CONTAGION VERSUS FUNDAMENTALS IN A PANEL DATA FRAMEWORK

-AN ANALYSIS OF THE LATEST INTERNATIONAL FINANCIAL CRISES-

By

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Submitted to

Central European University

Department of Economics

In partial fulfillment of the requirements of the degree of Master of Arts

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Budapest, Hungary

2007

Abstract

In the last decades, the financial world faced deep, significant and contagious currency and banking crises, which proved that traditional models predicting the main cause of currency crises as the deterioration of economic fundamentals are no longer valid: latest episodes show that countries with sound economic policies – ***'good health'***- were not immune to regional crises. New models that tried to explain financial crises emerged, linking crises to self-fulfilling prophecies and contagion effects.

The analysis below uses a Probit model to test for the probability of crisis occurrence, using a balanced panel data for 21 countries from Latin America and Asia, for a period of 31 years. The results show a strong significant impact of contagion, in addition for the effect of weak fundamentals. When dividing the sample into two separate sub-samples for Latin American and East Asian countries, the contagion effect increases, but weak fundamentals remain significant only for Latin American countries, leading to the conclusion that crises from this part of the world can be considered evidence on fundamental-based contagion, while events from East Asia belong to a different category of contagion- pure contagion.

AKNOWLEDGMENTS

I would like to thank to my supervisors, Prof. Julius Horvath and Prof. Andri Chassamboulli, for their support and valuable advices during the elaboration of this paper. I would like to bring special thanks to Prof. John Harbord, for his help and ideas in structuring the thesis.

Last but not least, I would like to thank my family and my husband, who offered their full support and understanding during the Master period.

CONTENTS

INTRODUCTION

The last decade of the 20th century brought important changes in the financial systems of many countries. The financial world faced deep, significant and contagious currency and banking crises, which led to the admission of the fact that not too much is known about international financial crises, their mechanisms of transmission from one country to another, determinants and impact on countries' financial stability.

As Kruger, Osakwe and Page (1998) acknowledged in their paper, there is no consensus in the theoretical literature regarding the causes of currency crises. Among the debates that gained an increased interest between economists has been the one concerning the ways to predict financial crises and their transmission mechanisms.

The severity of the financial crises that hit Latin America and East Asia showed that the well-known theory that strong macroeconomics fundamentals are the most important mechanism in avoiding financial crises is no longer valid. Although traditional models predict that the main cause of currency crises is the deterioration of economic fundamentals, latest episodes show that countries with sound economic policies – ***'good health'***[1]- were not immune to regional crises.

The episodes of deep international financial crises observed in the 1990s: the 1992-1993 crisis of the Exchange Rate Mechanism, the Mexican crisis of 1994-95 and its "tequila effect" that spread all over Latin American and other countries, the Asian crisis of 1997-98 and its "spillovers" to Brazil and Russia, persuaded the economists all around the world to search for the

[1] Bordo, M. (2000)

causes of currency crises outside the country. New models that tried to explain financial crises emerged, linking crises to self-fulfilling prophecies and contagion effects.

In the empirical analysis that follows, I will try to answer to some of the most debated questions in conversations between economists: how important is one country's 'good health' in times of financial turbulences and, in case a crisis hit more countries in the same time, is there any proof of contagion, measured as an increase in the probability of crisis occurrence not explained by changes in fundamentals?

The analysis is focused on emerging markets from Latin America and Asia; as an extension of the initial topic, I analyzed the evidence of contagion separately for Latin America and Asia. The empirical model that I am using is a Probit model that calculates the probability of crisis occurrence, taking into consideration different factors, out of which the most important for capturing pure contagion effect is a successful speculative attack in another country in the same period.

When one can argue that contagion occurred, the relation between weak macroeconomic fundamentals and contagion effect has two directions: first, when a speculative attack is transmitted from one country to another, the 'health' of economic system is important in defending the currency. Weak fundamentals increase the probability of a successful attack, because the monetary authority does not have the instruments necessary to defend itself. The question that arises here is how well good fundamentals can protect against or at least can diminish the effects of a contagious financial event. On the other hand, if the crisis occurs independently of the sound economic situation – which means we can consider that contagion occurred-, this will weaken the macroeconomic indicators. The secret in deciding what the relationship for each crisis is stays in the timing of the events.

In order to understand the mechanisms through which a crisis can spread from one country to another, it is necessary first to distinguish crisis periods from tranquil ones, to define a contagious currency crisis and to see the monetary and fiscal policy that the authorities can adopt in order to defend against it and minimize its effects.

As history proved during periods of financial insecurity, crises tend to happen more often in countries that use fixed rate or pegged currencies. There is a very logical explanation for this: floating currencies are able to adjust on a relatively gradual, daily basis to forces affecting them.

According to the definition that most authors agree with, one can say that a country faced a crisis when an official devaluation or revaluation took place, or when the currency was floated. This definition is too strict, for few reasons: first of all, as I will show later on, currency crises occurred also in countries that did not pegged their currency against a single currency or a basket of currencies. Speculative attacks led to depreciations of currencies that were normally allowed to float. Another reason is that, sometimes, currencies are devalued slightly, only to align the exchange rate with the fundamentals, even in periods that are characterized as tranquil ones.

I conclude that, for the purpose of this study, the size of depreciation is the one that matters. In my empirical analysis, I considered that a country experienced a currency crisis when either a strong depreciation or a high loss in international reserves was recorded.

Knowing the importance of strong macroeconomic fundamentals in defending against currency crises or at least diminishing their effects on financial stability is very important and it has been the subject of a vast literature. The empirical analysis below is focused on the relationship between weaknesses in the economy that lead to currency crisis (or, consequently, on strong fundamentals that helped preventing the occurrence of a crisis) and the transmission mechanisms of crises from one country to another in the same region.

Calvo and Reinhart (1996) distinguish between fundamentals-based contagion, which arises when the infected country is linked to others via trade or finance, and "true" or "pure" contagion, which arises when common shocks and all channels of potential interconnection are either not present or have been controlled for.

The paper has the following structure: the first chapter is organized as a debate regarding international financial contagion. It includes a discussion on different types of currency crises, defined in the related literature as first and second generation models. Contagious crises are considered as belonging to third generation models. A short discussion on the possible patterns of transmission follows; important theoretical papers on the subject are mentioned in this part. The literature regarding currency crises identifies as main channels of transmission the linkages through international trade, lending from the core to peripheral countries, linkages in arbitrage in short-term securities markets, stock markets, or commodities markets. As I mentioned before, these channels are a proof of the existence of fundamentals based-contagion, rather than pure contagion.

One can not disregard the fact that, when crises are contagious, the effect tends to spread across countries from the same region; knowing that international trade and lending between countries are higher among neighboring countries, we can analyze the fundamental based-contagion more as a regional contagion. A proof for pure contagion would be the transmission of a crisis between two countries that are not significantly linked through trade and are not similar in economic characteristics.

The first chapter closes with a discussion of two major episodes of financial crises, considered 'contagious', namely the Mexican peso crisis in late 1994, with its "Tequila effect" on Argentina and other Latin American countries, and the Asian financial crisis, that initially led to the devaluation of the baht in 1997 and then spread across all East-Asia.

In order to measure the transmission of shocks and to test for contagion, different models have been developed, which can be divided into four major categories, according to direction of the analysis: the study of cross-market correlation coefficients, the transmission of volatility changes through a GARCH framework, cointegration tests for co-movements of capital flows and rates of return and conditional probability of currency crisis occurrence, through Logit/Probit models. The second chapter begins with a short description of these models, followed by the analysis of indicators of currency crisis.

Next pages are dedicated to the empirical model that I implemented in order to test for the significance of fundamentals and existence of contagion. Using a Probit model, I calculated the conditional probability that a country is facing a speculative attack, knowing that a crisis occurred in the same period in another country. The sample contains data on 24 countries from Latin America and Asia, for a period of 31 years, between 1972 and 2002.

