The Role of Information Disparity in the 1994/95 Mexican Peso Crisis: Empirical Evidence*

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Abstract

In the Mexican Peso crisis 1994/95, the lack of readily available information, particularly regarding monetary aggregates, has often been commented on. This paper analyzes empirically whether information disparity with respect to economic fundamentals contributed to the crisis. Using historical forecast data collected by Consensus Economics, we show that uncertainties, as measured by the forecast variation, significantly influenced the pressure on the fixed Peso rate. This effect is additional to the one that actual and expected fundamentals had on the exchange rate pressure. Furthermore, the impact of information disparity is found to be contingent on the market expectation about fundamentals. It seems that the central bank's strategy of not publicly disclosing information was detrimental for the very reason that the market sentiment was generally optimistic with regard to the monetary development.

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1 Introduction

The Mexican Peso crisis 1994/95 is an interesting subject for studying the impact of information disparity among market participants in currency crises. Due to the increasing volume of information disclosed to financial markets and the sheer number of information processing and disseminating sources, analysis of informational impacts has gained importance in economic research. Financial crisis situations, in which market participants tend to coordinate their actions, are an especially noteworthy case to study the question of whether information disparity might have triggered the event. Finding an answer to this question is also of import for policy purposes. Because the central bank is one of the major sources for information disclosure with regard to economic fundamentals, it stands to reason whether, as is often proclaimed, increased transparency in situations of financial turmoil is actually conducive to preventing a crisis. In the case of the Mexican Peso crisis in 1994/95, the authorities chose a two-tiered strategy: whereas information about the real economy (GDP, trade balance, etc.) was made public regularly and timely, the central bank decided to disclose hardly any numbers on monetary aggregates. This strategy, however, did not prevent the attack on the Peso and its eventual free fall in December 1994. This paper scrutinizes the course of events and tries to verify empirically whether aspects of information disparity contribute to an explanation of the Peso crisis.

Theoretical studies on the role of information in currency crises came to different conclusions regarding the informational impact on speculators' behaviour. Second-generation currency crisis models (Obstfeld 1994, 1996) claimed that large sets of economic fundamentals may be accompanied by multiple equilibria. These equilibria are characterized by self-fulfilling expectations, such that a currency crisis takes place whenever market participants believe an attack will be successful. In other words, the same fundamental state of the economy might coincide with financial stability as long as speculators do not believe in the success of an attack. Second-generation models therefore do not allow to predict the occurrence of a crisis or to assess the exact role of information and traders' expectations. Also these models make rather extreme assumptions with regard to traders' knowledge of the economic fundamentals. Subsequent work relaxed these assumptions, focussing on information asymmetries among speculators. The models by Morris and Shin (1998, 1999, 2000) analyzed both private (individual) and public (common) information about economic fundamentals. These authors showed that whenever private information is sufficiently precise relative to public information, the currency

crisis model has a unique equilibrium. In this case, the fundamental state of the economy alone determines whether a successful attack on the fixed parity will take place or whether the exchange rate peg will remain stable. These papers were followed by work that scrutinized the impact of information disparity about economic fundamentals on crisis situations. Heinemann and Illing (2002) argue that in an environment where information is entirely private, a decrease in uncertainty following a dissemination of very precise information reduces the likelihood of a speculative attack. Metz (2002) arrives at different results under the assumption that market participants have access to both private and public information. In such a model, not only the market sentiment - defined as the mean of public information about economic fundamentals - influences the probability of a speculative attack, but so does the uncertainty among speculators as measured by the variance of information. Surprisingly, the effect of uncertainty in private information on the onset of a crisis is for the main part opposite to the impact of uncertainty that arises from public information. Another interesting finding is that the impact of uncertainty in general is contingent on the market sentiment, i.e. on whether the market is optimistic or pessimistic with regard to how the economy's fundamental state develops. According to Metz (2002), the effect of information disparity on a currency crisis depends on both the source of information, i.e. whether uncertainty stems from private or public information, and on the prevailing market sentiment regarding the economic environment.

To date, there has been little empirical work on the role of information disparity in currency crises. Two notable exceptions are the papers by Prati and Sbracia (2002) and Tillmann (2002). Prati and Sbracia (2002) study the impact of uncertainty stemming from both public and private information, following work by Morris and Shin (1999, 2000), on the 1997/98 Asian crisis. Using forecast data from Consensus Economics to build an indicator of information uncertainty, Prati and Sbracia find for a panel of six Asian countries covering the period January 1995 through May 2001, that the variance of information has a significant effect on the observed currency devaluations. The authors succeed in showing that the sign of the impact of the variance depends on whether expected fundamentals are "good" or "bad". However, their model does not allow to distinguish between the two types of information (private or public) as source of the observed information uncertainty. Hence, they cannot assess the implications of the disclosure policies of the respective national authorities for the information disparity that prevailed during the Asian crisis. Tillmann (2002) chose a different approach. He analyzes the impact of uncertainty that solely originates from private information among

foreign exchange traders. Within a Markov-switching framework, he finds that, for the crises of the French Franc and the Italian Lira in 1992, increasing information disparity indeed raises the probability of a speculative attack. As a measure of information disparity among market participants he employs so-called country fund discounts, that is the difference between the price of closed-end country funds and their underlying net asset value.

This paper examines empirically the influence of information and uncertainty on the event of a currency crisis as suggested in Metz (2002). Because the Mexican Peso crisis 1994/95 has often been mentioned as a situation in which the lack of information about economic variables was causal to the currency turmoil, we try to test the theoretical implications against the background of the Mexican economy using a data set from 1993 to 2000. Indices representing private and public information at the time are based on data obtained from Consensus Economics. This data set contains one-year forecasts of various economic variables as announced by different forecasting research agencies, banks, and other financial institutions. In comparison with Prati and Sbracia (2002), our regression model includes a more comprehensive, two-dimensional index of information, so that the model accounts simultaneously for different sources of uncertainty, that is, private and public. This study therefore allows to draw conclusions about the effectiveness of the information policy pursued by the Mexican authorities at the time. Our analysis offers the following main three results. First, we show that the mean of forecast values has an unambiguously negative impact on the exchange rate pressure. This leads us to conclude that an improvement in the market sentiment, i.e. of the commonly held belief about the fundamental state of the economy, lowers the likelihood of a currency crisis. Second, we find that informational uncertainty exerts a significant influence on the incidence of a crisis as well. This effect depends on whether the prevailing market sentiment is optimistic or pessimistic. The impact of uncertainty among market participants therefore may be harmful or benevolent, depending on the underlying market sentiment. In other words, increased disclosure of information as a transparency enhancing policy measure is not necessarily conducive to preventing crises. Third, in the case of the Mexican Peso crisis, it seems that the central bank's strategy of disclosing hardly any numbers about monetary aggregates, thereby increasing uncertainty, was particularly harmful since the market in general was still very optimistic about the monetary development. With respect to information about the real economy, we find that rather a decreasing uncertainty among speculators, accompanied by a deteriorating market sentiment, might have triggered the crisis.

