lack of the relevant data.[21]

The dependent variable is an index of sudden stops of capital flows. Following Calvo et al. (2004), I employ a dummy variable based on monthly data of capital flows. This high frequency of data is chosen because it best unveils the origin of sudden stop crisis episodes. Due to the high frequency of data, however, it is necessary to work with a proxy for the flows, netting out the trade balance from changes in foreign reserves. Then, the change in the capital flows with respect to the capital flows 12 months before is calculated to avoid seasonal effects.

The first criterion that determines whether a month is counted as a crisis month or not concerns capital flows: This criterion is fulfilled for an observation where the year-to-year decrease in capital flows lies at least two standard deviations below its sample mean. To introduce persistence in this measure, the criterion is also regarded as fulfilled if the flows decrease more than one standard deviation below the sample mean in the months that encircle the two standard deviation decrease. In addition to this first criterion, the second criterion is that the output of the economy has to contract at the same time. Thereby, only crisis episodes with costly disruptions in economic activity are identified. For robustness checks, I make also use of a crisis dummy variable,

[21] For more details, see Table 2.1 in Appendix 2.10.

for which only the capital flow criterion has to be fulfilled.[22] In the analysis with yearly data, a year is counted as a sudden stop year if it contains at least one month that fulfils the above-mentioned criteria.

The explanatory variable most interesting for the present analysis is uncertainty about the fundamentals. I use the standard deviation of growth forecasts by a group of country experts as a measure of uncertainty. In the models a la Morris and Shin (1998), uncertainty takes the form of the dispersion of the private signals around the true value of the fundamentals. In this chapter of the study, this translates into the dispersion of the private signals about the true value of government debt, i.e., the evaluation of the debt level by each of the private investors. Direct observation of the private signals of all investors is not possible. However, there is data that can be used as reliable proxy.

Firstly, given the distributional assumptions that I made in the theoretical model the expectation of the true value of the debt, given the private signal, is exactly the private signal itself: $E(D|D^i) = D^i$. If the private signals are dispersed with a standard deviation of ϵ around the true value of the debt, the expectations will as well. Therefore, the standard deviation of the expectations will give a good indication of the standard deviation of the signals of concern in this chapter. Data are available that closely proxies the expectations by private agents about the fundamentals.

Data on the standard deviation of expectations about the level of government debt are not available in a sufficient coverage. Therefore, the best available option is to use the standard deviation of expectations about GDP growth as a proxy. In doing this, I follow Prati and Sbracia (2002) who use these data to test the effect of uncertainty on the occurrence of currency crises

[22]No consensus in the literature exists about the concept of capital flows or the criteria to detect a sudden stop. While, for example, Calvo and Reinhart (2000) examine variations in net private capital flows, Milesi-Ferretti and Razin (1998), and Hutchison and Noy (2006) analyze changes in the current account. In addition, measures of the variation in capital flows differ. In one part of the literature, negative differences are measured relative to the country's GDP and considered a sudden stop if they exceed a specific threshold (see, for example, Calvo and Reinhart (2000) and Hutchison and Noy (2006)). However, newer literature also takes into consideration the unexpected character of such an extreme event and considers a drop in capital flows a crisis when it falls below a threshold in terms of the standard deviations below the sample mean (see Calvo et al. (2004), Cavallo and Frankel (2004), and Eichengreen et al. (2006)). I use the latter approach because it is consistent with my theoretical model.

in a similar model. In addition, because the model in this chapter of the study also works if the uncertainty lies on the productivity parameter, this procedure seems even more justified.

A second restriction is that no data exists on the private signals of all investors. Data collecting firms only survey the opinions of a group of about 20 banks and other market analysts per country. However, assuming that private agents can buy expert opinion, it is reasonable that they will buy different numbers of those opinions and will weigh these signals differently. If the experts strongly diverge in their expectations, private agents will most likely have even more divergent evaluations of the fundamentals. Therefore, dispersion of expert opinions, i.e., their standard deviation, seems a good indicator of the dispersion of private agents' expectations about the fundamentals.

I use data from two sources: the IFO Institute for Economic Research and Consensus Economics. Both institutes collect GDP forecasts of a group of experts within all the countries that they track at a particular point in time. The IFO Institute and Consensus Economics then report mean and standard deviation of these forecasts for the respective country. I use the standard deviations as the measure of uncertainty. When working with yearly data, I use both data sets. While the IFO Institute asks experts within tracked countries about their forecasts of GDP growth for the current year, once yearly in April Consensus Economics collects forecasts of GDP growth, CPI inflation, government budget balance, current account balance trade balance, and exports for the current and following year in monthly frequency. In the analysis with yearly data I display two sets of estimations: In the first set of estimations, the measure of uncertainty is a yearly average of the standard deviations of forecasts that Consensus Economics gathers. In the second set of estimations, I combine the observations by Consensus and WES (World Economic Survey by the IFO Institute). I do this by only taking the April forecast for the current year by Consensus. If both observations are available, I use the WES data.[23]

To achieve a constant one-year forecast horizon for the data by Consensus Economics, I follow Prati and Sbracia (2002) in computing a weighted average of the current and the following year forecast. In January a weight of 11/12 is attributed to the current and of 1/12 to the following year forecast. In

[23]For robustness checks, I ran the same regressions two more times: first, using WES data only and second, using a combination where in case of redundancy I took the Consensus data. The results are qualitatively the same and quantitatively similar.

February the weights equal 10/12 and 2/12 respectively. For every month in the same logic, another set of weights is applicable until December, where the respective weights are 0/12 and 12/12.[24]

I use a large set of control variables. Firstly, I control for the mean of the growths forecasts. This appears to be the most important control because I want to disentangle the effect of private investors having diverging opinions as opposed to all investors being sure that growth will be low. Additionally, I draw upon Calvo et al. (2004). They convincingly put forward the vulnerability to large real exchange-rate fluctuations and the degree of domestic liability dollarization as drivers of the occurrence of sudden stops. In addition, I use a large set of macroeconomic controls. When I work with monthly data, I have to interpolate several time series of the control variables that are only available in yearly frequency. This technique does have a cost: an understating of the variance of those series. Since I have monthly observations on the variables that I am most interested in and most of the controls that I have to interpolate represent economic variables that do not vary substantially in a year's time, it is very unlikely that this procedure influences the results. In addition, I can show the presence of the effect of uncertainty on the occurrence of sudden stops of capital flows with yearly data.

2.7.2 Benchmark Regression

As a benchmark regression I estimate a pooled probit controlling for country and time effects. The theoretical model is static and predicts the probability of a crisis at a particular point in time. Therefore, a probit approach to estimating the effect of uncertainty on the occurrence of a crisis appears most appropriate.

$$\begin{aligned} \text{Prob}(Suddenstop = 1|x_{it}\beta) &= G(\beta_0 + \beta_1 \text{unc}_{i,t-1} \\ &+ \beta_2 \text{mgexp}_{i,t-1} + \beta_3 \text{macrocntrls}_{i,t-1} \\ &+ \delta_i + \gamma_t + \varepsilon_{i,t}) \end{aligned} \tag{2.21}$$

with $i = 1, 2, ..., n; t = 1, 2, ..., T$.

[24] As a robustness check I rerun all the estimations with the current year and with following year forecasts separately. The results are qualitatively the same and quantitatively similar.

Suddenstop equals one if country i experiences a sudden stop in period t. x_{it} represents the set of explanatory variables, including the measure of uncertainty, explicitly named *unc* in the right hand side of Equation (2.21), the mean of the growth expectations, named *mgexp*, and a set of macroeconomic control variables, named *macrocntrols*. For a full list of the variables used as control variables, please refer to Table 2.2 in Appendix 2.10. δ_i stands for country fixed effects, γ_t stands for time fixed effects, and $\varepsilon_{i,t}$ represents the error term. β is the vector of the corresponding coefficients. $G(.)$ is the standard normal cumulative distribution function.

Country dummies are included into the analysis. The level of uncertainty varies strongly across countries.[25] While in some countries, for example, the Netherlands or Italy, the average of the uncertainty measure, i.e., the standard deviation between the growth forecasts of different experts (January 1990 - December 2001), is as low as 0.24 percentage points, in countries like Indonesia or Turkey, the average of the uncertainty measure reaches levels of 1.022 and 1.15 respectively. These statistics suggest that, systematically, some countries are characterized by higher uncertainty than other countries, therefore requiring control for country fixed effects. In a probit estimation obtaining consistent estimates requires controlling for time fixed effects by incorporating country dummies in a pooled regression.

Additionally, I control for time fixed effects. Calvo et al. (2004), in line with a large part of the literature, state that sudden stops in emerging economies "bunch" around the Tequila (1994), East Asian (1997), and Russian (1998) crises. In developed countries, sudden stops materialize mostly around the ERM (Exchange Rate Mechanism) crisis in 1993. The graphs in Figure 2.3 in the Appendix, which depict the sudden stop periods against the measure of uncertainty, also show this feature of the crises. Thus, controlling for time fixed effects is necessary. Mostly I do this by including time dummies in the regressions. However, where the data quality does not allow for this, I use polynomial time trends to reduce the number of dummy variables and approximate the variation over time.

[25] This is illustrated in Table 2.3 in the Appendix.

2.7.3 Analysis with Yearly Data

I run a pooled probit regression with a sample of all countries with yearly data. As seen in Table 2.4 in Appendix 2.10, the coefficient on the contemporaneous uncertainty has a positive sign, irrespective of the measure of uncertainty chosen here. Controlling for country and time effects, the result is significant.[26] However, sudden stops are mainly an emerging market phenomenon.[27] For some of the countries that do not experience sudden stops of capital flows, the country dummies are dropped from the regression, while the observations are included. This makes the result look weaker. To circumvent this difficulty, the analysis is repeated for emerging economies only. The results are reported in Table 2.5 in Appendix 2.10. Again, the effect of the uncertainty on the sudden stop crisis probability is positive and significant. However, if working with the uncertainty measure based on the Consensus data in the case of the inclusion of the quadratic time trend (column 3 in the left half of the table), none of the explanatory variables is significant. This seems to be related to the small number of 64 observations. This does not happen with the combined measure of uncertainty, for which it is possible to obtain 97 observations.

In all regressions, I control for the mean of the expectations over all the experts. Therewith, I ensure to disentangle the self-fulfilling effect of the expectations from the uncertainty about the fundamentals, i.e., the disagreement on the state of the economy. In most of the regressions, the mean of the expectations turns out to significantly impact the crisis probability: The lower the mean of the expectations, the higher the crisis probability. The other control variables, namely the domestic liability dollarization, the vulnerability to real exchange rate fluctuations, the index of exchange rate flexibility, the reserves over the current account deficit, M2 over reserves, credit growth, foreign direct investment over GDP, public balance over GDP, total debt over GDP, and TOT growths turn out to be insignificant in many of the regressions when controlling for country fixed effects.[28]

This analysis with yearly data suggests that the empirical findings are in

[26]The results stay the same when including higher order time trend. However, if country and year dummies are included, none of the explanatory variables are significant, which indicates that including all these dummy variables is demanding too much from the data.

[27]See Figure 2.3 in the Appendix.

[28]I present the results with the most convincing specification in terms of the control variables. However, I have run all the regressions with a larger set of controls and the results are qualitatively the same and quantitatively similar.

line with the theoretical model. However, due to data limitations, this analysis does not permit tackling one obvious problem of the analysis: the direction of causality. Here, the monthly data contributes to finding a remedy.

2.7.4 Analysis with Monthly Data

When repeating the analysis with monthly data, the one-month lag of the explanatory variables is used as a first step to reduce the problem of endogeneity. Additionally, one month is an appropriate time, on average, that investors can act according to their expectations. The capital flow proxy comprises portfolio investments, which are very liquid, and foreign direct investments, which are less liquid. The regression, which includes the entire country sample, suffers from the same difficulty of dropped country dummies as the counterpart with yearly data. The results of these regressions are displayed in Table 2.6. Still, the analysis shows that the sign of the effect of the uncertainty on the occurrence of crises is positive as expected. The pooled probit estimation with monthly data and the emerging market sample reveals the most interesting insights into the effect of uncertainty.

(Table 2.7 here)

The results of the analysis with monthly data and the emerging market sample turn out as expected by theory.[29] The lagged uncertainty influences the crisis probability positively. The lagged expectations themselves have the opposite impact. The fact that the vulnerability against real exchange rate fluctuations and the domestic liability dollarization are insignificant may lie in the interpolation of these series from yearly data. These are the variables that Calvo et al. (2004) put forward as main drivers of sudden stops. However, recall that in the analysis with yearly data[30], the two variables do not appear

[29]The result with respect to the uncertainty holds also when applying monthly time dummies into the analysis. However, most of the other variables prove insignificant, which may reflect that some of them are interpolated from yearly data. Therefore, the specification with time dummies is not displayed here and is not the most convincing specification.

[30]See Appendix 2.10, Tables 2.4 and 2.5.

significant in a number of specifications. This finding casts a doubt on the robustness of the results by Calvo et al. (2004), once country fixed effects are controlled for. As argued before, a pooled probit analysis using country and time dummies is a more convincing approach for the current question than the assumption of random effects as used in Calvo et al. (2004).[31]

The effect of uncertainty on the occurrence of sudden stops is not negligible. Assessing the relevance of the effect of uncertainty requires calculation of the marginal effects for the regressions from Table 2.7. The effect ranges between a 2.5 and 10.8 percent increase of the crisis probability, if uncertainty (i.e., the standard deviation of the growth forecasts) is increased by one percentage point. The most convincing specifications are those with a quadratic or cubic time trend. Therefore, it is safe to say that an effect of 2.5 to 5.6 percent is most realistic. The variation stems from different specifications.

(Table 2.8 here)

2.7.5 Facing Endogeneity

To dispel the possibility that the results presented above stem from an endogeneity problem rather than displaying the effect of the uncertainty about the fundamentals, I first apply higher order lags as explanatory variables. Second, I implement instrumental variable estimation.

The analysis with lags of the potentially endogenous variables (namely the uncertainty measure, the mean of the expectations, and the vulnerability to real exchange rate fluctuations) reveals that the uncertainty up to four month previous to the crisis period has a significant positive effect on the probability of a crisis. Earlier uncertainty, however, does not matter for a crisis to occur. This pattern does not materialize with respect to the mean of the expectations and the vulnerability to real exchange rate fluctuations, which both stay significant

[31] The result of the uncertainty influencing the crisis probability positively also holds under the assumption of random effects controlling for time effects.

when applying these higher order lags. These results are illustrated in Table 2.9 in Appendix 2.10.

It is hard to confirm that a lag of four month is enough to deny possible endogeneity. Nevertheless, four month prior to a crisis, it is mostly impossible to predict when and in which form the crisis will materialize. Therefore, investors cannot be certain that a crisis is going to happen. Furthermore, it is also not surprising that uncertainty does not have an effect for more than four month into the future. If the disagreement between investors about future outcomes at the point of the investment decision itself really matters, then one month should be a good proxy for the reaction time. To summarize: these results cannot exclude the possibility that the result is driven by endogeneity, but these results render it much less likely.

The next step in the attempt to cope with the potential endogeneity is to instrument the contemporaneous variable with its own lag. In the first stage, the uncertainty measure is regressed on its own lag controlling for the same set of controls as in the second stage regression. Based on the estimated coefficients, the contemporaneous uncertainty is then predicted. In the second stage, the predicted values are used along with the control variables.

The results in Table 2.10 in Appendix 2.10 suggest that uncertainty does have an aggravating effect on the probability of a crisis. Here, I display the results where I used the six-month lags of the potentially endogenous variables as instruments. I did the same analysis with lower- and higher-order lags. The results are similar for lower-order lags. For higher-order lags, however, they break down: Under some specifications, the lags are not significant in the first-stage regressions any more; and, under other specifications, the predicted values do not significantly explain the occurrence of a crisis. Keeping in mind the fast burst speed of many sudden stop events, it seems that a lag of six months is a sufficient distance to exclude the causality from the crisis to the uncertainty. In addition (and this also applies already to the argument when explaining the results with the lagged explanatory variables), I control for mean expectations and for time effects, which ensures against picking up the reverse causality by the uncertainty variable. Hence, both the analysis with lagged explanatory variables and the instrumental variable estimation further support the validity of the theoretical findings.

One additional possibility to avoid the endogeneity problem would be to look for past data revisions as an instrument for the uncertainty. However,

there might be also a problem that revisions of data often happen in sight of a crisis, e.g., to smooth outcomes.

2.7.6 Robustness Analysis

One additional set of estimations is reported in this analysis to check that the results are not sensitive to the econometric method chosen. Table 2.11 in Appendix 2.10 reports the results of these estimations. Additionally, to the pooled probit that was chosen as a benchmark case, I estimate a pooled logit controlling for country and time effects, a conditional logit in a panel setting with fixed effects, and a Chamberlain's panel probit estimations. All these approaches have in common that they control for country specific effects. Applying the logit estimation implies employing the logistic function instead of the normal cumulative distribution function as in the probit approach. The conditional logit allows for a fixed effects estimation, which is not possible in a probit setting. A fixed effects estimation in a probit setting leads to inconsistent coefficient estimates because the country effects cannot cancel out when they are within the cumulative distribution function. The problem is reduced in the case of the logistic function. Using Chamberlain's panel probit approach allows for the unobserved heterogeneity to be correlated with the mean of each of the explanatory variables, which is calculated by country and included into the estimation as further control. Therefore, this mean functions similarly to a country dummy.[32]

As Table 2.11 in Appendix 2.10 illustrates, the positive effect of uncertainty on the occurrence of sudden stops is robust against different estimation approaches; the negative effect of the expectations is robust as well.

All regressions are also run with the complete list of control variables.[33] The results do not qualitatively and quantitatively change when including the additional variables. The specification that I show here contains the most important explanatory variables. The different results illustrate different specifications in terms of the control for time effects (including time trends of differing order). This approach is the best available option because some of the series of control variables are interpolated and, therefore, data quality does not always allow inclusion of the 144 monthly time dummies in the regressions.

[32] See Wooldridge (2002), pp. 487f., for a detailed description.
[33] See Table 2.2 in Appendix 2.10.

Furthermore, I run all the above regressions with an alternative measure of sudden stops. Specifically, the analysis is repeated counting a month as sudden stop month if the criterion regarding the drop in capital flows is fulfilled while ignoring whether growth is positive or negative in the respective period. The results from this analysis are quantitatively the same as the ones that I report here.

The empirical findings conclude by noting the contemporaneous positive and significant effect of uncertainty on the crisis probability shown in the analysis with yearly data. However, recall the difficulty of resolving potential endogeneity with this data set. One way out of the problem of potential endogeneity is to switch to monthly data: I first apply higher-order lags as explanatory variables. In a further step, I perform a two-stage estimation with the lags of the potentially endogenous variables serving as instruments. This works for lags up to six months. Additionally, I check for different estimation approaches. In the analysis with monthly data, the positive and significant effect of uncertainty persists. By calculating the marginal effects, one can also show that the effect that I am showing is not negligible quantitatively.

Summarizing, the empirical results support the theoretical predictions of the model. Recall, the model predicts that the probability of a sudden stop increases with a deterioration of internal factors. Moreover, it predicts that the probability of a sudden stop increases with external conditions turning unfavorable. Most importantly, the model predicts that the probability of a sudden stop increases with an increase in uncertainty about the fundamentals.

2.8 Policy Implications

This section discusses the implications of the theoretical and empirical results for economic policies.

The increase in the technology parameter decreases the probability of a crisis. This implies that governments should try to enhance technological progress, rendering their country more attractive for investment. Also, in the context of the technology parameter, the safety of investment seems crucial so that investors can realize a high after-tax return on investment. In the same line of argument, high tax policies seem counterproductive. To summarize, all steps toward a credible increase in the long term rate of return on investment

help prevent a crisis. An interesting implication of this analysis is that, apart from the direct effect of an increase in the technology parameter, a government can buy scope for other policies that help private investors coordinate on the good equilibrium if they increase this parameter.

The international interest rate is not under the control of one economy. The model, rather, refers to small open economies. The findings in this context imply that governments should take into consideration that they have even less scope for action once the outside world turns unfavorable, i.e., if the international interest rate increases. Therefore, governments should take precautions for such cases of deteriorating external conditions.

Another finding of the present analysis is that private information with little noise is the most favorable setting for an economy. Therefore, a government should achieve such an informational structure to advance their interest in preventing a sudden stop event.

In the present model, the government mechanically services its debt in a static model. This means that problems of credibility or commitment are abstracted from. Therefore, one can only infer policy implications for a credible government. This model does not cover the mechanisms by which governments could achieve credibility. One venue by which a credible government could achieve a preferred setting, in which investors decide upon private information, would be to allow full access to government data to a small group of independent economic rating agencies. These institutions would be allowed to gather all relevant information on the fundamentals and could then sell their signals to private investors. The private investors could buy signals of different agencies, weighing those according to their preferences. This would make sure that signals, which the investors in the market have about the fundamentals, would be private and characterized by a small amount of noise.

2.9 Conclusion

This study considers the possibility of coordination failure between investors as a factor triggering a sudden stop. This finding is verified empirically. More specifically, the analysis shows that an increased uncertainty about the fundamentals of an economy increases the probability of a sudden stop of capital flows.

The main theoretical findings of this chapter about the causes of sudden stop events are the following: 1) The probability of a sudden stop decreases with technological progress. 2) The probability of a sudden stop increases with a higher international interest rate. 3) The probability of a sudden stop also increases with noisier private signals, which can be interpreted as higher uncertainty or disagreement about the fundamentals among private investors.

With regard to the discussion on internal versus external factors that attract capital to emerging markets, this study finds that, with increasing international interest rate, the scope of policy action, preventing a sudden stop, is reduced. In contrast to this result, the government gains scope for its actions through the use of policies that advance investment safety or technological progress. Thus, in terms of the discussion regarding pull and push factors of capital flows, the outcome is that the relative importance of those factors vary over time in an unfavorable way for the concerned economies. If the external conditions are unfavorable, governments have less possibility to influence the economic outcome by, for example, helping private investors to coordinate on the good equilibrium.

This study contributes to the empirical literature on sudden stops of capital flows by the verification of the theoretical findings on the effect of uncertainty on the probability of a sudden stop. To verify the theoretical result, a pooled probit analysis controlling for country and time effects is used. Calculating marginal effects also shows that the influence of the uncertainty on the occurrence of sudden stops is quantitatively not negligible. Additionally, a large number of robustness checks is implemented. These include two-stage estimations to address the potential endogeneity problem. In all these regressions, the positive effect of the uncertainty about the fundamentals on the probability of the occurrence of a crisis persists.

The results strongly suggest that governments should take uncertainty about the fundamentals in the economy into account. Lower precision of information about the government's fiscal policy and, therefore, uncertainty about these values increases the probability of a sudden stop of capital flows. Hence, an economy will be more vulnerable in times when uncertainty is higher. Policymakers should adjust their policies accordingly. Specifically, the provision of less noisy private information is crucial in this context. One venue would be to allow full access to all government data to a small set of independent agencies which could then sell their ratings to private investors.

Limitations of the present study are that considerations about default and thereby credit frictions have not been included. Furthermore, the analysis has not extended the non-monetary model to a monetary one. Calvo (2003) illustrates these extensions in his model. In the mentioned paper, Calvo also shows that foreseen a crisis is possible in the model. The introduction of infinitely many firms and the coordination problem do not alter these considerations. Banking crises, however, cannot be rationalized within the current framework. However, looking at these factors would be an interesting agenda for future work.