Empirical results for the analysis of the entire sample are presented in the last chapter of this paper. I conducted a more detailed analysis of speculative attacks periods, separately for Latin America and Asia in the extension of the initial analysis, also included in chapter three.

Conclusions are presented in the final part of the paper.

CHAPTER 1: CURRENCY CRISES – INTRODUCTION INTO THE TOPIC

Currency crises are generally defined as situations when an attack on the currency leads to substantial reserve losses, or to a sharp depreciation of the currency – if the speculative attack is ultimately successful- or both.

Lev Tolstoy's words from the introduction of his famous novel 'Anna Karenina' can describe very well the particularities of each currency crisis: '*Every happy family is the same. Every unhappy family is miserable in its own way.'* When a currency crisis arises, the manner in which it develops and the consequences it has over the general economic framework of the country under attack are different for each economy. Still, when discussing the main factors that triggered a currency crisis, three generations of models arose in the theoretical literature. Each model explains a particular aspect of the same problem and was developed after a particular crisis occurred, in such a way that fits the characteristics of the crisis perfectly.

1.1 First Generation Models of Currency Crises

Also called the 'canonical currency crisis model', the first generation model emphasizes the inconsistencies between fundamentals and fixed parity. Developed initially by Paul Krugman (1979) and refined later on by Flood and Garber (1984), these models explain crises as the result of a fundamental misalignment of domestic policies and the attempt to maintain a fixed exchange rate. As Krugman argued, the devaluation of the currency can be postponed, as long as the central bank has sufficient foreign currency reserves to intervene in the market and prevent devaluation.

When these reserves become inadequate, the government is no longer capable to defend the peg and crisis occurs; policymakers have no other solution but depreciation of the national currency because speculators force the issue with a wave of selling: it is no longer profitable for them to hold local currency, so they start exchanging it for foreign currency in the highest amount possible. Using Krugman's definition, ' *a speculative attack can be viewed as a process by which investors change the composition of their portfolios, reducing the proportion of domestic currency and raising the proportion of foreign currency'*(p.312).

Since first generation currency crises are a consequence of inadequacy between domestic policy and the attempt to maintain a fixed exchange rate there is no doubt in concluding that crises belonging to first generation models are predictable and deterministic.

1.2 Second Generation Models of Currency Crises

As first generation models were not able to predict or even explain a series of speculative attacks on EMS currencies in 1992/93 and on Mexican peso in 1994, different models were developed that enclosed the possibility that financial crises arise even in the presence of strong macroeconomic fundamentals.

Pioneered by Maurice Obstfeld (1986 and 1995), second generation models of currency crises are concentrated on the trade-off that the government must face when deciding to devalue the currency or not, meaning that the government will try to minimize as much as possible the loss function; it will be forced to choose between losses due to abandonment of parity and losses due to maintenance of it. Currency crisis occurs when the government decides not to defend the peg anymore and to devalue too late, when costs already incurred are very high and macroeconomic fundamentals are significantly affected. It was the case of Great Britain during

the ERM crisis in 1992-1993, when increasing interest rate became too expensive measured in terms of unemployment and deepening the recession.

In order to understand the costs and gains from abandoning a fixed rate, one must find the reasons why the government might be willing to devalue the currency. One possible explanation is a large debt burden, denominated in local currency. As much as the government is tempted to inflate this burden away, it can not do it, as long as it is committed to a fixed exchange rate. For example, the attacks on the French franc during the 1920s were triggered mainly by suspicions that the government might try to inflate away its legacy of debt from World War I.

Another possibility is that the country suffers from high unemployment, due to rigid nominal wages, and a more expansionary monetary policy that would relax the employment-rigid wages relationship can not be followed as long as the exchange rate is fixed. In this regard, Ozkan and Sutherland (1993) showed that the increase in the interest rate that would be necessary if the monetary authority is willing to defend its currency against a speculative attack would aggravate the unemployment problem even more. Thus, any increase in unemployment will increase the costs of defending the peg, consequently increasing the probability of a successful speculative attack on the currency. According to Kruger, Osakwe and Page (1998), this was the motivation for the British monetary authority to abandon the gold standard in 1931 and the exchange rate mechanism of the European Monetary System later on, in 1992.

A third ingredient in the 'mixture' that leads to a currency crisis of second generation is the assumption that the costs of defending the peg must themselves increase when people expect that the fixed exchange rate arrangement might be abandoned. When the public lack of confidence in the authorities' commitment to defend the peg regime is high, debt-holders may require a higher interest rate, because they expect depreciation in the future. Thus, the debt burden increases, becoming harder to manage without depreciation.

1.3 Third Generation Models of Currency Crises

Until now, none of the theoretical models that explained currency crises controlled for crises that occur in different countries in the same period. The financial episodes from the last decade of 20 century led economists to wonder if it is not the case that crises spread like a contagious disease from one country to another.

Reisen (1998) analyzed recent crisis episodes from Asia and Latin America, underlying the sources of crises and concluded that a common characteristic for the countries hit by currency crises was the weak domestic financial system. Reisen agreed argues that strong macroeconomic fundamentals are not enough to protect the countries against attacks, especially when there is the case that another country, neighbor or not, is experiencing a currency crisis. On the other hand, weak macroeconomic fundamentals are neither a necessary nor sufficient condition for the occurrence of crisis. There are many examples of countries that manage to attract foreign direct investments, increase their exports and not face a financial crisis, even if external debt and current account deficit present values higher than the normal limits.

A third generation of currency crises models arose, that tried to determine why some crises were contagious – spreading from one country to another, what were the channels of transmission and why some crises tend to spread further away and faster than others.

Although the subject of contagion raises interest of many economists, few studies have been trying to examine the channels through which disturbances are transmitted. Kaminsky and Reinhart(2001) brought a very important contribution, when describing the transmission mechanisms; according to them, one reason why countries may experience currency crises in the same period is a common adverse shock, for example a rise in world interest rate. But common

adverse shocks represent symmetric shocks, which, in many authors' opinion, should not be included in the definition of contagion.

Calvo and Reinhart(1995) consider two main channels through which a crisis can spread: first of all, real linkages between countries – mostly international trade and finance-, increase the probability that a currency is under attack. When the country that is subject to a speculative attack is linked to other countries through international trade, connections in the short-term security markets, stock or commodities markets (this group of factors are mostly important in transmission of crises between advanced economies), the probability that a 'healthy' economy - with strong economic fundamentals – is hit by the crisis increases. Economists labeled this type of contagion as fundamental based.

Linkages through international trade can explain, although partially, the devastating impact of the crisis, the speed and violence of its behavior. It was the case of Asian countries in 1997 (characterized by strong fundamentals). The Southeast Asian countries sell, to at least some extent, similar products in world export markets; thus, when the Thai authorities decided to devalue the baht, Malaysian exports products lost their competitiveness, pushing Malaysia past the critical point that triggers a crisis.

When common shocks and all channels of interconnection have been controlled for, the remaining effect is considered 'pure' contagion. Calvo and Mendoza (1998) associated true or pure contagion with rational herding behavior on the part of investors. As we can all agree, the assumption that foreign exchange markets are efficient - that is, that they make the best use of the available information, which is incorporated in both first and second generation currency crises models, is far from realistic. The efficiency or better said inefficiency of financial markets can have an impact on the probability of a crisis through the behavior of investors, that is, through the so-called 'herding' behavior.

In a study of investors' behavior during the 1987 stock market crash, Shiller (1989) found that, when facing a decrease in prices, investors started to sell stocks as fast as possible and without a limit. In the context of a currency crisis, this behavior will lead to a rush out of national currency.

Investors' behavior can be seen as irrational when they perceive as a group countries that do not show strong economic similarities, but some common, imperfectly observed characteristics. Still, the economic effects of such a behavior remain unclear.