The remainder of the paper is structured as follows. Section 2 presents the theoretical model, which delivers testable implications with regard to the influence of information on the currency crisis. Section 3 recounts the course of events in the Mexican Peso crisis 1994/95 with emphasis on the disclosure of information. Section 4 provides an overview on the data, describes the empirical methodology and presents the test results. Section 5 concludes.

2 Theoretical Model

The model we use as background for our empirical study is a simple coordination game that builds on Morris and Shin (1999, 2000) and Metz (2002). It rests on the presumption that speculators possess both private and public information about economic fundamentals. Private information in this respect can be interpreted as insider information or simply as individual interpretation of commonly accessible information. Hence, private information will differentiate within market participants. Public information, in contrast, is commonly shared by all traders. Moreover, all traders know that each of them disposes of this information, so that it becomes common knowledge. Both types of information can be incomplete in the sense that they are faulty signals of the true fundamental state of the economy.

This section depicts a very simple coordination game between a large number of foreign exchange traders, $i \in [0, 1]$, and a central bank that tries to defend a fixed exchange rate parity. Each trader is endowed with one unit of domestic currency and has to decide on whether to use this unit in a speculative attack on the fixed parity or not. A successful attack delivers a fixed payoff D (> 0) to each of the attackers. Choosing to attack is associated with transaction costs of t $(0 < t < D)$. For the central bank it is assumed that she enjoys a positive utility from keeping the peg. The costs of defending the parity, however, increase in the proportion l of attackers, and decrease in the economic fundamental index θ. For simplicity, we assume that the central bank has to give in to an attack and devalue the exchange rate whenever the proportion of attacking traders l is at least as high as θ. If $l < \theta$, the central bank is able to maintain the fixed-rate regime.

The time structure of the game is as follows. Assume that the fundamental state of the economy is represented by an index, denoted θ, of fundamentally relevant variables. In a first step, nature selects the fundamental state $\theta \sim N(y, \frac{1}{\alpha})$. The central

bank observes the true fundamental state, whereas speculators only get to know its distribution. Because the distribution of θ is assumed to be common information, we refer to α as the precision of public information. The mean of public information, y, is denoted as market sentiment. A good or optimistic market sentiment then refers to a high prior mean of the fundamental state, a bad or pessimistic sentiment to a low prior mean y. In addition to public information, speculators individually receive private signals $x_i|\theta \sim N(\theta, \frac{1}{\beta})$, which are independent of each other. Again, β is denoted as precision of private information. Contingent on private and public information, traders simultaneously have to decide whether or not to attack the fixed parity in the second step. The central bank finally observes the proportion l of attackers and abandons the peg whenever $l \geq \theta$.

The equilibrium in this model is found in best-response trigger strategies.[1] The equilibrium consists of a unique value for private information, denoted by x^*, such that each speculator with a signal x_i lower than x^* attacks the parity, but refrains from doing so for better private information. The central bank's best response to this strategy is to abandon the fixed parity whenever a fundamental state θ is realized which is lower than a unique threshold value θ^*. For better, i.e. higher, economic states θ, the fixed-rate regime is maintained.

The solution to this model is determined by solving the equilibrium conditions backwards. The central bank is indifferent between abandoning and keeping the peg whenever the proportion of attacking speculators l is equal to the realized fundamental state θ. Out of the continuum of speculators, only those will attack who observe private signals lower than x^*. Thus, we can write:

$$\begin{aligned} \theta &= \text{Prob}(x \leq x^*|\theta) \\ \theta &= \Phi(\beta(x^* - \theta)) \ . \end{aligned} \tag{1}$$

Each individual speculator is indifferent between attacking or not attacking the fixed parity if both actions lead to the same expected net-payoff:

$$0 = D \ \text{Prob}(\theta \leq \theta^*|x_i) - t \ . \tag{2}$$

Given the posterior distribution of fundamentals, the speculator's indifference condition reads:

$$t = D \ \Phi\big(\sqrt{\alpha + \beta}(\theta^* - \frac{\alpha}{\alpha + \beta}y - \frac{\beta}{\alpha + \beta}x)\big). \tag{3}$$

[1] A proof of best-response strategies that deliver the unique equilibrium is given in Morris and Shin (1998).

The equilibrium trigger values θ^* and x^* can then be determined as those values, which simultaneously make both speculators and central bank indifferent between their respective actions:

$$\theta^* = \Phi\Big(\frac{\alpha}{\sqrt{\beta}}\Big(\theta^* - y - \frac{\sqrt{\alpha+\beta}}{\alpha}\Phi^{-1}\big(\frac{t}{D}\big)\Big)\Big) \tag{4}$$

$$x^* = \frac{\alpha+\beta}{\beta}\theta^* - \frac{\alpha}{\beta}y - \frac{\sqrt{\alpha+\beta}}{\beta}\Phi^{-1}\big(\frac{t}{D}\big)\ . \tag{5}$$

As Morris and Shin (1999, 2000) and Metz (2002) show, the equilibrium (θ^*, x^*) is unique as long as private information is sufficiently precise,[2] i.e. for $\beta > \frac{\alpha^2}{2\pi}$. The existence of a unique equilibrium allows us to do rigorous comparative analysis. In the following, we will briefly restate the main results by Metz (2002) with regard to the influence of the informational parameters on the probability of a currency crisis. Afterwards we will focus on testable implications of the model, building on Prati and Sbracia (2002), to use in an empirical analysis of the 1994/95 Mexican Peso crisis.

In the model, the fixed parity will be abandoned whenever the index of economic fundamentals falls short of the trigger threshold θ^*. Hence, the ex-ante probability of a currency crisis can reasonably be approximated by the length of the interval $[-\infty, \theta^*]$.