For future research, two potential extensions of this theoretical model would be interesting. First, adding the assumption of public information about the debt level to the assumption of private information of each agent could be worthwhile. So far, this study assumes that agents base their decisions on personal interpretation of publicly available information, i.e., each agent does not know how the other agents interpret the available information. Morris and Shin (2004), Metz (2002), and Hellwig (2002) include public information that is known by all agents into their analysis. However, it is questionable whether this would generate different implications in the present setup. A vivid discussion on the interaction between public and private information exists in the context of central bank policy, triggered by Morris and Shin (2004).

Second, analyzing the distinction between domestic and foreign investors tackling the following questions could generate valuable insights. How would the probability of a sudden stop be influenced if the signals of domestic and foreign investors are differently dispersed around the true value of the debt? Are economies with investors that differ with regard to the precision of their information more prone to a crisis than economies with homogenous and only domestic investors? Corsetti, Dasgupta, Morris, and Shin (2004) analyze the effect of the presence of one big investor who is better informed than the rest on the occurrence of a currency crisis. In their setup, the large, well-informed speculator makes all other investors more aggressive. In the present setup if, for example, domestic investors are better informed and can coordinate more easily among themselves than foreign investors, one would expect all investors stampeding to the exits more often. Given the progressing financial integration of emerging market economies, this question appears relevant for future research.

2.10 Appendix

2.10.1 Value of the Firm

The firm is characterized by a linear production function $y_t^i = \alpha K_t^i$, where y_t^i is firm i's output in period t, α is the productivity factor and K_t^i is the capital invested.

The cash flow of firm i in period t is

$$S_t^i = \alpha(1-\tau)K_t^i - \dot{K}_t^i \tag{2.22}$$

where τ represents a constant output tax rate and $\dot{K}_t$ the rate of capital accumulation, neglecting capital depreciation.

The value of the firm at $t = 0$ is

$$V^i = \int_0^\infty S_t^i e^{-rt} dt \tag{2.23}$$

where r represents the constant international interest rate.

z_t^i, the growth rate of capital, is defined as $z_t^i = \frac{\dot{K}_t^i}{K_t^i}$. Normalizing the initial capital stock to one, solving the differential equation, and assuming that the firms only choose between constant growth paths, the value of the firm can be expressed in the following simplified form:

$$V^i = [\alpha(1-\tau) - z^i]\frac{1}{(r-z^i)}$$

In order to obtain this simple expression, one has to proceed in several steps. In a first step, one expresses K_t^i and $\dot{K}_t^i$ in Equation (2.22) in terms of the initial capital stock K_0:

First, one solves the differential equation $z_t^i = \frac{\dot{K}_t^i}{K_t^i}$. This can be expressed as

$$\begin{aligned}
\int_0^t z_s^i ds &= \int_0^t \frac{\dot{K}_s^i}{K_s^i} ds \\
&= \int_0^t \frac{dK_s^i}{ds}\frac{1}{K_s^i} ds = \int_0^t \frac{1}{K_s^i} dK_s^i \\
&= lnK_t^i - lnK_0^i \\
\Leftrightarrow e^{\int_0^t z_s^i ds} &= \frac{K_t^i}{K_0^i} \\
\Leftrightarrow K_t^i &= e^{\int_0^t z_s^i ds} K_0^i
\end{aligned}$$

Second, noting that $\dot{K}_t^i = z_t^i K_t^i$, plugging K_t^i and $\dot{K}_t^i$ into Equation (2.22), and normalizing K_0^i to unity delivers

$$S_t^i = \alpha(1-\tau)e^{\int_0^t z_s^i ds} - z_t^i e^{\int_0^t z_s^i ds}$$

Plugging the new expression of S_t^i into Equation (2.23) leads to

$$V^i = \int_0^\infty [(\alpha(1-\tau)e^{\int_0^t z_s^i ds} - z_t^i e^{\int_0^t z_s^i ds})e^{-rt}]dt$$

Third, because r is constant, e^{-rt} can be expressed as $e^{-\int_0^t r dt}$. Thus, the above expression can be rearranged to

$$\Leftrightarrow V^i = \int_0^\infty [\alpha(1-\tau) - z_t^i]e^{-\int_0^t (r - z_s^i)ds}dt$$

Given that firms choose between constant growth paths in the setup, this expression can be simplified to

$$\begin{aligned} \Leftrightarrow V^i = & \int_0^\infty [\alpha(1-\tau) - z^i]e^{-(r-z^i)t}dt \\ = & [\alpha(1-\tau) - z^i]\int_0^\infty e^{-(r-z^i)t}dt \end{aligned}$$

and, assuming r>z

$$= [\alpha(1-\tau) - z^i][\tfrac{e^{-(r-z^i)t}}{-(r-z^i)}]_0^\infty = [\alpha(1-\tau) - z^i]\frac{1}{(r-z^i)}$$

2.10.2 Lemma Proofs

Proof of Lemma 2.1

Proof. With the switching strategy I_T, the fraction of firms investing is $\pi^{-i}(I_T) = \int_0^1 I_T(D^j)dj$. Thereby, the expected value in Equation (2.11) is $E(D\pi^{-i}(D^j)|D^i) = E(D\pi^{-i}(I_T)|D^i)$.

By the use of the law of iterated expectations and the fact that D is more precise information than the private signals D^i and D^j, it is known that[34]

$$E(D\pi^{-i}(I_T)|D^i) = E(E(D\pi^{-i}(I_T)|D)|D^i)$$

[34]In general, it is known that if one has an information set $\Omega_3 = (\Omega_1, \Omega_2)$, then the expectation of a random variable X conditional on a small information set Ω_2, $E(X|\Omega_2)$ is equivalent to the conditional expectation given this smaller set Ω_2 of the conditional expectation given the bigger information set Ω_3 of X: $E(E(X|\Omega_3)|\Omega_2)$.

This is equivalent to

$$E(DE(\pi^{-i}(I_T)|D)|D^i)$$

As the signals, given D, are independent of each other, the expected fraction of firms that receive a signal smaller than some threshold T is equal to the probability that one firm receives such a signal given the realization of D:

$$E(\pi^{-i}(I_T)|D) = \text{prob}(D^j \leq T|D)$$

■

Proof of Lemma 2.2

Proof. The support of the distribution of the true value of the debt $[\breve{D}, \hat{D}]$ exceeds $\underline{D}$ and $\overline{D}$ (the borders of the multiplicity area in terms of the true value of the fundamentals, which were found in section 2.3.1, by at least more than ϵ each. Therefore, there exist signals $\underline{D}^0$ and $\overline{D}^0$, such that

$$E(D|\underline{D}^0) = \underline{D} \quad \text{and} \quad E(D|\overline{D}^0) = \overline{D}$$

and as

$$E(D|D^i = \underline{D}) = \underline{D} \quad \text{and} \quad E(D|\ D^i = \overline{D}) = \overline{D}$$

this implies that $\underline{D}^0 = \underline{D}$ and $\overline{D}^0 = \overline{D}$.

If firm i receives a signal of exactly $\underline{D}$, and even in the worst case that the probability of another firm investing was 0, the payoff difference equals 0 given this signal.[35] ■

Proof of Lemma 2.3

Proof. The monotonicity of $\widetilde{P}$ in D^i is a necessary condition for the iterated elimination of dominated strategies to work and to make sure that there are not several values for which Equation (2.14) holds.

The factor $\overline{z}\frac{1}{(r-\overline{z})r}$ is positive, thus I focus on the rest of the expression. It is clear that the term $-rD^i$ is strictly decreasing in D^i:

[35] Plug the right hand side of Equation (2.6) into Equation (2.13) and set $\text{prob}(D^j < K|D)|D^i = 0)$.

$$\frac{\partial(-\overline{z}rD^i)}{\partial D^i} = -r < 0$$

.

It is more difficult to show the characteristics of the term $E(D * \text{prob}(D^j < T|D)|D^i)$: Making use of the distributional assumptions that I made with regard to the true value of debt and the private signal, I can write the conditional density of the private signal, given the true value of the fundamentals, in the following way:

$$g(D^i|D) = \begin{cases} \frac{1}{2\epsilon} & \text{if } D - \epsilon \leq D^i \leq D + \epsilon \\ 0 & \text{otherwhise} \end{cases} \tag{2.24}$$

Therefore, I can write $\text{prob}(D^j < T|D)$ as

$$\text{prob}(D^j < T|D) = \begin{cases} 0, & \text{if } T < D - \epsilon \\ \frac{1}{2\epsilon}(T - D + \epsilon), & \text{if } D - \epsilon \leq T \leq D + \epsilon \\ 1, & \text{if } T > D + \epsilon \end{cases} \tag{2.25}$$

Now, in addition referring to the conditional density of the true value of debt given the private signal that firm i receives,

$$h(D|D^i) = \begin{cases} \frac{1}{2\epsilon} & \text{if } D^i - \epsilon \leq D \leq D^i + \epsilon \\ 0 & \text{otherwhise} \end{cases} \tag{2.26}$$

One can rewrite the expected value as:

$$E(D\text{prob}(D^j < T|D)|D^i) = \int_{D^i-\epsilon}^{D^i+\epsilon} D\text{prob}(D^j < T|D)\frac{1}{2\epsilon}dD$$

$$= \begin{cases} \int_{D^i-\epsilon}^{D^i+\epsilon} \frac{D}{2\epsilon} 0 dD, & \text{if } T < D^i - 2\epsilon \\ \int_{D^i-\epsilon}^{T+\epsilon} \frac{D}{2\epsilon}\frac{1}{2\epsilon}(T - D + \epsilon)dD & \\ + \int_{T+\epsilon}^{D^i+\epsilon} \frac{D}{2\epsilon} 0 dD, & \text{if } D^i - 2\epsilon \leq T \leq D^i \\ \int_{D^i-\epsilon}^{T-\epsilon} \frac{D}{2\epsilon} 1 dD & \\ + \int_{T-\epsilon}^{D^i+\epsilon} \frac{D}{2\epsilon}\frac{1}{2\epsilon}(T - D + \epsilon)dD, & \text{if } D^i \leq T \leq D^i + 2\epsilon \\ \int_{D^i-\epsilon}^{D^i+\epsilon} \frac{D}{2\epsilon} * 1 dD, & \text{if } D^i + 2\epsilon < T \end{cases} \tag{2.27}$$

The value of the conditional probability depends on the relative position of T to D and, therefore, the expectation of it given D^i also depends on the

relative position of T to D^i. Due to the fact that D^i is known to the firm, the integral is evaluated from $D^i - \epsilon$ to $D^i + \epsilon$.

Equation (2.27) delivers:

$$= \begin{cases} 0, & \text{if } T < D^i - 2\epsilon \\ \frac{1}{4\epsilon^2}\big(\frac{1}{3}((D^i)^3) - \frac{1}{2}(3\epsilon + T)(D^i)^2 & \\ +(2\epsilon^2 + T\epsilon)D^i + \frac{1}{6}T^3 + \frac{1}{2}T^2\epsilon - \frac{2}{3}\epsilon^3\big), & \text{if } D^i - 2\epsilon \leq T \leq D^i \\ \frac{1}{4\epsilon^2}\big(-\frac{1}{3}((D^i)^3) - \frac{1}{2}(3\epsilon - T)(D^i)^2 & \\ +(2\epsilon^2 + T\epsilon)D^i - \frac{1}{6}T^3 + \frac{1}{2}T^2\epsilon - \frac{2}{3}\epsilon^3\big), & \text{if } D^i \leq T \leq D^i + 2\epsilon \\ D^i, & \text{if } D + 2\epsilon < T \end{cases} \tag{2.28}$$

I have shown that the term $-rD^i$ is strictly monotonically decreasing in D^i. In addition, one knows that $\overline{z} < r$. Hence, for the monotonicity of the expected payoff difference between investing and not investing, $\widetilde{P}(D^i, I_T)$, it is sufficient that the derivative of the expected value that I am analyzing is smaller or equal to 1. The derivatives for the different intervals of the expected value are the following:

$$\frac{\partial E(D * \text{prob}(D^j < T|D)|D^i)}{\partial D^i} = \begin{cases} 0, & \text{if } T < D^i - 2\epsilon \\ \frac{1}{4\epsilon^2}\big((D^i)^2 - (3\epsilon + T)D^i & \\ +(2\epsilon^2 + T\epsilon)\big), & \text{if } D^i - 2\epsilon \leq T \leq D^i \\ \frac{1}{4\epsilon^2}\big(-(D^i)^2 - (3\epsilon - T)D^i & \\ +(2\epsilon^2 + T\epsilon)\big), & \text{if } D^i \leq T \leq D^i + 2\epsilon \\ 1, & \text{if } D + 2\epsilon < T \end{cases} \tag{2.29}$$

For the cases of $T < D^i - 2 * \epsilon$ and $D + 2\epsilon \leq T$, it is clear that the derivatives are 0 or 1 respectively and hence that $\widetilde{P}(D^i, I_T)$ is monotonically decreasing in D^i in these intervals.

For the case that $D^i - 2\epsilon \leq T \leq D^i$, the derivative is a positive quadratic function (U-shape) in D^i. So the derivative will take its maximum value at either of the borders of the analyzed interval.

Evaluated at $T + 2\epsilon$, the function

$$\frac{1}{4\epsilon^2}\big((D^i)^2 - (3\epsilon + T)D^i + (2\epsilon^2 + T\epsilon)\big)$$

takes the value of 0. Evaluated at T, the function takes the value of $\frac{1}{2}\big(1 - \frac{T}{\epsilon}\big)$ if $T \geq -\epsilon$. This is the maximum value that the derivative takes in the mentioned interval. ϵ is a very small positive number and T is bound to be positive by the support of D, hence the restriction is not binding.

So one can conclude that also in the interval of $D^i - 2\epsilon \leq T \leq D^i$ the expected payoff difference is monotonically decreasing.

If $D^i \leq T \leq D^i + 2\epsilon$, I find the following results. First of all, the function

$$\frac{1}{4\epsilon^2}\big(- (D^i)^2 - (3\epsilon - T)D^i + (2\epsilon^2 + T\epsilon)\big)$$

is a negative quadratic function in D^i (inverse U-shape). So it is necessary to find out how the function looks in the relevant interval, especially, whether the maximum of the function lies within it. This can be analyzed by taking the second derivative of the expected value. If it is positive over the entire interval, one knows that the analyzed interval is entirely located on the increasing branch of the function. Hence the function takes the maximum value at the upper limit of the interval. Accordingly, for an entirely negative second derivative, the interval lies in the decreasing branch and the function will take its maximum value at the lower limit of the interval. If the second derivative changes sign the situation is more complicated. Then, one has to find the maximum of the function.

In the present case, the second derivative of the expected value is

$$\frac{\partial^2 E(D\text{prob}(D^j < T|D)|D^i)}{\partial (D^i)^2} = \frac{1}{4\epsilon}(-2D^i - 3\epsilon + T)$$

This is a linear function in D^i. Plugging in the borders of the interval, one can determine the sign over the interval: At $T - 2\epsilon$, the function takes the value $\frac{1}{4\epsilon^2}(-T + \epsilon) < 0$ if $T \geq \epsilon$. As the upper bound of the dominance region where all firms invest, $\underline{D}$, is at least ϵ bigger than $\breve{D}$ and a signal within the dominance region cannot be a switching signal, the restriction of $T \geq \epsilon$ is not binding.

At T the second derivative takes the value of $\frac{1}{4\epsilon^2}(-T - 3\epsilon) < 0$ if $T > -3\epsilon$, where clearly the restriction is not binding. So the interval that one is interested in is entirely located in the declining branch of the negative quadratic function of the first derivative of the expected value. Therefore, the maximum of the first derivative will be at $D^i = T - 2\epsilon$. It is:

$$\frac{1}{4\epsilon^2}\big(- (T - 2\epsilon)^2 - (3\epsilon - T)(T - 2\epsilon) + (2\epsilon^2 + T\epsilon)\big) = 1$$

This is sufficient to proof monotonicity. One can conclude that the expected payoff difference is strictly monotonically decreasing in the private signal D^i.

To complete the evaluation of the function at the borders of the interval and thereby completing the proof of continuity of the first derivatives, I also show the value of the function at the upper bound T of the interval. Then

$$\frac{1}{4\epsilon^2}\big(-(D^i)^2-(3\epsilon-T)D^i+(2\epsilon^2+T\epsilon)\big)$$

takes on the value of $\frac{1}{2}\big(1-\frac{T}{\epsilon}\big)$ and $\frac{1}{2}\big(1-\frac{T}{\epsilon}\big)\leq 1$ if $T\geq-\epsilon$. This is the same value as when I evaluated the lower bound K for the interval $D^i-2\epsilon\leq T\leq D^i$. At all borders of intervals, the derivatives coincide; this indicates the continuity of the first derivatives and shows the smoothness of the expected value. One can show continuity for the expected value itself as well.

The above expression for the derivative of the expected value can hence be expressed as follows:

$$\frac{\partial E(D\text{prob}(D^j<T|D)|D^i)}{\partial D^i}=\begin{cases}0, & \text{if } T<D^i-2\epsilon\\ \in\big[0,\frac{1}{2}(1-\frac{T}{\epsilon})\big], & \text{if } D^i-2\epsilon\leq T\leq D^i\\ \in\big[\frac{1}{2}(1-\frac{T}{\epsilon}),1\big], & \text{if } D^i\leq T\leq D^i+2\epsilon\\ 1, & \text{if } D+2\epsilon\leq T\end{cases} \tag{2.30}$$

Adding the two terms that are dependent on D^i, one finds that $\widetilde{P}(D^i,I_T)$ is strictly monotonically decreasing in D^i. ■

Proof of Lemma 2.4

Proof. Finding the solution to Equation (2.14) implies setting $T=D^i=D^\star$ in Equation (2.27). It is straight forward that I do not have to take into consideration the cases where $T<D^i-2\epsilon$ and $T>D^i+2\epsilon$. From Equation (2.27), I see that for $K=D^i=D^\star$ the second term in the case of $D^i-2\epsilon\leq K\leq D^i$ disappears and the first term becomes

$$\int_{D^\star-\epsilon}^{D^\star+\epsilon}\frac{D}{2\epsilon}\frac{D^\star-D+\epsilon}{2\epsilon}\quad \text{dD} \tag{2.31}$$

In the case of $D^i\leq T\leq D^i+2\epsilon$, the first term disappears and the second term is identical with expression (2.31).

Solving the integral delivers:

$$=\frac{1}{4\epsilon^2}\big[\frac{1}{2}D^2D^\star-\frac{1}{3}D^3+\frac{1}{2}\epsilon D^2\big]_{D^\star-\epsilon}^{D^\star+\epsilon}$$

The above expression simplifies to:

$$\frac{D^\star}{2} - \frac{\epsilon}{6}$$

With this result, I can simplify Equation (2.14) to become

$$\widetilde{P}(D^\star) = \overline{z}^i \frac{\alpha - r - rD^\star + \overline{z}(\frac{D^\star}{2} - \frac{\epsilon}{6})}{(r - \overline{z}^i)r} = 0$$

Solving for $D^\star$ delivers the unique value

$$D^\star = \frac{\alpha - r - \frac{\epsilon}{6}\overline{z}}{(r - \frac{1}{2}\overline{z})}$$

■

2.10.3 Iterated Elimination of Dominated Strategies

One starts the elimination at the borders of the multiplicity area.

Due to the strict monotonicity in D^i, there exist unambiguous signals $\overline{D}^1 < \overline{D}^0 = \overline{D}$ and $\underline{D}^1 > \underline{D}^0 = \underline{D}$, such that:

$$\widetilde{U}(D^i, I_{\overline{D}^0}) < 0 \quad \text{for all} \quad D^i > \overline{D}^1 \quad \text{and} \quad \widetilde{U}(D^i, I_{\underline{D}^0}) > 0 \quad \text{for all} \quad D^i < \underline{D}^1$$

As $\overline{D}^0 > \underline{D}^0$, it also holds that $\overline{D}^1 > \underline{D}^1$. For the case of the upper border of the multiplicity area, this means: Given that the other firms do not invest when receiving signals above $\overline{D}^0$, the investment does not pay for signals above $\overline{D}^1$ either. One finds $\overline{D}^1$ by calculating $\widetilde{U}(D^i = \overline{D}^1, I_{\overline{D}^0})$. This process can be iterated. Given that the other firms do not invest when receiving signals above $\overline{D}^n$, it does not pay to invest at a signal $\overline{D}^{n+1}$ with $\overline{D}^{n+1} < \overline{D}^n$. The signals $\overline{D}^{n+1}$ are found by setting the expected payoff difference to 0, reflecting indifference between investment and no investment at firm i:

$$\widetilde{U}(\overline{D}^{n+1}, I_{\overline{D}^n}) = \overline{z}^i \frac{\alpha - r - r\overline{D}^{n+1} + \overline{z}E(D\text{prob}(D^j < \overline{D}^n | D) | D_i = \overline{D}^{n+1})}{(r - \overline{z}^i)r} = 0 \tag{2.32}$$

The sequence $\overline{D}^n$ is decreasing, monotone and bounded. By the common knowledge of rationality, this process is driven to its limit of $\overline{D}^\star = lim_{n\to\infty}\overline{D}^n$. Concretely, one finds a value $\overline{D}^\star$ such that

$$\widetilde{U}(\overline{D}^\star, I_{\overline{D}^\star}) = 0 \tag{2.33}$$

$\overline{D}^{\star}$ has the interpretation that above this signal all firms do not invest with certainty.

At the lower bound of the multiplicity area, the analogue situation occurs, just with the sequence $\underline{D}^{n}$ being increasing. There one iterates until one finds:

$$\widetilde{U}(\underline{D}^{\star}, I_{\underline{D}^{\star}}) = 0 \tag{2.34}$$

.

This means, one iterates until one finds a maximum [minimum] signal at which firm i is indifferent between investing and not, and which is at the same time the threshold of the switching strategy of all other firms, when starting off at $\overline{D}^{0} = \overline{D}$ [$\underline{D}^{0} = \underline{D}$].

The switching strategies $I_{\underline{D}^{\star}}$ and $I_{\overline{D}^{\star}}$ are Nash equilibria of the private information game. Milgrom and Roberts (1990) have shown that that in all games with strategic complementarity the set of strategies that resist the iterative elimination of dominated strategies are limited by Nash equilibria. Nash equilibria are not eliminated through this process. Therefore, $I_{\underline{D}^{\star}}$ and $I_{\overline{D}^{\star}}$ are the limiting Nash equilibria of the game. If $\overline{D}^{\star} = \underline{D}^{\star}$, there exists an unambiguous signal $D^{\star}$, below which in equilibrium all firms will invest and above which no one does.

