Culture and Currency Crises

How does Uncertainty Avoidance influence the Information Structure of Currency Crisis Models

Master Thesis

by

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Abstract

This master thesis analysis the influence culture, in particular uncertainty avoidance, has on the dissemination and evaluation of private and public information, in the currency crisis model of Metz (2002). Therefore, this thesis works out the importance of culture in the discipline of economics and the influence it has on institutions and currency crises. The way uncertainty avoidance influences the transmitters of information, such as the central bank, government, media and selective experts on the one hand and on the other, private agents as receivers of information, is illustrated. These insights are implemented into the Metz (2002) model, affecting the precision of private and public information. With the help of Metz´s (2002) comparative statistics the increase or decrease of the probability of a currency crisis can be estimated for uncertainty-avoiding and -accepting countries. These probabilities and further cultural insights are then used to derive a market sentiment for uncertainty-avoiding and -accepting countries, which is an indicator for the economic situation of a country.

1 Introduction

The Latin American currency crisis in the 1980s and, thereafter, the Asian and European Monetary System currency crises led to a rapidly evolving field of economic research. Since then economists have tried to derive and adapt economic models which are able to explain and predict future currency crises, beginning with the first-generation models of Krugmann (1979) and Flood and Garber (1984); leading to second generation models, such as that of Obstfeld (1996) and Morris and Shin (1998); and on to the so-called third generation models. Each generation of models attempts to incorporate new insights from economics or other disciplines, making them more realistic and accurate though also more complex.

My thesis contributes to the existing literature by raising awareness of the cultural influences on institutions and behavior. Based on De Jong (2009) and Williamson (2000), this thesis argues that one of the dimensions described by Hofstede (1980, 2001), namely uncertainty avoidance, plays a key role in how the formal institutions of a country are shaped. The way uncertainty avoidance influences the transmitters of information, such as the central bank, government, media and selective experts on the one hand and on the other the private agents as receivers of information is illustrated. In most models, the main institution providing information is the central bank. The design, mission and transparency of the central bank are therefore important for the quality of information private agents receive. The cultural insights my thesis will derive will then be incorporated into the model developed by Metz (2002), affecting the precision of private and public information. The goal of the thesis is to demonstrate that cultural aspects do indeed play a decisive role in currency-crisis models, and that by incorporating them, the models become more realistic and have greater explanatory power. With the help of Metz´s (2002) comparative statistics the increase or decrease of the probability of a currency crisis can be estimated for uncertainty-avoiding and -accepting countries countries. These probabilities and cultural insights are then used to derive a market sentiment for uncertainty avoiding and accepting countries.

The thesis proceeds as follows: Chapter 2 presents the relevant theoretical background knowledge. Therein, the framework of currency crises and the problem of fixed exchange rates is investigated. Furthermore, it presents a brief overview of the development of currency-crisis

models. In Chapter 3, the role of culture in economics is defined. In addition, the importance of culture and uncertainty avoidance in the design of formal institutions is explained, clarifying their importance in currency crises. Chapter 4 analyzes Morris and Shin's (1998) model. Thereafter, Chapter 5 presents a critical review of this model, and compares it to Obstfeld's (1996) model. Chapter 6 introduces the key model by Metz (2002). In Chapter 7, the cultural insights derived in Chapter 3 are incorporated into the Metz (2002) model. This chapter is followed by the conclusion in Chapter 8, and the discussion in Chapter 9.

2 Literature Review

This chapter presents the theoretical background to currency crises and speculative attacks in order to aid understanding of the rest of the thesis. It briefly explains currency crises and indicates the problems attached to them. Thereafter, the thesis historically and critically presents the development of currency-crisis models.

2.1 Currency Crisis

There have been numerous currency crises in the Post-World War II era (Kaminsky & Reinhart, 1999). However, up to the present day there has not been a general definition of what a currency crisis is. Burnside, Eichenbaum, Kleshchelski and Rebelo (2007) define a currency crisis as "an episode in which the exchange rate depreciates substantially during a short period of time." It is worthwhile asking why this occurs.

A currency crisis is a type of financial crisis, and is often associated with a real economic crisis. The main reason that currency crises occur is that one country links its currency to that of another country. If a country has implemented a fixed exchange rate between the two currencies, a situation can arise in which genuine doubt exists as to whether a country's central bank has sufficient foreign-exchange reserves to maintain the fixed exchange rate. The serious doubt regarding the maintenance of a fixed exchange rate can trigger speculative attacks on the currency peg, creating a yet more vulnerable situation. That is, a currency crisis is the result of a balance of payments deficit. If the fixed exchange rate cannot be maintained it is likely that, in a two-country world, one currency will devaluate while the other appreciates. Especially in a two-world model, this

may lead to more severe problems. Because of the appreciation of the foreign currency relative to the home currency, denominated foreign debt will appreciate too. Financial institutions, businesses and the government could encounter problems meeting debt obligations, and the currency crisis could evolve into an economic crisis. Therefore, currency crises are linked to banking and default crises.[1]

Recent currency crises that led to recessions are the economic crisis in Mexico in 1994, the Asian financial crisis of 1997, the Russian financial crisis of 1998, and the Argentine economic crisis from 1999 to 2002.

2.1.1 Fixed Exchange Rate

In this subsection, the importance of the fixed exchange rate and its role in a currency crisis from a two-country perspective is explained.

With a fixed, or pegged, exchange rate, the value of a currency is fixed against the value of another currency. The main operating institution is the central bank, which typically relies on open-market mechanisms to maintain the peg. The central bank is obliged to buy and sell its currency at a fixed price in order to ensure the stable value of its currency in relation to the pegged currency. This is effected either by providing assets or foreign currencies (Dornbusch, Fischer, Startz, 2011). A brief example is as follows: if demand for the foreign currency increases, the fixed exchange rate is at risk. An increase in the demand for the foreign currency increases the value of the foreign currency. In this case, the central bank has to act. One option would be to sell excess units of the foreign currency in exchange for the home currency. In such a case, both the central bank's reserve of foreign currency, as well as the money supply of the home country, will decline. How long the central bank can maintain the exchange rate is substantially dependent on the central bank's foreign currency reserve. As mentioned in the previous chapter, if the fixed exchange rate cannot be maintained, this may lead to a currency crisis.

Maintaining a fixed exchange rate can be beneficial, but it is risky. Consequently, the risks and benefits of maintaining a fixed exchange rate should be reviewed. The main argument in favor of a fixed exchange rate pertains to international trade and investment. If currency values between two countries are fixed, trade and investments become easier and more predictable due the elimi-

[1] Note that the causality of crises could occur the other way around too.

nation of exchange-rate risk and the uncertainty involved in this. Furthermore, the fixed exchange rate reduces volatility and keeps prices stable. This can be beneficial for a country that suffers high inflation. However, maintaining a fixed exchange rate also has disadvantages. In order to ensure the currency peg, the central bank has to closely monitor and, if necessary, intervene in the currency market. This requires sufficiently elaborate functioning from this institution. Furthermore, in most cases the peg does not reflect the actual optimal market equilibrium. Consequently, the peg may reduce market efficiency and, to some extent, lead to a distortion in trade patterns. Eventually, the central bank will have a credibility problem. The central bank will be interrogated by experts, the media, and private agents as to whether it has sufficient home and foreign currency to maintain the fixed exchange rate and, if so, whether in all cases it will use the reserves in order to maintain the peg[2]. Therefore, a fixed exchange rate can lead to speculation as to whether the central bank is capable of maintaining the peg. If, for instance, the home country's economy is underperforming and the state disseminates information about its fundamental economic condition to the public, private agents could use this information to launch a speculative attack.