Proposition 1 (Metz 2002)

The probability of a currency crisis, as approximated by the length of the interval $[-\infty, \theta^*]$*, decreases in the market sentiment* y*. For* $y >$ $(<)$ $\theta^* - \frac{1}{2\sqrt{\alpha+\beta}}\Phi^{-1}(\frac{t}{D})$*, the likelihood of a crisis decreases (increases) in the precision* α *of public information. For* $y >$ $(<)$ $\theta^* - \frac{1}{\sqrt{\alpha+\beta}}\Phi^{-1}(\frac{t}{D})$*, the probability of a crisis increases (decreases) in the precision* β *of private information.*

The most interesting result of this proposition concerns the largely opposite effects of private and public information's precision. The impact of both precision parameters is moreover found to be contingent on the market sentiment. The intuition behind this result is the role of coordination in the model. When deciding whether or not to attack, each speculator not only has to take into account his own information about the unknown fundamental state, but also his opponents' expectations about θ. The more strongly one speculator believes his opponents' private information to be similar to his own, the more he is willing to rely on this type of information. Consider the following example: assume that, a priori, the market expects the fundamental state to be bad,

[2] For an intuition behind the uniqueness result, see the infection argument as suggested by Morris et al. (1995).

i.e. y is low. If public information is very precise relative to private information, each speculator knows that all other traders will attach a large weight to the pessimistic prior mean y. This provides a strong incentive for attacking the fixed parity. If, in contrast, private information is much more precise than public, then traders know that all others will tend to neglect the low prior mean. This might decrease the incentive to attack. The opposite holds for an optimistic market, where the prior expected value of the fundamental state, y, is high.[3]

Concerning our primary objective of empirically analyzing the role of information disparity in a currency crisis, it is hard to find a measure for the crisis probability, though. In a paper by Prati and Sbracia (2002) slightly different results are derived, which deliver more easily testable implications. These authors focus on the influence of the parameters on the proportion of attacking speculators, i.e. of those who receive sufficiently low private signals. A natural empirical counterpart for the share of attackers might be found in the exchange rate pressure.

Proposition 2 (Prati and Sbracia 2002)

The share of attackers on a fixed exchange rate, as given by Prob$(x_i \leq x^*|\theta)$, decreases in the fundamental index, θ, and in the market sentiment, y. For $y >$ $(<)$ $\theta^* - \frac{1}{2\sqrt{\alpha+\beta}}\Phi^{-1}(\frac{t}{D})$, the share of attackers decreases (increases) in the precision of public information α. If $\theta >$ $(<)$ $x^* + 2\beta\frac{\partial x^*}{\partial \beta}$, the proportion of attacking speculators decreases (increases) in the precision of private information β.

Intuitively, both improving fundamentals and an improving market belief about fundamentals decrease the pressure on a fixed exchange rate. As before, the effect of a change in the precision of public information α depends on the market sentiment. Whenever the market is optimistic, i.e. y is sufficiently high, more precise public information reduces the incentive to attack so that the share of attackers diminishes. For a low prior mean of fundamentals y the opposite holds. However, the impact of changes in β is no longer necessarily opposite to the effect of α. The influence of private information's precision β is not even directly contingent on the market sentiment any more. It rather depends on the actually realized fundamental state of the economy θ. How do we have to interpret this result? In contrast to α, the precision of private information β not only influences the posterior expected fundamental state and, hence, the trigger value x^*, but it also

[3] For a more comprehensive delineation of the comparative statics and the underlying structure of the equilibrium in this model, see also Metz (2003).

determines the distribution of private signals around the unknown θ. Thus, β has two distinct channels through which it influences the proportion of attacking traders. First of all, β affects the threshold x^* through equilibrium condition (5). This effect is again opposite to the effect of α on x^*. Secondly, whenever the realized fundamental state of the economy is sufficiently good ($\theta > x^*$), more precise private information makes less speculators receive private signals below the threshold of x^*, because the distribution of private signals becomes more dense around its mean of θ. Hence, the proportion of attacking traders decreases. The opposite holds in the case of a bad fundamental state θ ($\theta < x^*$). This second effect of β on the share of attackers may even outweigh the first, which tends to be the case if either θ and y are both sufficiently good or both are sufficiently bad. Then, the impact of private information precision β is analogous to public information precision α on the proportion of attackers. In contrast, if either θ is low and the market sentiment very optimistic, i.e. y is high, or vice versa, then α and β tend to have opposite effects on the share of attackers.

What are the testable implications of the theoretical model? First of all, the model states that the prior expected fundamental state of the economy, i.e. the market's general expectation of the fundamental index, y, decreases the pressure on the exchange rate. Secondly, the model shows that the precision of information has an individual effect on exchange rate pressure. This effect is contingent on *i*) the source of uncertainty, i.e. on whether it originates from private or public information, and on *ii*) the prior mean of economic fundamentals, i.e. on whether the market is optimistic or pessimistic with regard to economic development.

Before the testing procedure with respect to these statements and the data are described, let us first recount the course of events in the 1994/95 Mexican Peso crisis. As we will see, the way in which the events unfolded displays most interesting characteristics regarding the influence of information disparity.

3 The Mexican Peso Crisis in 1994/95

Mexico was an episode of financial stability and growth from the mid-1950s to the 1970s. This stability ended when Mexico became insolvent in 1982. After the collapse of the economy, the Mexican government started a comprehensive reform program. The reform comprised a fundamental opening of the country to international competition, privatization and deregulation, fixing the exchange rate against the U.S.$, and the so-

called Pacto, an agreement between government, labor unions and the private sector to guide the development of prices, wages and the exchange rate. The successful execution of the reforms shifted international attention towards the Mexican financial markets and strengthened investors' confidence in the country. By the end of 1992, Mexico had achieved fiscal balance, and inflation was reduced to single digits. Restrictive fiscal policy also helped stabilizing the exchange rate. Between 1988 and 1994, Mexico changed its exchange rate system several times, from a completely fixed parity to a preannounced rate of devaluation, and finally to a band with a sliding ceiling. Until the autumn of 1993, the Peso exchange rate was stable, hovering in the lower half of the band.

Concerning the success of the reforms, Edwards (1997) notes that a significant difference had arisen between Mexico's achievements in terms of reform policies and in terms of economic results. Although political achievements were sometimes spectacular, the economic achievements were rather modest. The rate of real growth averaged 2.8 percent between 1988 and 1994. Productivity growth was near zero, and private savings were decreasing. Yet, on the positive side, capital inflows into the country remained strong until the beginning of 1994.