2.10.4 Figures and Tables

	Industrialized Countries	Emerging Markets Countries
World Economic Survey (IFO Institute)	Australia, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, United Kingdom, Italy, Japan, Netherlands, Norway, New Zealand, Portugal, Sweden, USA	Argentina, Brazil, Chile, Columbia, Czech Republic, Ecuador, Indonesia, South Korea, Mexico, Peru, Philippines, Thailand, Turkey, South Africa
Consensus Economics Forecasts (Consensus Economics)	Australia, Canada, Switzerland, Germany, Spain, France, United Kingdom, Italy, Japan, Netherlands, Norway, New Zealand, Sweden, USA	Argentina, Brazil, Chile, Colombia, Czech Republic, Indonesia, South Korea, Mexico, Peru, Thailand, Turkey

Table 2.1: Country samples

Variables	Expected effect on crisis probability	Measures	Sources
Dependent Variable:			
Sudden stop indicator		Capital flow proxy: Monthly data on trade balance minus changes in international reserves. Evaluated in 1995 US dollars	Calvo, Izquierdo, Mejia (2004), CIM(2004): IMF: IFS
		Yearly Growth rate of Gross Domestic Product	CIM (2004): IMF: IFS
Explanatory Variable:			
Uncertainty measure	positive	Monthly data of the weigthed average of the standard deviations of the current and following year forecast of ecomic growth. The standard deviation is calculated for the expectations that experts for the specific economy utter at a particular point in time. In January the standard deviation of the current year forecasts is weighted with 11/12 and the standard deviation of the following year forecasts with 1/12. In February the current year value receives 10/12 weight and the following year one 2/12. This scheme continues until December with a weighting of 0/12 for the current year value and 12/12 for the following year value. When working with yearly data, we build the mean of the 12 monthly values.	Consensus Economics
Control Variables:			
Vulnerability to real exchange rate fluctuations	positive	As shown in Calvo, Izquierdo, Mejia (2004), the fraction of the current account deficite relative to the demand for tradable goods in an economy is a good indicator for the vulnerability against real exchange rate fluctuations. This measure can be interpreted as the percentage fall in the demand for tradables needed to close the current account gap.	CIM(2004)
		The sum of agricultural and industrial output minus exports is used to proxy imports and the part of tradable output that is consumed domestically. The share of this tradable output is built relative to total GDP at constant prices. Then the share of tradale output in total output is multiplied with the total dollar GDP.	Worldbank: WDI
		Current account deficit	IMF: WEO
Domestic Liability Dollarization	positive	Developed countries: Local asset positions in foreign currency by BIS reporting banks as a share of GDP. EMs: Dollar deposits plus bank foreign borrowing as a share of GDP.	CIM (2004): BIS, Honohan and Shi (2002), Central Banks of Australia, New Zealand, Columbia, Korea, Brazil, IMF: IFS
TOT growth	negative	Terms of trade on goods and services, annual rate of change	CIM (2004): Worldbank: WEO
Total Debt over Revenues	positive		CIM (2004)
		Devoloped countries: Public debt from OECD. EMs: WDI; Gross central government debt	OECD, Worldbank: WDI
		Revenues of the central government	IMF: WEO
Reserves over CAD	negative		CIM (2004)
		International reserves	IMF: IFS
		Current account deficit	IMF: WEO
Ex. Regime 3	positive	Exchange rate regime classification into 3 categories: 1=float, 2= intermediate, 3= fix	Levy-Yeyati and Sturzenegger (2002)
Ex. Regime 5	positive	Exchange rate regime classification into 5 categories: 1=inconclusive, 2= float, 3= dirty, 4=dirty/crawling peg, 5= fix	Levy-Yeyati and Sturzenegger (2002)
Credit Growth	negative	Credit to private sector, annual rate of change	CIM (2004): IMF: IFS
FDI/GDP	negative	Net foreign direct investment	CIM (2004): IMF: IFS
Public Balance/GDP	positive	Balance of general government	CIM (2004): IMF: WEO
M2 over Reserves	positive	Money plus quasi-money	CIM (2004): IMF: IFS

Table 2.2: List of variables

country	Mean (over time) of mean (over experts) of growth expectations by country	Max (over time) of mean (over experts) of growth expectations by country	Min (over time) of mean (over experts) of growth expectations by country	Mean (over time) of standard deviation (over experts) of growth expectations by country	Max (over time) of standard deviation (over experts) of growth expectations by country	Min (over time) of standard deviation (over experts) of growth expectations by country	Number of months that are counted as sudden stops
Argentina	3.29	6.45	-3.30	0.87	2.80	0.37	26
Australia	3.14	4.26	1.14	0.51	0.94	0.24	8
Brazil	2.69	4.67	-2.80	0.76	1.73	0.33	0
Canada	2.75	3.86	-0.15	0.42	0.70	0.15	0
Chile	5.20	8.93	2.10	0.49	0.80	0.24	12
Colombia	3.30	5.30	0.95	0.58	1.12	0.25	12
Czech Republic	2.76	5.28	0.25	0.53	0.93	0.28	3
France	2.37	3.56	0.38	0.27	0.58	0.14	0
Germany	2.02	4.06	-0.55	0.33	0.64	0.11	5
Indonesia	4.63	7.56	-7.71	1.02	3.32	0.18	11
Italy	2.07	3.37	0.62	0.24	0.51	0.06	0
Japan	1.71	4.91	-0.96	0.67	1.30	0.21	12
Mexico	3.43	5.48	-1.60	0.58	1.17	0.20	7
Netherlands	2.48	3.81	0.71	0.24	0.51	0.09	0
New Zealand	2.68	4.04	1.49	0.53	0.95	0.30	0
Norway	2.44	3.81	0.34	0.47	0.94	0.23	0
Peru	4.07	6.90	-1.35	0.67	1.20	0.30	6
South Korea	5.83	7.96	-1.40	0.82	2.11	0.20	11
Spain	2.85	4.65	0.50	0.24	0.38	0.10	9
Sweden	1.76	2.84	0.70	0.26	0.60	0.14	14
Switzerland	1.76	2.84	0.70	0.26	0.60	0.14	0
Thailand	4.15	8.53	-3.31	0.95	2.84	0.25	19
Turkey	3.23	5.38	-0.97	1.15	1.90	0.59	26
United Kingdom	2.11	3.42	-0.17	0.42	0.85	0.19	0
United States	2.53	4.13	-0.14	0.37	0.76	0.13	12

Table 2.3: Descriptive statistics

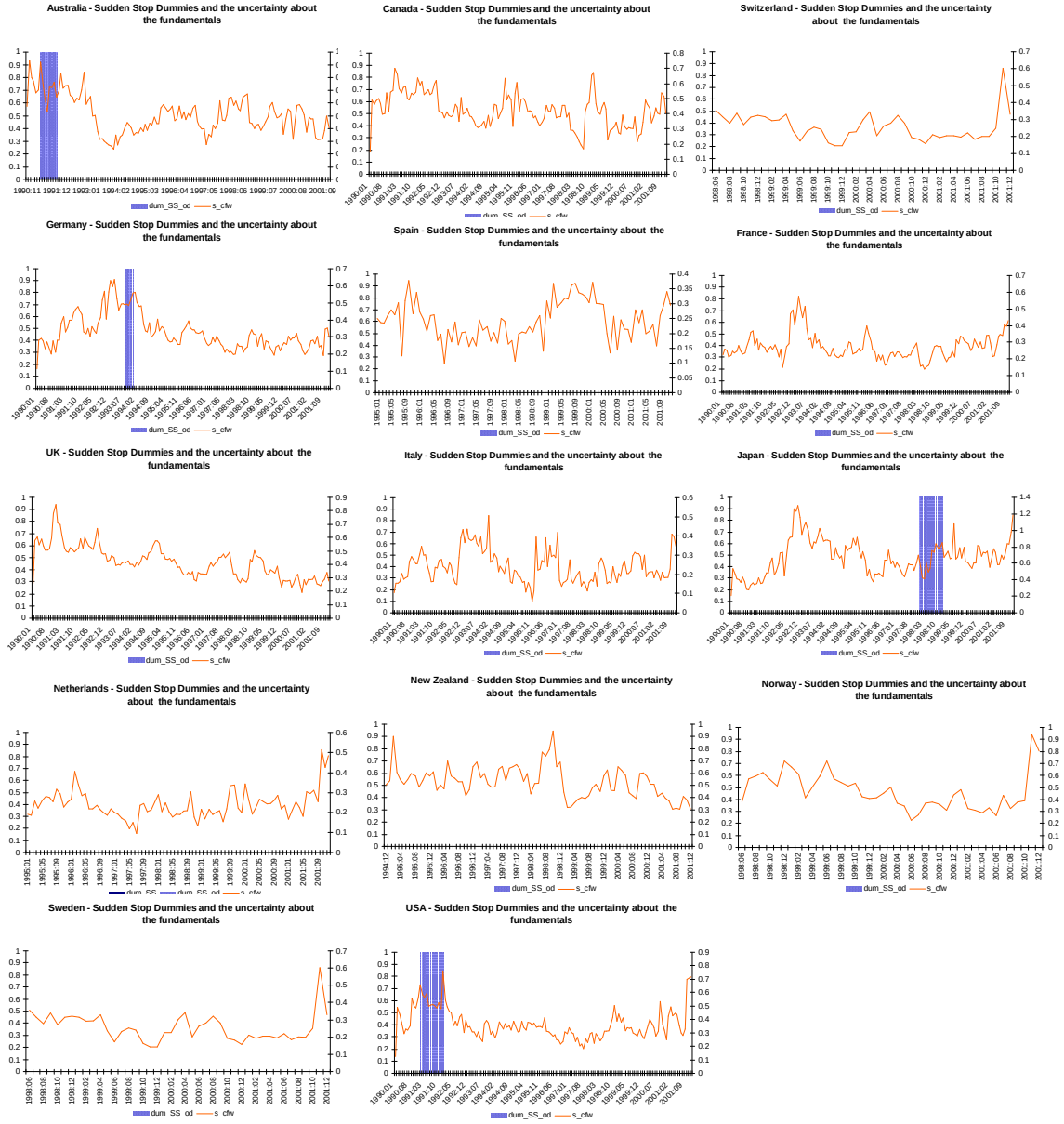

Figure 2.3: Sudden stops versus uncertainty

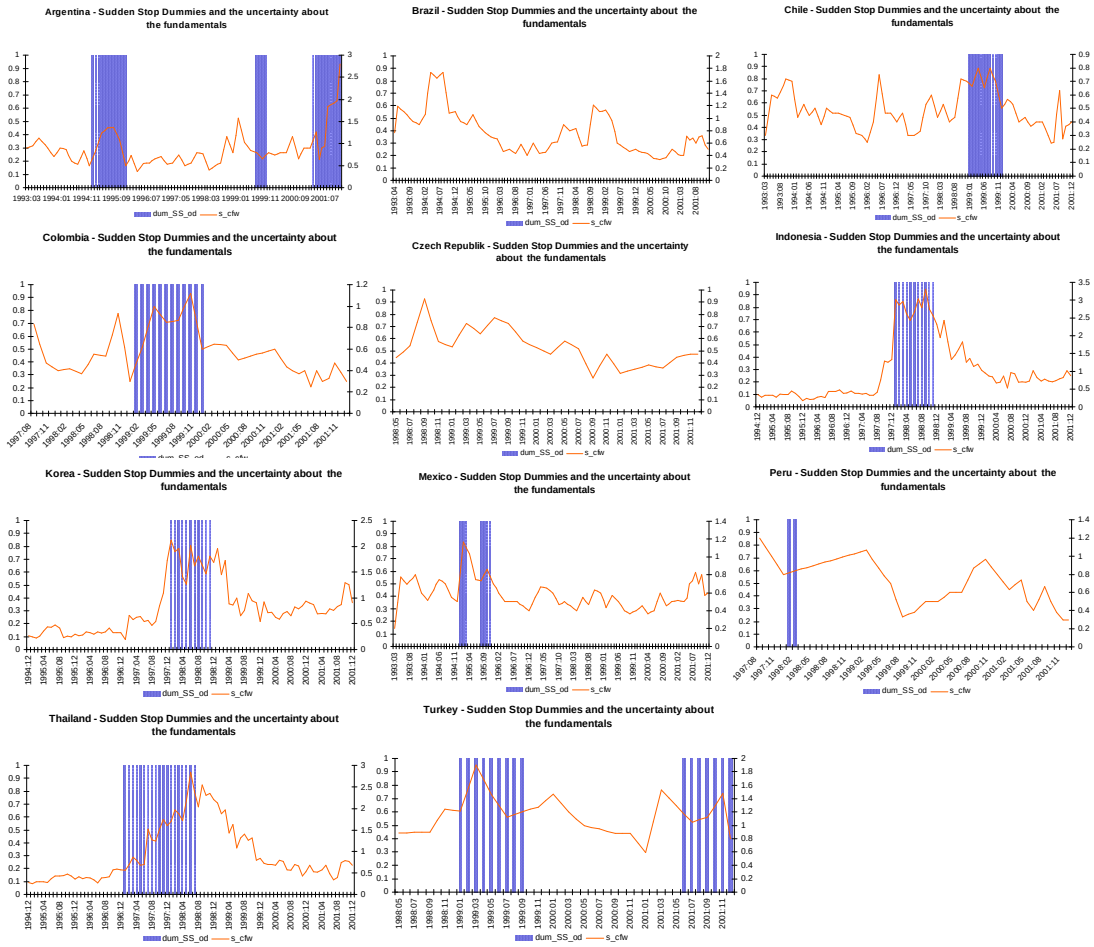

Figure 2.4: Sudden stops versus uncertainty (continued)

Pooled Probit - Yearly Data

All Countries - Dependent Variable: Sudden Stop Indicator

	Uncertainty Measure: Consensus			Uncertainty Measure: Combination Consensus WES		
	(1)	(2)	(3)	(1)	(2)	(3)
uncertainty	4.227***	4.894*	6.688*	0.632*	1.340*	1.092
	(1.104)	*(2.644)*	*(3.718)*	*(0.328)*	*(0.795)*	*(0.795)*
mean expectation	0.034	-0.565	-1.539	-0.313***	-0.697***	-0.750***
	(0.122)	*(0.425)*	*(1.035)*	*(0.080)*	*(0.252)*	*(0.261)*
lag of RER vuln	-1.104	20.705	-16.247	2.194	64.480**	58.756**
lag of DLD	-14.942***	-41.949**	-70.996**	-0.628	29.896*	30.147**
int. RER vuln DLD	114.247***	199.502**	482.341**	62.741**	-164.842	-155.958
Ex. Regime 5	-0.138	0.571	2.439	-0.169	0.632*	0.700**
lag res over CAD	0.001	0.027	0.034	-0.001	0.023	0.019
lag M2 over reserves	-0.049*	-0.089	-0.575	-0.069*	-0.210	-0.224
lag credit growth	0.112	-1.818	-4.670	0.769	4.030	2.956
lag FDI/GDP	-15.205	-35.652	-8.392	-16.397*	-19.395	-24.774
country dummies	no	yes	yes	no	yes	yes
linear time tr.	no	no	yes**	no	no	yes
quadr. time tr.	no	no	yes**	no	no	yes
Constant	-2.093**	-0.974	-5.874	-0.495	-7.947*	-8.427*
	(0.911)	*(2.917)*	*(9.658)*	*(0.764)*	*(4.313)*	*(4.507)*
Observations	194	84	84	277	137	137

Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Table 2.4: Estimation with yearly data (all countries sample)

Pooled Probit - Yearly Data

Emerging Markets - Dependent Variable: Sudden Stop Indicator

	Uncertainty Measure: Consensus			Uncertainty Measure: Combination Consensus WES		
	(1)	(2)	(3)	(1)	(2)	(3)
uncertainty	5.890***	9.637**	159.486	0.814*	2.011*	3.497**
	(1.822)	*(4.028)*	*(71,842.597)*	*(0.444)*	*(1.065)*	*(1.758)*
mean exp	0.311	-1.071	-37.497	-0.244**	-0.458*	-0.490
	(0.191)	*(1.151)*	*(4,422.012)*	*(0.100)*	*(0.268)*	*(0.421)*
lag of RER vuln	10.654	14.230	-899.803	15.429*	67.434*	124.065
lag of DLD	-13.805*	-80.466	-1,566.751	5.289	31.087	56.144
int. RER vuln DLD	82.528	438.659	9,034.767	12.653	-161.271	-455.848
Ex. Regime 5	-0.276	1.109	50.569	-0.057	0.742*	0.904*
lag res over CAD	0.022*	0.055	-0.853	0.008	0.01	0.041
lag M2 over reserves	0.089	0.024	14.904	-0.072	1.419	3.899
lag credit growth	-0.097	3.666	157.022	1.278	3.223	12.316
lag FDI/GDP	-25.805	-84.541	-1,675.585	-28.623	-9.163	-76.614
country dummies	no	yes	yes	no	yes	yes
linear time trend	no	no	yes	no	no	yes
quadratic time tr.	no	no	yes	no	no	yes
Constant	-4.838***	-0.469	-119.757	-2.392	-13.376	-40.099*
	(1.827)	*(8.049)*	*(135873.81)*	*(1.508)*	*(8.284)*	*(23.292)*
Observations	77	64	64	115	97	97

*Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.5: Estimation with yearly data (emerging countries sample)

Pooled Probit - Monthly Data

All Countries - Dependent Variable: Sudden Stop Indicator

	(1)	(2)	(3)	(4)	(5)	(6)
lag uncertainty	2.06***	1.021***	1.068***	0.473	0.503	0.551
	(0.200)	*(0.353)*	*(0.363)*	*(0.374)*	*(0.381)*	*(0.381)*
lag of mean exp	-0.198***	-0.523***	-0.544***	-0.638***	-0.648***	-0.622***
	(0.035)	*(0.062)*	*(0.065)*	*(0.071)*	*(0.072)*	*(0.072)*
lag of RER vuln	-0.525	3.494	3.956	0.455	-0.354	0.121
lag of DLD	-3.543***	-7.638***	-8.247***	-4.296	-3.567	-3.895
int. RER vuln DLD	55.443***	53.616***	55.504***	72.544***	78.018***	73.776***
Ex. Regime 5	-0.153	0.134	0.125	0.095	0.087	0.071
lag res over CAD	0.006***	0.02***	0.022***	0.023***	0.024***	0.024***
lag M2 over res	-0.003	-0.055**	-0.054**	-0.075***	-0.083***	-0.071***
lag credit growth	-1.833*	-3.28**	-3.503**	-3.927***	-4.121***	-4.174***
lag FDI/GDP	1.561	-4.023	-5.066	15.955	16.78	10.174
country dummies	no	yes	yes	yes	yes	yes
month dummies	no	no	yes	yes	yes	yes
linear time trend	no	no	no	yes***	yes	yes
quadratic time tr.	no	no	no	no	yes*	yes
cubic time tr.	no	no	no	no	no	yes
Constant	-1.894	-0.074	0.134	2.494	1.644	2.623
	(0.220)***	(0.572)	(0.631)	(0.815)***	(0.935)*	(1.155)**
Observations	2258	1217	1217	1217	1217	1217

*Standard errors in Parantheses, *significant at 10%, **significant at 5%, ***significant at 1%*

Table 2.6: Estimation with all countries sample

Pooled Probit - Monthly Data

Emerging Markets - Dependent Variable: Sudden Stop Indicator

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lag uncertainty	1.077***	1.368***	1.545***	1.140***	1.157***	1.188***	1.169**	0.941*
	(0.31)	*(0.384)*	*(0.407)*	*(0.429)*	*(0.428)*	*(0.459)*	*(0.464)*	*(0.482)*
lag of mean exp	-0.258***	-0.381***	-0.391***	-0.473***	-0.458***	-0.497***	-0.497***	-0.469***
	(0.048)	*(0.065)*	*(0.068)*	*(0.077)*	*(0.076)*	*(0.083)*	*(0.083)*	*(0.088)*
lag of RER vuln	-0.574	0.725	0.853	-2.214	-2.842	-2.231	-2.547	-2.767
lag of DLD	-0.213	-6.390**	-7.166**	-5.511	-4.338	4.212	3.845	8.354
int. RER vuln DLD	44.532***	58.712***	62.125***	78.863***	76.978***	63.848***	65.458***	58.846***
Ex. Regime 5	-0.134**	0.116	0.1	0.083	0.051	0.111	0.117	0.052
lag res over CAD	0.028***	0.016**	0.017***	0.017**	0.019***	0.032***	0.032***	0.034***
lag M2 over reserves	0.182***	0.222**	0.247**	0.260**	0.295**	0.229*	0.235*	0.225*
lag credit growth	-1.024	-2.898*	-2.577	-2.960*	-3.105*	-3.484*	-3.507*	-3.742**
lag FDI/GDP	-15.750***	-2.008	-3.53	12.357	-0.788	-20.184	-19.751	-23.257
country dummies	no	yes	yes	yes	yes	yes	yes	yes
month dummies	no	no	yes	yes***	yes*	yes***	yes	yes**
linear time trend	no	no	no	yes***	yes*	yes***	yes	yes**
quadr. time trend	no	no	no	no	yes	yes***	yes	yes**
cubic time trend	no	no	no	no	no	yes***	yes	yes**
fourth order time trend	no	no	no	no	no	no	yes	yes**
fifth order time trend	no	no	no	no	no	no	no	yes**
Constant	-1.475***	-1.163*	-1.146	0.536	-2.45	-24.872***	-18.232	-266.830**
Observations	837	689	689	689	689	689	689	678

*Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.7: Estimation with monthly data (emerging countries sample)

Table 2.8: Marginal effects for the estimation with monthly data and emerging markets

Pooled Probit - Monthly Data - marginal effects

Emerging Markets - Dependent Variable: Sudden Stop Indicator

	(1)	(2)	(3)	(4)	(5)
lag uncertainty	0.108***	0.064***	0.056***	0.025***	0.09**
	(0.037)	*(0.031)*	*(0.027)*	*(0.018)*	*(0.068)*
lag of mean exp	-0.030***	-0.026***	-0.022***	-0.010***	-0.03***
	(0.008)	*(0.008)*	*(0.008)*	*(0.006)*	*(0.017)*
lag of RER vuln	0.059	-0.124	-0.137	-0.046	-0.15
lag of DLD	-0.507**	-0.308	-0.209	0.087	0.68
int. RER vuln DLD	4.655***	4.411***	3.704***	1.324***	3.16
Ex. Regime 5	0.009	0.005	0.002	0.002	0.003
lag res over CAD	0.001***	0.001**	0.001***	0.001***	0.005***
lag M2 over reserves	0.018**	0.015**	0.014**	0.005*	0.013
lag credit growth	-0.230*	-0.166*	-0.149*	-0.072*	-0.146
lag FDI/GDP	-0.159	0.691	-0.038	-0.419	-2.23
country dummies	yes	yes	yes	yes	yes
month dummies	no	yes	yes	yes	no
linear time trend	no	yes	yes	yes	no
quadratic time tr.	no	no	yes	yes	no
cubic time tr.	no	no	no	yes	no
fourth order time tr.					no
time dummies					yes
Observations	689	689	689	689	420

*Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%*

Pooled Probit Estimation - Monthly Data

Emerging Markets - Dependent Variable: Sudden Stop Indicator

lag explanatory variables	1. lag (1)	2. lag (2)	3. lag (3)	4. lag (4)	5. lag (5)	6. lag (6)
lag uncertainty	1.188***	1.345***	1.179***	0.822**	0.35	0.038
	(0.459)	*(0.444)*	*(0.42)*	*(0.398)*	*(0.39)*	*(0.393)*
lag of mean exp	-0.497***	-0.457***	-0.395***	-0.320***	-0.240***	-0.179**
	(0.083)	*(0.081)*	*(0.077)*	*(0.073)*	*(0.071)*	*(0.072)*
lag of RER vuln	-2.231	1.692	6.294**	11.713***	19.231***	26.315***
lag of DLD	4.212	6.564	9.001*	12.190**	15.833***	17.385***
int. RER vuln DLD	63.848***	50.477***	25.93	-6.465	-48.207***	-77.978***
Ex. Regime 5	0.111	0.108	0.078	0.081	0.086	0.08
lag res over CAD	0.032***	0.033***	0.031***	0.032***	0.036***	0.040***
lag M2 over reserves	0.229*	0.218*	0.183	0.109	-0.004	-0.063
lag credit growth	-3.484*	-5.854***	-4.812***	-3.900***	-2.798**	-2.388*
lag FDI/GDP	-20.184	-19.906	-16.766	-21.202	-33.914***	-44.941***
country dummies	yes	yes	yes	yes	yes	yes
month dummies	yes	yes	yes	yes	yes	yes
linear time trend	yes***	yes***	yes***	yes***	yes***	yes***
quadratic time trend	yes***	yes***	yes***	yes***	yes***	yes***
cubic time trend	yes***	yes***	yes***	yes***	yes***	yes***
Constant	-24.872***	-27.880***	-27.670***	-27.591***	-27.948***	-28.148***
Observations	689	680	671	662	653	644

*Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.9: Different lags

Pooled Probit IV Estimation - Monthly Data

Emerging Markets - Dependent Variable: Sudden Stop Indicator

	(1)	(2)	(3)	(4)	(5)	(6)
predicted lag of uncertainty	2.593***	3.130***	3.094***	3.501***	3.432***	3.576***
	(0.59)	*(0.683)*	*(0.705)*	*(0.677)*	*(0.678)*	*(0.717)*
predicted lag of mean exp	-0.053	-0.277**	-0.309***	-0.281**	-0.281**	-0.300**
	(0.08)	*(0.11)*	*(0.114)*	*(0.115)*	*(0.113)*	*(0.119)*
predicted lag of RER vuln	16.142***	17.188***	16.971***	12.019*	9.938	12.477*
lag of DLD	2.952	-12.083**	-12.176**	-12.912**	-11.822**	-2.428
interaction RER vuln DLD	-22.008	12.921	15.717	46.79	52.266	27.906
Ex. Regime 5	-0.202***	-0.023	-0.026	-0.011	-0.027	0.043
lag res over CAD	0.036***	0.020***	0.021***	0.018**	0.018**	0.033***
lag M2 over reserves	0.069	0.12	0.145	0.187*	0.210*	0.132
lag credit growth	-1.167	-2.472	-2.121	-2.56	-2.717	-2.685
lag FDI/GDP	-21.971***	2.336	1.4	18.065	12.075	-13.036
country dummies	no	yes	yes	yes	yes	yes
month dummies	no	no	yes	yes	yes	yes
linear time trend	no	no	no	yes	yes	yes***
quadratic time tr.	no	no	no	no	yes	yes***
cubic time tr.	no	no	no	no	no	yes***
fourth order time tr.	no	no	no	no	no	no
time dummies	no	no	no	no	no	no
Constant	-3.545***	-3.139***	-2.957***	-2.720*	-4.399**	-31.161***
Observations	777	610	610	610	610	610

Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Instruments are the sixmonths lags of the uncertainty, of the mean of the expectations and of the vulnerability to real

The instruments are significant at least at the 10% level in the first stage regressions

Table 2.10: IV estimation

Emerging Markets - Dependent Variable: Sudden Stop Indicator

Method	pooled probit		logit	conditional logit, fe	Chamberlain's panel probit
	(1)	(2)	(3)	(4)	(5)
lag uncertainty	1.157***	1.188***	2.072**	1.986**	1.188***
	(0.428)	*(0.459)*	(0.846)	(0.833)	(0.459)
lag of mean exp	-0.458***	-0.497***	-0.920***	-0.888***	-0.497***
	(0.076)	*(0.083)*	*(0.157)*	*(0.153)*	*(0.083)*
lag of RER vuln	-2.842	-2.23	-4.111	-3.863	-2.231
lag of DLD	-4.338	4.212	7.987	7.808	4.212
int. RER vuln DLD	76.98***	63.85***	118.33***	113.38***	63.85***
Ex. Regime 5	0.051	0.111	0.155	0.146	0.111
lag res over CAD	0.019***	0.127***	0.056***	0.054***	0.032***
lag M2 over reserves	0.295**	0.229*	0.399*	0.373	0.229*
lag credit growth	-3.105*	-3.484*	-7.421**	-7.466**	-3.484*
lag FDI/GDP	-0.788	-20.184	-36.482	-35.420	-20.184
country dummies	yes	yes	yes	no	no
month dummies	yes	yes	yes	yes	yes
linear time trend	yes	yes	yes***	yes***	yes***
quadratic time tr.	yes*	yes	yes***	yes***	yes***
cubic time tr.	no	yes	yes***	yes***	yes***
Constant	-2.45	-24.872***	-46.077***	no	-28.798***
Observations	689	689	689	689	837

*Standard errors in Parantheses, *significant at 10%, **significant at 5%, ***significant at 1%*

Table 2.11: Alternative estimation methods

Focal crises - Headline crises - (large IMF packages, defaults, currency crises)

						measures				
				Output		Private Net Flows on Debt 5/	Net Private Capital Flows		Net Private Capital Flows plus Net Errors and Omissions	
Country	year	What defined crises	IMF-supported Programs/Aid packages	((GDPt - GDPt-1) /GDPt-1)*100	((GDPt+1 - GDPt-1) /GDPt-1)*100,	Global Development Finance 2/	WEO 3/	BOP YB 4/	WEO 3/	BOP YB 4/
the 70s										
Peru	1978	sovereign default, Currency crisis (FR), no banking crises	1978: IMF stabilization program+ multilateral rescheduling with official and private creditors	0.08	5.68	-6.89	-4.75	-5.93	-4.32	-4.77
Turkey	1978	sovereign default, no currency crises, fall in Central bank reserves, 1982-85 Systemic banking crisis		2.83	1.93	-5.89	-2.65	-1.61	-2.88	-2.01
United Kingdom	1974-76	Currency Crisis in 1976 (ERW), Borderline and smaller banking crisis		-1.70	-2.38		5.08	2.24	5.08	2.25
Zaire	1978	Sovereign default since 1976, Enormous amounts of external debt lead to Paris Club reschedulings in 1979 as well as 1981 and with a syndicate of commercial banks in 1980, Currency Crisis in 1979 (MR and BP), 1980s Systemic banking crisis		-5.30	-5.02	-0.21	-6.86		-6.69	
crises countries 80s										
Argentina 1982-88	1982	sovereign default, Currency Crises in 1981 (MR1, FR, GKR) and 82 (FR, BP, GKR), 1980-82 Systemic banking crisis, 1989-90 Systemic banking crisis, hyperinflation		-3.15	0.47	0.24	0.18	-0.11	0.16	-0.23
Bolivia	1980	sovereign default in 1980, hyperinflation, Spring 1984 suspension of interest payments to commercial banks, Currency Crises in 1980 (MR2), 1982 (MR, FR, BP, GKR), 83 (FR, BP, GKR), 84 (FR) and 85 (FR, BP, GKR),1986-88 Systemic banking crisis		0.61	1.54	-10.13	-12.29	-2.40	-19.60	-14.72
Brazil	1982	sovereign default 1983, Currency Crisis in 1982 (BP) and 83 (FR, BP, GKR), no banking crisis	Brady Plan: Brazil Parallel Financing agreement, terms announced Sep 1988	-4.36	-8.63	0.24	-0.69	-0.41	-1.12	-0.38
Bulgaria 1990	1989	No sovereign default but during second half of 80s build up of large external debt in order to finance enlarging current account deficit. no data on currency crises available, but exhaustion of foreign reserves. 1995-97 Systemic banking crisis	Brady Plan: Bulgaria Brady, terms announced Mar 1994	-0.50	-9.55	0.68	-0.30	-3.88	0.49	-2.01
Chile (Cline p. 287	1982	Sovereign default in 1983, Currency Crises in 1982 (MR, FR, GKR) and 83 (FR), 1981-86 Systemic banking crisis		-13.42	-16.44	-5.50	-9.57	-10.03	-9.95	-10.49
China	1990	Currency Crises 1990 (MR), 1991 Systemic banking crisis		3.80	13.35	1.14	-1.74	-0.21	-2.46	-0.95
Colombia (Cline p	1983	No Sovereign default, Currency Crises in 1983 (GKR) 1985 (BP and GKR), 1982-87 Systemic banking crisis		1.57	4.98	-1.88	-3.21	-2.56	-3.72	-3.33
Costa Rica	1981	Sovereign default, Severe balance of payment crisis, Currency Crises in 1981 (MR and FR), no banking crisis	Brady plan: Costa Rica Brady terms announced May 1990	0.80	-6.25	-8.41	-7.07	-10.07	-9.32	-7.19
Cote d'Ivoire	1984	Sovereign default, no Currency Crisis, Systemic banking crisis from 1988-91	Brady plan concluded in 1997	-2.00	1.55	0.38	-25.75	-13.32	-20.19	-12.80
Ecuador	1982	Sovereign default, Currency Crises in 1983 (MR2), 84 (MR1) and 86 (MR, FR),1980- 83 Systemic banking crisis	Brady plan:Ecuador Brady, terms announced May 1994	1.20	-1.63	-7.93	0.93	7.40	3.46	2.30
Korea (Sachs, p. 12	1980	No Sovereign default, but in 1981world's fourth largest debtor country. Currency Crisis in 1980 (MR, BP and GKR), Doubling of inflation from 14.4 % in 1978 to 28.7 % in 1980.		-2.09	4.24	-0.11	0.77	1.99	6.74	1.83
Jordan	1989	Sovereign default on loans to commercial banks, Currency Crisis (MR1, FR, BP), Non systemic banking crisis	Brady Plan: Jordan Brady, terms announced in July 1993	-13.45	-7.29	24.74	-41.37	-3.59	-34.87	-5.61

Table 2.12: Headline crises from 1970 - 2000

Focal crises - Headline crises - (large IMF packages, defaults, currency crises)

				Output		**measures** Private Net Flows on Debt 5/	Net Private Capital Flows		Net Private Capital Flows plus Net Errors and Omissions	
Country	**year**	**What defined crises**	**IMF-supported Programs/Aid packages**	((GDPt - GDPt-1) /GDPt-1)*100	((GDPt+1 - GDPt-1) /GDPt-1)*100,	Global Development Finance 2/	WEO 3/	BOP YB 4/	WEO 3/	BOP YB 4/
the 90s till present										
Argentina	1995	Contagion from Mexican crisis, background currency board without deposit incsurance scheme and without lender of last resort: withdrawal of bank deposits, significant loss of central bank's gross reserves, liqidity crunch, surge in interest rates, output contraction, Systemic banking crisis	X / EFF	3.85	7.79	5.36	-1.16	-1.88	-1.91	-2.38
Argentina	2001-2	sovereign default, no data on currency crisis, 2001-present Systemic banking crisis		2.10	5.27		-7.19	-4.28	-5.02	-5.06
Brazil	1998	No sovereign default, Currency crises in 1999 (MR1), substantial curret account deficit, surge of interest rates, outflow of capital, Output contraction, 1994-9 Systemic banking crisis	X/ SBA/ SRF, new arrangement, 12/2/98, X / SBA/SRF, new arrangement, 9/14/01,	0.13	0.92	0.07	0.41	0.82	0.31	0.85
Ecuador	1999	El Nino crisis, default on external and internal debt, Currency Crises in 1999 (MR1), 1998-present Systemic banking crisis		-6.30	-3.67	-4.26	-16.63	-13.47	-14.09	-15.36
ERM	1992/1993	Currency Crises: Denmark 93 (GKR), Finland 92 (GKR, ERW), Ireland 92 (ERW), Italy 92 (ERW), Portugal 93 (MR1), Spain 92 (GKR) and 93 (GKR), Sweden 92 (ERW), UK 92 (ERW)		0.00	0.00					
Finland	1991-94	No sovereign default, Currency Crisis in 1991 (GKR) and 92 (GKR, ERW), Systemic banking crisis		-6.26	-9.37		-3.20	-5.88	-1.55	-4.19
Indonesia	1997-98	no sovereign default, consequence of unresolved capital account crisis, important short-term private sector external debt, depreciation, hyperinflation, runs on deposits, collaps of corporate balance sheets, sharp economic contraction, Currency Crisis in 1997 (MR2, BP, GKR), 1997-present Systemic banking crisis	X/ SBA, new arrangement, 11/5/97	4.54	-9.18	-2.92	-0.90	-3.71	0.95	-5.46
Korea	1997-8	No sovereign default, but high level of short term private foreign debt, Curreny Crisis in 1997 (MR2, FR, BP, GKR) and 98 (MR1)	X/ SBA/SRF, new arrangement, 12/4/97	5.01	-2.01	-6.32	-8.52	-4.54	-9.70	-5.72
Mexico	1994-5	Tequila crisis. No sovereign default, Currency Crisis in 1994 (BP, GKR) and 95 (MR), 1994-97 Systemic banking crisis	X / SBA, new arrangement, 2/1/95	-6.17	-1.33	0.10	-4.09	-4.32	-2.67	-2.90
Malaysia	1997-8	No sovereign default, interest rate surge, real GDP contraction, Currency Crisis in 1997 (FR, BP), 1998 (MR1), 1997-present Systemic banking crisis		7.32	-0.57	1.39	-7.82	-7.17	-7.55	-4.83
Norway 1987-93	1989	No sovereign default, currency crisis in 1986 (ERW), Systemic banking crisis		0.90	2.92		-2.69	-2.94	-2.85	-3.10
Pakistan	1999-2000	Sovereign default, Eurobond exchange, no Currency Crisis in 1999, 2000 n.a., no data on banking crisis		3.96	7.57	-0.72	-1.06	0.97	-0.49	0.57
Phillipines	1997	No sovereign default, Currency Crisis in 1997 (FR, GKR), 1998-present Systemic banking crisis	X/ EFF	5.19	4.58	2.55	-4.83	-4.82	-7.60	-7.54
Russia	1998	Sovereign default 1998-99, interest rate surge, Currency Crises in 1998 (GS), 1998-9 Systemic banking crisis	EFF/SFR/CCFF, Augmentation and Extension, 7/20/98	-4.90	0.24	2.90	0.26	1.46	-0.51	0.47
Sweden	1991	No sovereign default, Currency Crisis 1992 (GKR), Systemic banking crisis		-1.11	-2.83		-4.02	-9.30	-4.02	-4.67
Thailand	1997-8	No sovereign default, but roll over of short term debt stopped, Currency Crisis in 1997(MR2, FR, BP, GKR), 1997-present Systemic banking crisis	X/ SBA, new arrangement, 8/20/97	-1.37	-11.74	-7.11	-18.42	-12.75	-18.54	-13.05
Turkey	1994	No sovereign default, interest rate surge, Currency Crisis in 1994 (BP, GKR), Non systemic banking crisis	X/ SBA	-4.97	1.57	-9.47	-4.45	-6.19	-4.45	-4.23
Turkey	2000	No sovereign default, no data on currency crisis available, 2000-present Systemic banking crisis	X / SBA/SRF, augmentation, 5/15/01, SBA, new arrangement, 2/4/02	7.36	-0.69	1.18	-1.33	3.75	-1.33	1.53

Table 2.13: Headline crises from 1970 - 2000 (continued)

Chapter 3

The Uncertainty About the Fundamentals and the Spread of Stock Market Crises

3.1 Introduction

Financial crises in emerging markets in recent years have been especially centered around the Mexican (December 1994), the Thai (July 1997), and the Russian (August 1998) crises. Financial markets witnessed a similar accumulation of crises in developed countries in the context of the crisis of the European Exchange Rate Mechanism (September 1992).[1] These periods of crises concentration suggest contagion effects across countries.

Because of the high costs of these financial crises in emerging markets, researchers and practitioners have been exploring these cases. Specifically under investigation are the mechanisms through which crises spread, the factors that render countries vulnerable to contagion, and, most importantly, which policies might help prevent contagion.

This chapter addresses these questions by analyzing one particular mechanism of the spread of crises: the contagion of crisis through uncertainty about the fundamentals. This chapter focuses on financial crises characterized by a severe plunge in stock market returns.

[1] See, for example, Broner et al. (2006), Caramazza et al. (2004), or Kaminsky et al. (2000) for the dates of the crises.

It can be observed that, after a number of crises, the disagreement about the fundamentals in other markets – especially those markets that are later on themselves hit by a crisis – increases. Figure 3.1 illustrates this observation in the case of the Thai crisis in 1997.[2] As illustrated in the graph, the uncertainty not only increases in Thailand after the crisis, but also in neighboring countries. Korea, for example, is characterized in the data by a build-up of uncertainty after the Thai crisis. Korea is then hit by a currency crisis in November 1997. In addition, Figure 3.1 shows that the crisis in Thailand does not have an effect on the degree of uncertainty in Taiwan and the UK, neither were these countries economically strongly affected by the crisis.

However, in the case of other financial crises, careful scrutiny reveals that uncertainty about the fundamentals decreases in other markets after the crisis in the initial market. For example, this is the case in the period around the Argentinean crisis in 2002, which is illustrated in Figure 3.2.

The recent literature distinguishes between surprise crises as, for example, the Thai crisis in 1997 and anticipated crises as, for example, the Argentinean crisis in 2001/2002. This literature argues that the international repercussions of the anticipated crises in Brazil (January 1999), Turkey (February 2001), and Argentina (December 2001) were much less important than those after the crises in Mexico (December 1994), Thailand (August 1997), and Russia (August 1998).[3]

This chapter picks up this distinction and shows that surprise crises increase uncertainty about fundamentals in other countries, thereby resulting in a higher probability of crises there. In contrast, the occurrence of anticipated crises decreases disagreement about the state of the fundamentals in other countries, thereby lowering the probability of a crisis there.

This chapter contributes to the literature in two ways: First, uncertainty about the fundamentals is theoretically illustrated as a factor transmitting

[2]The left Y-axis displays the crisis variable. The two bars in the figure show the two most pronounced crisis events in the Thai crisis: First, the severe devaluation of the Bath in the beginning of July 1997 and second, the substantial drop in stock market returns one month later. The dates are chosen in accordance with Kaminsky et al. (2000) and Goldstein (1998). The right Y-axis displays the uncertainty about the fundamentals in the tracked economies. Uncertainty is measured by the standard deviation of growth forecasts for the current and following year, by financial analysts within the tracked countries. For more details on this measure, please refer to Appendix 3.6.

[3]See Kaminsky et al. (2000) or Didier et al. (2006)

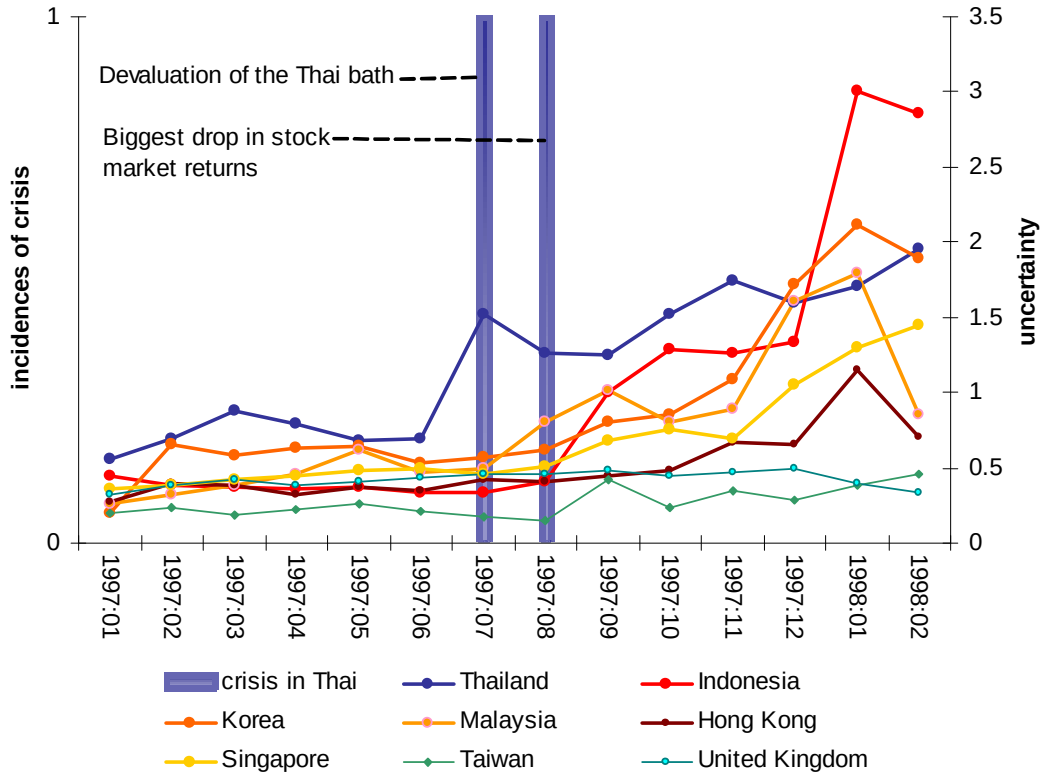

Figure 3.1: Uncertainty in the surroundings of the Thai crisis

crises across markets. Second, predictions of the theoretical model are validated empirically. The role of uncertainty about the fundamentals has been neglected in the existing literature on contagion. So far, common investors have been detected as the main reason of the spread of financial crises between economies. While early research focused on trade linkages[4] and on macroeconomic similarities between economies[5], more recent analyses converge to the view that common creditors are at the core of contagion. This view is supported by a large number of empirical analyses.[6]

Based on the insight into the role of common investors, the theoretical literature suggests different propagation mechanisms. Research thus far examines

[4]See, for example, Gerlach and Smets (1996).
[5]See, for example, Goldstein (1998).
[6]See, for example, Van Rijckeghem and Weder (2001) and Caramazza et al. (2004).

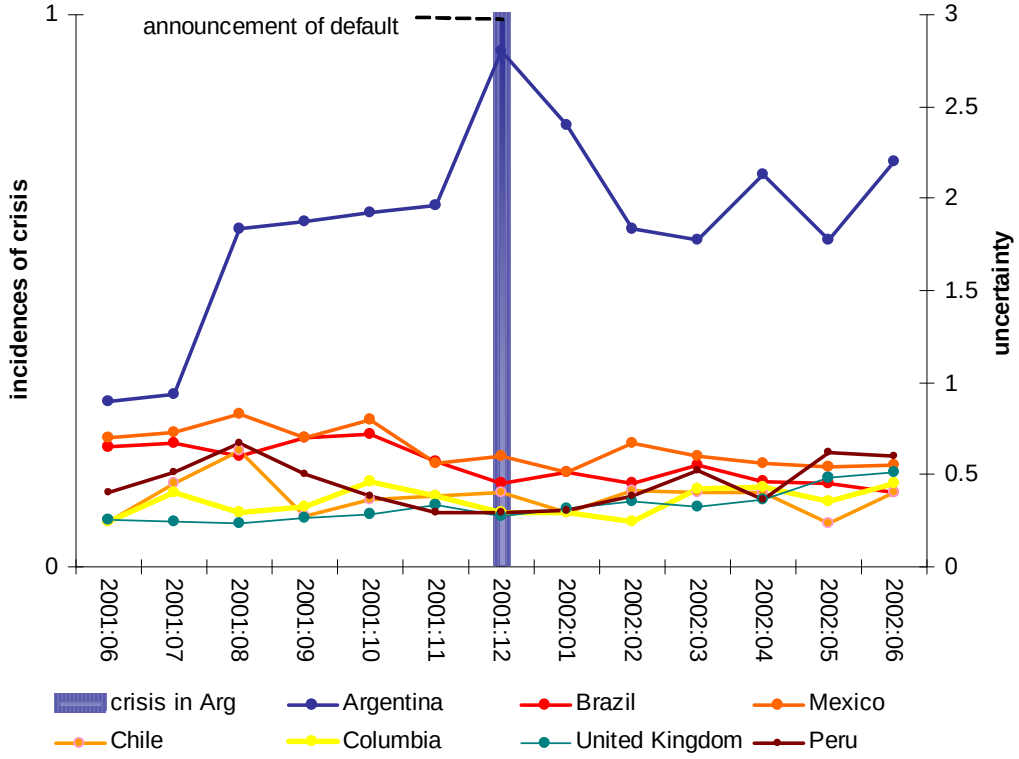

Figure 3.2: Uncertainty in the surroundings of the Argentinean crisis

herding due to fixed information cost[7], differently informed investors[8], changes in investors' risk aversion[9], and wealth effects[10] as possible propagation channels for crises.