In this thesis, a speculative attack is considered an attack on the home currency. The elementary way of explaining a speculative attack is without transaction cost. The following scenario could be exemplary. A private agent believes, due, for instance, to "bad" economic fundamentals or other reasons – or no reason at all – that the central bank is not able to maintain the current peg. As a result, the private sector may not be willing to hold the domestic currency, which it believes is going to depreciate. The private agent then is willing to use his or her money, or even takes on debt in the home country's currency. Thereafter, the private agent trades the home currency for the foreign currency. If many private agents behave in the same manner, this would increase demand for the foreign currency, put pressure on the central bank, and could cause the currency peg to collapse, leading to depreciation of the home currency and appreciation of the foreign currency – which is a capital gain for the private agent. This practice is called "short selling."

[2] For example, Switzerland did not maintain the fixed exchange rate between the Swiss franc and the euro after the European Central Bank initiated the quantitative easing program.

2.2 First-generation Models

The early models, now called first-generation models, were developed in light of the currency crises in Mexico (1973-1982) and Argentina (1978-1981) (Flood, Marion, 1998). The two most essential models that tried to encapsulate these crises are those of Krugman (1979) and Flood and Garber (1984). Both models set up frameworks based upon speculative attacks. Those reasons for currency crisis are similar to that presented in the previous chapter. A currency crisis is the outcome of a successful speculative attack on the foreign-exchange reserves of a central bank which collapses the fixed currency-exchange rate. According to the first-generation models, the reason for a speculative attack lies with the country's economic fundamentals. Both Mexico and Argentina, especially at that time, could be considered developing countries. Their "excessively expansionary pre-crisis fundamentals" (Flood & Marion, 1996, p. 4) were proceeded with strong expansionary monetary and fiscal policies (Jeanne, 2000). These fundamentals and policies led to increasing doubt in the private sector about whether the central bank was able to maintain the currency peg, and these doubts were then utilized to gain profits through the medium of a speculative attack.

The main contribution of the first-generation models was to show that speculative attacks do not happen irrationally on the part of market participants. They in fact are the result of inappropriate policies on the one side, and rational arbitrage on the part of speculators (Jeanne, 2000).

2.2.1 Criticism

In retrospect, the first-generation models explained the Mexican and Argentinian crises reasonably well. But the EMS crisis from 1992 to 1993 put into question the view contained in the first-generation models (Jeanne, 2000). Although there were some countries, such as Italy and Spain, which had expansionary monetary and fiscal policies, this was not the case in the UK or France (Jeanne, 2000). Hence, there must be other reasons to explain this particular currency crisis. It was in order to explain the EMS currency crisis that the so-called second-generation models emerged.

2.3 Second-generation Models

The constraints of the first-generation models with regard to the EMS crisis led to the development of the second-generation models, or as Jeanne (2000) refers to them, "escape clause models" (p. 3). According to Jeanne (2000), these escape-clause models attempted to adapt the existing models in three different ways. First, they allowed the government and central banks a more active role. On basis of a simple cost and benefit analyzes the central bank and the policymaker can decide if the currency peg should be defended or if an "escape clause" should be effected. Exercising an escape clause means that the currency is able to devalue, revalue or float. The second adaptation made was to the conception of fundamentals. While in the first-generation models only fiscal and monetary policies were considered, the escape-clause models exposed the fundamentals to all the variables that may influence the decisions of the policymakers (Jeanne, 2000). These variables can either be "hard" observable variables, such as interest rates, trade balances or unemployment; or "soft" variables which incorporate unobservable phenomena such as the beliefs of market participants (Jeanne, 2000, p. 3-4). The third, and most important, adaptation was to the relation between economic fundamentals and the triggering of a speculative attack. While, in the first-generation models, a speculative attack was always related to the state of a country's fundamentals, this does not have to be the case in the escape clause models[3]. The provision of a new theory of self-fulfilling speculation and multiple equilibria radically transformed the view of currency-crisis.

Self-fulfilling speculations, as well as self-fulfilling prophecy, are related to the Thomas theorem. Thomas (1928) states that if "men define situations as real, they are real in their consequences" (p. 572). This citation concerns the difference between subjective and objective realities and is in line with the view of Alexander von Humboldt, who stated, analogously, that it is not the facts that decide, it is rather the opinion we have about the facts. In terms of the escape-clause models, this means that causality does not run strictly from the fundamentals to the market participants and thence to market expectations (Jeanne, 2000). In fact, causality runs both ways, which can lead to the existence of multiple equilibria. That is, if the currency crisis is not necessarily related to the fundamentals of a country, it could be determined by the self-fulfilling mood of the market (Jeanne, 2000). This means that, even if the fundamentals of a country are considered robust, a

[3] This explains the EMS crisis with respect to the sound fundamentals of the UK and France.

speculative attack could still occur. Hence, a speculative attack could occur when, having considering the fundamentals and the possible objectives of the policy makers, private agents believe that a "escape clause" is going to be executed (Jeanne, 2000, p. 5).

In order to give a deeper, more representative understanding of the core idea of the second-generation models, and in order to aid understanding of the remainder of this thesis, below I investigate the strategic foundations of the Obstfeld (1996) model in greater detail. Obstfeld is one of the primary authors of the second-generation models.

2.3.1 Obstfeld's Model

The Obstfeld (1994, 1996) model is the initial second-generation model, and the starting point for all further currency crisis models. Its main contribution is the insight that in certain situations the devaluation of a currency becomes self-fulfilling. Furthermore, even though the fundamentals of a country are sound and the currency peg could be maintained unproblematically, self-fulfilling speculative attacks can cause the collapse of the currency peg. In the strategic foundation section of his paper, Obstfeld (1996) presents a theoretical game based upon Nash equilibria.

The game is a one-shot noncooperative game with three participants: a government that tries to maintain the currency exchange rate by selling foreign reserves, and two private agents who are holders of domestic currency[4]. The private agents can either hold the domestic currency or sell it to the government in return for foreign currency. Each private agent has six units of monetary resources. If the private agents prefer to hold their money, no costs are involved; if, on the other hand, they want to exchange their money, they have to pay a transaction cost of -1. The game has three different scenarios, as exhibited in Figure 1. The first scenario (a) is a high-reserve game in which the government has a reserve of 20 money units. The second scenario (b) is a low-reserve game in which the government has only six money units. In the last scenario (c) the government has an intermediate reserve of 10 money units. In what follows, the outcomes of the three games are examined individually.

In the first scenario (a), the combined monetary resources of the private agents are 12 money units, which is less than the government reserve of 20. Therefore, even if the agents sell their 12

[4] In this model, the state authority transmitting public information is the government.

units, the government still has eight units left. Thus, the currency peg is not at risk. If either private agent wants to exchange currency, they suffer a -1 transaction cost. Consequently, the payoff is -1. Hence, the dominant strategy for both private agents is to retain their domestic currency. The Nash equilibrium is in the upper left corner.

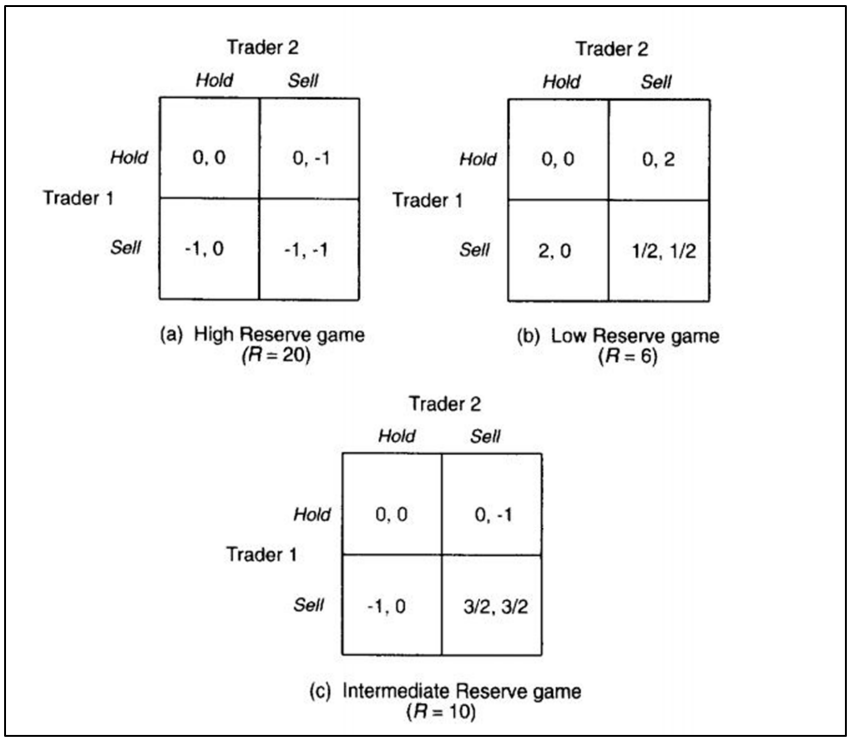

Figure 1: "The extent of the central bank's commitment to defend the exchange rate determines the nature of possible equilibria" (Obstfeld, 1996, p. 1038).