Another direction for herding behavior is given by the policy makers rather than investors: when one country is committed to a fixed exchange rate, it is politically less costly to abandon the peg when another neighboring country took the same decision, as compared to the situation when it had to devalue on its own. It was the case of 1992-93 EMS crises: Sweden abandoned its peg to the DM after Britain and Italy left the exchange rate mechanism, thus decreasing the political costs of such a decision.

It is important to mention that the main purpose of these models is not to predict the timing of currency crises, but to predict which countries are going to be hit hardest, given the occurrence of a crisis somewhere in the world. In the third generation crises model scenario, a necessary and sufficient condition for the occurrence of the crisis is international financial illiquidity.

1.4 The 1990s – a Decade of Crises

The 1990s have offered the spectacle of three distinct regional waves of currency crises: Europe in 1992-93, Latin America in 1994-95 and Asia in 1997. These financial episodes have been the subject of an extensive economic literature, both theoretical and empirical. In the following pages I included a short description and a survey of the theoretical literature regarding

Tequila crisis and Asian flu. The next chapter is dedicated to the empirical literature on the topic, followed by the econometric analysis of the two most important episodes of financial instability that lead to deep contagious crises: 1994-95 and 1997 scenarios.

1.4.1 Mexico in Crisis and the Tequila Effect

1.4.1.1 Mexican devaluation – what triggered the crisis?

Mexico experienced a deteriorating situation during 1994. One of the main factors that increased the suspicions around Mexican economy was the uncertainty in the political environment: the assassination of the ruling's party Presidential candidate and the relaxation of monetary and fiscal policy in the wake of election led to a decrease in foreign capital inflows, followed by a rapid decline in international reserves. As a consequence, the government was unable to repay its short-term debt denominated in dollars.

Devaluation of the Mexican peso took place in two steps: first, shortly after the election, under external pressure, the government decided to devalue the peso by 15 percent. This devaluation did not have the expected results; on the contrary, it turned out not to be a sufficient measure to strengthen the economy. The only effect was a loss in government's credibility to commit to a fixed rate, leading to higher inflation. The government saw itself forced to raise interest rates, even if the immediate consequence was a sharp contraction in domestic demand and 7 percent fall in GDP. Using a massive international loan, Mexico succeeded in regaining access to international capital and reaching economic growth, repaying the loan ahead of schedule.

1.4.1.2 Tequila effect

The Mexican crisis had the expected effect over the international investors' sphere: fearing of devaluations in neighboring countries, investors started to search for signs of currency vulnerability and weak fundamentals. As a consequence, countries in a weaker position, which took advantage of investor confidence and high levels of capital inflows before December 1994 (date considered by analysts the defining moment for the Mexican crisis), suddenly lost that privilege. Several of these countries faced a speculative attack, including Argentina, Brazil and the Philippines. Out of these, the one that was hit the hardest was Argentina.

The belief that the currency board arrangement that linked the Argentinean peso to the US dollar at a one-to-one parity will act as a defensive wall against the speculative attack turned out not to be realistic. Nothing predicted that Mexican crisis will have an effect on Argentinean economy. On the contrary, the government expected that the strong commitment to the peg and the absence of strong trade linkage with Mexico would prevent any contagion. As it turned out, investors' beliefs in such a commitment were not that strong; speculators attacked the currency, suspecting that Argentina might abandon the currency board arrangement. Despite this situation and the problem of high unemployment that needed a fast solution, the government decided not to abandon the peg, hoping that the investors will reinforce their confidence in the authorities' commitment to the peg and that the pressure would ease. In 1996, Argentina also resumed economic growth.

Many economists agreed with J. Sachs, A. Tornell and A. Velasco(1995), who argued that the Mexican crisis only reached previously weakened countries, vulnerable to self-fulfilling investors' panics. Countries with strong banking systems or high foreign exchange reserves only suffered from declines in capital inflows, but for a short period.

The Mexican Tequila crisis and its spread across neighboring countries can not be labeled as belonging to any particular generation of currency crises. As underlined by Bruinshoofd, Candelon and Raabe(2005), elements that characterize both second and third generation models can be found in the formula for 'Tequila hangover'. Authors found that measures of banking sector strength – deposits by banks, lending boom and especially foreign bank penetration- have significant explanatory power. Thus, transmission through the trade channel corresponds to second generation models of currency crises. The authors also underline the fact that the crisis tended to be transmitted through common lenders: countries that suffered from Tequila hangover were competing with Mexico for international funds. In concordance to the idea of investors' panic, Bruinshoofd et al. found a significant effect of foreign bank penetration, leading to the conclusion that foreign banks provide instability, as they tend to be the first to run in case of a speculative attack. In an addition analysis, the authors included more traditional macroeconomic control variables (GDP growth, trade deficit, budget deficit, real exchange rate, interest rate, international reserves). They turned out to be insignificant, suggesting that the Tequila crisis can not be considered a first generation crisis.

1.4.2 The devaluation of the bath and the Asian flu

1.4.2.1 Review of the prelude and aftermath of the crisis

The Asian scenario and the Argentinean crisis from 2001-02 have a very important element in common: the main reason that led to devaluation. The Asian countries adopted the same measure as Argentina did in its attempt to fight against high inflation: many of them pegged their local currency against the US dollar. As in the case of Argentina, this had a positive effect on

exports level: virtually all of the Asian economies that have been mentioned in the context of the Asian financial crisis have based their economic strategies on export promotion.

The situation changed when the US dollar appreciated in comparison with the Japanese yen and third world countries; the competitiveness of Asian exports declined, and it would have continued to decline as long as the authorities would not have abandoned the fixed exchange rate regime[2].

The second of July 1997 is considered by everybody the defining moment for the beginning of the 'Asian flu'. The Thai government decided, after years of fixed exchange rate regime, to switch to a managed float of the baht and devalued the currency by 20 percent against the US dollar.

Within weeks the Philippines and Malaysian governments were heavily intervening to defend their currencies, while Indonesia allowed the currency to move in a widened trading range - a sort of a float but with a floor below which the monetary authority defends in order to prevent future falls of currency below the fixed value accepted. By the end of the month there was a 'currency meltdown'[3]. Soon after, other East Asian economies became involved, Taiwan, Hong Kong, Singapore and others[4]. Stock and property markets were also feeling the pressure though the declines in stock prices tended to show a less volatile but nevertheless downward trend over most of 1997. The Asian crisis had devastating effects on the other side of the ocean as well: on 27 October, the Dow Jones industrial index registered the biggest fall in history, decreasing by 554.26 or 7.18 percent. The stock exchange officials took the drastic measure of suspending the trade.

[2] Many economists argued that Argentina should have learned from the Asian experience and abandon the currency board arrangements thus avoiding the default from 2002.
[3] Term used by David Richardson in '*Asian Financial Crisis'* ,1998
[4] See N. Roubini - *'Chronology of the Asian Currency Crisis and its Global Contagion'* for a detailed description of all countries that suffered from the Asian 'flu'.

1.4.2.2 Thailand and Korea

Maybe the countries that suffered the most from the Asian flu were Thailand and Korea. The crisis that affected these two countries goes far away from being a simple, though contagious, currency crisis. Analysts argued that a twin crisis hit Thailand and Korea, affecting both the banking-financial sector and the currency stability.

When characterizing the events from 1997-1998, Burnside, Eichenbaum and Rebelo(2007)[5] concluded that standard economic indicators, such as inflation rates, monetary growth rates, past government deficits, failed in predicting the occurrence of the crisis (in line with the assumption that the Asian crisis was not an example of first generation currency crises) and its severity and speed of spreading. Both countries had records of low inflation rates (the CPI rose at annual rates of 5 and 4.6 percent respectively for Thailand and Korea), giving no hint of the events that followed. The same is true for the fiscal deficit and debt: both countries have been running fiscal surpluses and the ratios of debt over GDP were small.