Following Goldstein and Pauzner (2004), I model the financial crisis in country B as a coordination game between private investors. The reason for using a coordination game is that the setup of a coordination game is well suited to analyze the effect of uncertainty about the fundamentals. The present model differs from the Goldstein and Pauzner (2004) setup in two crucial ways. The first difference concerns modeling the initial-crisis country and the potentially-affected subsequent country. While Goldstein and Pauzner

[7]See Calvo and Mendoza (2000).
[8]See Kodres and Pritsker (2002).
[9]See Broner et al. (2006).
[10]See Goldstein and Pauzner (2004).

(2004) explicitly model the sequence of two bank-run crises of the Diamond and Dybvig (1983) type, I focus on the second economy exclusively. I model the occurrence of a crisis in the second country, assuming that either a surprise crisis takes place in the first country or an anticipated crisis.

The second difference concerns the mechanism through which the crisis spreads. In Goldstein and Pauzner (2004), the crisis spreads due to a wealth effect. In my setup, the change in uncertainty about the fundamentals transmits the crisis. I assume that uncertainty about the fundamentals increases in the second country if a surprise crisis hits the first country. Further, I assume that uncertainty decreases if an anticipated crisis occurs in the first country. The illustrative model in this chapter is then used to show that an increase in uncertainty increases the probability of a crisis in the second country while a decrease in uncertainty makes a crisis less likely there.

This study offers two justifications of the assumption that a surprise crisis in an initial-crisis country increases the uncertainty in another country: The first justification is the empirical evidence presented in Figures 3.1 and 3.2. The second justification is the following line of arguments: If a crisis hits a country by surprise, i.e., without investors expecting the event, investors learn that they did not put sufficient effort into information processing given existing data-processing technology. If they want to predict crises in other countries, they have to increase their investment in information processing. However, a number of the investors realizes losses in the first country and, hence, are less inclined to invest in the second economy.[11] Given the assumption that the payoff of one agent positively depends on the fraction of other agents investing, i.e., that strategic complementarity prevails between investments, this leads to all agents optimally choosing to spend less on their information processing after the crisis in the first country.[12] As a result, all agents receive more dispersed signals about the true value of the fundamentals.

This mechanism about how the degree of uncertainty depends on a crisis in a first country works in the opposite direction if an anticipated crisis materializes. In this case, investors' trust in their information processing is strengthened and they are willing to spend a higher amount on gathering information, despite the crisis in the first market. This higher effort in information processing, in turn, leads to more precise signals.

[11] This is an outcome of the model by Goldstein and Pauzner (2004).

[12] The assumption of strategic complementarity is common in the global game literature.

The model in this chapter illustrates the presence of contagion in a coordination game: In country B, infinitely many investors (agents) have one unit of endowment available for investment there. If they choose not to invest, they receive a certain return of zero. In case that they invest, the return depends positively on the fraction of other agents who invest. In addition, the return decreases with an increasing level of the fundamentals. A high level of fundamentals indicates high costs of investing (this could be due to high political instability or high transaction costs). The fundamentals of the economy are uniformly distributed over a finite support. However, investors cannot observe the true realization of the fundamentals but receive a private signal that is symmetrically and uniformly distributed around the realization of the true fundamentals. This means that investors base their investment decisions on the expected return, given their private evaluation of the fundamentals.

This information structure yields a threshold equilibrium in terms of the fundamentals in B and the outcomes in A. Below the threshold, the investors coordinate on investing; above, no one invests. Comparative static analysis shows that the threshold is a decreasing function of the dispersion of the private signals. The dependence of the uncertainty in B on the crisis in A together with the result of the comparative static analysis of the threshold in B are sufficient to illustrate the existence of contagion: A surprise crisis in country A increases the dispersion of the private signals, i.e., the support of the private signals around the true value of the fundamentals, in B and hence, decreases the threshold there. The decrease in the threshold means that coordination on the bad equilibrium becomes more likely, i.e., a crisis becomes more probable. In the case of an anticipated crisis in country A, the opposite is true.

To validate empirically the uncertainty channel of contagion, I construct a rich data set for 38 countries with monthly time series (December 1993 to September 2005). This country sample and the associated time frame enables the inclusion of the following six pronounced crisis periods into the analysis: Mexico (1994), Thailand (1997), Russia (1998), Brazil (1999), Turkey (2001) and Argentina (2001). The two main variables in the data set are a stock market crisis dummy and an uncertainty measure. A stock market crisis is detected by significant negative variation in stock market returns. The monthly stock market returns that serve as a basis for the crisis dummy are computed from the IFC (International Finance Corporation) investable US dollar total

return index.[13] When necessary, I complete the returns with data from MSCI (Morgan Stanley Capital International) or national sources. As in the previous chapter, the measure of uncertainty is the standard deviation of GDP growth forecasts between country experts. Additionally, I employ a large set of domestic control variables and alternative channels of contagion.

I proceed in two distinct steps. Firstly, I use fixed-effects panel estimations to establish the link from the initial crisis in country A to the uncertainty in other countries B. I control for country and time effects, running various robustness checks. Secondly, I quantify the effect of uncertainty in those economies on the probability of a crisis there. For this second step, I employ pooled probit estimation, controlling for country and time effects. Again, I control for potential domestic drivers of crises. Finally, as a check for alternative channels of contagion, I control for contagion through common creditors, trade links, the size effect of the initial stock market, and for overexposed common fund investors.

The empirical analysis in this chapter expands the existing empirical literature on the spread of crises in several respects. First, the effect of uncertainty in the context of the spread of crises has been neglected so far. Second, as the panel data spans a larger time horizon, I can consider a larger number of crises periods.[14] Third, I control for a large number of alternative contagion channels, adapting them to the particular kind of crises analyzed – namely, substantial stock market drops. Fourth, including control for time effects results in very strict tests for the transmission channels of crises. The time-effects control takes care of all effects present at a particular point in time. In case of all emerging markets, the time-effects control for increases in the interest rates in the financial centers. Not all of the alternative contagion channels controlled for remain significant when controlling for time effects.

The analysis yields two main empirical findings. The first finding is that uncertainty about the fundamentals is a propagation mechanism of contagion, if the first country is hit by a surprise crisis. The first step of the analysis finds that the Mexican, Thai, and Russian crises increase the uncertainty in potentially-affected countries. The effect is stronger within the region where

[13]The investable indices take into consideration restrictions on foreign investment. Therefore, this measure represents the part of the national stock markets accessible to foreign investors, which is relevant in the context of contagion.

[14]For example, Van Rijckeghem and Weder (2001) only consider the Mexican, Thai, and Russian crises, while Broner et al. (2006) analyze the Thai, Russian, and Brazilian crises.

the crises occur; the effect appears more pronounced in countries nearer to the initial crises country. The second step of the analysis finds that the effect of uncertainty on crisis probability in countries B is positive, significant, and, as shown by marginal effects, not negligible in size.

The second finding is that in the case of an anticipated crisis, uncertainty about the fundamentals in the second economy is decreased, which, in turn, decreases the probability of a crisis there. The first step of the analysis yields the following result: The Brazilian, Turkish, and Argentinean crises decrease the uncertainty in the potentially-affected countries. The effect is stronger within the region where the crises occur and in countries closer to the initial-crisis country. The second step of the analysis confirms that the effect of uncertainty in the potentially-affected countries on the probability of a crisis there is positive, significant, and not negligible.

These findings have several implications. The first, obvious implication is that a close monitoring of the fundamentals in the resident country and also of other countries is crucial. Particularly other countries in the first-country region and geographically close ones should be focused on. Surprise crises seem to be especially bad because they set off mechanisms that further worsen the situation. This chapter illustrates such a mechanism through the uncertainty about the fundamentals. The second implication is that, once a surprise crisis has hit a first country, policy makers in potentially-affected countries should move toward policies that diminish the potential increase in uncertainty. One venue could be to develop mechanisms for such situations through which governments could credibly disseminate very precise information about the state of their economy so that the private signals get as precise as possible. One could even start to think about subsidies for information-gathering technology.

The chapter is organized as follows. In section 3.2, I describe the model. In section 3.3, I present the empirical analysis. Section 3.4 explains policy implications while section 3.5 contains the conclusion.

3.2 The Model

This section presents a simple coordination game to illustrate the occurrence of contagion between two markets that are uncorrelated in terms of their fundamentals. The focus of the model is on the potentially-affected country. In

an investment game, I illustrate that a crisis in country B becomes more probable after a surprise crisis in country A and becomes less probable after an anticipated crisis materializes in a first country. The transmission functions through the uncertainty about the fundamentals. For the theoretical illustration of this channel, three ingredients are necessary. A first ingredient is that the dispersion of private signals in country B increases due to a surprise crisis in country A and, conversely, that dispersion of private signals decreases due to an anticipated crisis in country A. In this study this effect of a crisis on uncertainty about the fundamentals is introduced as an assumption.[15]

The second ingredient is a unique threshold equilibrium in terms of the fundamentals of the economy, so that it is possible to attribute to each level of the fundamentals the realization of the investment or the non-investment equilibrium. Once this unique threshold equilibrium is determined, the third ingredient is the comparative static analysis of the threshold equilibrium with respect to the uncertainty about the fundamentals. If the threshold shifts with changes of the uncertainty, contagion is present.

The assumption that a surprise crisis in an initial-crisis country increases uncertainty about the fundamentals in another country can be justified by the empirical evidence presented in the introduction to this chapter. Additionally, it could be argued that investors learn after a surprise crisis that they did not put sufficient effort into information processing, given existing data-processing technology. If investors want to predict crises in other countries, they must increase investment in information processing. However, a number of the investors realize losses in the first country and, hence, are less inclined to invest in the second economy.[16] Given the assumption that the payoff of one investor depends positively on the fraction of other agents investing, i.e., that strategic complementarity prevails between investments, this leads to all investors choosing optimally to spend less on information processing after the crisis in the first country.[17] As a result, all investors receive more dispersed signals about the true value of the fundamentals. The mechanism works in the opposite direction if an anticipated crisis materializes in the initial-crisis country. In this case, investor trust in information processing is strengthened. Therefore, investors are willing to spend a higher amount on gathering infor-

[15]It is an interesting topic for future research to explicitly model this effect.
[16]This is an outcome of the model by Goldstein and Pauzner (2004).
[17]The assumption of strategic complementarity is common in the global game literature.

mation despite the crisis in the first market. This in turn leads to more precise signals.

The notion of a surprise crisis and an anticipated crisis in the first crisis country are absent in the setting of Goldstein and Pauzner (2004). However, the idea of the distinction between surprise crises and anticipated crises is consistent with the setup of a global game. Think of a surprise crisis in the following way: If the prior expectation about the value of the true fundamentals is lower than the threshold equilibrium, investors, on average, expect that no crisis will happen. If the fundamentals are then realized in the range above the threshold, this realization can be interpreted as a surprise crisis. On the other hand, if the prior expectation about the value of the true fundamentals is higher than the threshold equilibrium, investors expect the bad equilibrium to be realized. If is the bad equilibrium is then realized, this can be interpreted as an anticipated crisis.

3.2.1 Model Setup

Here, I describe the game in country B taking as a given the outcomes in the initial crises country A.[18]

As with the fundamentals in the previous chapter, in this chapter the investment environments are assumed to be uniformly distributed over the finite interval $\theta \sim [\breve{\theta}, \hat{\theta}]$. A high value of the fundamentals θ signifies an adverse environment for investment with high investment obstacles.

There is a continuum of $[0, 1]$ identical investors . Each investor decides whether to invest 1 unit or not. If an investor does not invest, he receives a certain return of 0. If he decides to invest, he receives an uncertain return of $P(\theta, \pi^{-i})$, which depends negatively on the level of fundamentals θ and positively on the fraction of other investors that invest in B, π^{-i}. A strategy is defined as $\pi^i : [\breve{\theta}, \hat{\theta}] \rightarrow [0, 1]$, which means that investor i invests in state θ with probability $\pi^i(\theta)$. Due to the mass of agents being 1, the fraction of agents who invest at a particular state of fundamentals can be expressed as $\int_0^1 \pi^j(\theta)dj = \pi^{-i}(\theta)$ for $j \neq i$. The positive dependence on the fraction of other agents investing, i.e., strategic complementarity between the agents, can be

[18]The investment game in country B is a straight application of the theory of global games by Carlsson and van Damme (1993). Similar investment games have been used in the literature, for example, by Heinemann (2005).

explained by increasing returns on aggregate investment. These assumptions are reflected by the following payoff function of investor i:

$$P = R\pi^{-i}(\theta) - \frac{1}{2}\theta^2 \tag{3.1}$$

in which $R\pi^{-i}(\theta)$ stands for the simplest form of a return that is positively dependent on the fraction of other agents investing. Further, the last term can be interpreted as a cost of investing that increases exponentially with the worsening of the investment environment.

An investor decides whether to invest or not to invest in a country after receiving information about the fundamentals of the country. Assuming that the fundamentals are not common knowledge, each investor privately interprets publicly available information. The investors thus act upon their private signals. The private signals are uniformly distributed in an η surrounding of the true fundamentals θ: $\theta^i \sim U[\theta - \eta, \theta + \eta]$. Now, the variance of the signals depends on the outcomes in country A. In the case of a surprise crisis in country A, the private signals are uniformly distributed in an $\eta + c$ surrounding of θ, with c being a small positive number. In case of an anticipated crisis in A, the private signals are uniformly distributed in an $\eta - d$ surrounding of θ, with d being a small positive number.

An investor is more likely to invest if 1) the obstacles to invest are lower and 2) if a large number of other investors invest in the same country. However, in line with global games literature, I assume that there are small ranges at the extremes of the support of the fundamentals where investors have dominant strategies. If the fundamentals are very good, i.e., if the investment obstacles are very low, it is optimal for an investor to invest irrespective of the actions of all the other investors. On the other extreme, if the state of the fundamentals is very adverse to investment, then it is the optimal strategy of an investor not to invest, irrespective of the actions of the other investors.

Formally, this assumption means that the support of the fundamentals has to exceed the border of the dominance region by at least 2η: $\breve{\theta} + 2\eta < \underline{\theta} < \overline{\theta} < \hat{\theta} - 2\eta$, in which $\underline{\theta}$ stands for the border of the lower dominance range and $\overline{\theta}$ stands for the border of the upper dominance range. This condition ensures that an investor is indifferent between investing and not investing at the borders of the dominance ranges. At the border of the dominance region at the high end of the support, the investor is indifferent, even if the fraction of other agents investing equals 1, $P(\overline{\theta}, 1) = 0$. At the border at the dominance

region at the low end of the support, the investor is indifferent even if no one else invests, $P(\underline{\theta}, 0) = 0$. When an investor receives a signal $\theta^i < \underline{\theta} - \eta$, he knows that his payoff $P^i > 0$, no matter what all the other investors are doing. Therefore, he will invest. Analogously, if he receives a private signal $\theta^i > \overline{\theta} + \eta$, he knows that $P^i < 0$, no matter what all the other investors are doing. Therefore, he will not invest. In contrast, between the borders of the dominance regions, the payoff of an investor depends on the actions of other investors. This results in the same tripartite partition of the fundamentals as in the model of chapter 2. Under common knowledge, multiple equilibria exist in this intermediate range of fundamentals. Because the common knowledge game is extensively described in chapter 2, I proceed here immediately to the investment game with private information.

3.2.2 Solving the Model

Firstly, I will show that the game with private information is characterized by a unique Bayesian Nash equilibrium in country B.

Proving the existence and the uniqueness of the equilibrium requires several steps. In the first step, a simple switching strategy is assumed to be followed by all investors. In the second step, the monotonicity of the expected payoff difference in the private signal has to be proved. Based on this, dominated strategies can then be iteratively eliminated in the third step, beginning at borders of the dominance regions. Finally, it has to be shown that there is only one unique value of the level of debt, for which the payoff difference, given the private signal, equals zero. This level of debt is the threshold value, below which all agents invest and above which no one invests.

In the private information game, a strategy is a function of the private signal received instead of the true value of the fundamentals: $\pi^i(\theta^i) : [\breve{\theta}, \hat{theta}] \rightarrow [0, 1]$.[19] The payoff function of an investor now depends on his private signal on the state of the fundamentals and is therefore given by

$$P(\theta^i) = E[R\pi^{-i}(\theta^j) - \frac{1}{2}\theta^2|\theta^i] \tag{3.2}$$

[19]Note that the private signal is drawn from the same support as the true value of the fundamentals. No private signal will be realized at a level of debt that is, in reality, nonexistent. As noted earlier, the support of the true value of the fundamentals must exceed the borders of the dominance regions sufficiently, i.e., by 2η, so that there exist private signals that are consistent with those dominant strategies.

Analogously, the fraction of other agents investing $\pi^i(\theta^i)$ is a function of the private signals θ^j they receive.

In the first step towards the unique equilibrium, it is assumed that all investors follow a simple switching strategy. A switching strategy I_T means that an investor invests with probability one if, and only if, the signal it receives is below a threshold T and abstains from investing with probability one if the signal is above the threshold[20]

$$I_T = \begin{cases} 1 & \text{if } \theta^i < T \\ 0 & \text{if } \theta^i \geq T \end{cases} \tag{3.3}$$

The simple switching strategy permits rewriting the payoff function, replacing the fraction of other investors investing with the probability that one other investor receives a signal that is smaller than the threshold signal

$$\pi^{-i}(I_T) = \int_0^1 I_T(\theta^j)dj = prob(\theta^j \leq T) \tag{3.4}$$

$$P(\theta^i, I_T) = R \cdot 1 \cdot prob(\theta^j \leq T) + R \cdot 0 \cdot prob(\theta^j > T) - E(\frac{1}{2}\theta^2|\theta^i) \tag{3.5}$$

Recall that at the borders of the dominance regions, the investors are indifferent between investing and not investing.[21] If the payoff function is monotonically decreasing in the private signal, clearly, these borders are the lowest and the highest possible threshold signals for the switching strategies. In the dominance region at the low end of the support of the fundamentals, the investment obstacles are so low that the payoff of an investor is positive if investing, irrespective of the actions of all other investors. At the border itself an investor is, then, indifferent. In the dominance region at the high end of the support, the investment obstacles are so high that the payoff of an investor is positive if investing, irrespective of the actions of all other agents. In the case of a monotone payoff function, the borders of the dominance regions are, therefore, the starting points of the iterative elimination of dominated strategies.

Accordingly, in a second step towards the unique equilibrium, the monotonicity of the payoff function in the private signal has to be shown.

[20] Continuity arguments show that such a simple switching strategy is optimal. Therefore, generality is not lost when imposing it in the first place.

[21] More precisely, each investor is indifferent at the border of the high dominance region, given that all other investors invest $P(\overline{\theta}, 1) = 0$ or at the border of the dominance region at the high end of the support, if no one else invests $P(\underline{\theta}, 0) = 0$.

Lemma 3.1 *$P(\theta^i, I_T)$ is strictly monotonically decreasing in the private signal θ^i.*

Proof. See Appendix 3.6. ∎

Due to the strict monotonicity of the payoff, the lowest possible threshold for a switching strategy of all the investors is $\underline{\theta}$. Similarly, the highest possible threshold is $\overline{\theta}$. For all $\theta^i < \underline{\theta}$, the payoff is positive, irrespective of the actions of all other investors. As the rationality of the investors is common knowledge, not to invest is a dominated strategy for signals below $\underline{\theta}$. At the other extreme, for all signals $\theta^i > \overline{\theta}$, the payoff difference is negative.

Due to the strategic complementarity between investors, the worst scenario that an investor must consider is the case where $I_T = I_{\underline{\theta}}$. This case means that for all values of the fundamentals in the multiplicity range, investors choose not to invest although the fundamentals would, in case of coordination on the high growth equilibrium, also allow for this. The best scenario would be a switching strategy of $I_T = I_{\overline{\theta}}$.

At this point, it is possible to start the iterated elimination of dominated strategies. This iteration permits cutting the multiplicity range down to a unique threshold signal. The elimination functions as follows: If an investor i receives a signal that is very close to the border of the dominance region, the probability that other investors receive signals within the dominance region and, thus, have a dominant strategy is very high. Due to the strict monotonicity, this suffices to induce the investor i to have a dominant strategy as well. This is true for all the investors. Therefore, the range between the signal of investor i and the former border of the dominance region can be added to the dominance region. Performing this addition at both ends of the support and iterating this process leads to the maximum [minimum] signal at which investor i is indifferent between investing and not investing; this signal has to be, at the same time, the threshold of the switching strategy of all other investors.[22]

According to Milgrom and Roberts (1990), in all games with strategic complementarity the set of strategies that resist the iterative elimination of dominated strategies are limited by Nash equilibria. Nash equilibria are not eliminated through this process. Thus $I_{\underline{\theta}^\star}$ and $I_{\overline{\theta}^\star}$ are the most extreme Nash equilibria of the game. No Nash equilibrium exists below $\underline{\theta}^\star$ in which the in-

[22] For a more formal consideration of the iterative elimination, please see Appendix 3.6.

vestors do not invest. Likewise, no Nash equilibrium exists above $\overline{\theta}^{\star}$ in which the investors invest.

Steps one and two enable the third step in the proof of the uniqueness of the equilibrium. Given Lemma 3.1, it now suffices to show that equation

$$P(\theta^i = \theta^{\star}, I_{\theta^{\star}}) = Rprob(\theta^j \leq \theta^{\star}) - E(\frac{1}{2}\theta^2|\theta^i) = 0 \tag{3.6}$$

has a unique solution. This can be expressed in the following Lemma.

Lemma 3.2 *There exists only one value, for which the expected payoff equals* 0 *given that investor i receives exactly the threshold signal* $\theta^{\star}$ *as a private signal, and given that all other investors have a switching strategy, in which the switching signal equals exactly* $\theta^{\star}$*.*

Proof. See Appendix 3.6. ∎

This unique solution is

$$\theta^{\star} = (R - \frac{1}{3}\eta^2)^{\frac{1}{2}} \tag{3.7}$$

The three steps can be summarized in the following proposition:

Proposition 3.1 *There exists a unique threshold equilibrium* $\theta^{\star}$ *of the game with imperfect information, such that any investor i invests if and only if* $\theta^i \leq \theta^{\star}$ *and does not invest if* $\theta^i > \theta^{\star}$*.*

Proposition 3.1 permits the conclusion that $\theta^{\star}$ identified by Equation (3.7) is the unique threshold equilibrium of the game with private information.

3.2.3 Results and Implications

The unique threshold equilibrium allows to show that an increase in the degree of disagreement about the fundamentals in country B increases the probability of a crisis there.

Proposition 3.2 *A crisis becomes more likely to occur in country B if a surprise crisis happens in country A. A crisis becomes less likely to occur in country B if an anticipated crisis materializes in country A.*

Proof. To prove Proposition 3.2, it suffices to calculate the comparative statics of the unique threshold equilibrium in terms of the fundamentals with respect to η.