The second scenario (b) is the other extreme case, in which the government only has a reserve of six units. This means that one private agent alone can break the currency peg[5]. Following the model of Obstfeld, the government devalues the domestic currency by 50% if the currency peg is toppled. A private agent who sells the six domestic units has a capital gain of three units in domestic currency. After the transaction fee, the net gain for a single private agent is two. Consequently, the payoff is also two units. If both private agents decide to sell their domestic money,

[5] According to Obstfeld's (1996) definition, the government devalues the currency if its reserves equal the attacking units.

each only receives half of the government's three-unit reserve. Their capital gain is now 1.5 units each, and their net gain after the transaction cost is 0.5 units. Hence, for both agents, selling their currency and bringing down the currency peg is the dominant strategy. The Nash equilibrium is in the lower right corner.

The last scenario (c) is the essential one. In this case, the government has a reserve of 10 money units. Neither of the private agents alone can undo the currency peg. Only if both private agents sell in concert the currency peg will fall. In this scenario the payoff structure is as follows: if an agent retains the domestic currency, he or she does not lose or gain money: the payoff is 0. If one private agent sells the domestic currency, the currency peg is maintained and the agent suffers transaction costs, resulting in a payoff of -1. Assuming that both private agents decide to sell their domestic money, each receives half of the reserve (5 units). If the domestic currency devalues by 50%, each agent receives a capital gain of 2.5 units, and a net gain or 1.5 units. The interesting new part of this scenario is that there are now two Nash equilibria. The first, in which both traders sell their domestic currency and the currency peg falls, is in the lower right corner; and the second, in which neither trader believes that the other one will attack and, therefore, the currency peg maintains, in the upper left corner. In scenario (c), the Nash equilibrium that collapses the currency peg includes a self-fulfilling element, because it relies on the perception of the other private agent. The state of the government's fundamentals makes a currency collapse possible, but not an economic necessity.

The Obstfeld (1996) scenarios demonstrate that the state of the economic fundamentals generally determines whether a unique, or multiple, equilibria exist. This is contrary to the first-generation models, where the economic fundamentals generate a unique equilibrium. If we recall the previous section concerning first-generation models, "bad" fundamentals lead to an agent attacking, whereas "good" fundamentals result in the agent not attacking. In the Obstfeld (1996) model, this is merely the case in the extreme scenarios (a) and (b). The novelty of the Obstfeld model is that the more complex situation arises if it is not clear whether the economic fundamentals can be considered "good" or "bad." In this case, it depends on the prevailing self-fulfilling expectations of the speculators as to whether a combined attack will occur. The existence of an uncertain situation and the multiple equilibria that arise explain why currency crises occur even though the fundamentals cannot be described as "bad." If a currency crisis emerges, confidence in the currency

may decline, which may lead to a panic and a "run" on the currency, similar to a bank run. The prevailing attitude of the market may shift from a positive to a negative view, opening the possibility for private agents to coordinate their actions. In terms of the Obstfeld model, this would mean a shift from the non-attacking equilibrium to the attacking equilibrium.

2.3.2 Critical Views of the Obstfeld Model

The central criticism of Obstfeld's (1996) and similar multi-equilibria models is that they lack an explanation of why the shift from a non-attacking equilibrium to an attacking-equilibrium occurs. The question arises as to the reasons private agents have for changing their decision from not attacking to attacking, even though the economic fundamentals of the country have not changed.

The Obstfeld model reaches its conclusions because of its presumptions, such as perfect information about the true state of the fundamentals, and perfect coordination of all market participants. That is, the model is coherent but not particularly realistic. In reality, private agents cannot observe the market perfectly and accordingly cannot know the actual state of the fundamentals. In fact, each private agent is likely to interpret the information provided differently. This leads to the problem that the individual private agents do not know how the other private agents are evaluating the information. If the knowledge about the true state of a country's fundamentals differs, due to differences in the evaluation of information, it is not likely that the private agents will collectively and simultaneously decide to attack or refrain from attacking the currency.

A study by Morris and Shin (1998) highlights the problem with these types of multi-equilibria models. They criticize the too simplistic information structure, which suggests universal common knowledge, and choose a different, more realistic approach. Their model is built on that of Carlsson and Van Damme (1993), which assumes imperfect information. As each agent still receives the same information about the state of the fundamentals, Morris and Shin (1998) introduce a new influential factor called "noise." Noise alters the information in some way, so that each private agent receives a private signal. This private signal contains information that is known only to the private agent, not to the other market participants. Hence, because there is no longer common knowledge about the state of the country's fundamentals, and the agents cannot be sure what information other participants receive, they can no longer perfectly coordinate their behavior. Therefore, other mechanisms and strategies become important. The model of Morris and Shin

(1998) will be analyzed in greater detail in Chapter 4. At this point, it is only important to mention that by adding "noise" to the information structure, the presumptions transform from a perfect to an imperfect condition, with the consequence that a unique equilibrium arises for every state of the fundamentals. This means that, as with the first-generation models, a unique equilibrium exists at which the currency peg can be maintained or abandoned. The difference from the first-generation models is that, due to the new information structure, not all agents attack or refrain from attacking. Morris and Shin's (1998) model consequently changed the view on analyzing speculative attacks. The models of Morris and Shin (1999) and Metz (2002) elaborate further on the information structure by diversifying information into public information and private information.

At this point, the importance of information structure should be stressed, as should the fact that small changes to this structure lead to different outcomes in the models. For this reason, it is important that the models incorporate a precise and realistic information structure that reflects how private agents receive and evaluate information. Besides the information structure regarding the state of the economic fundamentals, other aspects are also noteworthy. The next subsection describes the other key factors that are influential and could lead to a currency crisis.

2.3.3 Key Factors in Currency Crises

With his work, Obstfeld (1996) introduced the theory that besides economic fundamentals, self-fulfilling beliefs are significant when investigating speculative attacks. He names five alternative mechanisms for explaining self-fulfilling crises: public debt, banks, income distribution, real interest rates, and spillover and contagion effects. Eichengreen, Rose, and Wyplosz (1994, 1995) examine a large number of attack episodes. Their findings show that speculative attacks differ widely in terms of their causes. They could not determine any clear early warning signals in the pre-crisis macroeconomic conditions. This led Obstfeld (1996) to the conclusion that at least some speculative attacks must involve a self-fulfilling element. In his work, Jeanne (1997) supports Obstfeld's argument by investigating expectations regarding the devaluation of the French franc in 1992 and 1993, which could not be explained by macroeconomic conditions alone. He argues that the expectations were induced by a strong self-fulfilling element.