What is important for interpreting the onset of the crisis in the light of our theoretical findings is that the economic situation in Mexico at the beginning of the 1990s was highly praised by economists, financial experts, academics and the media in general. With only very few exceptions, the Mexican reforms were seen as a major success, with Mexico's development representing a miracle among the group of emerging countries. The fact that economic growth was still low and the current account deficit increasing, was mostly neglected by commentators. Even if the lack of fundamental growth was taken into account, it was argued that positive results were "around the corner" (Calvo et al., 1996). One of the few economists to argue against this common trend of praising Mexican reform efforts was Rudiger Dornbusch. As early as 1992, he claimed that Mexico's most urgent problem was its overvalued exchange rate. However, there was large dissent about this point in the community. While some market observers did not believe the fixed exchange rate to be overvalued, others claimed that, due to the surge in capital inflows, Mexico experienced an "equilibrium appreciation" that was fully justified by fundamentals. A more moderate view admitted that, although Mexico had a growth problem, this was only transitory and would be solved automatically over time (Gil-Diaz, 1997). Dornbusch and Werner, however, feared the overvaluation to be a serious, long-lasting problem: "Overvaluation stops growth and, more often than not,

ends in a speculative siege on the exchange rate and ultimately currency realignment" (Dornbusch and Werner, 1994).

To give an overview on the widely diverging views that economists, financial analysts, and market commentators held at the beginning of the 1990s, consider the following collection of statements as taken from Edwards (1997). The *IMF* praised Mexico's reform efforts until only a few months before the crisis hit the economy in December 1994. In October 1994, the IMF's *World Economic Outlook* predicted that, although growth had been low, it would quickly pick up speed. The *World Bank* held an ambiguous view. At the 1993 Annual Meeting, the World Bank stated that the Mexican reform process was mature and appeared to be consolidated. In a publication in November 1994, the World Bank argued that with the president elect, Ernesto Zedillo, the economy would improve rapidly and economic growth would reach its highest level in five years. In contrast, an article in *Trend in Developing Economies* in 1993 stated that the recent slowdown in Mexican growth was a direct consequence of the real exchange rate appreciation. In November 1992, the bank noted that the opening of the capital account exposed Mexico to large risks resulting from the volatility of short-term capital movements, which might need adjustment through higher interest rates or a depreciation of the Peso. In contrast, investment bankers of the Mexican economy and fund managers were generally enthusiastic about the prospects. JP Morgan, as late as October 1994, and the Swiss Bank Corporation, even in December 1994, urged a credit rating upgrade for Mexico. According to Edwards (1997), out of twenty studies released by major institutions in the *Emerging Markets Investor* in November/December 1994, twelve dismissed the possibility of a Peso devaluation. *Euromoney* raised the country risk ranking for Mexico between March and September 1994. However, Dornbusch argued in November 1992 that the daily rate of depreciation for the Peso should be tripled to prevent a major crisis. The Mexican central bank explained that, although the capital account was in deficit, the exchange rate band might deal with possible disequilibria. Furthermore, productivity was expected to surge before long and fundamentals to remain healthy. In an interview with the *Economist* in January 1994, the Governor of the Mexican central bank stated that the current account deficit was associated with an inflow of foreign funds rather than expansionary domestic policy and, hence, presented no problem.

Summing up we find that, during 1993 to mid-1994, large uncertainties prevailed over the question of whether the Peso appreciation was a temporary phenomenon or a non-equilibrium real overvaluation. In 1994 the economic situation was aggravated by political turmoil, and uncertainty among analysts shifted from economically related aspects

to questions of political strategy. While at the end of 1993 the market was still enthusiastic about Mexico on average, the Chiapas uprising on January 1st 1994 reminded the world that Mexico remained to be a country with social problems and inequalities. Following this event, the exchange rate rose to the upper bound in February. Surprisingly, international reserves held by the Mexican central bank did not fall, and inflow of direct foreign investments did not recede. The Mexican capital markets did not even react to the Fed's decision to tighten U.S. monetary policy in February 1994, which was taken as a sign of fundamental stability.

However, the climate changed abruptly with the assassination of Luis Donaldo Colosio, the presidential candidate of the ruling party PRI on March 23, 1994. This time, investors reacted in panic and strongly reduced their exposures in Mexico. To secure the Peso parity, the Mexican authorities intervened: reserves fell from $26 billion to $18 billion almost overnight (Lustig, 1995). Moreover, Peso interest rates were increasing rapidly. Yet, the financial community swiftly regained its faith after the U.S. government decided on March 24 to extend a $6 billion swap facility to Mexico. The Financial Times on March 25 reflected the confidence in Mexico with the front page stating "Even with Mexico's dependence on foreign capital to cover a current account deficit of over Dollars 20bn, a crisis is eminently avoidable". On March 28, the Financial Times claimed that a "sense of calm returned to Mexico".

While the media were regaining faith, Mexico was experiencing ever larger difficulties rolling over its maturing Peso denominated debt. What is more, the financial community seemed to have been wide aware of this fact. In April 1994, JP Morgan publicly stated that the Mexican government would have to weigh the trade-off between rising interest rates and devaluing the fixed exchange rate to solve its problems. Quite generally, during the first half of 1994, concerns grew among international analysts regarding Mexico's external situation. In the spring meeting of the Brookings Institution Economics Panel, Calvo argued that the Mexican fixed-rate regime was at risk because of a lack of credibility. Stanley Fischer expressed doubts concerning the sustainability of Mexico's external situation. Members of the Fed argued that a devaluation of the Peso should not be ruled out. On the opposite side, on May 2 1994, the U.S. Under Secretary of the Treasury in a memorandum emphasized that Mexico's exchange rate policy was sustainable.

Between April and October 1994, the Mexican central bank did not disclose any information about changes in the position of its international reserves. The exchange rate, how-

ever, rose with the ceiling band. Also, it was observed that the central bank increasingly replaced Peso-denominated debt (Cetes) with Dollar-denominated Tesobonos, thereby changing the composition of money. Again, these facts were discussed in the media and in financial circles. During the course of the year 1994, it became clear to financial observers that the Mexican authorities deliberately withheld information on money market aggregates and international reserves. In June 1994, an IMF mission returned to Washington after only two weeks in Mexico, complaining that it did not obtain any data from the Bank of Mexico on the recent development of international reserves. The level of reserves was timely revealed for the third time in 1994 only as late as the end of October. Several investors commented on the lack of readily available and reliable information (Edward and Savastano, 1998). Yet, risk measures as publicly announced by different financial institutions at the time indicate that the market's perception of the situation in Mexico remained roughly stable until December.

In August 1994, Ernesto Zedillo was elected president, the Pacto was renewed and the exchange rate system maintained. Following the assassination of another politician in September 1994, investors became increasingly nervous and the Mexican authorities intensified the substitution of Tesobonos for Cetes. Although on October 21 the Mexican central bank announced the level of international reserve holdings to be at $17.12 billion, many analysts believed this number to be too high. At the end of November 1994, reserves held by the central bank had reportedly decreased to $12.5 billion, with short term public debt in excess of $27 billion. This level of reserves was clearly insufficient to back short term domestic debt, and a major financial crisis loomed.