These deliver the following result:

$$\frac{\partial \theta^\star}{\partial \eta} = \frac{1}{2}(R - \frac{1}{3}\eta^2)^{-\frac{1}{2}}(-\frac{2}{3}\eta) < 0 \tag{3.8}$$

This result implies that the threshold below which all investors invest shifts to the left (right), i.e., to better (worse) levels of the fundamentals, if the dispersion of private signals around the true value of the fundamentals increases (decreases) due to a surprise (anticipated) crises in country A. Thereby, the probability space of the good equilibrium is reduced (increased) and, hence, a crisis becomes more (less) likely in the case where private signals are dispersed in an $\eta + c$ ($\eta - d$) surrounding of the true fundamentals, as opposed to the case where they are only dispersed in an η surrounding. ■

Due to the assumption that higher uncertainty results from a crisis in another country, e.g., Thailand in the case of Korea, the shift of the threshold can be viewed as an incident of contagion.[23]

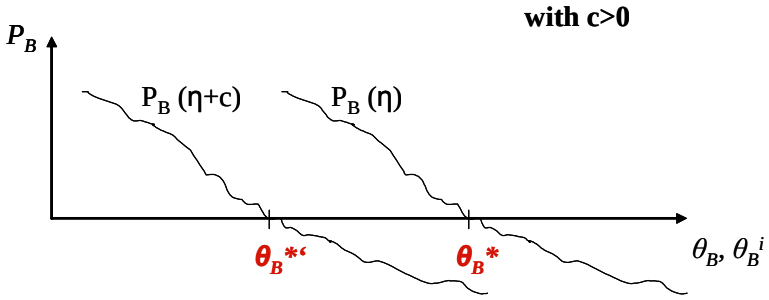

Figure 3.3: $\theta_B^\star$ as a function of the dispersion of private signals in country B

Figure 3.3 illustrates the comparative static analysis. The payoff is plotted against the level of the fundamentals. $\theta_B^{\star'}$ lies at lower levels of the fundamentals than $\theta_B^\star$ as described above due to $\eta + c$ being a higher value than η. Clearly, the threshold based on a dispersion of private signals $\eta - d$ would lie at higher levels of the fundamentals than $\theta_B^\star$.

[23]This assumption is justified by empirical evidence, see Figure 3.1.

3.2.4 Testable Hypotheses

In this section, the predictions of the theoretical model are translated into testable hypotheses. From Proposition 3.2, two testable hypotheses can be derived:

Hypothesis 1 *The occurrence of a surprise crisis in a first country makes a crisis in a second country more likely through an increase in uncertainty about the fundamentals in the second country.*

Hypothesis 2 *The occurrence of an anticipated crisis in a first country makes a crisis in a second country more likely through a decrease in uncertainty about the fundamentals in the second country.*

3.3 Empirical Analysis

The purpose of this section is to validate the predictions of the theoretical model. I focus on showing the effect of uncertainty about the fundamentals as a channel through which crises spread from one financial market to another.

3.3.1 The Data

A rich data set is used comprising monthly observations of different alternative crisis measures as the dependent variable, a measure of uncertainty as the main explanatory variable, and a large set of control variables.[24] The data run from December 1993 to September 2005. The sample comprises 38 countries – 15 developed and 23 emerging – where the selection of the period and countries reflects the existence of uncertainty and return data.[25] I exclude the initial crises countries (Argentina, Brazil, Mexico, Russia, Thailand, and Turkey) from the set of potentially-affected countries. Although this means a non-negligible loss in observations, this procedure is in favor of finding convincing results.

The explanatory variable that is most interesting for the current analysis is uncertainty about the fundamentals. As in the chapter on sudden stops

[24]Please refer to Table 3.2 in Appendix 3.6 for detailed descriptions of the time series and their calculation.

[25]For details, please refer to Table 3.1 in Appendix 3.6.

of capital flows, I use the standard deviation of growth forecasts by a group of country experts as a measure of uncertainty. In models similar to Morris and Shin (1998), uncertainty takes the form of the dispersion of private signals around the true value of the fundamentals. In the current model, this is the dispersion of the private signals about the true value of the investment environment. Such data is not directly observable. However, investment environments correlate strongly with the country levels of GDP and associated growth. Hence, the available data by Consensus Economics on the standard deviation of GDP growth forecasts between experts in an economy seems a reasonable proxy.[26]

To measure the significant drops in stock returns, a crisis dummy variable is constructed. Monthly stock market returns, computed from IFC (International Finance Corporation) investable US dollar total return index, serve as a basis for this crisis dummy.[27] When needed, I complete the returns with data from MSCI (Morgan Stanley Capital International) or national sources.[28] I construct a binary crisis variable of severe drops in stock market returns, in which a month is counted as a crisis month if the total return undershoots its sample mean by more than two standard deviations. After this initial drop, the subsequent months are also counted as crisis months until the return reverts into the one standard deviation band around the sample mean.[29]

I use a rich set of domestic control variables. Most important are the mean of the growth expectations by Consensus Economics to control for the status of the economy and its evaluation by investors. Additionally, I disentangle the effect of uncertainty about the fundamentals from effects linked to the volatility of stock market returns, which I include as a control variable into the regressions. Following Broner et al. (2006), I use the ICRG (In-

[26]Please refer to chapter 2 for detailed arguments why this measure is a good proxy of the dispersion of private signals around the true fundamentals of an economy. See Table 3.2 in Appendix 3.6 for a description of the exact construction of the variable. In the main analysis, I use a weighted average of current and following year forecasts as described in Table 3.2. However, as a robustness check I repeat all estimations with the current year, and all estimations with following-year forecasts, separately. The results are qualitatively the same and quantitatively similar.

[27]The investable indices take into consideration restrictions on foreign investment. Therefore, this measure represents the part of the national stock markets accessible to foreign investors, which is relevant in the context of contagion.

[28]For more details, please refer to Table 3.2 in Appendix 3.6.

[29]I run the regressions with variants of this measure, i.e., 1.5 standard deviations and also 3.

ternational Country Risk Guide) indices of financial, economic, and political risk as a summary statistics to control for the state of the fundamentals in the potentially-affected country. Then, domestic liability dollarization, TOT growth, and credit growth are included as further control variables.

Numerous alternative mechanisms of contagion appear to be relevant in the context of stock market drops. Specifically, I control for contagion through common creditors. In line with Van Rijckeghem and Weder (2001), I use consolidated data of BIS banking statistics to construct an index of contagion through the presence of a common creditor. However, I construct a different index than their index. The index used in this chapter of the study reflects the dependence on common creditors as opposed to their measure that reflects the competition for funds. In the context of stock market drops, the dependence appears more relevant than competition for their funding.[30] Another relevant channel of contagion is trade with the crisis country. Following Glick and Rose (1999), I use bilateral export data from the IMF Direction of Trade Statistics to construct the measure of trade contagion. However, in contrast to their contagion measure, I use the export share to country A in total exports. For the control of contagion through common overexposed fund investments, I use the index developed by Broner et al. (2006). I interact the alternative contagion measures with the crisis dummies for country A. It seems natural that the contagion variables only play a role for the uncertainty in country B if there is a crisis in country A to begin with.

3.3.2 Methodology

The goal of this study is to show that uncertainty about the fundamentals has a separate and non-negligible effect on the spread of crises apart from the channels already studied. If the goal of the present study were to prove the relevance of uncertainty and its predominant role relative to other potential explanatory variables in spreading financial crises, the best procedure to prove this point would be a two-step instrumental variable estimation.[31]

In the context of analyzing contagion, it would be difficult to find a valid instrument for the uncertainty in country B. Arguing, for example, for the use

[30] For detail on the construction of this index, please refer to Table 3.2 in Appendix 3.6.

[31] A good example of a convincing instrumental variable estimation is Acemoglu, Johnson, and Robinson (2001) who analyze institutions as opposed to geography as explanation of differences in current dispersion of countries' incomes.

of the crisis in country A as an instrument for the uncertainty in B requires the crisis in A to significantly affect the uncertainty in B but not to directly affect the probability of a crisis in country B and not to affect it through a channel different from uncertainty. The existing literature on alternative channels of contagion already proves the last assumption wrong. Other variables linked to the crises in A, which might serve as instruments for the uncertainty in B, would have the same problem: they are likely to also feed into alternative channels of contagion.

Given the presence of alternative contagion channels other than the uncertainty channel and therefore the impossibility of finding a valid instrument for uncertainty in B, this empirical analysis is designed in the following way:[32] In a first step, the effect of the crisis in country A on the uncertainty in a second country B is estimated. To ensure that the effect of the crisis in A on the uncertainty in B is correctly quantified, I control for potential domestic drivers of uncertainty. I also control for country and time effects. Thereby, I employ a very strict test on the effect of uncertainty on the occurrence of a crisis. The control for time effects is often avoided in the literature. In the second step, I analyze the effect of uncertainty in country B on the probability of a crisis there. In this step, I run probit regressions estimating the effect of the uncertainty in B on the probability of crises there. I control for domestic factors that could trigger crises and also for alternative contagion channels. Additionally, I control for country and time effects.

One drawback of this approach is that in contrast to an instrumental variable estimation, reverse causality from the crisis in B on the uncertainty there cannot be entirely ruled out. However, as described in more detail in subsection 3.3.3, I run a number of regressions to be confident that this possibility is minimized in the chosen setup.

Methodology Used to Estimate the Effect of the Initial Crisis on the Uncertainty in Potentially-affected Countries

To analyze the relevance of the uncertainty channel of contagion, I proceed in two distinct steps. In the first step, I pin down the effect of the crisis in country A on the uncertainty in a second country B. In the second step, I analyze the effect of uncertainty in country B on the probability of a crisis

[32] In section 3.3.3, the reasons for this design are described in further detail.

there.

In step one, I estimate two sets of regressions. Firstly, I specify the following test:

$$\begin{aligned} \text{unc}_{B,t} &= \alpha_0 \\ &+ \alpha_1 \text{d\_cr}_{Arg,t-1} + ... + \alpha_6 \text{d\_cr}_{Tur,t-1} \\ &+ \alpha_7 \text{d\_cr}_{B,t-1} + \alpha_8 \text{macrocntrls}_{B,t} + \delta_B + \varepsilon_{B,t} \end{aligned} \tag{3.9}$$

with $B = 1, 2, ..., 32; t = 1, 2, ..., 141,$

where $\text{unc}_{B,t}$ signifies the uncertainty in the potentially-affected country B at time t. I exclude the initial crises countries Argentina, Brazil, Mexico, Russia, Thailand, and Turkey in the panel as potentially-affected countries. Therefore, the index B represents the 32 remaining countries in the sample. $\text{d\_cr}_{A,t-1}$ signifies the lag of the crisis dummies in the initial-crisis countries A, representing Argentina, Brazil, Mexico, Russia, Thailand, and Turkey. The dummy variable takes a value of 1 if there is a significant drop in the stock market return. $\text{macrocntrls}_{B,t-1}$ stands for the set of domestic control variables described in section 3.3.1. δ_B stands for country specific effects. The level of uncertainty varies strongly across countries.[33] Systematically, some countries are characterized by higher uncertainty than other countries, therefore, requiring control for country effects. I run fixed-effects regressions to accommodate this fact. Finally, $\varepsilon_{B,t}$ stands for the error term.

Controlling for time effects in the above setting is not possible because the average effect of each of the initial crises on the uncertainty in all the countries contained in the sample is estimated. As the coefficients for each of the crises are forced to be the same in the regression in all the potentially-affected countries, it could be that the coefficients of the time dummies capture part of the effect that actually comes from the crisis variable. To circumvent this problem, I interact the crisis variable with the distance between the crisis variable and the potentially-affected countries. I employ the distance variable first used by Rose (2004). This creates heterogeneity in the crisis variable across countries, which is necessary to be able to control for time effects.

[33] This is illustrated in chapter 2, in which I first introduce the measure of uncertainty.

Therefore, I run additional regressions based on the following equation:

$$\begin{aligned} \text{unc}_{B,t} &= \alpha_0 \\ &+ \alpha_1 \text{d\_cr}_{Arg,t-1}\text{dis}_{Arg,B} + ... + \alpha_6 \text{d\_cr}_{Tur,t-1}\text{dis}_{Tur,B} \\ &+ \alpha_7 \text{d\_cr}_{B,t-1} + \alpha_8 \text{macrocntrls}_{B,t} + \delta_B + \gamma_t + \varepsilon_{B,t} \end{aligned} \tag{3.10}$$

where all the abbreviations have the same meaning as in Equation (3.9). Additionally, the terms $\text{dis}_{Arg,B}$ and γ_t stand for the distance from initial-crisis country to the potentially-affected country B and for the time effects, respectively. To estimate Equation (3.10), I also run fixed-effects panel regressions, additionally controlling for time effects.

Methodology Used to Estimate the Effect of the Uncertainty on the Probability of a Crisis in Potentially-affected Countries

For the analysis of the effect of uncertainty on the probability of a crisis in a potentially-affected country, I specify the following estimation equation:

$$\begin{aligned} \text{Prob}(d\_cr_B = 1|x_{B,t}\beta_0) &= G(\beta_0 \\ &+ \beta_1 \sum_{A=Arg,...,Tur} (\text{ctg}_{A,B,t-1} * \text{d\_cr}_{A,t-1}) \\ &+ \beta_2 \text{unc}_{B,t-1} * \sum_{A=Arg,...,Tur} (\text{d\_cr}_{A,t-1}) + \delta_B + \gamma_t + \varepsilon_{B,t}) \end{aligned} \tag{3.11}$$

with $B = 1, 2, ..., 32; t = 1, 2, ..., 141$.

Since this study is interested in the increase of the probability of a crisis, I employ probit estimations. Hence, $G(.)$ is the standard normal cumulative distribution function. $\text{ctg}_{A,B,t-1}$ represents the alternative channels of contagion from country A to country B: common creditors, trade, dependence on a common overexposed fund investor, and finally also the market size of the crisis country. These are interacted with the crises in the initial-crisis countries taking into account that it is important to control for their effect in transmitting those crises to country B. I also include the interaction of uncertainty with the crises because it is the effect of uncertainty – if a crisis in country A takes place – which is of interest.

Probit models do not lend themselves to consistent estimates of the coefficients in a fixed effects regression. Hence, instead of a fixed-effects panel

estimation, a pooled probit introducing dummies can capture the country effects and time effects. Additionally, I estimate a linear probability model to overcome the potential incidental-parameter problem that can arise in the described procedure. As a plausibility check, I repeat the regressions with the continuous return as dependent variable and run simple OLS regressions.

Using the interaction term of the uncertainty measure in B with the sum of crises variables in countries A as a regressor implies the following risk: It could be that the coefficient on this term simply picks up the direct effect of the crises in A on a crisis in B. To ensure that this is not the case, I estimate a set of regressions, in which I enter the uncertainty variable and the initial crises variables separately. In these very simple regressions, I use the following specification:

$$\begin{aligned} \text{Prob}(d\_cr_B = 1 | x_{B,t}\beta_0) &= G(\beta_0 \\ &+ \beta_1 \text{d\_cr}_{A,t-1} + ... + \beta_6 \text{d\_cr}_{A,t-1} \\ &+ \beta_7 \text{unc}_{B,t-1} + \beta_8 \text{mgexp}_{B,t-1} + \delta_B + \varepsilon_{B,t}) \end{aligned} \tag{3.12}$$

with $B = 1, 2, ..., 32; t = 1, 2, ..., 141$.

Again, the abbreviations stand for the same variables as before. Furthermore, I put the mean growth expectations explicitly in Equation (3.12) to emphasize that it is used in this simple regression as a summary of the situation of country B.

3.3.3 Results

The results of the empirical analysis suggest that the uncertainty channel of contagion does play a role in spreading crises across markets. First, I find a significant and robust effect of the initial crisis on the uncertainty in potentially-affected countries. Second, I find a significant and robust effect of the uncertainty in the second country on the probability of a crisis there.[34]

[34] In the following, I show the results calculating the stock market returns from the MSCI index, using a return drop of more than 2 standard deviations below the sample mean as crisis criterion and employing a weighted average of current and following year GDP forecasts as basis for the uncertainty measure. However, I have run the estimations also with the return data from IFC, with two variations of the crisis criterion, and with the current year and the following year forecasts separately. The results of these different sets of

The Effect of a Crisis in an Initial-crisis Country on the Uncertainty in a Potentially-affected Country

The analysis of the effect of an initial crisis on disagreement about the fundamentals in potentially-affected countries shows an interesting pattern: I find that the Mexican, Russian, and Thai crises significantly increase disagreement about the fundamentals in other countries. The literature identifies these crises as surprise crises.

However, in the case of the three other crises in the sample – the Brazilian, Turkish, and Argentinean crises – the panel analysis shows a different pattern: The Turkish and Argentinean crises significantly decrease the uncertainty in potentially-affected countries. The effect of the Brazilian crisis is less clear. The literature identifies these crises as anticipated crises.

These results are robust to choosing regional sub-samples, emerging markets sub-samples, and including a large number of control variables. Table 3.5 summarizes the results of the fixed-effects panel regressions with those sub-samples.

(Table 3.5 here)

The different columns in Table 3.5 correspond to the regression results from different sub-samples. Column 1 shows the coefficients of the fixed-effects panel regression of uncertainty in all potentially-affected countries on the crises in all the initial crises countries and a set of control variables. Column 2 displays regression results of the regression of the crises in all initial crises countries on uncertainty in emerging market economies. Columns 3 to 10, then, show results for regressions of the regional crises in the sub-samples of all economies (columns 3, 5, 7, 9) and only the emerging economies (columns 4, 6, 8 and 10) within Asia (columns 3 to 6), within Eastern Europe (columns 7 and 8) and within Latin America (columns 9 and 10).

In all regressions, the lag of the 1994 Mexican, the 1998 Russian, and the 1997 Thai crises have a significant and positive effect on the uncertainty in the

analyses are qualitatively the same and quantitatively similar. Therefore, I do not include them in this chapter.

potentially-affected countries. Comparing columns 9 and 10 with columns 1 and 2 reveals that the effect of the Mexican crisis is stronger on uncertainty in Latin American countries (they are all emerging countries, which explains why columns 9 and 10 are identical) than on the entire sample of countries or the sub-sample of all emerging economies. A crisis event in Mexico leads to an increase of the standard deviation of growth expectations across country experts of 0.174 percentage points in Latin American countries. The Mexican crisis exerts a smaller effect on uncertainty in the sample of all emerging markets, increasing the standard deviation of growth expectations by 0.059 percentage points. This effect is slightly bigger than the one observed in the sample of all countries, where the increase is 0.044 percentage points.

The same pattern holds for the Russian and Thai crises. However, for these two crises, the difference in the magnitude of the effect within their own region, compared to the effect on the entire sample of countries, is not as large as for the Mexican crisis. The effect of the Thai crisis on uncertainty in emerging Asia is an increase of 0.123 percentage points of the standard deviation, while its effect on all Asian countries is a bit smaller: 0.112. In the sample of all emerging markets, the effect of the Thai crisis is 0.085 percentage points and in the sample of all the countries, the effect is 0.063. While the Russian crisis increases the standard deviation of growth expectations in Eastern European countries by 0.145 percentage points, its effect on all emerging and all countries amounts to 0.086 and 0.048 percentage points only.

These results suggest that the Mexican crisis has the strongest effect on uncertainty in other countries, in magnitude within its own region among the three mentioned crises. However, the Mexican crisis has less impact beyond its own region than have the Russian and the Thai crises. Furthermore, these results suggest that the Thai crisis has the biggest effect of all three crises in the developed world.

A closer look on results for the 2002 Argentinean, the 1999 Brazilian, and the 2001 Turkish crisis reveals a different picture. While the Argentinean crisis decreases the standard deviation of growth expectation by 0.146 percentage points in Latin American countries, the effect is weaker in the sample of all emerging markets and all countries: a decrease of 0.039 and 0.026, respectively. In case of the Brazilian crisis, only the decrease of 0.027 percentage points of standard deviation of the growth expectation in the sample of all countries is significant at the five-percent level, while the effect of this crisis is insignifi-

cant in all the sub-samples. The Turkish crisis delivers the same pattern as the Argentinean crisis. However, the Turkish crisis presents one interesting additional finding. First, estimating the effect of the Turkish crisis in the subsample of Eastern European countries shows that the Turkey crisis yields a decrease of uncertainty of 0.043 measured in the standard deviation of growth expectations in those countries. Second, estimating the effect of the Turkish crisis in the subsamples of emerging Asian countries and all Asian countries, the effect is much stronger: There the crisis in Turkey results in a decrease of 0.1 and 0.074 percentage points respectively.

These results suggest that the negative effects of the Argentinean and Turkish crises on uncertainty in potentially-affected countries are stronger within their own regions than beyond. The Turkish crisis shows a bigger effect in Asia than in Eastern Europe. The effect of the Brazilian crisis is less clear.

The coefficients on the control variables used in the regressions have the expected signs. In particular, as expected, the lag of the mean of the growth expectations impacts uncertainty negatively. This variable can be seen as a summary of the state of the fundamentals and the expectations about it. If the fundamentals are good – or everyone expects them to be good – then disagreement about the fundamentals decreases. The lag of the crises in the potentially-affected countries shows a positive and significant effect on uncertainty. Past stock market volatility also has a strong positive and significant effect on uncertainty.[35] Additionally, I use the ICRG financial, economic, and political risk indices as summary of the fundamentals following Broner et al. (2006). The coefficients on these variables are mostly not significant in the regressions.

To further ensure the robustness of the effects that the above regressions reveal, I run a second set of regressions, controlling for time effects. As explained in section 3.3.2, controlling for time effects in the above setting is not possible. To circumvent this problem, I interact the crisis variable with the distance between the crisis variable and the potentially-affected countries.[36]

[35]By introducing the stock market volatility, I lose India from the sample and also lose a non-negligible amount of observations. Therefore, I have run all the regressions also without the stock market variable. The results are qualitatively and quantitatively very similar. For this reason only the results including the stock market variable are displayed. In regressions without the stock market volatility, the coefficient on past crisis in country B is slightly higher.

[36]By using the distance variable, I lose Slovakia and Taiwan, for which the distances to

This creates heterogeneity in the crisis variable across countries, making control of time effects possible. Clearly, the meaning of the explanatory variable is slightly changed. Now additionally, whether the distance in the sense of Rose (2004) increases or decreases the effect of a crisis on the uncertainty in the potentially-affected countries, makes a difference.

I repeat the above fixed-effects panel regression, replacing the lagged crises variables for the Argentinean, Brazilian, Mexican, Russian, Thai, and Turkish crisis with the interaction term between those crises variables with the distance to the potentially-affected countries and control for time effects in addition. Table 3.6 in Appendix 3.6 displays the results. The overall pattern of effects remains the same as in the first set of regressions. The effects are still highly significant. The only exception is the coefficient on the interaction term of the Russian crisis with the distance variable in the regressions with the samples of all and of all emerging markets, which become insignificant.

As the effect of the crises in the initial countries on uncertainty becomes smaller, the question arises whether this stems from the interaction of the crises with the distance or from the control for time effects. To disentangle these two cases, I also run regressions with the interaction variables without controlling for time effects. The results are displayed in Table 3.7 in Appendix 3.6. The regression results are very similar to the ones where I control for time effects. This result suggests that the interaction with the distance variable explains the lower coefficients and thus the weaker effect of the crisis in the initial-crisis countries on uncertainty; the control for time effects is not driving this result. Hence, it is safe to say that the effect of the initial-crisis country diminishes with an increasing distance. Taken together, these regression outcomes confirm the observations from the first set of regressions. The results are robust against the inclusion of time effects.

To summarize the findings of the first step of the analysis: The analysis shows that the Mexican, the Russian, and the Thai crises significantly increase uncertainty in potentially-affected countries. The effect is stronger within the region where the crisis takes place. The Argentinean, the Turkish, and, to a lesser extent, the Brazilian crises decrease uncertainty in potentially-affected countries. These last three crises have a stronger negative effect within their region. The effect appears to decrease with increasing distance.

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the initial crises countries are not available in the data set underlying Rose (2004).

These findings are in line with the hypotheses derived from the theoretical model. Recall that surprise crises increase uncertainty in other countries, while anticipated crises decrease uncertainty in other countries. The findings regarding the different regional effects are not captured by the theoretical model.