Kaminsky, Lizondo and Reinhart (1998) attempted to develop an early warning system for currency crises. They utilized Obstfeld's (1996) variables and in addition derived 105 indicators that could potentially precipitate a currency crisis. They group the indicators into seven categories: "1) the external sector, 2) the financial sector, 3) the real sector, 4) public finances, 5) institutional and structural variables, 6) political variables, and 7) "contagion effects"" (p. 9). However, Cumperayot and Kouwenberg (2013) criticize the poor performance of existing early warning models. In their work they use extreme value theory to investigate whether the 18 most common economic and financial indicators have an influence on the occurrence of currency crises. Their empirical investigation for the period 1974-2008 demonstrated no significant effect by most of the indicators on the occurrence of a currency crisis[6].

The work of Kaminsky, Lizondoand Reinhart (1998) had already highlighted the fact that, in addition to the indicators mentioned above, there could be additional political and institutional issues of importance involved in a currency crisis (Mutgeert, 2013). In their empirical work, Kaminsky, Mati and Choueiri (2009) investigated the late 1980s currency crisis in Argentina. They studied the role of domestic macroeconomic conditions and found that the loose monetary policy in combination with a sharp output contraction was primarily responsible for the collapse of the Argentinian currency in 2002 (Mutgeert, 2013). Furthermore, other domestic factors, such as capital account restrictions, the interest rate, and credit-control restrictions played a role too (Mutgeert, 2013). These latter factors reveal that an institutional element is required to explain currency crises (Mutgeert, 2013).

Shimpalee and Breuer (2006) investigated the cause of currency crises by taking into account a broader array of institutional factors while controlling for economic factors. The key background studies for their research are the work of Alesina and Wagner (2003) and Calvo and Mishkin (2003), both of which investigate the quality of institutions and exchange-rate arrangements. Alesina and Wagner (2003) found out that countries with poor quality institutions have difficulties in maintaining a currency peg and are more likely to abandon it. Calvo and Mishkin (2003) argue that stronger institutions relating to stronger fiscal, financial, and price stability are essential for macroeconomic stability, and therefore crucial in order to avoid a crisis.

[6] Only changes in the real interest rate and the real interest rate differential are potentially useful as a warning system.

The research of Shimpalee and Breuer (2006) asks two key questions: “1) what mix of institutions may contribute to or set the stage for a currency crisis? and 2) what mix of institutions may affect the depth of currency crisis as measured by a decline in output?” (p. 1) They derive several institutional indicators based on the work and evidence of other researchers. To give a sample of results of researchers who have been incorporated in the model of Shimpalee and Breuer (2006), it is worth naming:

“Rossi(1999) [who] considers capital account openness, bank supervision, and depositor safety, Ghosh and Ghosh (2002) [who] consider governance, rule of law, creditor and shareholder rights and Mulder et al. (2002) [who] consider among other factors, the legal regime, contract enforcement, and accounting standards” (Shimpalee & Breuer, 2006, pp. 127-128).

Thereafter, they develop 13 institutional indicators, some of which are similar to the Kaufmann (2002) governance variables. These 13 institutional variables include: bureaucratic quality, government stability, corruption, law and order, ethnic tensions, external and internal conflicts, the exchange rate regime, capital controls, central bank independence, deposit insurance, financial liberalization, and legal origin.

Their main idea, that institutions influence currency crises by means of two causal mechanisms, is based on Li and Inclan (2001). The first and most obvious is that institutions correlate with the well-being of the national economy. Hence, institutions which tend to lead to poor economic fundamentals are likely to contribute to a currency crisis; while, on the other hand, institutions that tend to lead to sound economic fundamentals could remove one possible risk for the occurrence of a currency crisis. The second mechanism is related to the role institutions play in informing market agents and is therefore strongly related to currency crises and speculative attacks. Institutions inform market agents about the current or future state of economic fundamentals and can thereby shape market expectations. Accordingly, institutions which correlate with poor economic fundamentals lead to destabilizing market expectations and therefore increase market uncertainty and the probability of a currency crisis through speculative capital outflows. Institutions that correlate with sound economic fundamentals stabilize market expectations and reduce market uncertainty and the probability of a currency crisis by means of speculative capital outflows.

The results of Shimpalee and Breuer (2006) show that institutions and macroeconomic factors play a decisive role in currency crises and furthermore influence the contraction in the output that ensues. They find consistent support for the argument that a less stable government, weak attributes of law and order, widespread corruption, and a fixed exchange-rate regime increase the likelihood of a currency crisis. In addition, they find modest support for the notion that capital controls and the central bank's independence reduce the probability of a currency crisis. Ambiguous results are observed regarding deposit insurance. Little or no evidence can be found concerning institutional variables such as bureaucratic quality, ethnic tensions, and external or internal conflicts.

After establishing that institutions play a role in currency crises, the question emerges as to what influences institutions. Here De Jong (2009) and Williamson (2000) respond that the nation's culture may play an important role. Hence, a theoretical framework has to be set up that explains the way in which culture influences institutions and, subsequently, currency crises. However, before the role that culture performs in currency crises is interpreted and determined in this thesis, the role of culture in economics, and the effects it has on behavior, institutions, and society requires further investigation. This is detailed in Chapter 3.

2.4 Third-generation Models

The third-generation models are not of importance for this thesis but are briefly presented for the sake of comprehensiveness. The Asian crisis of 1997 lead to the development of the so-called third-generation models. These models link currency crises and banking crises, which are often referred to as twin-crises (Kaminsky & Rheinhardt, 1999). Furthermore, links between currency crises and debt sustainability, sovereign defaults, and the behavior of international capital markets have been investigated (Jones, 2016). Jeanne (2000), however, argues that third-generation models do not differ in their approach from those of first- and second-generation models, and therefore cannot be considered a distinct new approach.

3 Culture and Institutions

In this chapter the role of culture in economics is analyzed. A short historical introduction is presented, followed by a definition of culture from Hofstede (1980). Thereafter, the importance of uncertainty avoidance and how it influences institutions and economic behavior is explained. Subsequently, the thesis elaborates on the effect uncertainty avoidance has on information structure and transmission by using a version of the Shannon-Weaver communication model, and by referring to the model of Chelli and Della Posta (2007).

3.1 The Historical Background of Culture in Economics

If we retrace the beginning of economics as an independent discipline, the literature often refers to Adam Smith's two important books: *The Theory of Moral Sentiments* (1759) and *The Wealth of Nations* (1776). Classical economic approaches were often universal approaches, incorporating different aspects such as politics, society, morality, institutions, values, norms and beliefs (De Jong, 2009). These aspects are influential factors in the economic system and are therefore naturally incorporated into economic analysis. With the marginalist revolution and the rise of formal economics, the former universal approaches went into decline. The marginalist revolution had the goal of turning economics into a formal science "with the maximization of subjective value as its central object" (De Jong, 2009, p. 15). In formal economics the focus shifted to individual choice and rationality, leaving no space for institutions, values and beliefs (De Jong, 2009).

As culture was not represented in the formal economic view, Max Weber is considered the founding father of cultural economics. With his book *The Protestant Ethic and the Spirit of Capitalism* (1930), Weber was one of the first researchers who again focused attention on the connection between culture and economics. His book was written in opposition to Karl Marx's *Das Kapital* (1867). Weber's argument against the historical materialistic approach of Marx was that the "idea" (beliefs, norms, values, religion) shapes material conditions and not, as Marx stated, the other way around (De Jong, 2009).

Culture in economics nevertheless merely played a minor role for many years. It began to re-emerge with the decline of, and loss of trust in, neoclassical theory. While neoclassical theory

emphasizes rational choice and rational expectations, cultural approaches take the limited cognitive ability of human beings into account when modeling human actions (De Jong, 2009). Different approaches to how to incorporate culture into economic models follow in Chapter 3.4.

One of the most important contributions to culture and economics comes from Hofstede (1980). With his empirical research, he derived variables and a definition of culture which made it possible to incorporate cultural aspects into economic research.