According to the same authors, both Korea and Thailand experienced banking crises that began before the currency crises, due to high pre-crisis non-performing loans.

On 20 August, after signing an agreement with the IMF for receiving a stand-by credit of up to $US 3.9 billion, out of which $US1.6 billion available immediately, Thailand adopted a package of measures, which included: a floating exchange rate regime, a revised fiscal policy aimed to produce surplus, stronger financial regulation and transparency of CB activities and accelerated privatization.

[5] C. Burnside, M. Eichenbaum and S. Rebelo – '*Understanding the Korean and Thai currency crises'*

Similar measurements were adopted by Indonesia and Korea. The later received a $US 2.1 billion credit conditioned by the adoption of tighter monetary and fiscal policy, strengthening of the financial system and trade liberalization.

CHAPTER 2 – EMPIRICAL ANALYSIS

2.1 Literature Review of the Analysis of Currency Crises

In order to measure the transmission of shocks and to test for contagion, different models have been developed, which can be divided into four major categories, according to direction of the analysis: the study of cross-market correlation coefficients, the transmission of volatility changes captured by a GARCH framework, cointegration tests for co-movements of capital flows and rates of return and conditional probability of currency crisis occurrence, through Logit/Probit models.

The study of cross-market correlation coefficients is considered by Forbes and Rigobon (1999) the most straightforward and intuitive method for analyzing currency crises. The empirical model measures the correlation in returns between two markets by comparing tranquil and agitated periods. Contagion occurs when the correlation coefficients increased significantly, compared to tranquil periods, suggesting that the crises transmitted between the two countries. Calvo and Reihart (1995) tested this model for a sample of Asian and Latin American emerging market economies, after the 1994 crisis of Mexican peso, and observed that the correlation between stock prices and Brady bonds increased significantly, suggesting that the crisis spread contagiously.

Another paper related to the Asian crisis from 1997 was written by Reiny and Fredrik (2002)[6] , who analyzed the Indonesian economy in the period following the Asian crisis in an attempt to see whether the contagion from the economic crisis in Thailand triggered the crisis in

[6] Indonesia pdf

Indonesia. They found that contagion was present in the factors that weakened the Indonesian economy. Investors' behavior, rather than real links, is identified as one important channel for contagion.

A second direction for the empirical analysis of contagion, followed by Edwards (1998), Edwards and Susmel(2000) and Bartram and Wang (2004), tests for the variance-covariance transmission mechanism across countries using an ARCH/GARCH framework. Edwards for example examined the bond markets after the Tequila crisis. The author implemented an augmented GARCH model and found significant spillovers from Mexico to Argentina. Bartram and Wang used a device common in financial research – Monte Carlo simulation to generate time-series of financial asset returns. Their results provide evidence that contagion exists during financial crises.

While the study of cross-market correlation coefficients focuses on the short-run changes in the relation between capital flows, the co-integration tests are concentrated on long-run changes. The procedure is similar; the difference is that this method tests for changes in co-integrating vector between stock markets, instead of changes in variance-covariance matrix. For instance, Longin and Solnik (1995) model the conditional multivariate distribution of international asset returns. Using data for USA, UK, France, Germany and Japan, they test for the existence of predictable time-variation in conditional correlation for the period 1960-1990 and find that international covariance and covariance matrices are instable over time.

When analyzing currency crises, many economists have wondered if they can be predicted and what are the factors that increase/decrease the conditional probability of crisis occurrence. Probit/Logit models have been used to test for the probability of crisis occurrence, having as dependent variable a dummy variable, equal to 1 if the currency was under attack in that particular period and 0 otherwise. Authors tried different specifications and used different

explanatory variables in order to understand what triggers a crisis and how a speculative attack can be predicted (a review of the most significant variables and intuition behind them follows in the next subsection of the paper).

Probit/Logit models present a couple of advantages compared to other models. In particular in the case of Probit models, due to the fact that the significance of variables is tested simultaneously, it is easier to check the explanatory power of newly included variables, interpreting the result as the increase in the probability of a successful attack (crisis occurrence). On the other hand, when using probability models, one can not separate the explanatory power of one particular variable from the others, since the result depends on all the variables included.

2.2 Indicators of Currency Crises in Probit Models[7]

One of the first studies dealing with currency crises was carried out by Bilson(1979).Using annual data on 32 countries with emphasis on Ecuador, Mexico and Peru, the author introduces 'shadow' exchange rate to assess the size of the devaluation and the ratio of international reserves over base money as an indicator of the probability of a devaluation.

A more specific analysis was conducted by Collins (1995). Keeping in mind the general opinion that countries which pegged their currencies are more susceptible to financial crises, Collins controls for eighteen countries with pegged exchange rates at the beginning of 1979 and finds that variables like international reserves/GDP, current account/GDP, real GDP growth, inflation rate, and amount of foreign aid are significant in explaining the probability of crisis occurrence.

[7] For a detailed survey on the literature on international currency crises see Kaminsky, Lizondo and Reinhart(1997) – '*Leading indicators of currency crises'*

Eichengreen, Rose and Wyplosz [8](1996) wrote one of the first studies that evaluate recent crises. Using Probit models belongs to, they tested for contagion in the abandonment of a fixed exchange rate regime in the ERM episode. Using thirty years of panel data from twenty industrialized countries, the authors found evidence that speculative attacks tend to be temporarily correlated and that currency crises seem to pass from one country to another. The behavior of several macroeconomic fundamentals is followed during the four years around the crises and events compared to the evolution of these variables around periods of tranquility. The authors also conclude that an important variable that explains currency co-movements is represented by the existing linkages in international trade between the countries affected.

Flood and Marion (1995) developed and tested a model for 17 Latin American countries that examines the size and timing of devaluations, focusing on the trade-off between the cost of realigning and the costs of a misalignment. Bae, Karolyi and Stulz (2001) extended the analysis and used more advanced probability tests, including the application of multinomial regressions.

Kaminsky and Reinhart (1996) found evidence for 76 currency crises and 26 banking crises, for a sample of 20 countries – 5 industrial and 15 developing-, using monthly data for 1970-1995 period. They examined the behavior of variables 18 months before and after the crises and compared it to the behavior of the indicators during 'tranquil' periods. In predicting the probability of a speculative attack, the authors used the degree of financial liberalization and a dummy variable, equal to 1 if the country experienced a banking crisis.

It is the general opinion that crises have different impacts on countries they affect, and that the magnitude of this impact depends on the strength of macroeconomic fundamentals and monetary and fiscal policies followed by the authorities. In order to explain why some countries

[8]Eichengreen, B., Rose, A., and Ch. Wyplosz - "Contagious Currency Crises," *National Bureau of Economic Research Working Paper* 5681, 1996.

were more affected by the Mexican crisis than others, Sachs, Tornell and Velasco (1995), used monthly and annual data for 20 emerging market economies between 1985 and 1995 and identified three factors that determine whether a country is vulnerable to financial crisis: a weak banking system, low levels of foreign exchange reserves and a large appreciation of the real exchange rate. They found that different experiences of emerging markets in 1995 can be explained by differences in fundamentals.

A more sensitive analysis was conducted by Frankel and Rose (1996), who examined the determinants of currency crashes, a subset of currency crises. As their analysis showed, not all macroeconomic fundamentals that describe first generation models can be associated with currency crises: in particular, high foreign interest rates, low output growth and high credit growth have a significant explanatory power on crisis index, but current account and government budget deficit are found to be insignificant.

2.3 Contagion versus Fundamentals in a Panel Data Framework

The empirical analysis from this paper is concentrated around the last type of models developed to analyze currency crises. Using a Probit model, I will calculate the conditional probability that a country is facing a speculative attack, knowing that a crisis occurred in the same period in another country. The main purpose of this analysis is not to conclude if there can be found any proof of contagion or not, but to assess the direction for the relationship between pure contagion and weak macroeconomic fundamentals in the particular case of South-East Asian and Latin American countries.