The Effect of the Uncertainty on the Probability of a Crisis in a Potentially-affected Country

In the second step of the analysis, I show robustly that uncertainty in the potentially-affected country increases the probability of a crisis there. These results are summarized in Tables 3.8 to 3.12.

Firstly, I run a pooled probit regression of the crises in the potentially-affected countries on the interaction of uncertainty in country B, with the sum of all initial crises countries, controlling for a set of variables including country and time effects. Apart from the controls for country and time effects, these variables classify in two categories: 1) domestic control variables and 2) alternative contagion channels, which could influence the likelihood of a crisis in the potentially-affected countries. Table 3.8 displays the results. The results of the pooled probit estimations including country and time controls are displayed in column 1 for the sample of all countries and column 2 for the sample of all emerging market countries. The estimation results of the linear probability model are shown in columns 3 and 4. The outcomes of the simple OLS regressions with the continuous return variable as dependent variable appear in columns 5 and 6.

Columns 1 and 2 of Table 3.8 show the lag of uncertainty interacted with the sum of crises in all initial crises countries has a positive and strongly significant effect on the probability of a crisis in the potentially-affected country. The effect is stronger in emerging economies. Introducing the dummies into the pooled probit regression does not seem to create a severe incidental parameter problem. The magnitude of the effect is, indeed, smaller in columns 3 and 4 but the effect is still strongly significant and not negligible. The effect of the uncertainty on the continuous return variable in columns 5 and 6 not being significant is not problematic. The theoretical model is about crises, which are extreme events. The regression with the continuous return variable as regressand is a plausibility check, only. For example, if an increase in uncertainty increased the return, while simultaneously increasing the probability

of a crisis, this would worry.

Secondly, I run the regressions with the interaction of uncertainty with the sum of the crises in Mexico, Russia and Thailand. These are the crises identified to increase the uncertainty in other countries. The results of these regressions are summarized in Table 3.9.

(Table 3.9 here)

Clearly, the effects of uncertainty are stronger in the current regression than in those with all initial crises countries.[37] Here, also the coefficients of the uncertainty term are significant when using the continuous return variable as regressand.

Calculating marginal effects makes clear that the effect of the uncertainty on the probability of crises in the potentially-affected countries is not negligible. Details are shown in Table 3.12.

(Table 3.12 here)

The control variables have the expected signs. With regard to country characteristics the following variables are controlled for: the lag of the mean growth expectations, the lag of stock market volatility, and the ICRG risk indices for economic, financial, and political risk.

With regard to alternative contagion channels, the following variables are controlled for: the common creditor channel of contagion, the direct trade channel, contagion from important stock markets, and contagion through common overexposed fund investors. I use slightly different definitions than the

[37]This finding goes beyond what is explained by the theoretical model, which would not distinguish the intensity of an increase or decrease of uncertainty after a surprise crisis or an anticipated crisis.

literature to construct the index of common creditors and the index of trade share with the initial-crisis country. The definitions that I use are more plausible in the context of stock market drops, rather than the existing indices which have been developed to study contagion of currency crises. Section 3.3.1 explains the construction of these variables exactly. I estimate regressions, which include the channel through overexposed fund investors separately, and show the results in Table 3.10. This is due to the fact that I have the index of overexposed common creditors only for the sample of emerging markets without Ukraine.[38]

The market size of the initial-crisis country turns out to be not significant in the regressions (see Tables 3.8 to 3.10). If not controlling for overexposed common fund investors, I find that common creditors and trade share have a high explanatory power for the occurrence of a crises in the potentially-affected countries (see Tables 3.8 and 3.9). However, if I introduce the control of the overexposed common fund investor index, these two variables become insignificant, which makes them appear not entirely robust, at least in the emerging market sample, for which I can test the overexposure channel. Notably, the overexposure channel cannot significantly contribute to the explanation of the continuous fund returns in columns 5 and 6 in Table 3.10, while Broner et al. (2006) find a significant effect. This difference could stem from the severe test with control for country and time effects that I run in the present analysis.

As explained in section 3.3.2, care must be taken to ensure against only picking up the direct effect of the crises in the initial-crises countries when interacting the uncertainty in B with the sum of crises in the initial-crises countries. The results in Table 3.11 show that the uncertainty has a distinct positive and strongly significant effect on a crisis event in the same economy.

The possibility of reverse causality is not tackled in this second step of my empirical analysis. This problem could arise if the crisis in B itself caused the uncertainty to increase. There are two answers to this concern: First, the present analysis is interested in the uncertainty that is caused by crises elsewhere. I show robustly that a crisis in A significantly influences uncertainty in country B. In this step, reverse causality is unlikely. Hence, this part of the analysis is not affected by the endogeneity concern.

[38] I am very thankful to Broner et al. (2006) for making their overexposure index available to me. Due to the expensive underlying source data, I would not have been able to control for this relevant contagion channel otherwise.

The problem arises only in the second step. Here, singling out perfectly the uncertainty caused by the crisis in country A is not possible. However, interacting uncertainty in B with the crises in the initial crises countries and, at the same time, controlling for domestic causes of increased uncertainty provides the second answer to the endogeneity concern. The interaction allows to consider exclusively the relevant time periods. Therefore, uncertainty caused by the crises in the other countries should be especially high. Additionally, controlling for the fundamentals in country B in the same regressions corrects for domestic causes of increased uncertainty in B. As a check in the second step, I estimate a set of regressions, in which I include uncertainty and crisis indices for the initial crises countries both as separate explanatory variables. Also in these regressions, the effect of uncertainty is positive and strongly significant. In a follow-up check, I run a further set of regressions, including exclusively either the crises indices in countries A or the uncertainty in B as explanatory variables. The coefficient of uncertainty does not change significantly. Thereby, I make sure that the uncertainty has a separate effect on the probability of crises in B from the direct effect of the crisis in A.

Instrumental variable estimation is not an answer to the endogeneity concern in the present setup. Instrumenting uncertainty, for example, by its past realizations does not help. In the case where the instrument reaches far enough back into the past, the instrument might be realized before the crises in the initial-crisis country. It would then pick up exactly the part of uncertainty that is not of interest in this analysis. Therefore, the series of checks conducted in the present study appear to be the best available option.

These arguments support plausibility and reliability of the results. Further soundness comes when taking these arguments together with the results of the analysis on sudden stops in chapter 2. There, I show the strongly significant effect of uncertainty on the occurrence of a crisis after taking care of the endogeneity problem.

Together with the findings in section 3.3.3, the sets of regressions in the current section support the theoretical model. Uncertainty in potentially-affected countries increases with the occurrence of a surprise crisis in initial-crises countries. In turn, this increase in uncertainty leads to an increase of the probability of a crisis in potentially-affected countries. In case of an anticipated crisis in the first country, the uncertainty in the second country is reduced. In turn, this decreased uncertainty decreases the probability of a crisis in the

second country. The fact that the coefficients on the interaction term in Table 3.8 are larger than those in Table 3.9 suggests that the decreasing effect of a decreasing uncertainty on the crisis probability after an anticipated initial crisis is weaker than the increasing effect of an increased uncertainty after a surprise crisis in the initial-crisis country on the crisis probability. However, the weaker results in Table 3.8 could also stem from the Brazilian crisis not having a clear-cut effect on the uncertainty in potentially-affected countries.

These empirical results align with the theoretical model. First of all, a large part of the literature agrees that there was much less international response in form of crisis in other countries to the Brazilian, the Turkish, and the Argentinean crisis than to the three other crises.[39] Additionally, Didier et al. (2006) and Mondria (2006a) argue that the Brazilian, Turkish, and Argentinean crises were anticipated by the investors while the Mexican, Thai, and Russian crises caught them by surprise.

3.4 Policy Implications

The first, obvious implication of my analysis is that investors and governments should closely monitor fundamentals also of other countries, especially in the region and in adjacent countries. Surprise crises appear to be especially bad because they set off mechanisms that worsen the situation further. This chapter illustrates such a mechanism through the uncertainty about the fundamentals.

Second, once a surprise crisis has hit a first country, governments need to apply policies that counteract the increase in uncertainty about the fundamentals in country B. One venue could be to develop mechanisms for such situations through which governments could disseminate credibly very precise information about the state of their economy. In this model, I have not been concerned with credibility issues, so I can only infer something about a credible government. In reality, governments might not be credible – they might be tempted strongly to signal that the fundamentals in their country are very satisfying. However, one way toward overcoming the credibility problem and helping private investors receive more precise private signals, would be to allow full access to the government accounts to a few independent institutions, which could then sell the information to private investors. Such a procedure

[39] See, for example, Kaminsky et al. (2000) or Didier et al. (2006).

ensures that private investors have private information but with little dispersion around the true value of the fundamentals. Another venue would be to think about subsidies for information-gathering technology.

3.5 Conclusion

In this chapter, I illustrate the uncertainty channel of contagion in a coordination game and then validate the predictions empirically. In particular, I find that surprise crises in an initial-crisis country such as the Mexican, Thai, or Russian crises increase the probability of a crisis in other countries. In the case of an anticipated crisis such as the Brazilian, Turkey, or Argentinean crises, uncertainty is reduced making crises in potentially-affected countries less likely. Additionally, the empirical analysis shows that the effects through uncertainty are stronger in potentially-affected countries within the same region as and closer to the initial-crisis country.

The results of the present analysis suggest that investors and governments should closely monitor the fundamentals of neighboring countries to minimize the risk of a surprise crisis. Second, policy makers should take uncertainty about the fundamentals into account. Once a surprise crisis happens elsewhere, policy makers should be ready to counteract the increase in the disagreement about the fundamentals by adequate policies. Strategies that help private investors receive precise private signals appear prudent in the light of this analysis.

The present analysis also confirms the findings of the relevance of other contagion channels especially through overexposed fund investors, also through trade links and common creditors. However, on top of these channels, which have been analyzed by the literature for some time, uncertainty does play a role in explaining contagion patterns. And, as the analysis of marginal effects shows, the effect is not negligible.

In this chapter, I have taken the change in dispersion of the private signals in the second economy as given if a crisis happens in the first country. A worthwhile future research agenda is to explicitly model the optimal choice of spending on information-gathering technology. This would result in an endogenous change in dispersion of the private signals in the second market.

As to the empirical analysis, future research moving to higher frequency

data, if available, could be worthwhile. This step might allow the exploration of more convincing ways of determining the direction of causality.

3.6 Appendix

3.6.1 Lemma Proofs

Proof of Lemma 3.1 (Monotonicity of P)

Proof. The monotonicity of P in θ^i can be very easily shown: In

$$P(\theta^i, I_T) = R \cdot prob(\theta^i \leq T) - E(\frac{1}{2}\theta^2|\theta^i)$$

R does not depend on θ^i. In addition,

$$\frac{\partial prob(\theta^i \leq T)}{\partial \theta^i} = \begin{cases} 0 & \text{if } T < \theta^i - 2\eta \text{ and } T > \theta^i + 2\eta \\ < 0 & \text{if } \theta^i - 2\eta < T < \theta^i + 2\eta \end{cases}$$

Therefore, the term $R \cdot prob(\theta^i \leq T)$ is weakly decreasing in θ^i. The term

$$-\frac{\partial E(\frac{1}{2}\theta^2|\theta^i)}{\partial \theta^i} < 0$$

is strictly decreasing in θ^i. As a consequence, $P(\theta^i, I_T)$ is strictly monotonically decreasing in θ^i. ■

Proof of Lemma 3.2 (Uniqueness of Equilibrium)

Proof. Equation (3.6) can be rewritten as follows:

$$P(\theta^\star, I_{\theta^\star}) = R \cdot prob(\theta^j \leq \theta^\star) - \frac{1}{2\eta}\int_{\theta^\star-\eta}^{\theta^\star+\eta} \frac{1}{2}\theta^2 d\theta = 0 \tag{3.13}$$

This leads to

$$P(\theta^\star, I_{\theta^\star}) = \frac{1}{2}R - \frac{1}{2\eta}[\frac{1}{6}\theta^3]_{\theta^\star-\eta}^{\theta^\star+\eta} = 0 \tag{3.14}$$

This equation defines $\theta^\star$ and can easily be rearranged to equation (3.7). ■

3.6.2 Iterated Elimination of Dominated Strategies

The elimination is started at the borders of the dominance ranges. Due to the strict monotonicity in θ^i, there exist unambiguous signals $\overline{\theta}^1 < \overline{\theta}^0 = \overline{\theta}$ and $\underline{\theta}^1 > \underline{\theta}^0 = \underline{\theta}$, such that

$$P(\theta^i, I_{\overline{\theta}^0}) < 0 \quad \text{for all} \quad \theta^i > \overline{\theta}^1 \quad \text{and} \quad P(\theta^i, I_{\underline{\theta}^0}) > 0 \quad \text{for all} \quad \theta^i < \underline{\theta}^1$$

As $\overline{\theta}^0 > \underline{\theta}^0$, it also holds that $\overline{\theta}^1 > \underline{\theta}^1$. For the case of the upper border of the multiplicity area, this means: Given that the other agents do not invest when receiving signals above $\overline{\theta}^0$, the investment does not pay for signals above $\overline{\theta}^1$ either. Where I find $\overline{\theta}^1$ by calculating $P(\theta^i = \overline{\theta}^1, I_{\overline{\theta}^0})$. This process can be iterated. Given that the other agents do not invest when receiving signals above $\overline{\theta}^n$, it does not pay to invest at a signal $\overline{\theta}^{n+1}$ with $\overline{\theta}^{n+1} < \overline{\theta}^n$. The signals $\overline{\theta}^{n+1}$ are found by setting the expected payoff difference to 0, reflecting indifference between investment and no investment for investor i:

$$P(\overline{\theta}^{n+1}, I_{\overline{\theta}^n}) = R \cdot prob(\theta^j \leq \overline{\theta}^n) - E(\frac{1}{2}\theta^2 | \theta^i = \overline{\theta}^{n+1}) \tag{3.15}$$

The sequence $\overline{\theta}^n$ is decreasing, monotone and bounded. By the common knowledge of rationality, this process is driven to its limit of $\overline{\theta}^\star = lim_{n\to\infty}\overline{\theta}^n$. Concretely, it is possible to find a value $\overline{\theta}^\star$ such that

$$P(\overline{\theta}^\star, I_{\overline{\theta}^\star}) = 0 \tag{3.16}$$

$\overline{\theta}^\star$ has the interpretation that above this signal all agents do not invest with certainty.

At the lower bound of the multiplicity area, the analogue situation occurs, just with the sequence $\underline{\theta}^n$ being increasing. There one iterates until one finds:

$$P(\underline{\theta}^\star, I_{\underline{\theta}^\star}) = 0 \tag{3.17}$$

That means, one iterates until one finds a maximum (minimum) signal at which agent i is indifferent between investing and not, and which is at the same time the threshold of the switching strategy of all other agents, when starting off at $\overline{\theta}^0 = \overline{\theta}$ ($\underline{\theta}^0 = \underline{\theta}$).

The switching strategies $I_{\underline{\theta}^\star}$ and $I_{\overline{\theta}^\star}$ are Nash equilibria of the private information game. According to Milgrom and Roberts (1990), in all games with strategic complementarity, the highest and the lowest equilibrium that resist the iterative elimination of dominated strategies are Nash equilibria. Put the other way round: These Nash equilibria can never be eliminated. If $\overline{\theta}^\star = \underline{\theta}^\star$, there exists an unambiguous signal $\theta^\star$, below which in equilibrium all agents will invest and above which no one invests.

3.6.3 Figures and Tables

Developed Countries				Emerging Market Countries			
Asia & Australia	Eastern Europe	Latin America	Western Europe & North America	Asia & Australia	Eastern Europe	Latin America	Western Europe & North America
Australia			Canada	China	Czech Republi	Argentina	
Japan			France	Hong Kong	Hungary	Brazil	
New Zealand			Germany	India	Poland	Chile	
			Italy	Indonesia	Romania	Columbia	
			Netherlands	Korea	Russia	Mexico	
			Norway	Malaysia	Slovakia	Peru	
			Spain	Singapore	Turkey	Venezuela	
			Sweden	Taiwan	Ukraine		
			Switzerland	Thailand			
			UK				
			USA				

The sample comprises 38 countries, of which 15 developed and 23 Emerging Market countries. There are 7 Latin American, 12 Asian & Australian, 8 Eastern European and 11 Western European and North American countries.

Table 3.1: Country sample

Variables	Measures	Sources
Crisis measure:		
Drops in stock market returns	Basis for the crisis measure is the percentage change in US $ national, total return stock market indices relative to the previous month. A month is counted as a crisis month if the total return drops at least 2 standard deviations below the sample mean. Subsequent months are also counted as crisis months until the return moves back into the one standard deviation band around the sample mean.	2 sets of crisis measures: 1) IFC investable, total return indices, 2) MSCI total return indices. In both cases I have to use local sources for Romania, Slovakia and Romania. To convert these three national indices from national currency to US $ I use exchange rate end of period data from the IMF: IFS.
Explanatory Variable:		
Uncertainty measure	Monthly data of the weighted average of the standard deviations of the current and following year forecast of economic growth. The standard deviation is calculated for the expectations that experts for the specific economy utter at a particular point in time. In January the standard deviation of the current year forecasts is weighted with 11/12 and the standard deviation of the follwoing year forecasts with 1/12. In February the current year value receives 10/12 weight and the follwing year one 2/12. This scheme continues until December with a weighting of 0/12 for the current year value and 12/12 for the following year value.	Consensus Economics

Table 3.2: List of variables

Variables	Measures	Sources
Domestic control variables		
Mean growth expectations	Monthly data of the weighted average of the mean of the current and following year forecast of GDP growth. The mean is calculated for the expectations that experts for the specific economy utter at a particular point in time. The weighting scheme is the same as for the standard deviation.	Consensus Economics
Stock market volatility	Standard deviation of daily returns calculated for a time window of three months from month t-2 to t.	Cf. crisis measure. However restricted availability of daily returns.
Changes in the political risk	Difference in political risk indicatior relative to previous month.	ICRG
Changes in the economic risk	Difference in economic risk indicatior relative to previous month.	ICRG
Changes in the financial risk	Difference in financial risk indicatior relative to previous month.	ICRG
Distance to initial crisis country	Calculated by Rose (2004)	Rose (2004)
Domestic liability dollarization	Developed countries: Local asset positions in foreign currency by BIS reporting banks as a share of GDP. EMs: Dollar deposits plus bank foreign borrowing as a share of GDP.	Calvo, Izquierdo, Mejia (2004): BIS, Honohan and Shi (2002), Central Banks of Australia, New Zealand, Columbia, Korea, Brazil, IMF: IFS
TOT growth	Developed countries: Local asset positions in foreign currency by BIS reporting banks as a share of GDP. EMs: Dollar deposits plus bank foreign borrowing as a share of GDP.	Calvo, Izquierdo, Mejia (2004): BIS, Honohan and Shi (2002), Central Banks of Australia, New Zealand, Columbia, Korea, Brazil, IMF: IFS
Credit growth	Credit to private setor, monthly rate of change	IMF: IFS

Table 3.3: List of variables (continued)

Alternative contagion channels		
Index of common creditors	Degree of dependence on the same creditors as the initial crisis country. I calculate the index as the sum over all creditors of the product of the dependence of country B on creditor i times the importance of the initial crisis country, A, for creditor i. The dependence of country B on creditor i is the ratio of the volume that country B borrows from creditor i relative to the total borrowing by country B. The importance of country A to creditor i is the ratio of the volume that creditor i lends to country A relative to total lending by creditor i.	BIS quaterly review, consolidated banking data, table 9B. I construct the monthly timeseries from the quarterly observations by interpolation.
Trade share	Exports from country B to the initial crisis country relative to total exports by country B	IMF: Direction of trade statistics
Stock market size	Market value of IFC investable / FTSE index	IFC investable/ FTSE index
Index of common overexposed fund investors	Degree of dependence on fund investors that are overexposed to the initial crisis country	Broner, Gelos, Reinhart (2006)

Table 3.4: List of variables (continued)

Panel regressions of uncertainty in B with fixed effects on the lag of crisis in initial crises countries

Step 1 Effect of crises in the initial crises countries on the uncertainty in other countries

Dependent Variable uncertainty in country B at t. The initial crises countries are excluded as affected countries.