3.2 Hofstede and Culture

There exist many definitions of culture, some broad, others very narrow. This thesis follows the definition of Hofstede (1980), who defines culture as "the collective programming of the mind that distinguishes the members of one group or category of people from others" (p. 21). With the idea of "collective programming of the mind," Hofstede refers to his onion model, which reflects the similar values a group holds. These values are at the core of the model and are practiced through rituals, heroes, and symbols. With this system one can distinguish one group from another. In this sense, a group can be, for instance, a department, a firm, an occupation, or a nation. Often culture is transmitted from generation to generation; it refers to the learned aspects of life. The novelty of Hofstede's research and the impact it had on culture and economics arrived inadvertently.

In his research, Hofstede (1980) did not actually commence measuring aspects related to culture, but rather why IBM affiliates in 40 countries performed differently. To this end, he devised a cross-national survey asking IBM employees what they desired in their work life. The survey responses Hofstede received displayed surprising differences among countries as regards the manner in which people prefer their work life. As Hofstede had used matched samples in his research method, he was able to conclude that the differences in the responses could only be explained by national differences. These are manifested in the values held by individuals, and therefore in differences between national cultures.

Hofstede calculated the national means of the answers, which were than used for factor analysis and correlations. In this manner, he discovered four dimensions of culture: power distance, collectivism vs. individualism, femininity vs. masculinity, and uncertainty avoidance. The dimensions are enumerated along a scale ranging from 0 to 100 points, allowing the quantitative com-

parison of the individual country's scores. By introducing the four cultural dimensions, Hofstede (1980) allowed the development of new theories in the field of economics. Based upon the derived differences in national cultures, several national differences in financial systems, bilateral trade, and GDP growth can be explained from a different angle (Mutgeert, 2013). However, up to the present, these cultural differences have rarely been referred to when investigating currency crises.

One of the few studies which incorporate a cultural dimension in their research is the empirical work of Inklaar and Yang (2012). They investigated the impact of financial crises and the tolerance for uncertainty on investments. In their work they take different types of financial crisis into account, such as banking, debt and currency crises. Their results demonstrate that the negative effects of a crisis in investments differ significantly between countries. In higher uncertainty-avoiding countries, the impact of a financial crisis is more severe, resulting in significantly less investment after a crisis. The reason for this is that firm owners in higher uncertainty-avoiding countries shy away from investment in times of turmoil – they would rather wait until economic conditions improve and become more predictable. Furthermore, Inklaar and Yang (2012) conclude that uncertainty avoidance and institutions might be linked. These links are investigated in the following section.

The results of the research of Inklaar and Yang (2012), De Jong (2009) and others demonstrate that uncertainty avoidance, especially, is a crucial cultural determinant in economic research. Therefore, this thesis focuses on how uncertainty avoidance, as a cultural determinant, influences currency crises. The importance of uncertainty avoidance for institutions, economic behavior, information structures, and lastly for currency crises will become clear in the sections that follow.

3.3 Uncertainty Avoidance and Institutions

Uncertainty avoidance is defined as "the extent to which the members of a culture feel threatened by ambiguous and unknown situations" (Hofstede G., Hofstede G.J., Minkov 2010, p. 191). It is important to understand that uncertainty avoidance is different from risk avoidance. As Hofstede et al. (2010, p. 197) explain, "risk is to uncertainty as fear is to anxiety." Risk and fear both have a specific focus on something predictable; while uncertainty and anxiety do not have this focus and are more diffuse feelings.

Having defined uncertainty avoidance, we must elaborate on the manner in which uncertainty avoidance influences currency crises. Currency crises, and crises in general, are extremely uncertain and unpredictable situations. Cultures with a high degree of uncertainty avoidance tend to reduce the uncertain situation by, for instance, more cautious behavior or more elaborate institutions. In his book, De Jong (2009) demonstrates the impact of uncertainty avoidance with several examples. In countries with a high level of uncertainty avoidance, the need for law, order and regulations is stronger. In order to protect themselves from uncertainty, people establish more precise and rigid laws. The opposite can be perceived in the uncertainty-accepting countries. These countries tend to have less employment protection, leading to more flexible labor market practices and decentralized bargaining. Furthermore, they liberalized foreign trade and financial flows earlier, and have a positive attitude towards innovative industries and towards exports containing high levels of innovation. One explanation for the latter aspect is the comparative advantage of the market-based financial system, with its higher levels of venture and risk capital. The difference in financial systems highlights the difference between uncertainty-avoiding and -accepting countries relatively well and can be seen as one of the main distinctions. Uncertainty-accepting countries tend to have a fairly market-based financial system. In very reduced form, this means that in a market-based financial system, external finance comes from financial markets. Under certain conditions[7], the market-based system is the more efficient system; however, it also has disadvantages, such as incomplete information, which lead to asymmetric information distribution and moral hazards among market agents. Therefore, markets cannot provide insurance for many kinds of risk. On the other hand, bank-based systems are favored by uncertainty-avoiding countries. In the bank-based system, external finance comes from financial intermediaries. These intermediaries are able to provide risk- sharing and risk-smoothing instruments. In addition to the financial system, Hofstede (2001) indicates that uncertainty-avoiding countries have stronger resistance to change.

As has been illustrated above, uncertainty avoidance affects countries' institutions. Exemplifying and defining institutions, Hodgson (2006) asserts that institutions are "systems of established and prevalent social rules that structure social interactions." Alternatively, Menard and Shirley (2005)

[7] Financial markets need a certain amount of depth to work in an orderly fashion; that is, large volumes of trade and a large number of intermediary agents(De Jong, 2009). Röell (1996) finds that institutional investors and pension funds in particular are critical of providing funds to be invested in financial markets (De Jong, 2009).

define institutions as all the rules or codes of conduct aimed at controlling the environment in order to reduce uncertainty. This definition is quite close to those of Williamson (2000) and De Jong (2009) who both diversify institutions into informal and formal institutions. Customs, traditions, norms, beliefs, and religion, among others, can be considered informal institutions. Formal institutions arise and reflect the informal institutions. A country's constitution, laws, and property rights may be considered formal institutions. Therefore, institutions structure social action and "enable ordered thought, expectation, and action by imposing form and consistency on human activities" (Hodgson, 2006, p. 2). That is, they reduce uncertainty.

This leads to the conclusion that countries with higher degrees of uncertainty avoidance feel the urge to reduce uncertainty and therefore establish more elaborate institutions (Hofstede et al., 2010). Uncertainty-avoiding countries have more elaborately structured institutions; while uncertainty-accepting countries have more flexible institutions.

3.4 Institutions, Culture and Economics

Following the explanation of institutions, and the importance of uncertainty avoidance for the design of institutions, the thesis now demonstrates the importance of institutions for economic behavior and outcomes. In the existing literature, three approaches of culture and economics can be distinguished, two of which are of significance for this thesis. The first approach is the "culture as constraint" approach and is related to new institutional economics theory, which emphasizes the importance of institutions for the functioning of the economy[8] (De Jong, 2009, p. 32). According to this theory, institutions "enable individuals' actions by imposing constraints on each participant's behavior" (De Jong, 2009, p. 32). North (1990) defines institutions as interaction-shaping constraints developed by humans. In his book, De Jong (2009) elaborates on the thought that within the culture as constraint approach, institutions are, on the one hand, shaped by culture and, on the other, influence economic behavior. De Jong's (2009) ideas are based on the work of Williamson (2000), with the adaptation presented schematically in Figure 2.

[8] The culture and economics approach can therefore be considered a substantive economics approach, rather than a formal economics approach.