In estimating the econometric model, I will start from the model used by Kruger, Osakwe and Page in 'Fundamentals, contagion and currency crises: an empirical analysis' – 1998. The

main improvement consists in the sample: the authors examine the determinants of currency crises in 19 developing countries from Latin America, Asia and Africa, spanning the period 1977-1993; since my main interest stays in the financial events from the last decade of 20th century, I will extend the sample size and consider the period 1972-2002. Second, I will concentrate on the events from Latin America and Asia, since crisis that occurred in this part of the world have been considered the most devastating and with the largest spread area for the last decade of 20^{th} century.

Kruger, Osakwe and Page found that not all the macroeconomic variables considered as causes of currency crises are significant. Real exchange rate misalignment, the ratio of M2 to international reserves and a measure of lending boom are the only variables that can be consistently linked to currency crises. Other variables, like growth rate of domestic credit or current account deficit are not significant or become insignificant when the definition of crisis index or the sample size is changed.

The authors further analyzed the evidence of contagion and found that currency crises that occurred in Latin America, Asia and Africa between 1977 and 1993 can not be considered as belonging to first generation models – meaning that they can not be explained solely by the inconsistency between macroeconomic policies and maintenance of a fixed exchange rate -, and that the effects of regional contagion, as well as speculative behavior of investors can not be disregarded.

My paper is related to the analysis of Kruger, Osakwe and Page to the extent that it is focused on developing countries and it uses the same Probit model:

$$crisis_{i,t} = \alpha \cdot C\left(crisis_{j,t}\right) + \beta \cdot V\left(F_{i,t-1}\right) + \varepsilon_{i,t}$$

where:

- $\boldsymbol{\alpha}$ is the coefficient of the contagion variable $C(crisis_{j,t})$;
- $\boldsymbol{\beta}$ is the set of coefficients for the vector of macroeconomic fundamentals $V(F_{i,t-1})$;
- $\boldsymbol{\varepsilon}$ is the disturbance term, assumed normally distributed;
- ***t*** is the time index and ***i*** and ***j*** are indexes for countries.

The crisis index, $\boldsymbol{crisis_{i,t}}$ was constructed following the methodology adopted by Sachs, Tornell and Velasco (1996) and Kaminsky and Reinhart (1996). $Crisis_{i,t}$ is a dummy variable equal to 1 if we consider that the country was under a speculative attack at time '*t*' and 0 otherwise. The question that arises is when can one say that a country is facing a speculative attack, successful or not? To answer this question, Sachs, Tornell and Velasco defined an index of market pressure and regarded as a proof of a speculative attack any value that exceeds a certain threshold. The index of exchange market pressure is constructed as a weighted average of monthly nominal exchange rate depreciations relative to the US$ and (the negative of) percentage losses in official international reserves.

The advantage of using a weighted index is that it takes into consideration both successful and unsuccessful speculative attacks. The intuition behind it is straight forward: monetary authority has three alternatives to defend against a speculative attack: it can devalue the currency, decrease international reserves or raise interest rates. The decrease in the international reserves can be seen is the same time as a consequence of the behavior of investors: when they realize that the currency is under attack and the possibility that the authorities will devalue is high, investors start exchanging deposits from local currency to foreign currency, which is protected from the devaluation. In this way, reserves of foreign currency decline; when they reach null value or even

earlier, the government will have no other solution than devaluation and/or increase in interest rates.

The same index is used by Vlaar(1999), but the author models the crisis index itself, not as a dummy variable with regard to a threshold. Vlaar argues that there are several advantages in using continuous modeling approach: first, by using the crisis index itself, information regarding the severity of a crisis is not disregarded; second, the continuous modeling approach allows distinguishing variables that have an effect on the probability of a crisis from those that affect the severity of the crisis.

However, since the focus of this paper is not on severity of crisis but on evidence of contagion and relationship with macroeconomic fundamentals that affect the probability of crisis occurrence, I will use the index implemented by Sachs, Tornell and Velasco and further developed by Kaminsly and Reihart.

In order to avoid the prevalence of one factor or the other in the definition of the crisis index, different weights are attributed to the monthly percentage change in exchange rate and international reserves, 80% and 20% respectively. Further more, these monthly values are averaged to obtain the annual index of exchange market pressure.

A similar index of exchange market pressure was implemented by Eichengreen, Rose and Wyplosz (1995, 1996), but the authors included in the formula equal weights for percentage change in international reserves, nominal exchange rate depreciations and interest rates. Since in many countries from my sample the interest rates are controlled by the central banks, I decided not to include them in the formula of market pressure index.

In the construction of this index there is an exception from the general formula used in the previous literature, a special case that I introduced: for countries that pegged their exchange rate the index is equal to the percentage change in international reserves (in the case when the

authorities decide not to abandon the peg and incur the costs of this decision with regard to international reserves and interest rates, there will be no change in the exchange rate).

The crisis index takes the value 1 if the weighted index exceeds 1.5 standard deviations from the mean and 0 otherwise. This definition of the crisis index perfectly predicts the 1997 East Asian crisis and Tequila crisis of 1994 in my sample.

2.3.1 Measuring Contagion

Since the focus of this paper is on the evidence of contagion during the latest financial events and its connection with macroeconomic fundamentals, the main independent variable is a so-called 'contagion index' – a dummy variable that takes the value 1 if two conditions are satisfied in the same time: the country ***i*** is experiencing a currency crisis (the crisis index equals 1) and there is another country, ***j***, that is under attack in the same period.

Two directions for the analysis evolve from this definition of the contagion index: first, a general approach, when the index takes the value 1 if there is another crisis anywhere else in the world, and a regional approach, when an additional condition must be satisfied for the index to take the value 1: the two countries under attack must belong to the same region. Kruger, Osakwe and Page use in their analysis this definition for the regional contagion, arguing that the index implemented by Eichengreen, Rose and Wyplosz (1996) is too general, since '*it would be difficult to argue that a currency crisis in a country such as Senegal would have a significant effect on Mexico*'[9].

For this reason, following Kruger, Osakwe and Page, I will further improve my model and only consider regional contagion:

[9] Kruger, Osakwe and Page – '*Fundamentals, Contagion and Currency Crises: An Empirical Analysis'* – p.8

$$crisis_{i,t} = \alpha \cdot R\left(crisis_{j,t}\right) + \beta \cdot V\left(F_{i,t-1}\right) + \varepsilon_{i,t}$$

where $R\ (crisis_{j,t})$ takes the value 1 if both countries *i* and *j* are under attack and they are situated in the same geographical region.

2.3.2 Macroeconomic Fundamentals

As I mentioned before, the model controls for changes in macroeconomic fundamentals, indicated in the general framework by the vector V ($F_{i,t-1}$). Most of the variables considered here are included with a lag, consistent with the idea that weak fundamentals have a delayed rather than immediate effect on crisis probability. Still, as my analysis will show later on, the effect of some of these variables can be better capture in a simultaneous equation.

The variables that I am controlling for are the ones that most empirical and theoretical papers consider as having a significant effect on the probability of crisis, even though for some of them the correlation with the dependent variables is found by several authors to have different levels of significance. Kaminsky and Reinhart (1996) included a vast review of all variables used in the empirical literature and found as having a significant explanatory value on the probability of crisis occurrence. I used their review when deciding which variables to include in the model.

The first variable that my analysis will take into consideration is the change in international reserves, measured as total reserves minus gold. The logic behind it is very intuitive: a decrease in the international reserves can be a signal of inconsistency between fundamentals and fixed exchange rate regime. When investors know that the fixed exchange rate is no longer sustainable and expect that the monetary authority will abandon the peg, they start redrew their investments and change deposits from local currency to an international one, considered stable. As a

consequence, the reserves of foreign currency that the National bank has will decline. From this point of view, we can regard the international reserves as a consequence of currency weaknesses. On the other hand, they can also trigger a crisis: when reserves are small, independent of a speculative attack, the monetary authority can not defend the peg for a long period and will decide to devalue earlier. I expect that the higher the international reserves are the lower is the probability of crisis.