On December 1 1994, the new administration under President Zedillo took office. Reserves were suspected to continue their declining trend, although the Mexican central bank did not disclose any new numbers. On December 5, the U.S. Secretary of the Treasury was informed by institutional analysts' calculations that Mexican international reserves must be close to only $10 billion. The private sector in Mexico, however, seemed to have been rather unaware of the fast decline of reserves during November and December 1994. Yet, as Edwards (1997) points out, analysts should have had enough information to calculate the necessary figures and get an idea about the country's international reserve position. Obviously, however, financial market participants preferred to be seduced by the still positive information given by Mexican policy makers (Frankel and Schmukler, 1996).

Due to the vanishing reserves, Mexican authorities decided to widen the exchange rate

band on December 20, to allow for a devaluation of 15 percent. Yet, this policy change was not accompanied by a supporting program, and, hence, did not appear very promising to solve the problems. Investors immediately started to flee the country in disbelief. As a result, the Mexican central bank lost $4 billion of reserves in one day, and eventually the fixed Peso exchange rate had to be abandoned, giving in to a fully fledged currency crisis.

4 Information Disparity: Empirical Evidence

4.1 Empirical Methodology

In order to verify whether mean and dispersion of speculators' information have a significant impact on the exchange rate pressure at the onset and during the 1994/95 Mexican Peso crisis, we use forecast data collected by Consensus Economics. These data comprise forecasts from different research agencies, banks, and other financial institutions concerning various economic variables, such as GDP, industrial production, consumer prices, current account, currency reserves, among others. In order to relate the data to the theoretical model presented above, consider the following. Building on Prati and Sbracia (2002), it is reasonable to assume that each of the n individual forecasters announces his posterior mean of the respective economic variables to Consensus Economics. From theory, we know that the posterior expected value of θ is given by $\frac{\alpha y+\beta x_i}{\alpha+\beta}$. The mean of these n individual forecasts, denoted $f^e(x_1,...,x_n)$, then can be calculated as

$$f^e(x_1,...,x_n) = \frac{\alpha}{\alpha+\beta}y + \frac{\beta}{\alpha+\beta}\frac{\sum x_i}{n} \ . \tag{6}$$

With the number of forecasters going to infinity, i.e. $n \to \infty$, this random variable, for a given fundamental state θ, converges to

$$f(\theta) = E[f^e(x_1,...x_n)|\theta] = \frac{\alpha}{\alpha+\beta}y + \frac{\beta}{\alpha+\beta}\theta \ . \tag{7}$$

The mean of the forecasts provided by Consensus Economics is therefore influenced by both the prior mean y, i.e. the market sentiment, and the realized fundamental state θ. Recall that both parameters have the same impact on exchange rate pressure (proposition 2). Moreover, the model implies that $E(\theta) = y$, so that the average of the posterior expected values should be equal to the prior mean y. Note that this average does not depend on the precision values α and β any more. We can therefore take the

average forecast value as a proxy for the prior mean of fundamentals as represented by the market sentiment y.

Concerning the variance of individual forecasts, the theoretical model suggests that

$$[\sigma^e(x_1, ...x_n)]^2 = \sum_i \frac{[f_i^e(x_i) - f^e]^2}{n} = \frac{\beta^2}{(\alpha+\beta)^2} \frac{\sum(x_i - \bar{x})^2}{n} \ , \tag{8}$$

where $\bar{x} = \frac{\sum_i x_i}{n}$. For $n \to \infty$, the variance of forecasts approaches

$$\sigma^2 = \frac{\beta}{(\alpha+\beta)^2} \ . \tag{9}$$

Hence, for a large number of forecasts, the dispersion of predictions only depends on the precision parameters. The variance decreases in α, while the impact of β is negative if $\beta > \alpha$, and positive otherwise. This can be explained by the fact that, although more precise private signals tend to be closer to the actual fundamental θ and thus decrease the variance of forecasts, a higher precision of private information also increases the weight that speculators attach to their private signals relative to public information. This makes forecasts more heterogeneous across traders. We follow Prati and Sbracia (2002) and assume that $\beta > \max\{\alpha, \frac{\alpha^2}{2\pi}\}$, so that the equilibrium is always unique and the precision of private information always exerts a negative influence on the variance of forecasts. Thus, precision of both private and public information reduces the dispersion of forecasts.

Using the mean and variance of the economic forecasts collected by Consensus Economics should allow a realistic assessment of the influence that market sentiment and information dispersion exert on the exchange rate pressure. In order to capture the informational effects, we use an estimation equation of the following general form:

$$ERP_t = \gamma_0 + \gamma_1 f_t^e + \gamma_2 \sigma_t^e (f_t^e - \underline{\gamma_t}) + \gamma_3 g_t + u_t. \tag{10}$$

ERP_t represents a measure of exchange rate pressure in period t. The variables f_t^e and σ_t^e are, respectively, the mean and the standard deviation of forecasts regarding specific economic variables as taken from Consensus Economics. The variable $\underline{\gamma_t}$ represents the threshold separating "good" from "bad" expected fundamentals. It is a proxy for the threshold functions of influence of α and β on exchange rate pressure. The variable g_t represents a function of economic variables, that might play a significant role in explaining exchange rate pressure. Finally, u_t is the error term of the regression equation.

From the theoretical analysis we expect γ_1 to take on a negative sign. The better the market sentiment, as represented by the mean of economic forecasts, the lower should the pressure on the exchange rate be. The influence of the forecasts' standard deviation, however, depends on two facts: the market sentiment and the source of uncertainty, private or public. If the market sentiment is very optimistic, the expression in brackets in regression (10) is positive. In that case, uncertainty originating from public information should have an increasing effect on exchange rate pressure due to proposition 2, so that γ_2 should be positive. If the market is pessimistic, the expression in brackets will be negative, so that a decreasing effect of uncertainty in public information is captured by a positive sign of γ_2 as well. The parameter γ_2 will also be positive if uncertainty is due to private information and actual and expected fundamentals are either both sufficiently good or both bad. If, however, the market sentiment is optimistic and actual fundamentals turn out to be bad or vice versa, then uncertainty stemming from private information will have a negative influence on ERP. The sign of γ_3 depends on which specific economic variable we choose to include in the model. The exchange rate, for instance, should have a positive impact on exchange rate pressure, i.e. the closer the exchange rate moves to the upper ceiling of the currency band, the larger is the incentive to attack and, thus, the higher is the exchange rate pressure.