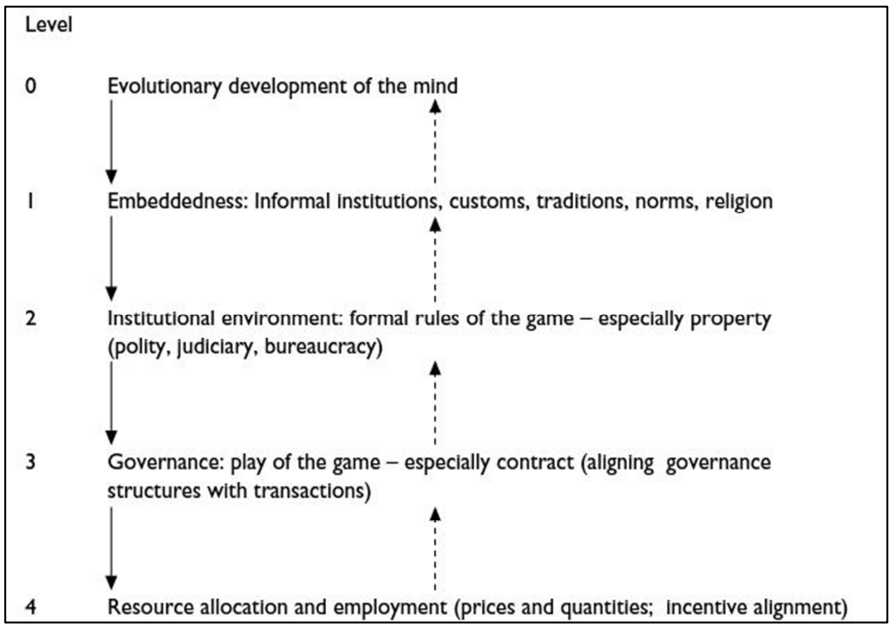

Figure 2: "Culture as constraints. Adapted from Williamson (2000) Figure I." (De Jong, 2009, p. 33)

Figure 2 presents the ideas in a plastic manner. According to Williamson (2000) and De Jong (2009), the first stage (level 0) is the evolutionary development of the mind. This influences the levels that follow. In fact, each level of institutions is embedded in each other. Therefore, each level acts to constrain to the following level (Kuncic, 2012). The more embedded a level is, the slower it evolves or changes[9]. The most embedded institutions are the informal ones. These shape the daily life of the society and contain unwritten social contracts. Often a silent agreement exists; or, expressed differently, these institutions are so ingrained in a culture's spirit that most people do not think about them and consider them naturally given. It is for this reason that De Jong (2009) refers to them as culture. These informal institutions shape the design of the formal institutions. The culture is reflected in the constitutions, laws, and rights of a country. The third level concerns the institution of governance. The institutions of governance incorporate the informal rules of private agents and of how "the game is played." Governance institutions are of especial importance in order to avoid having to solve every minor problem in court, which is costly and time consuming. The last level concerns resource allocation and employment and thus the economy and its outcomes[10]. As mentioned above, causality follows embeddedness and therefore the solid arrows in Figure 2. According to Williamson (2000), reverse causality (the dashed

[9] A crisis can change an institution more rapidly.
[10] This is the field of neoclassical economics research.

arrows in Figure 2) and influence are possible too, but is strongly dominated by the first relationship. The general scheme presented in Figure 2 can be adapted to each field of economics research, such as financial markets, labor markets, and the welfare system.

The second approach is the "culture as preference" approach and, to a large extent, it overlaps with the culture as constraint approach (De Jong, 2009, p. 34). In the culture as preference approach, beliefs and preferences are significant. Therefore, culture is here defined as "the systematic variation in preferences or beliefs" (Fernández & Fogli, 2007, p. 1), "which distinguishes the members of one group or category of people from another" (Hofstede, 2001, p. 9), and is "a system of attitudes, values, and knowledge that is widely shared within a society and transmitted from generation to generation" (Inglehart, 1997, p. 15). These values can be described as "broad tendencies to prefer certain states of affairs over others" (Hofstede & Hofstede, 2005, p. 8). In a manner similar to that of the culture as constraint approach, culture both directly and indirectly influences economic behavior, the economy, and its outcomes (De Jong, 2009, p. 38).

While in Williamson's (2000) "culture as constraint" approach clear dominance and causality exist between the levels and preference is considered exogenous, the culture as preference approach has a different perception. In this approach, causality can operate in either direction and therefore the higher levels of less embedded institutions can change the more embedded institutions and dominate them. Hence, no distinct directionality of causality or dominance of levels can be ascertained. In order to show this graphically, Figure 2 is often drawn horizontally.

This thesis follows the work of Mutgeert (2013), who distinguishes two channels through which culture is able to influence economic behavior and economic outcomes. Mutgeert (2013) refers to the first channel as the "institutional channel;" this incorporates most of the insights of the culture as constraint approach. Accordingly, culture influences and shapes institutions and how they operate; the way an institution works, constrains economic behavior and economic outcomes. The second channel is called the "behavioral channel." The distinct preferences of the society both directly and indirectly influence economic behavior and economic outcomes.

Following the derivation of these insights, it is important to refer back to currency crises. A currency crisis is triggered by the economic behavior of private agents, and as economic behavior is

linked to culture, currency crises must also be related to culture[11]. Consequently, the next step is to investigate the influence of culture, more precisely of uncertainty avoidance, on currency crises and thereafter on information structure.

3.5 Uncertainty Avoidance and Currency Crises

The influence of culture on economic behavior via the institutional channel and the behavioral channel provides some insights into how to incorporate a country's degree of uncertainty avoidance in the analysis of currency crises. As has been stated, culture, especially uncertainty avoidance, influences the design and strength of institutions. Hence, countries with a higher degree of uncertainty avoidance may react and perform differently in certain situations and crises than countries with a lower degree of uncertainty avoidance. Evidence of countries reacting differently in times of crisis has been found by, for instance, De Jong and Van Esch (2013), who investigated the different reactions of European leaders towards the European sovereign debt crisis, the reform resistance of southern European countries and, as Inklaar and Yang (2012) found out, different investment decisions. Potential influences of a country's degree of uncertainty avoidance on currency crises via the institutional channel could be described as follows: countries with a high degree of uncertainty avoidance tend to build more elaborate formal institutions in order to protect themselves against crisis. The disadvantage of more elaborate formal institutions is that they operate according to stricter rules and are therefore less flexible. These stricter rules may protect a country in difficult times; however, they may also prevent the decisive discretionary response that is required to end the crisis. It is therefore difficult to predict whether a lower or higher degree of uncertainty avoidance is better for a country.

In times of economic prosperity, inflexible institutions could hamper growth, whereas countries with flexible institutions grow faster and are more innovative. Yet, in difficult times, strong institutions can prevent a crisis from occurring. In such a case, uncertainty-avoiding countries are at an advantage. In times of severe crisis, flexibility, creativity, and to a certain degree boldness, are needed in order to end the crisis. Hence, inflexible institutions may lead to the extension of the crisis.

[11] In case of this thesis, uncertainty avoidance is the key determinant of culture.

Taking into account characteristics that could influence currency crises is a link to the behavioral channel. The manner in which private and public agents behave may have an influence on currency crises. As an example, the cautious behavior of private agents in countries with a higher degree of uncertainty avoidance might under certain conditions trigger a crisis more easily. It is important to note is that not all private agents are influenced by cultural elements. Companies, especially large international companies, react rationally in their decision-making processes and in such cases cultural factors might be annulled. Nevertheless, companies are likely to take the cultural attributes and the economic behavior of a country into account, particularly if they are investors. In addition to that of private agents, the behavior of politicians and the central bank are significant. The questions here concern whether they would be willing and able to act; whether they would do and proclaim everything necessary to defend the currency (as, for example, the European Central Bank did during the European sovereign debt crisis); and whether they show resistance to reforms. Additionally, the preferences of agents in the economy play an important role. Agents' preferences for certain media or for specific experts, and belief in the published opinion can change the mood of the market and thereby either trigger or calm a crisis.

This leads on to the last point in this chapter: the importance of the information structure and how agents receive information.

3.6 Information Structure and Currency Crises

The manner in which agents perceive and interpret information, and the criteria by which they choose to act are determined by their mental models, and thus by cultural norms (DiMaggio, 1994). In order to shed light on what is often referred as the "black box" of the information process, a basic communication model, shown in Figure 3, is investigated.