The ratio of quasi-money (M2) on international reserves is a measure of reserve adequacy, suggesting what part of the domestic money supply is backed by international reserves. An increase in the ratio, due to either an increase in M2 or a fall in international reserves or both indicates that the monetary authority losses its power to defend the fixed parity. The M2-to-reserves ratio is an indicator of first generation crisis. The crisis probability and the ratio of M2 over reserves should be negative.

Although most of empirical analysis uses the real exchange rate, I decided to use nominal exchange rate due to data availability. Including nominal exchange rate as an explanatory variable has the same explanation as including it in the formula for crisis index: when the currency is under attack and the monetary authority decide not to devalue (in case it devalues, this decline is a direct evidence of speculative attack), it has no other choice but decreasing international reserves. This can happen as long as the Central Bank still has international reserves. The devaluation occurs when reserves are exhausted or even earlier, as a consequence of too small international reserves to defend the peg. This scenario can happen both when one single country is under attack and when the crisis is transmitted from one country to another. Overvalued nominal exchange rate is expected to increase the probability of crisis. The exchange rate can also be regarded as a measure of competitiveness: when a neighboring country devalues, exports from the first country are not competitive anymore, so the government must devalue as

well, because it is not able to pay its external debt anymore. This is the first reason why I also included external debt as an independent variable. The second reason is that an increase in short-term foreign debt, due to reasons not associated with crises, causes the financial system to be more fragile. Chang and Velasco (1998) agree with this and also argue that international illiquidity position of a country is a necessary and sufficient condition for financial crisis and/or balance of payments crisis. The higher is the external debt and, consequently, the ratio of external debt over GDP, the higher should be the probability of a speculative attack.

Knowing that the budget deficit has been always seen as a major source of weak fundamentals, idea supported by Krugman, I will include in the main regression lagged values of the budget deficit. The explanation of the effect that a high budget deficit can have on fundamentals is quite simple: in their attempt to finance the deficit, the monetary authority will print money, thus causing an overvaluation of the domestic money.

My regression controls for the ratio of current account deficit/surplus over GDP. A reversal in the current account may signal a future 'massive real depreciation'. According to Krugman (1999), this happened in Thailand in 1997. Krugman's scenario is as follows: after the real depreciation, firms lose confidence in the monetary authority commitment, because the real depreciation worsens their balance sheets. Problems in the private sector always affect financial system as well and I expect that the correlation with the probability of crisis to be negative, meaning that current account surplus can protect a country in case of an attack on currency. When a country is facing huge real appreciation of the currency – due to a fixed exchange rate regime for example, there is also a huge current account deficit, which the government will try to decrease.

A second indicator for the loss of competitiveness in the international goods market is the export growth. Export growth may decline due to an overvalued domestic currency (as I

explained earlier in the paper), so it can be considered a proxy for the currency overvaluation. The relationship goes in both directions: as exports decline for reasons not related to the overvaluation of currency, the pressure on domestic currency increases. I expect a negative coefficient for the export growth variable.

As Lestano and Kuper (2003) argue, real interest rate should be included in the analysis because it is a proxy for the degree of financial liberalization. Higher interest rate can be observed either before a crisis (broadcasting a future crisis and a liquidity crunch), or after the crisis occurred, as the measure that the monetary authority takes for defending against the speculative attack.

Since a weak macroeconomic system due to misalignment with the fixed parity is usually characterized by a high inflation rate, it seems logically to control for the inflation rate also. However, due to lack of data availability, I included in my analysis the percentage change in the consumer price index as a measure for the inflation rate. The CPI can be used to track changes in prices of goods and services purchased for consumption by households; it is calculated as a weighted average of prices for a specified set of goods and services purchased by consumers; an increase in this average signals a decrease in the standards of living, thus worsening economic conditions. Coefficients for both the interest rate and CPI change should be positive.

Finally, the regression also controls for the unemployment rate: unemployment is one of the first and most important economic and social consequences of a recession. A problem arises when controlling for both inflation (measured by CPI) and unemployment rate: the two variables are correlated. Evidence come both from the Phillips curve and NAIRU theory: inflation decreases as unemployment rises. I will deal with the problem of correlation later on.

2.3.3 Data availability

The data that I am using to implement the balanced panel data model can be divided into two sub-sets, Latin American countries and Asian countries respectively. Due to availability and taking into consideration former research on the topic of contagion, I decided to include in my analysis Argentina, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Panama, Paraguay, Peru, Uruguay and Venezuela from Latin America and Thailand, Malaysia, Philippines, Korea, Indonesia and China from Asia.

All data, except that for total external debt, are available from International Monetary Fund-International Financial Statistics. Unfortunately, IFS do not provide data for total external debt for all the countries included in the analysis. These data are provided by The World Bank -*'2006 World Development Indicators Online'* – Development Data Group, 2006. A full description of the variables used in the model, together with their sources, can be found in the appendix.

CHAPTER 3: EMPIRICAL RESULTS AND FURTHER ECONOMETRIC STEPS

3.1 Empirical Results - The General Approach

In order to capture the impact of weak fundamentals and to prove the existence of contagion for the financial turbulences that affected Latin America and South East Asia in the 30 years period between 1972 and 2002, I estimated the Probit model in a balanced panel data framework and found strong evidence of contagion, backed by significant effects of some of the fundamentals that I controlled for. As I mentioned earlier, the total sample includes 651 observations (data for 21 countries in 31 consecutive years). However, complete data were available only for 232 observations, out of which 220 are tranquil period, when the crisis index equals 0, and the other 12 are crisis episodes, with the index equal to 1.

One should keep in mind that, when using a binary model, interpretation of coefficients is different from OLS models: in Linear Probability Models, the coefficient measures the predicted change in the probability of success when the explanatory variable increases by one unit[10], holding all other factors fixed, not the change in the dependent variable given a one-unit increase in the independent variable. In the same time, couple of problems appears which I will discuss in the next section (biasedness of results, heteroskedasticity due to violation of one of the Gauss-Markov assumptions, endogeneity).

Before reaching the final framework for the model, I tried different specifications, most important of them included in the Appendix. When including the ratio of budget deficit over

[10] Wooldridge, J. M., " Introductory Econometrics. A Modern Approach", Second edition

GDP into the regression, the problem of multicollinearity appears and all coefficients become insignificant. An additional regression for the independent variables shows a strong multicollinearity between them.

Table 1 presents the results for the final version of currency crisis risk analysis. As we expected, fundamentals can not be considered the solely reason for which crises occurred in Latin America and South East Asia for the analyzed period. Interpretation of contagion coefficient is more difficult than the others, since both the dependent and independent variables are dummy variables. Still, the contagion index variable is strongly significant, even at 1% level of confidence; one can say that, when a speculative attack takes place simultaneous in more than one country, the probability of a successful attack increases. Another interpretation takes into consideration the significance of the macroeconomic variables also: when a country is characterized by weak fundamentals, contagion increases the probability that the speculative attack, which otherwise may occur, in this period, later or not at all, will occur now.

Some of the fundamentals are found to have a significant impact on the probability of success: current account deficit over GDP, non-gold international reserves over GDP, nominal exchange rate, changes in consumer price index and unemployment.

The external debt variable does not have explanatory power over the probability of crisis. A fast look over the spreadsheet of this variable shows that the debt did not increase too much from one period to another, neither when measured in level, or as a percentage of GDP (the average increase is 11.61%, with a minimum of -20.94% and a maximum of 121.55% during 1976 in Venezuela), leading me to believe that this increase is more due to a time trend than a shock; however, higher increases tend to occur after the speculative attack. Same conclusions can be drawn when comparing the increase in external debt, as a percentage of GDP. Thus, one can regard this increase in the external debt as the consequence, not the cause of the crisis.