4.2 The Data

To study the impact of information disparity on the event of the Mexican currency crisis, we use an index of exchange rate pressure based on three parameters. The calculation draws on Prati and Sbracia (2002). The index ERP is the sum of i) the monthly depreciation of the Peso against the U.S. \$, ii) the normalized fall in international reserves in percent of the 12-month moving average of imports, and iii) the normalized short-term real interest rate. Figure 1 presents the time-series behaviour of the index.[4] As the figure shows, exchange rate pressure was decreasing in 1993. Pressure built up during 1994, with a first maximum at the time of Colosio's assassination in March 1994. Exchange rate pressure reached its absolute maximum in December 1994 at the top of the crisis and decreased afterwards.

Informational data for Mexico has been taken from Consensus Economics. Note that

[4] In order to clarify the informational impact in the months leading up to the crisis and at the onset of the turmoil, we will in the following concentrate on data in the period March 1993 to December 1996. The regression analysis, however, is based on data from March 1993 to December 2000.

all historical data for Latin America from Consensus Economics are bi-monthly, except for the year 1993, for which only 5 data points are available, because data collection did not start before March 1993. In each period, about 20-25 institutions announced their forecasts of various economic variables for the current and subsequent years. In order to work with a constant forecast horizon of one year, we follow Gourieroux and Monfort (1997), and compute the weighted average of the current and following year forecast with weights of $\frac{5}{6}$ and $\frac{1}{6}$ in the first period, $\frac{4}{6}$ and $\frac{2}{6}$ in the second period etc.

As the regression results will show, in order to get a concise picture of the market's information at the time, only two variables turn out to be significant: forecasts of GDP-growth and of currency reserves held by the central bank. Once these two variables are included into the regression, all other information parameters turn out to be largely insignificant. For a first impression of informational data for Mexico, see figure 2. The chart presents the mean forecasts for GDP-growth (in percent), as one of the most comprehensive indicators of economic development. As figure 2 shows, before the crisis hit the Mexican economy in December 1994, average forecasts of GDP-growth were relatively stable. At the time of the attacks, GDP-growth forecasts plummeted to record lows, while increasing steadily in the two years following the crisis. Interestingly, the months before the start of the currency turmoil are characterized by a decreasing dispersion of GDP forecasts, as shown in figure 3. While the standard deviation of GDP-growth forecasts took a value of 0.8 at the end of 1993, it fell to less than 0.5 immediately before the speculative attack hit the country. Of course, the variation in GDP-growth forecasts spiked at the onset of the crisis in December 1994.

Figures 4 and 5 depict the development of expected currency reserves as the second explanatory variable in our regression model. While market observers generally expected currency reserves to increase during 1993 and the beginning of 1994, expectations faltered later in 1994, reaching their lowest level at the time of the crisis in December 1994/January 1995. The spike in October 1994 can be explained by one of the central bank's few declaration of currency reserves, which gave a very optimistic view. Figure 5 shows that the variation of reserves forecasts decreased during the first half of 1994 from a standard deviation of about 4 to half that value; the standard deviation increased from August 1994 on and hovered at a level of around 3 until the crisis hit. The dispersion of the forecasts reached a maximum at the end of 1995 with a standard deviation of 5.3.

In order to arrive at a first assessment of traders' information about the economic state

during the Mexican currency turmoil 1994/95, it is reasonable to compare the predicted economic values with the realized ones. Actual and predicted development of GDP can be seen from figure 6, the development of actual international currency reserves and forecast values from figure 7.

Regarding GDP-growth, figure 6 shows that in 1993, actual growth rates, represented by the light grey line, were lower than expected (black line), whereas during 1994, speculators tended to underestimate actual GDP-growth. Hence, for the months leading up to the currency crisis, we find that actual and expected development of GDP did not coincide and that the market was rather pessimistic. Combining this with our theoretical results, we have to state that uncertainties originating from private information about GDP-growth should have had an effect on the exchange rate pressure opposite to the one of uncertainties arising from public information about GDP development. Since expectations about GDP-growth displayed a diminishing variance in the months leading up to the crisis, this leads us to conclude that, if the regression analysis results in a positive sign of uncertainty regarding GDP forecasts, then public information was driving the predictions. If, on the other hand, the sign of GDP forecast variation is negative, this should be taken as private information being the origin of uncertainty.

For the development of international currency reserves, figure 7 shows that, in particular in the second half of 1994, traders were much more optimistic than warranted by the amount of reserves actually held by the central bank (light grey line). Again, private and public information precision therefore should be expected to have opposite effects. Combined with the formerly presented finding that the variance of forecasts with respect to the central bank's currency reserves was decreasing during the first half of 1994 and increasing during the second half, we might expect the source of uncertainty again being found in public information. Hence, if the market generally believed currency reserves to be still sufficiently high, increasing uncertainty about this knowledge would raise the pressure on the fixed exchange rate. Again, this conclusion would be corroborated by a positive sign of the variation of reserves forecasts in the regression analysis. However, due to the fact that there was only little publicly accessible information in the market about the level of the reserves, this variable might also be a candidate for a strong influence of private information. The sign of information disparity should then turn out to be negative in the regression. If this were the case, then increasing uncertainty about currency reserves would indeed have helped to keep the fixed rate regime, because this would have eased exchange rate pressure.

4.3 Regression Results

Our test is based on a pure time-series regression, which comprises the period March 1993 through December 2000:

$$ERP_t = \gamma_0 + \gamma_1 f^e_{GDP_t} + \gamma_2 \sigma^e_{GDP_t} \cdot (f^e_{GDP_t} - \underline{\gamma_{GDP_t}}) + \gamma_3 df^e_{CR_t} + \gamma_4 \sigma^e_{CR_t} \cdot (f^e_{CR_t} - \underline{\gamma_{CR_t}}) + \gamma_5 de_t + u_t \ . \tag{11}$$

As a proxy for the prior mean information, we use forecasts both of GDP-growth ($f^e_{GDP_t}$) and of the change in currency reserves ($df^e_{CR_t}$). This is in contrast to Prati and Sbracia (2002), who chose a one-dimensional proxy for information. Our two-dimensional approach allows us to discriminate between different sources of information (private or public) as the drivers of the uncertainty among market participants. In this respect we might suspect GDP-forecasts to be driven through public information mainly, whereas the described lack of information about the Mexican central bank's international reserves in 1994 might have caused forecasts to be more strongly based on individual interpretations and hence to originate from private information.