	(1) all crises, all countries	(2) all crises, emerging markets	(3) regional crises, asia	(4) regional crises, emerging asia	(5) regional crises, asia + turkey	(6) regional crises, emerging asia + turkey	(7) regional crises, eastern europe	(8) regional crises, emerging eastern europe	(9) regional crises, latin america	(10) regional crises, emerging latin america
lag of crisis in Arg	-0.026**	-0.039**							-0.146***	-0.146***
	(0.011)	(0.019)							(0.041)	(0.041)
lag of crisis in Bra	-0.027**	-0.021							-0.041	-0.041
	(0.013)	(0.024)							(0.051)	(0.051)
lag of crisis in Mex	0.044**	0.059*							0.174***	0.174***
	(0.017)	(0.032)							(0.061)	(0.061)
lag of crisis in Rus	0.048***	0.086***					0.145***	0.145***		
	(0.011)	(0.019)					(0.031)	(0.031)		
lag of crisis in Tha	0.063***	0.085***	0.112***	0.123***	0.108***	0.116***				
	(0.009)	(0.016)	(0.019)	(0.026)	(0.019)	(0.026)				
lag of crisis in Tur	-0.036***	-0.070***			-0.074***	-0.100***	-0.043*	-0.043*		
	(0.009)	(0.017)			(0.019)	(0.026)	(0.025)	(0.025)		
lag of crisis in B	0.164***	0.137***	0.227***	0.221***	0.230***	0.229***	0.064*	0.064*	0.136**	0.136**
	(0.018)	(0.025)	(0.030)	(0.036)	(0.030)	(0.036)	(0.036)	(0.036)	(0.055)	(0.055)
lag of mean growth expectations	-0.119***	-0.122***	-0.122***	-0.122***	-0.125***	-0.126***	-0.103***	-0.103***	-0.106***	-0.106***
	(0.002)	(0.003)	(0.004)	(0.005)	(0.004)	(0.005)	(0.008)	(0.008)	(0.009)	(0.009)
lag of stock market volatility	5.092***	5.468***	5.332***	5.764***	4.968***	5.190***	3.896***	3.896***	6.490***	6.490***
	(0.357)	(0.493)	(0.734)	(0.870)	(0.734)	(0.873)	(0.723)	(0.723)	(1.355)	(1.355)
lag of economic risk index	-0.000	0.002	-0.004	-0.006	-0.003	-0.006	-0.002	-0.002	0.022*	0.022*
	(0.004)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.013)	(0.013)	(0.011)	(0.011)
lag of financial risk index	-0.007*	-0.014**	-0.009	-0.007	-0.009	-0.008	-0.005	-0.005	-0.021	-0.021
	(0.003)	(0.006)	(0.007)	(0.009)	(0.007)	(0.009)	(0.010)	(0.010)	(0.013)	(0.013)
lag of political risk index	-0.003	-0.001	-0.011*	-0.022**	-0.010	-0.021**	-0.003	-0.003	0.012	0.012
	(0.003)	(0.005)	(0.006)	(0.009)	(0.006)	(0.009)	(0.010)	(0.010)	(0.008)	(0.008)
Constant	0.842***	1.100***	1.095***	1.232***	1.131***	1.289***	0.850***	0.850***	1.029***	1.029***
	(0.012)	(0.022)	(0.030)	(0.044)	(0.031)	(0.046)	(0.027)	(0.027)	(0.046)	(0.046)
Observations	2657	1293	944	598	944	598	353	353	342	342
Number of country	30	16	9	6	9	6	6	6	4	4
R-squared	0.60	0.65	0.70	0.74	0.70	0.74	0.46	0.46	0.45	0.45

Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3.5: Step 1: Effect of crisis in A on uncertainty in B

Table 3.6: Step 1: Effect of crisis in A on uncertainty in B, interacted explanatory variable, time effects

Panel regressions of uncertainty in B with fixed effects on the lag of crisis in initial crises countries

Step 1 Effect of crises in the initial crises countries on the uncertainty in other countries

Dependent Variable uncertainty in country B at t. The initial crises countries are excluded as affected countries.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	all crises, all countries	all crises, emerging markets	regional crises, asia	regional crises, emerging asia	regional crises, asia + turkey	regional crises, emerging asia + turkey	regional crises, eastern europe	regional crises, emerging eastern europe	regional crises, latin america	regional crises, emerging latin america
lag of interaction crisis in Arg* distance to B	-0.004***	-0.006***							-0.016***	-0.016***
	(0.001)	(0.002)							(0.005)	(0.005)
lag of interaction crisis in Bra* distance to B	-0.002	-0.001							-0.007	-0.007
	(0.001)	(0.003)							(0.006)	(0.006)
lag of interaction crisis in Mex* distance to B	0.009***	0.010**							0.028***	0.028***
	(0.002)	(0.004)							(0.007)	(0.007)
lag of interaction crisis in Rus* distance to B	0.000	0.000					0.009**	0.009**		
	(0.000)	(0.001)					(0.004)	(0.004)		
lag of interaction crisis in Tha* distance to B	0.005***	0.009***	0.010***	0.009**	0.010***	0.010**				
	(0.001)	(0.002)	(0.003)	(0.004)	(0.003)	(0.004)				
lag of interaction crisis in Tur* distance to B	-0.002*	-0.003			-0.005*	-0.005	0.003	0.003		
	(0.001)	(0.002)			(0.003)	(0.004)	(0.003)	(0.003)		
lag of crisis in B	0.165***	0.153***	0.238***	0.212***	0.242***	0.218***	0.067***	0.067***	0.108**	0.108**
	(0.017)	(0.025)	(0.032)	(0.039)	(0.032)	(0.039)	(0.025)	(0.025)	(0.049)	(0.049)
lag of mean growth expectations	-0.121***	-0.132***	-0.132***	-0.132***	-0.133***	-0.133***	-0.100***	-0.100***	-0.121***	-0.121***
	(0.003)	(0.004)	(0.005)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)	(0.008)	(0.008)
lag of stock market volatility	4.904***	4.231***	3.799***	3.896***	3.732***	3.791***	0.720	0.720	3.900***	3.900***
	(0.425)	(0.656)	(0.786)	(0.974)	(0.785)	(0.976)	(1.051)	(1.051)	(1.227)	(1.227)
lag of economic risk index	-0.003	-0.000	-0.005	-0.005	-0.004	-0.004	-0.018*	-0.018*	0.016	0.016
	(0.004)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.010)	(0.010)	(0.010)	(0.010)
lag of financial risk index	-0.006*	-0.013**	-0.012*	-0.012	-0.012*	-0.012	0.008	0.008	-0.017	-0.017
	(0.003)	(0.006)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)	(0.012)	(0.012)
lag of political risk index	-0.004	-0.003	-0.012*	-0.021**	-0.011*	-0.020**	-0.006	-0.006	0.008	0.008
	(0.003)	(0.005)	(0.007)	(0.009)	(0.007)	(0.009)	(0.008)	(0.008)	(0.007)	(0.007)
time effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Constant	1.649***	2.312***	2.111***	-0.312	2.116***	-0.230	0.588	0.588	2.510***	2.510***
	(0.108)	(0.276)	(0.235)	(0.754)	(0.235)	(0.756)	(5.086)	(5.086)	(0.352)	(0.352)
Observations	2440	1076	844	498	844	498	236	236	342	342
Number of country	27	13	8	5	8	5	4	4	4	4
R-squared	0.64	0.70	0.73	0.77	0.73	0.77	0.68	0.68	0.58	0.58

Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Panel regressions of uncertainty in B with fixed effects on the lag of crisis in initial crises countries

Step 1 Effect of crises in the initial crises countries on the uncertainty in other countries

Dependent Variable uncertainty in country B at t. The initial crises countries are excluded as affected countries.

Data source: MSCI

	(1) all crises, all countries	(2) all crises, emerging markets	(3) regional crises, asia	(4) regional crises, emerging asia	(5) regional crises, asia + turkey	(6) regional crises, emerging asia + turkey	(7) regional crises, eastern europe	(8) regional crises, emerging eastern europe	(9) regional crises, latin america	(10) regional crises, emerging latin america
lag of interaction crisis in	-0.005***	-0.008***							-0.023***	-0.023***
Arg* distance to B	(0.001)	(0.002)							(0.006)	(0.006)
lag of interaction crisis in Bra*	-0.005***	-0.007**							-0.013*	-0.013*
distance to B	(0.001)	(0.003)							(0.007)	(0.007)
lag of interaction crisis in	0.012***	0.019***							0.041***	0.041***
Mex* distance to B	(0.002)	(0.004)							(0.007)	(0.007)
lag of interaction crisis in	0.001	0.000					0.010***	0.010***		
Rus* distance to B	(0.000)	(0.001)					(0.003)	(0.003)		
lag of interaction crisis in	0.005***	0.008***	0.011***	0.014***	0.010***	0.013***				
Tha* distance to B	(0.001)	(0.002)	(0.003)	(0.004)	(0.003)	(0.004)				
lag of interaction crisis in Tur*	-0.005***	-0.009***			-0.011***	-0.015***	-0.003	-0.003		
distance to B	(0.001)	(0.002)			(0.002)	(0.003)	(0.003)	(0.003)		
lag of crisis in B	0.174***	0.165***	0.262***	0.259***	0.262***	0.263***	0.077***	0.077***	0.111**	0.111**
	(0.018)	(0.025)	(0.033)	(0.040)	(0.032)	(0.040)	(0.026)	(0.026)	(0.053)	(0.053)
lag of mean growth	-0.120***	-0.125***	-0.121***	-0.121***	-0.126***	-0.127***	-0.101***	-0.101***	-0.108***	-0.108***
expectations	(0.003)	(0.004)	(0.004)	(0.006)	(0.004)	(0.006)	(0.006)	(0.006)	(0.009)	(0.009)
lag of stock market volatility	4.983***	5.210***	5.436***	5.797***	4.830***	4.831***	1.969*	1.969*	6.633***	6.633***
	(0.431)	(0.661)	(0.787)	(0.961)	(0.785)	(0.968)	(1.098)	(1.098)	(1.306)	(1.306)
lag of economic risk index	-0.003	-0.000	-0.005	-0.007	-0.004	-0.004	-0.015	-0.015	0.016	0.016
	(0.004)	(0.006)	(0.007)	(0.009)	(0.007)	(0.008)	(0.010)	(0.010)	(0.011)	(0.011)
lag of financial risk index	-0.006*	-0.013**	-0.011	-0.010	-0.011	-0.010	0.007	0.007	-0.020	-0.020
	(0.003)	(0.006)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)	(0.013)	(0.013)
lag of political risk index	-0.003	-0.001	-0.013*	-0.025**	-0.011	-0.022**	-0.010	-0.010	0.012	0.012
	(0.003)	(0.006)	(0.007)	(0.010)	(0.007)	(0.010)	(0.008)	(0.008)	(0.008)	(0.008)
time effects	no	no	no	no	no	no	no	no	no	no
Constant	0.848***	1.164***	1.105***	1.276***	1.157***	1.361***	0.839***	0.839***	1.032***	1.032***
	(0.014)	(0.029)	(0.031)	(0.049)	(0.032)	(0.052)	(0.031)	(0.031)	(0.045)	(0.045)
Observations	2440	1076	844	498	844	498	236	236	342	342
Number of country	27	13	8	5	8	5	4	4	4	4
R-squared	0.62	0.68	0.70	0.75	0.71	0.76	0.62	0.62	0.48	0.48

Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3.7: Step 1: Effect of crisis in A on uncertainty in B, interacted explanatory variable, no control for time effects

Panel regressions of crisis in potentially affected country on the lagged uncertainty in B

Step 2 Effect of uncertainty in a country on the probability of a crisis there if a crisis takes place in an initial crisis country
Dependent Variable crisis as measured by significant negative returns in country B at t
The considered crises periods are Mexico 1994/5, Thailand 1997, Russia 1998, Brazil 1999, Turkey 2001, Argentina 2002

				returns as dep. Variable		
	(1)	(2)	(3)	(4)	(5)	(6)
	pooled probit all crises, all countries	pooled probit all crises, emerging markets	linear probability all crises, all countries	linear probability all crises, emerging markets	OLS, all crises, all countries	OLS, all crises, emerging markets
lag of interact. uncert. in B & crisis in all initial crisis cntrs.	0.100**	0.125**	0.040***	0.025***	0.001	0.003
	(0.047)	(0.050)	(0.006)	(0.009)	(0.002)	(0.004)
lag of interact. com creditors & crisis in A	5.825**	4.963	0.165**	1.677**	-0.017	-0.316
	(2.930)	(3.475)	(0.076)	(0.653)	(0.032)	(0.267)
lag of interact. tradeshare & crisis in A	6.918***	7.190***	1.441***	1.331***	-0.465***	-0.475***
	(2.551)	(2.630)	(0.264)	(0.405)	(0.113)	(0.166)
lag of interact. market size & crisis in A	-0.000	-0.000	-0.000*	-0.000	0.000***	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lag of mean growth expectation	0.127***	0.120***	0.011**	0.010	-0.009***	-0.009***
	(0.041)	(0.044)	(0.004)	(0.007)	(0.002)	(0.003)
lag of stockmarket volatiltiy	9.828**	7.310	1.824***	0.981	-0.369*	-0.313
	(4.350)	(4.607)	(0.488)	(0.687)	(0.208)	(0.281)
lag of economic risk index	-0.064	-0.076	-0.007	-0.010	-0.001	-0.001
	(0.045)	(0.047)	(0.005)	(0.008)	(0.002)	(0.003)
lag of financial risk index	-0.043	-0.051	-0.009**	-0.017**	0.003	0.002
	(0.038)	(0.040)	(0.004)	(0.008)	(0.002)	(0.003)
lag of political risk index	-0.019	-0.002	-0.005	-0.003	0.001	0.001
	(0.040)	(0.042)	(0.004)	(0.007)	(0.002)	(0.003)
time effects	yes	yes	yes	yes	yes	yes
country effects	yes	yes	yes	yes	yes	yes
Constant	-62.138***	-57.881**	-4.685***	-8.027**	0.499	0.561
	(21.660)	(25.941)	(1.533)	(3.146)	(0.654)	(1.286)
Observations	1309	903	1923	961	1923	961
R-squared			0.24	0.26	0.04	0.05

Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3.8: Step 2: Effect of uncertainty in B on crisis there, all initial crises countries

Table 3.9: Step 2: Effect of uncertainty in B on crisis there, Mexican, Russian and Thai crises

Panel regressions of crisis in potentially affected country on the lagged uncertainty in B

Step 2 Effect of uncertainty in a country on the probability of a crisis there if a crisis takes place in an initial crisis country
Dependent Variable crisis as measured by significant negative returns in country B at t
The considered crises periods are Mexico 1994/5, Thailand 1997, Russia 1998, Brazil 1999, Turkey 2001, Argentina 2002

returns as dep. Variable

	(1)	(2)	(3)	(4)	(5)	(6)
	pooled probit all crises, all countries	pooled probit all crises, emerging markets	linear probability all crises, all countries	linear probability all crises, emerging markets	OLS, all crises, all countries	OLS, all crises, emerging markets
lag of interact. uncert. in B &	0.286***	0.314***	0.092***	0.071***	-0.013***	-0.010*
crisis in Mex, Rus, Tha	(0.078)	(0.082)	(0.010)	(0.015)	(0.004)	(0.006)
lag of interact. com creditors	5.556*	5.136	0.152**	1.605**	-0.003	-0.220
& crisis in A	(2.865)	(3.424)	(0.075)	(0.642)	(0.032)	(0.264)
lag of interact. tradeshare &	5.779**	5.867**	1.234***	1.132***	-0.380***	-0.408**
crisis in A	(2.536)	(2.602)	(0.264)	(0.405)	(0.113)	(0.167)
lag of interact. market size &	-0.000	-0.000	-0.000	-0.000	0.000***	0.000***
crisis in A	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lag of mean growth	0.149***	0.139***	0.011***	0.013**	-0.011***	-0.012***
expectation	(0.040)	(0.043)	(0.004)	(0.006)	(0.002)	(0.003)
lag of stockmarket volatility	11.193**	8.918*	2.009***	1.179*	-0.343*	-0.291
	(4.390)	(4.615)	(0.481)	(0.678)	(0.207)	(0.279)
	-0.049	-0.061	-0.004	-0.007	-0.001	-0.001
lag of economic risk index	(0.045)	(0.047)	(0.005)	(0.008)	(0.002)	(0.003)
	-0.043	-0.052	-0.008*	-0.017**	0.002	0.002
lag of financial risk index	(0.038)	(0.040)	(0.004)	(0.008)	(0.002)	(0.003)
	-0.010	0.009	-0.004	-0.001	0.001	0.001
lag of political risk index	(0.040)	(0.042)	(0.004)	(0.007)	(0.002)	(0.003)
time effects	yes	yes	yes	yes	yes	yes
country effects	yes	yes	yes	yes	yes	yes
Constant	-61.549***	-57.002**	-3.606**	-7.253**	0.521	0.837
	(21.754)	(26.069)	(1.509)	(3.079)	(0.649)	(1.267)
Observations	1309	903	1923	961	1923	961
R-squared			0.25	0.27	0.04	0.05

Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3.10: Step 2: Effect of uncertainty in B on crisis there, additional control for common overexposed fund investors

Panel regressions of crisis in potentially affected country on the lagged uncertainty in B

Step 2 Effect of uncertainty in a country on the probability of a crisis there if a crisis takes place in an initial crisis country
Dependent Variable crisis as measured by significant negative returns in country B at t
The considered crises periods are Mexico 1994/5, Thailand 1997, Russia 1998, Brazil 1999, Turkey 2001, Argentina 2002

	(1)	(2)	(3)	(4)	(5)	(6)
	pooled probit all crises, emerging markets	linear probability all crises, emerging markets	OLS, all crises, emerging markets	pooled probit all crises, emerging markets	linear probability all crises, emerging markets	OLS, all crises, emerging markets
lag of interact. uncert. in B & crisis in all initial crisis cntrs.	0.109**	0.029**	0.003			
	(0.055)	(0.012)	(0.005)			
lag of interact. uncert. in B & crisis in Mex, Rus, Tha				0.281***	0.074***	-0.018**
				(0.096)	(0.020)	(0.008)
lag of interact. com creditors & crisis in A	2.976	0.506	-0.147	3.384	0.569	0.060
	(4.459)	(0.985)	(0.392)	(4.385)	(0.953)	(0.381)
lag of interact. tradeshare & crisis in A	5.715	1.540	-0.510	3.397	1.063	-0.509
	(5.363)	(1.135)	(0.452)	(5.343)	(1.119)	(0.447)
lag of interact. market size & crisis in A	-0.000	-0.000	0.000*	-0.000	-0.000	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lag of interact. overexp. index & crisis in A	0.013**	0.002**	-0.000	0.012**	0.002*	-0.000
	(0.006)	(0.001)	(0.000)	(0.006)	(0.001)	(0.000)
lag of mean growth expectation	0.194***	0.029***	-0.018***	0.220***	0.033***	-0.023***
	(0.056)	(0.011)	(0.004)	(0.056)	(0.010)	(0.004)
lag of stockmarket volatiltiy	5.682	1.663	-1.511***	8.524	2.117	-1.708***
	(6.159)	(1.308)	(0.521)	(6.426)	(1.308)	(0.522)
lag of economic risk index	-0.039	-0.006	-0.002	-0.023	-0.003	-0.003
	(0.058)	(0.011)	(0.004)	(0.057)	(0.010)	(0.004)
lag of financial risk index	-0.082*	-0.021**	0.003	-0.084*	-0.021**	0.002
	(0.046)	(0.009)	(0.004)	(0.046)	(0.009)	(0.004)
lag of political risk index	-0.044	-0.011	0.003	-0.033	-0.009	0.002
	(0.050)	(0.011)	(0.004)	(0.051)	(0.010)	(0.004)
time effects	yes	yes	yes	yes	yes	yes
country effects	yes	yes	yes	yes	yes	yes
Constant	-530.683***	-71.981***	12.395**	-501.949***	-65.410***	10.416**
	(94.537)	(12.951)	(5.158)	(95.941)	(13.010)	(5.198)
Observations	539	571	571	539	571	571
R-squared		0.28	0.10		0.29	0.10

Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Panel regressions of crisis in potentially affected country on the lagged uncertainty in B

Step 2 Effect of uncertainty in a country on the probability of a crisis there if a crisis takes place in an initial crisis country

Dependent Variable crisis as measured by significant negative returns in country B at t

Data source: MSCI

The considered crises periods are Mexico 1994/5, Thailand 1997, Russia 1998, Brazil 1999, Turkey 2001, Argentina 2002

returns as dep. Variable

	(1) pooled probit all crises, all countries	(2) pooled probit all crises, emerging markets	(3) linear probability all crises, all countries	(4) linear probability all crises, emerging markets	(5) OLS, all crises, all countries	(6) OLS, all crises, emerging markets
lag of uncertainty in B	0.292**	0.267*	0.061***	0.043**	0.005	0.011
	(0.134)	(0.140)	(0.013)	(0.019)	(0.006)	(0.008)
lag of mean of growth exp.	-0.026	-0.038	-0.007***	-0.008**	-0.004***	-0.003**
	(0.026)	(0.027)	(0.002)	(0.004)	(0.001)	(0.002)
lag of crisis in Arg	0.318**	0.272*	0.018*	0.028	-0.008*	-0.008
	(0.145)	(0.159)	(0.009)	(0.018)	(0.004)	(0.008)
lag of crisis in Bra	0.608***	0.650***	0.057***	0.116***	-0.021***	-0.026***
	(0.157)	(0.172)	(0.011)	(0.022)	(0.005)	(0.010)
lag of crisis in Rus	0.391*	0.555**	0.096***	0.191***	0.042***	0.037***
	(0.202)	(0.223)	(0.015)	(0.029)	(0.007)	(0.013)
lag of crisis in Tha	0.818***	0.869***	0.076***	0.131***	-0.032***	-0.055***
	(0.102)	(0.113)	(0.008)	(0.015)	(0.004)	(0.007)
lag of crisis in Tur	-0.059	0.026	0.004	0.016	-0.002	-0.001
	(0.130)	(0.141)	(0.008)	(0.016)	(0.004)	(0.007)
country effects	yes	yes	yes	yes	yes	yes
Constant	-2.741***	-1.714***	-0.032	-0.009	0.028***	0.027*
	(0.412)	(0.342)	(0.021)	(0.033)	(0.011)	(0.014)
Observations	2828	1630	4016	1947	4113	1946
R-squared			0.15	0.20	0.03	0.05

Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3.11: Step 2: Effect of uncertainty in B on crisis there, robustness check

Table 3.12: Marginal effect of uncertainty in B on probability of a crisis there

Marginal effects of probit regressions of crisis in potentially affected country on the lagged uncertainty

Step 2 Effect of uncertainty in a country on the probability of a crisis there if a crisis takes place in an initial crisis country

Dependent Variable crisis as measured by significant negative returns in country B at t

Data source: MSCI

The considered crises periods are Mexico 1994/5, Thailand 1997, Russia 1998, Brazil 1999, Turkey 2001, Argentina 2002

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	all countries	emerging markets	all countries	emerging markets	all countries	emerging markets	all countries	emerging markets
lag of interact. uncert. in B &	0.025***	0.039***			0.042**	0.052***		
crisis in Mex, Rus, Tha	(0.007)	(0.011)			(0.017)	(0.019)		
lag of interact. uncert. in B &			0.009**	0.016**			0.016	0.020*
crisis in all initial crisis cntrs.			(0.004)	(0.007)			(0.010)	(0.010)
lag of interact. com creditors &	0.481*	0.637	0.511*	0.626	0.301	0.629	0.255	0.550
crisis in A	(0.263)	(0.431)	(0.274)	(0.445)	(0.773)	(0.818)	(0.785)	(0.827)
lag of interact. tradeshare &	0.500**	0.728**	0.607***	0.907***	0.713	0.631	1.064	1.057
crisis in A	(0.224)	(0.326)	(0.229)	(0.334)	(0.956)	(0.988)	(0.955)	(0.986)
lag of interact. market size &	-0.000	-0.000	-0.000	-0.000	0.000	-0.000	0.000	-0.000
crisis in A	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lag of interact. overexp. index					0.002**	0.002**	0.002**	0.002**
& crisis in A					(0.001)	(0.001)	(0.001)	(0.001)
lag of mean growth expectation	0.013***	0.017***	0.011***	0.015***	0.042***	0.041***	0.038***	0.036***
	(0.003)	(0.005)	(0.004)	(0.006)	(0.010)	(0.010)	(0.010)	(0.010)
lag of stockmarket volatility	0.968**	1.107*	0.862**	0.922	1.838	1.584	1.384	1.051
	(0.387)	(0.567)	(0.387)	(0.576)	(1.139)	(1.203)	(1.086)	(1.144)
lag of economic risk index	-0.004	-0.008	-0.006	-0.010	-0.002	-0.004	-0.005	-0.007
	(0.004)	(0.006)	(0.004)	(0.006)	(0.010)	(0.011)	(0.010)	(0.011)
lag of financial risk index	-0.004	-0.006	-0.004	-0.006	-0.014*	-0.016*	-0.014*	-0.015*
	(0.003)	(0.005)	(0.003)	(0.005)	(0.008)	(0.009)	(0.008)	(0.009)
lag of political risk index	-0.001	0.001	-0.002	-0.000	-0.009	-0.006	-0.010	-0.008
	(0.003)	(0.005)	(0.004)	(0.005)	(0.009)	(0.009)	(0.009)	(0.009)
time effects	yes	yes	yes	yes	yes	yes	yes	yes
country effects	yes	yes	yes	yes	yes	yes	yes	yes
Observations	1309	903	1309	903	586	539	586	539

Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

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Eidesstattliche Versicherung

Ich versichere hiermit eidesstattlich, dass ich die vorliegende Arbeit selbständig und ohne fremde Hilfe verfasst habe. Die aus fremden Quellen direkt oder indirekt übernommenen Gedanken sowie mir gegebene Anregungen sind als solche kenntlich gemacht. Die Arbeit wurde bisher keiner anderen Prüfungsbehörde vorgelegt und auch noch nicht veröffentlicht.

Washington, den 3. Oktober 2007

Fritzi Köhler-Geib

Curriculum Vitae

February 2008	PhD (Dr. oec. publ) in economics Ludwig-Maximilians-Universität, Munich
October 2003 - February 2008	PhD Program in Economics, Munich Graduate School of Economics at Ludwig-Maximilians-Universität, Munich
March-June 2006 February-July 2007	Visiting Ph.D student, Universitat Pompeu Fabra, Barcelona
October 2002	Master (lic. oec. HSG) in economics Universität St. Gallen, St. Gallen
	CEMS-Master in international management (Community of European Management Schools) Universität St. Gallen, St. Gallen
September- December 2000	Exchange student, University of Michigan Business School, Ann Arbor
October 1999- June 2000	Exchange student, Hautes Etudes Commerciales, HEC, Paris
July 1997	Abitur, Amos Comenius Gymnasium, Bonn