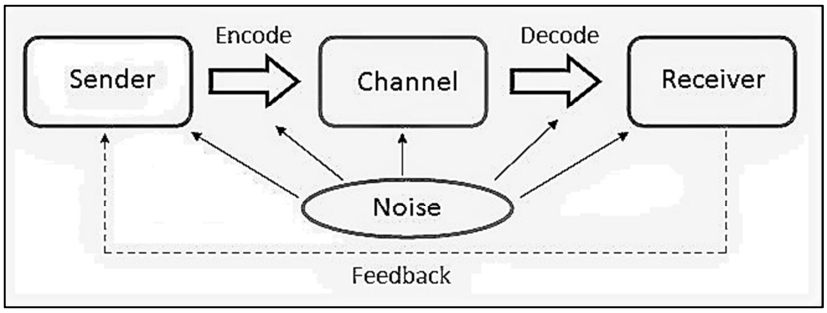

Figure 3: "Adaption of a Shannon-Weaver-communication-model"

In this model, there is a "sender" which publishes information and a "receiver" who receives information. The sender encodes information or translates thoughts and ideas into a form of language that can be understood by the receiver. In context of currency crises, it is important to analyze who disseminates information on, for instance, the state of the economy to the public. In most currency-crisis models it is assumed that the sender of information is the central bank. In reality the situation is more diverse. Besides the central bank, politicians, the media, and subject-matter experts are important transmitters of information. The media, especially, is often of a degree of importance that may go unnoticed: it has the power to influence public opinion, which is of importance for political leaders. Political actors are increasingly required to take the role and logic of the media into account in order to be represented in it and gain support, a phenomenon called mediatization (Hjarvard, 2008 and Mazzoleni & Schulz, 1999). The media has thus become a "social institution" acting within the political field (Cook, 1998 and Sparrow, 1999).

The manner in which information is presented to the public is described by the channel, for example, at a press conference, in person, in a newspaper, as open-access data, and so forth. Receivers, agents with their own agenda, decode the information in the message and translate it into thoughts and perceptions. Hence, the receiver could obtain public information which is common knowledge to everyone, and is additionally a private signal. Public information is transmitted by institutions, such as the central bank, and is influenced by culture. Private information consists of additional information from the media and experts, and is likely to be received differently by agents. In all parts of the process of information transmission, noise is likely to occur. Noise is a phenomenon that interferes with the sending or understanding of the message and can thereby cause misinterpretation and misunderstanding. Noise can occur naturally, unwillingly or willingly[12]. Ultimately, the sender is likely to obtain some sort of feedback from the receiver. In a currency-crisis setting this may include the receiver's decision whether or not to attack the currency.

Furthermore, it is important to note that there can be a number of senders and receivers connected in a series. For instance: a receiver obtains information from a sender. If the receiver wants to disseminate the information further, the receiver becomes the new sender. It is likely that the quality of the information will decrease the more senders and receivers there are in the series.

[12] Note that noise both captures all aspects that lead to an information loss, and captures the precision of the information in the first place. If, for instance, the sender publishes biased information, the noise factor will capture this too.

Following consideration of the straightforward transmission of information, it is necessary to examine the accurateness of the information transmitted. As indicated in Chapter 2.3.2, the factor central to whether a speculative attack occurs or not is the information private agents receive. This being the case, it is imperative to consider whether the private information agents receive is accurate or whether it is biased. Cheli and Della Posta (2007) investigate biased private information as concerns a self-fulfilling currency-crisis model. This thesis follows their idea and adds that transmitted public and private information is likely to be influenced by culture, in particular by uncertainty avoidance. By means of the institutional and behavioral channels, uncertainty avoidance influences the publishing and evaluation of information. The degree to which the information is biased or manipulated is captured in the noise variable.

Before this thesis can examine the effects these insights have on the currency-crisis model of Metz (2002), a deeper understanding of the functioning of second-generation global-game models is required. To this end, the models of Morris and Shin (1998, 1999, 2000) are investigated in the following chapters.

4 Morris and Shin: Unique Equilibrium in a Model of Self-Fulfilling Currency Attacks

Morris and Shin's (1998) model of speculative attacks against a fixed exchange rate is based upon the global-game model of Carlsson and Van Damme (1993). Today, the Morris and Shin (1998) model is considered the most important second-generation model. It lays the groundwork for their subsequent models, and for nearly every other one that followed. The other models referenced in this thesis, such as those of Metz (2002) and Chelli and Della Posta (2007), all refer to it or to one of its extensions. The Morris and Shin (1998) model is not only relevant to currency crises – it can be used for several crises, such as debt crisis.

In contrast to Obstfeld's (1996) model described in Chapter 2.3.1, which assumes perfect information, Morris and Shin's (1998) assumes incomplete information. In Obstfeld's model, perfect information leads to multi equilibria, whereas in the Morris and Shin's, imperfect information leads to a unique equilibrium. The main difference thus lies in information structure. Morris and

Shin (1998) replace the common knowledge of Obstfeld (1996) with the concept of noisy private signals[13]. This means that every agent receives noisy information about the true fundamentals of the economy. The addition of noise to the accurate information on the fundamentals allows for small errors in the information. These errors are justified because each agent is likely to receive and interpret information about the economic fundamentals differently. Hence, as the information is different for everyone, the signal is called private. Agents do not know the beliefs and perceptions of the other agents. Furthermore, agents cannot observe whether the currency is under attack by other agents, making it difficult to coordinate attacks. A decision whether or not to attack the currency is based upon the game's outline and a cost-benefit analysis by the agents. The detailed workings of this process is the content of the sections that follow. By explaining this model, the thesis will attempt to reduce, wherever possible, the use of formulas.

4.1 The Model

In the Morris and Shin (1998) model, the economy of a country is characterized by certain values for the state of fundamentals θ, which is assumed to be normally distributed between [0,1], indicating θ that is chosen by nature. This means that each value of θ has the same chance of occurring. The model further describes a situation in which one country has pegged its own relatively weak currency to a stronger currency. Therefore, the country's currency is permanently overvalued, independent of its economy. This means that for every state of the fundamentals, the level of the exchange rate, which is given by e*, is always above the "natural" free-floating exchange rate of $f(\theta)$. Hence, even if the economy were in the best possible condition, the currency would still be overvalued. This means that the country constantly has to intervene in the foreign-exchange market in order to maintain the currency peg. Furthermore, a higher value of θ reflects stronger fundamentals, indicating that f is increasing in θ.

The model considers two rational "players," both of whom take action according to a cost-benefit analysis. On the one hand, we have the government as a player, which has the option of defending or abandoning the peg. On the other, we have a continuum of speculators who have the option of either attacking the currency, or refraining from attacking the currency. How the players act depends on the information they receive. The government is able to observe the actual state of

[13] Note that Morris and Shin (1998) do not mention who transmits the information. Furthermore, no public information is incorporated into the model.

fundamentals θ and the number of speculators attacking the currency directly. The group of speculators on the other hand cannot observe θ directly. The only information each speculator individually receives is a unique noisy private signal x. The noisy signal x contains imperfect information about the actual state of fundamentals θ. Therefore, the noisy signal x is uniformly drawn from the interval [θ-ε, θ+ε], where ε indicates noise. The noise parameter ε is considered to be small though greater than zero. Every signal in the interval [θ-ε, θ+ε] has the same chance of occurring. Signal x is the only signal received by the speculators, which means they do not have common knowledge about the economic fundamentals. However, they do have common knowledge about the distribution of the signal x. The speculators know that each signal x has the same chance of occurring and that it lies within the interval [θ-ε, θ+ε]. This makes it impossible for a speculator to estimate the signals the other speculators receive. Furthermore, the true state of the fundamentals θ cannot be perfectly determined.