In regression equation (11), the threshold value $\underline{\gamma_{GDP_t}}$ was chosen as the yearly growth rate of GDP. The threshold $\underline{\gamma_{CR_t}}$ was calculated as the 5-term moving average of forecast currency reserves. Note that the expression representing the deviation of market sentiment from the actual economic variable is measured in growth rates for GDP information, but in absolute values for currency reserves information. This is due to the fact that Consensus Economics announces only growth rates forecasts for GDP. However, the slightly different treatment of the two variation variables of GDP forecasts and currency reserves forecasts should not be expected to have any influence on the regression outcome, because it only impacts the calculation of sign of the precision values and not the dispersion values per se. The same peculiarity of Consensus Economics data forced us to use two slightly different types of thresholds. Whereas the threshold for GDP information, $\underline{\gamma_{GDP_t}}$, was calculated from actual GDP-growth rates, we had to build a threshold from forecast data for currency reserves, $\underline{\gamma_{CR_t}}$. This is because the set of research agencies announcing their forecasts to Consensus Economics changes from period to period. Hence, we are not able to calculate the standard deviation of changes in individual predictions with regard to currency reserves. Using actual reserves values as thresholds, however, leads to an overweight impact of uncertainty with regard to this variable, because currency reserves were changing strongly before and at the time of the crisis. One reasonable compromise to find an acceptable index of optimism or pessimism in the market therefore is to compare predicted currency reserves with the

long-run trend of forecasts, which leads to the described threshold series $\underline{\gamma_{CR_t}}$.

In addition to information with respect to GDP-growth and currency reserves development, we also included the change in the exchange rate as an explanatory variable in the equation. Because the fixed Peso exchange rate was abandoned in December 1994, we will find that the exchange rate plays a significant role in explaining exchange rate pressure, in particular for the year 1995 and onwards.

The results from our regression for the period March 1993 through December 2000 is depicted in table 1. The results show that the two variables representing the market sentiment have the expected negative sign, so that, indeed, the more optimistic the market is with respect to economic development, the lower the pressure on the exchange rate tends to be. Both coefficients (γ_1 and γ_3) are significant at the 1 per cent level. With respect to information dispersion, our analysis states that uncertainty has a significantly positive influence on exchange rate pressure, since both coefficients γ_2 and γ_4 have a positive sign. However, significance for the variation coefficient in predictions of currency reserves is given at the 1 per cent level, whereas GDP-growth forecasts have a significant variation coefficient only at the 5 per cent level. Taking these results as such, the model implies that the main force lying underneath fundamental uncertainty may either be a change in the precision of public information, so that the whole market is less sure about economic fundamentals, or uncertainty is due to a change in the precision of private information while at the same time both expected and actual fundamentals are either good or bad. Since we learned from the data for predicted and actual fundamental values displayed in figures 6 and 7, that expectations did hardly coincide with the true development of fundamentals, neither for GDP-growth nor for international currency reserves, the type of information driving the results should, for the main part, be public. Furthermore, we know that in the months leading up to the crisis uncertainty with regard to GDP-growth forecasts was decreasing, while the market in general was overly pessimistic. The opposite holds for predictions regarding currency reserves. Here, the market was quite optimistic, while uncertainty about this view was increasing. Hence, we might conclude that neither the way information about GDP-growth influenced the speculators was in favour of the fixed exchange rate regime in Mexico, nor was information dissemination about currency reserves. Thus, if the Mexican central bank deliberately held back information about the level of reserves in order to keep speculators from attacking, the result of this strategy was exactly opposite to the intention.

Running the same regression on the pre-crisis sample, i.e. on data for the period March

1993 through December 1994 only, delivers roughly the same results. However, it is reasonable to drop the exchange rate from the regression, because the currency peg was fairly stable during that period. Furthermore, the coefficient of the mean GDP growth forecasts is not as significant as for the whole sample (regression results for the pre-crisis sample are given in table 2). Of course, it should be noted that the number of data is strongly decreased in the pre-crisis sample, which makes the result rather weak.

What remains to be done is to verify whether the influence of information disparity on the exchange rate pressure is indeed contingent on the market sentiment, as stated in proposition 2. Thus, the following regression, in addition to the explanatory variables of equation (11), allows for an impact of the simple standard deviation of GDP-growth forecasts and of currency reserves forecasts as well. As can be seen from the results in table 3, both additional explanatory variables turn out not to be significant. Yet, the mean forecasts of GDP-growth and currency reserves still have a significantly negative impact on the exchange rate pressure. Also, the effect of uncertainty contingent on the market sentiment has a significantly positive sign.

Summing up our regression results we may state that information disparity strongly attributes to an explanation of exchange rate pressure on the Peso exchange rate before, during and in the aftermath of the 1994/95 Mexican crisis. Whereas the market sentiment has a positive influence on the fixed rate regime, the effect of information uncertainty depends on whether the market is optimistic or pessimistic with regard to economic development and on whether it is private or public information that gives rise to the uncertainty. For the Mexican case, the model points to public information as having triggered the event. In particular, it seems to have been the lack of publicly available information about international currency reserves held by the central bank that was attributable to the onset of the currency attack. This finding also indicates that it might not have been the unobservability of the level of reserves per se but rather the public awareness of the lack of commonly available information about it that moved the market.

5 Conclusion

Financial market crises pose a particularly difficult problem for central banks that typically have superior access to information about economic variables: how should they disseminate their information about the state of the economy? What aggravates the

problem is the fact that in crisis situations, traders' actions are often strategic complements so that for each individual market participant it is rational to coordinate his own action on the actions expected of the others. Even though it is generally held that the best remedy for financial crises is to create full transparency about all relevant economic variables, central banks frequently choose the opposite strategy. This has also been done by the Mexican central bank at the onset of the Peso crisis in 1994/95. During the economic deterioration in 1994, the bank decided to disclose hardly any new information on the development of monetary aggregates, because this was believed to be the most sensitive information to the market.

In our paper, we questioned whether the chosen strategy worked. Based on the results of a theoretical model, we studied whether the market sentiment, defined as the common belief of the market with regard to the economic development, had a significant impact on exchange rate pressure and hence on the onset of the Mexican Peso crisis. Furthermore, we tried to verify the theoretical result that information disparity had an individual effect on exchange rate pressure that was contingent both on the market sentiment and on the source of uncertainty.

Our regression analysis comes to a favourable result with respect to both questions. We can show that an optimistic market generally decreases exchange rate pressure, while a pessimistic market has the opposite effect. Moreover, the specification of information disparity that we chose for our regression equation has a positive influence on exchange rate pressure in an optimistic market and a negative impact in a pessimistic environment. Comparing the market sentiment as observed during the Mexican crisis using data provided by Consensus Economics with the actual development of fundamentals, our model indicates that the major source driving uncertainty was public information. This finding leads us to conclude that the strategy of creating intransparency about monetary aggregates as conducted by the Mexican central bank was detrimental to the stability of the exchange rate peg. Our empirical findings are thus in line with theoretical work by Heinemann and Metz (2002), which demonstrates that the success of information policy by monetary authorities is very sensitive to the market sentiment and to the way in which information is disseminated. In the case of the Mexican crisis, our model indicates that is was not necessarily the pure variation in speculators' perceptions about monetary aggregates, but rather the fact that the central bank was publicly known to not give any information about international currency reserves, that might have triggered the crisis.