Table 1: ***Contagion vs. fundamentals***

Empirical results – full sample

Contagion vs. fundamentals	***Variable***	***Lagged***	***Coefficient***	***Standard error***	***P-value***
Contagion effect	Contagion index	No	3.688930	0.969241	0.0001
Macroeconomic fundamentals	External debt	Yes	-3.99E-06	3.01E-06	0.1847
	CAD over GDP	Yes	-1.756121	0.892290	0.0491
	Int. reserves over GDP	Yes	-3.226375	1.679764	0.0548
	Nominal exchange rate	Yes	-0.000882	0.000474	0.0629
	Nominal exchange rate^2	Yes	9.73E-08	4.97E-08	0.0504
	Real interest rate	No	0.015008	0.011127	0.1774
	Consumer price index	Yes	-0.035286	0.018790	0.0604
	Exports growth	No	-2.042985	1.304775	0.1174
	Unemployment	Yes	-0.162289	0.054616	0.0030

The inability of a country to repay its external debt in the period before the successful speculative attack is strongly correlated with its decrease in exports. Even if my results do not show a significant decrease in the exports right before the financial turbulences, not even at 10% level of confidence, one can not reject the null hypothesis that exports and non-gold international reserves are jointly significant. Any decline in exports is a consequence of the loss in competitiveness, which can be explained by a devaluation of the currency in the neighboring country.

An interesting finding regards current account deficit: Kruger, Osakwe and Page found the variable, measured as percentage of GDP, to be insignificant, even though first generation models predict that they should be significant. My results show a significant effect of an increase in the

current account deficit over GDP. The direction of the correlation is the expected one: keeping in mind that deficit is measured as a negative number and surplus as a positive one: lower ratios imply lower probabilities of a successful attack. Kruger, Osakwe and Page considered that current account deficit is high when its absolute value exceeds 4% of GDP. Both current account deficit and exports growth are measures of external competitiveness.

Maybe the most important indicators of currency crises are the nominal exchange rate and the level of international reserves compared to GDP. As expected, the ratio of international reserves over GDP has a strong, lagged effect on the probability of success, which is in line with the idea that the monetary authority will try first to defend the currency against devaluation by decreasing the level of international reserves and only after, when reserves are too low or when the costs of defending the peg are too high, in terms of, for example, unemployment, it will abandon this path and eventually devalue. Connected with this, the previous unemployment level is also found to be significant.

Nominal exchange rate enters the equation in a quadratic form, introduced first by Klein and Marion (1994), to capture the idea that exchange rate has a decreasing effect on the probability of successful attack. Both variables, introduced with lag, are significant at 6% and 5% level of confidence respectively, although the values are very small. Still, their significance is in line with the idea that overvalued local currency increase the probability of a successful speculative attack. An interesting approach is to test if the nominal exchange rate variable, both in linear form and quadratic, has a simultaneous effect on the probability of a successful crisis. A table including the results from this analysis is available in the Appendix. The results obtained are quite similar, and the only improvements of the model can be observed in the percentage of crises moments correctly predicted, which improved slightly, and in the Akaike info criterion and Schwarz criterion values, which decreased (lower values are associates with better fitted models).

The coefficient for consumer price index variable is found significant for 10% level of confidence. Still, its effect is very small, and has the opposite sign: according to the empirical results, an increase in CPI should decrease the probability of success, which is misleading, because the logic and historical episodes show an increase in inflation (thus in CPI) before the crisis.

The analysis above showed that, in a general framework, crises that hit Latin America and Asia between 1972 and 2002 can not be characterized as belonging to one single generation of currency crises models. The main result of the general regression analyzed in the previous section is that, during the financial turmoil episodes from Asia and Latin America in the last 30 years, weak fundamentals joined forces with a regional effect of contagion, resulting in international financial crises, more virulent and more widespread than ever before. Among the macroeconomic fundamentals that I controlled for, the ratios of current account deficit over GDP and non-gold international reserves over GDP, nominal exchange rate both in linear and quadratic form, consumer price index and unemployment level were found to have a significant effect on the probability of success.

3.2 The Asian Contagion versus Latin American Contagion

Many authors argued that the financial crises that hit Latin America during the last decades have been more contagious than the one that hit countries from Asia. I consider that a higher coefficient for regional contagion in the sub-sample of Latin countries- obtained after the division of the sample into two regional sub-samples- is a strong enough evidence to support the idea that Latin America was more contagious than Asia.

For this test, I used the same methodology as before only that I divided the general sample into two sub-samples, corresponding to Latin and Asian countries. My analysis shows different results: the coefficient for pure regional contagion is higher in the case of Asia sub-sample, leading to the conclusion that crises that hit Asia were more contagious than the ones that hit Latin America. But one should not take this observation literally, first of all because the difference in coefficients is not very high, and second of all because I am referring to pure contagion: it is not the case that crises in Latin America spread less than the ones in Asia; crises here spread more because of the additional effect of weak fundamentals.

Another important observation regards the change in the fundamentals: different macroeconomic indicators are significant in the sub-samples: before the speculative attack, Latin countries were fighting against high external debt and current account deficit, together with increasing levels of unemployment. On the other hand, one can say that the Asian flu is the perfect example for pure contagion: none of the fundamentals is significant. Countries affected by the Asian flu can be characterized by strong fundamentals, increasing exports and a ratio of external debt to GDP in normal limits. The Asian flu spread only because the monetary authorities did not have the patience to wait and risk a decrease in competitiveness and in international reserves, risk an overall depreciation of economic situation and choose to devalue directly, shortly after the Thai government decided to devalue the Bath.

In conclusion, crises in Latin America can be considered more as evidence for fundamental-based contagion, while Asia shows strong evidence of pure contagion. The results of both analyses were included in Table 2.

Table 2:
Empirical results – Comparison between Latin American and Asian sub-sample

Variable	*Latin America*			*Asia*		
	Coefficient	*Standard error*	*P-value*	*Coefficient*	*Standard error*	*P-value*
Contagion index	7.200754	3.343762	0.0313	8.628544	4.695999	0.0661
External debt	-8.74E-06	5.06E-06	0.0842	-2.19E-05	1.51E-05	0.1469
CAD over GDP	-0.066946	0.032243	0.0379	17.48062	10.87803	0.1081
International reserves over GDP	-	-	-	-3.540120	4.507271	0.4322
Nominal exchange rate	-0.077661	0.078536	0.3227	-0.002987	0.002296	0.1932
Nominal exchange rate squared	2.17E-05	2.54E-05	0.3912	3.24E-07	2.32E-07	0.1632
Real interest rate	0.039933	0.016624	2.402147	0.113034	0.151924	0.4569
Consumer price index	-0.128127	0.072232	0.0761	0.030727	0.051778	0.5529
Exports growth	2.812808	2.625239	0.2840	1.597483	3.479419	0.6461
Unemployment	-0.161718	0.053029	0.0023	-0.657249	0.400691	0.1009

3.3 Further Steps in Econometric Modeling- Weaknesses of the Model

In a panel data framework like the one I used to estimate the probability of crisis occurrence, one can not assume that the observations are independently distributed. Another problem is heteroskedasticity: when analyzing currency crises using a linear probability model, the estimation always suffers from heteroskedasticity, due to violation of one of the Gauss-Markov assumptions[11]. A Breusch-Pagan F-test can be used to detect the presence of heteroskedasticity; further more, to remove the unobserved effect, one can apply the first difference method in adjacent time periods. Using FD method makes it easier to compute heteroskedasticity-robust statistics.

[11]Wooldridge, J. M., " Introductory Econometrics. A Modern Approach", Second edition

The first difference method can be a good instrument to correct for another problem that appears – the upward bias of the results. According to Pesaran and Pick (2006), ignoring endogeneity and interdependence can introduce an upward bias in the estimate of the contagion coefficient. The authors used Monte Carlo experiments to further show that this bias could be substantial.