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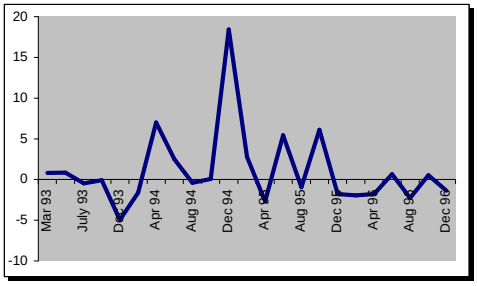

Figure 1: Exchange Rate Pressure Index 1993-1996

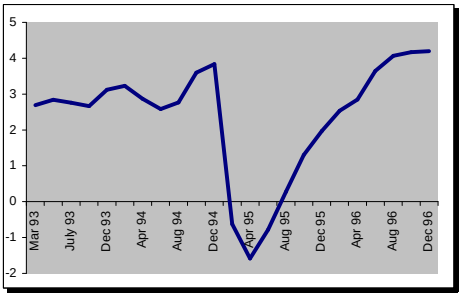

Figure 2: GDP-Growth Forecasts: Mean

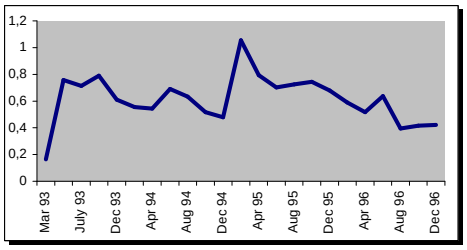

Figure 3: GDP-Growth Forecasts: Standard Deviation

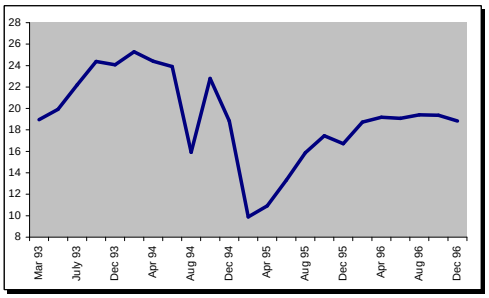

Figure 4: Currency Reserves Forecasts in Billion U.S. $: Mean

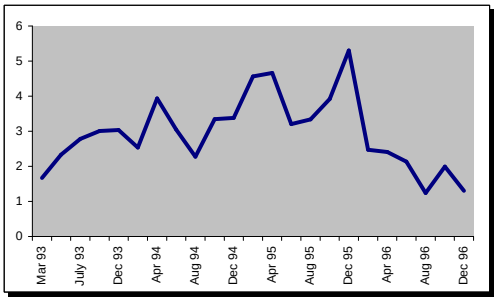

Figure 5: Currency Reserves Forecasts in Billion U.S. $: Standard Deviation

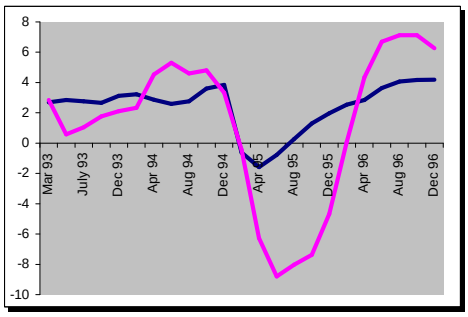

Figure 6: Actual and Expected GDP Growth Rate in Percent

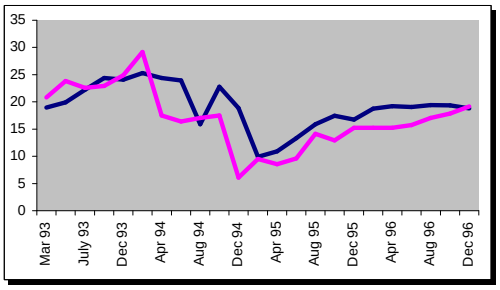

Figure 7: Actual and Expected Currency Reserves Forecasts in Billion U.S. $

Table 1:

Variable	**Coefficient**	**Std.Error**
C	3.4884^{***}	0.8780
f^e_{GDP}	-0.9817^{***}	0.3460
$\sigma^e_{GDP} \cdot (f^e_{GDP} - \underline{\gamma_{GDP}})$	0.5066^{*}	0.2609
df^e_{CR}	-1.2380^{***}	0.2304
$\sigma^e_{CR} \cdot (f^e_{CR} - \underline{\gamma_{CR}})$	0.7485^{***}	0.0922
de	0.1795^{***}	0.0591
R^2	0.6928	
DW-Statistic	2.1304	
F-Statistic	18.0442	
Prob(F-Statistic)	0.0000	

***, **, * significance at 1, 5, and 10 percent

Table 2:

Variable	**Coefficient**	**Std.Error**
C	16.8416	12.1968
f^e_{GDP}	-5.2384	4.0341
$\sigma^e_{GDP} \cdot (f^e_{GDP} - \underline{\gamma_{GDP}})$	3.1466^{*}	1.2732
df^e_{CR}	-2.3402^{***}	0.4926
$\sigma^e_{CR} \cdot (f^e_{CR} - \underline{\gamma_{CR}})$	1.3693^{***}	0.3182
R^2	0.8778	
DW-Statistic	0.6777	
F-Statistic	8.9819	
Prob(F-Statistic)	0.0167	

***, **, * significance at 1, 5, and 10 percent

Table 3:

Variable	**Coefficient**	**Std.Error**
C	4.4622^{*}	2.3214
f^e_{GDP}	-1.0062^{**}	0.3862
σ^e_{GDP}	-2.0347	3.1987
$\sigma^e_{GDP} \cdot (f^e_{GDP} - \underline{\gamma_{GDP}})$	0.5205^{*}	0.2691
df^e_{CR}	-1.2181^{***}	0.2376
σ^e_{CR}	0.0821	0.5382
$\sigma^e_{CR} \cdot (f^e_{CR} - \underline{\gamma_{CR}})$	0.7287^{***}	0.1020
de	0.1879^{**}	0.0717
R^2	0.6961	
DW-Statistic	2.1368	
F-Statistic	12.4357	
Prob(F-Statistic)	0.0000	

***, **, * significance at 1, 5, and 10 percent