Although the model used in this analysis to estimate for contagion effects and importance of weak/strong fundamentals suffers from biasedness, heteroskedasticity and endogeneity, it can be considered a good instrument to shed light on the issues of contagion.

CONCLUSIONS

I dedicated the pages above to the review of both theoretical and empirical literature on currency crises, highlighting the importance of contagion. The latest financial crises proved to be more virulent than anyone expected. The financial world faced deep, significant and contagious currency and banking crises, which led to the admission of the fact that not too much is known about international financial crises, their mechanisms of transmission from one country to another, determinants and impact on countries' financial stability.

Since previous models for explaining currency crises turned out to be incapable of predicting and explaining the episodes of financial turmoil from the last years, a new model was developed, that introduced the notion of contagion – transmission of a crisis from one country to another. Authors distinguished between two types of contagion: fundamental-based contagion and pure contagion. According to the fundamental-based model of contagion, crises spread from one country to another because of weak fundamentals, meaning that a crisis would anyway hit the country, sooner or later, but the occurrence of another crisis in a neighboring country speeds up the process.

The severity of the financial crises that hit Latin America and East Asia showed that the well-known theory that strong macroeconomics fundamentals are the most important mechanism in avoiding financial crises is no longer valid. Although traditional models predict that the main cause of currency crises is the deterioration of economic fundamentals, latest episodes show that countries with sound economic policies – ***'good health'***- were not immune to regional crises. Crises spread to countries with showed good economic situation, strong fundamentals, countries that otherwise could very easy defend against a speculative attack.

I implemented a Probit model that tested for the probability of crisis occurrence, using a balanced panel data for 21 countries from Latin America and Asia, for a period of 31 years. The results show a strong significant impact of contagion, in addition for the effect of weak fundamentals. When dividing the sample into two separate sub-samples for Latin American and East Asian countries, the contagion effect increases, but weak fundamentals remain significant only for Latin American countries, leading to the conclusion that crises from this part of the world can be considered evidence on fundamental-based contagion, while events from East Asia belong to a different category of contagion- pure contagion.

Although the model used in this analysis to estimate for contagion effects and importance of weak/strong fundamentals suffers from biasedness, heteroskedasticity and endogeneity, it can be considered a good instrument to shed light on the issues of contagion.

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APPENDIX

DATA AVAILABILITY

All data, except the ones for the external debt, were obtained from IMF's International Financial Statistics. Data were downloaded separately for each country.

- Non-gold international reserves were obtained from IFS series 1L.DZF... and converted from local currency to US$ for all sample.
- The nominal exchange rate is the official rate against US$, from the IFS series AE.ZF...
- The monetary aggregate M2 (eliminated from the analysis) is IFS series MB.ZF...
- The interest rate represents the deposit rate (available for all countries) from IFS series 0L.ZF..., calculated as a percentage per annum
- The unemployment rate is IFS series 7R.ZF..., calculated as a percentage per annum
- Exports are expressed in US$ and data were available from IFS series 70.DZF.
- Current account data are from IFS series ALDZF..., expressed in US$ and take positive values for surplus and negative ones for deficit.
- Government deficit/surplus is IFS series 80...ZF..., also expressed in US$.
- Gross domestic product (GDP) was calculated by converting values available in IFS series 9B..ZF..., from local currency to US$, using official exchange rate.
- Consumer price index is IFS series 64..XZF...
- The external debt data are available from The World Bank -'*2006 World Development Indicators Online'* – Development Data Group, 2006.

Table 1: ***Contagion vs. fundamentals*** Empirical results – full sample

Contagion vs. fundamentals	***Variable***	***Lagged***	***Coefficient***	***Standard error***	***P-value***
Contagion effect	Contagion index	No	3.688930	0.969241	0.0001
Macroeconomic fundamentals	External debt	Yes	-3.99E-06	3.01E-06	0.1847
	CAD over GDP	Yes	-1.756121	0.892290	0.0491
	Int. reserves over GDP	Yes	-3.226375	1.679764	0.0548
	Nominal exchange rate	Yes	-0.000882	0.000474	0.0629
	Nominal exchange rate^2	Yes	9.73E-08	4.97E-08	0.0504
	Real interest rate	No	0.015008	0.011127	0.1774
	Consumer price index	Yes	-0.035286	0.018790	0.0604
	Exports growth	No	-2.042985	1.304775	0.1174
	Unemployment	Yes	-0.162289	0.054616	0.0030

Table 1.1: ***Contagion vs. fundamentals*** Empirical results – full sample: Simultaneous nominal exchange rate

Contagion vs. fundamentals	***Variable***	***Lagged***	***Coefficient***	***Standard error***	***P-value***
Contagion effect	Contagion index	No	4.170237	1.076347	0.0001
Macroeconomic fundamentals	External debt	Yes	-4.57E-06	3.13E-06	0.1434
	CAD over GDP	Yes	-2.028676	0.942390	0.0313
	Int. reserves over GDP	Yes	-3.732926	1.775701	0.0355
	Nominal exchange rate	No	-0.001357	0.000580	0.0194
	Nominal exchange rate^2	No	1.51E-07	5.94E-08	0.0113
	Real interest rate	No	0.019153	0.011267	0.0891
	Consumer price index	Yes	-0.047362	0.020379	0.0201
	Exports growth	No	-1.371932	1.364759	0.1174
	Unemployment	Yes	-0.161053	0.054430	0.3148

Table 2: Empirical results – ***Comparison between Latin American and Asian sub-sample***

Variable	*Latin America*			*Asia*		
	Coefficient	*Standard error*	*P-value*	*Coefficient*	*Standard error*	*P-value*
Contagion index	7.200754	3.343762	0.0313	8.628544	4.695999	0.0661
External debt	-8.74E-06	5.06E-06	0.0842	-2.19E-05	1.51E-05	0.1469
CAD over GDP	-0.066946	0.032243	0.0379	17.48062	10.87803	0.1081
International reserves over GDP	-	-	-	-3.540120	4.507271	0.4322
Nominal exchange rate	-0.077661	0.078536	0.3227	-0.002987	0.002296	0.1932
Nominal exchange rate squared	2.17E-05	2.54E-05	0.3912	3.24E-07	2.32E-07	0.1632
Real interest rate	0.039933	0.016624	2.402147	0.113034	0.151924	0.4569
Consumer price index	-0.128127	0.072232	0.0761	0.030727	0.051778	0.5529
Exports growth	2.812808	2.625239	0.2840	1.597483	3.479419	0.6461
Unemployment	-0.161718	0.053029	0.0023	-0.657249	0.400691	0.1009

Table 3: ***Contagion vs. fundamentals*** Different specifications

Variable	*Model 1*		*Model 2*		*Model 3*	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Contagion index	2.680620	0.0201	3.003597	0.0039	3.949833	0.0026
External debt	-2.64E-06	0.5763	-3.56E-06	0.2542	-3.78E-06	0.2478
CAD over GDP	0.412226	0.9179	0.214674	0.9497	0.855889	0.7427
International reserves over GDP	-1.440541	0.5152	-1.548632	0.3358	-3.743526	0.0521
Nominal exchange rate	-0.000322	0.3685	-0.000530	0.0752	-0.001249	0.0329
Nominal exchange rate^2	-	-	-	-	1.29E-07	0.0399
Real interest rate	0.028271	0.0883	0.011572	0.3026	0.016741	0.1346
Consumer price index	-0.047951	0.0771	-0.056439	0.0354	-0.054011	0.0446
Exports growth	-1.706522	0.3967	-2.715054	0.0768	-1.227670	0.4447
Unemployment	-0.244930	0.0639	-0.137505	0.0049	-0.152647	0.0070
Budget deficit over GDP	-2.247761	0.8510	-2.690396	0.3860	-5.779400	0.3028
M2 over reserves	-0.080406	0.4246	-	-	-	-