Having described the information structure of the game, the player's payoff structure has to be explained. A speculator who decides to attack the currency has to sell short. Associated with selling short is transaction cost t, which is fixed and is greater than zero. If a speculator decides to sell short and the government abandons the currency peg, the payoff for the speculator is a fall in the exchange rate minus the transaction cost: $e^* - f(\theta) - t$. If the government defends the currency peg, the speculator achieves no capital gain but has to pay the transaction cost t. In this case the payoff would be -t. If the speculator decides not to attack, the payoff is zero. Already at this point a problem becomes visible. As speculators cannot observe θ directly, they are not able to determine their actual payoff in the case where the government abandons the currency peg. Therefore, as is shown later in this thesis, speculators have to make their calculations using an expected payoff based upon their private signal x.

The government's payoff structure is derived from the value v, which is greater than zero, of defending the exchange rate at the pegged level and the cost entitled. The cost of defending the currency peg depends on the state of the fundamentals θ and the proportion of speculators attacking the currency α, with α ranging from [0,1]. Hence, the cost of maintaining the currency peg is $c(\alpha,\theta)$. The cost c is continuous, and is positively related to the proportion of speculators attacking the currency, and negatively to the state of the fundamentals. Consequently, defending the exchange rate results in a payoff of $v - c(\alpha,\theta)$. On the other hand, abandoning the exchange rate

leads to a payoff of zero. As a result of the manner in which the game is arranged, the government is able to observe α and θ. Hence, the government can directly calculate the value of v and so determine whether it is profitable to defend the exchange rate or not. Figure 4 illustrates the cost and benefit to the government of maintaining the currency peg. In Figure 5, the managed exchange rate and the exchange rate in the absence of intervention as a function of fundamentals are presented.

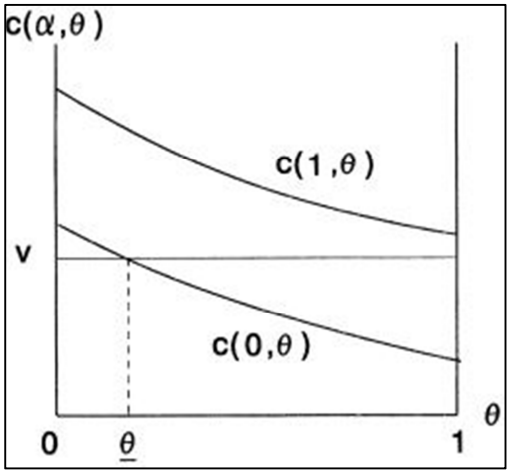

Figure 4:

"Cost and benefit to the government in Maintaining the currency Peg". (Morris & Shin, 1998, p. 589)
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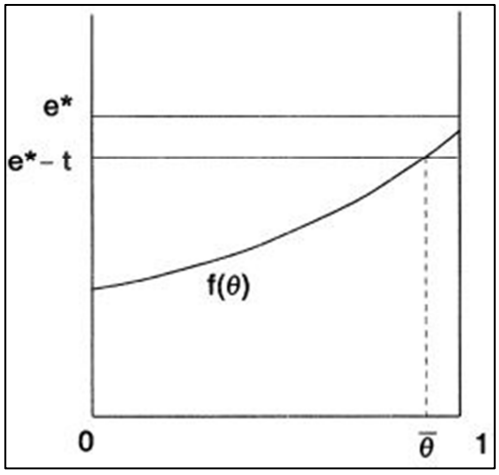

Figure 5:

"The managed exchange rate and the exchange rate in the absence of intervention as a function of the state of the fundamentals"

(Morris & Shin, 1998, p. 589)

Figure 4 shows that if the fundamentals are in the worst state, namely zero, the cost of defending the currency is so high that it exceeds the value v, even if no speculators attack. In this case c(0,0) > v. The other extreme case is if all speculators decide to attack the currency. In this case, not even the soundest fundamentals would justify the cost of defending the currency, illustrated by c(1,1) > v. The interesting point is $\underline{\boldsymbol{\theta}}$. At this point, in the absence of any speculative selling, the government is indifferent to defending or abandoning the peg. This means that the cost of maintaining the peg is equal to value of defending the peg, hence c(0,θ) = v. Therefore, if $\theta < \underline{\boldsymbol{\theta}}$, the cost of defending the currency always exceeds the value, even in absence of attacking speculators.

Figure 5 illustrates the payoff for the speculators. If the fundamentals are in the best state, the floating exchange rate is so high and close to the fixed exchange rate e* that the transaction cost t outweighs any profit from the deprecation of the currency after the government abandons the peg. Hence, e* - f(1) < t. As a result, there has to be a θ at which the speculator is indifferent to either attacking or refraining from attacking the currency. The point that solves the equation f(θ) = e* - t is $\overline{\theta}$. At this point, the floating exchange rate is equal to the fixed exchange rate minus the transaction cost. Accordingly, for every θ < $\overline{\theta}$, the speculator would receive a profit and is therefore willing to attack. For every θ > $\overline{\theta}$, the floating exchange rate is sufficiently high to prevent any positive payoff for the speculator.

In a manner similar to the Obstfeld (1996) model, the fundamentals can be divided into three different regions. The analysis of figures 4 and 5 shows that there is an interval [0, $\underline{\theta}$] at which the government has no reason to defend the currency. Therefore, the currency can be considered unstable for every θ ∈ [0, $\underline{\theta}$]. The next obvious interval lies between [$\overline{\theta}$, 1]. Here the speculators do have the power to force the government to abandon the peg, although this is highly unlikely. The resulting deprecation of the currency would be so small that they could not pay off the cost of attacking the currency. Hence, the rational decision not to attack is the dominant strategy. For every θ ∈ [$\overline{\theta}$, 1], the currency is considered stable. The last and most interesting interval lies between [$\underline{0}$, $\overline{\theta}$]. When θ lies within this interval, the currency is considered "ripe for attack." For the government, the value of defending the exchange rate is greater than the cost, under the assumption of a small number of speculators are attacking. In this case, v > c(α, θ), which means that the government will maintain the peg. The government's willingness to defend the currency could justify the decision of a speculator to refrain from attacking. However, if all the speculators decide to attack the currency, the cost of defending the currency becomes too high, resulting in v < c(α, θ), which leads to a decrease in the exchange rate. For every θ within the interval [$\underline{0}$, $\overline{\theta}$], the speculator will make a positive profit if the government abandons the peg. In order to force the government, in this interval, to abandon the peg sufficient speculators are required. If the speculator believes that the currency peg will be abandoned, attacking the currency is the rational action.

If, as in the Obstfeld (1996) model, perfect information and common knowledge about the true state of the fundamentals is considered, the "ripe for attack" interval would produce multiple

equilibria due to the self-fulfilling nature of the speculators' beliefs. However, in Morris and Shin's (1998) model, only imperfect information exists, which changes the outcome of the game in a unique manner.

4.2 A Game with Imperfect Information of Fundamentals

The game with imperfect information follows the model descriptions above. Additionally, Morris and Shin (1998) assume that if speculators are indifferent to either attacking or refraining from attacking, they will decide not to attack. If the government is indifferent to either defending the currency peg or not defending it, the government will abandon the peg. In this game the speculators move first. The government observes all the attacks and thereafter reacts as described in Chapter 4.1. As described in the previous section, within the "ripe for attack" interval, the number of speculators attacking the currency is of importance. In order to deduce the government's strategy whether or not to abandon the currency, a critical proportion of speculators is needed that inevitably leads to a drop of the peg at state θ. This proportion Morris and Shin (1998) call "critical mass" and it is denoted by a(θ). If the state of the fundamentals is in the unstable interval, no speculator is needed in order to bring down the exchange rate and a($\underline{\theta}$) = 0. If θ > $\underline{\theta}$, a(θ) is the value of the critical mass needed for the government to be indifferent to abandoning or maintaining the peg. Hence, a(θ) is the value of α which solves the equation c(α, θ) = v. Figure 6 illustrates the behavior of the function a(θ), which is strictly increasing in θ.

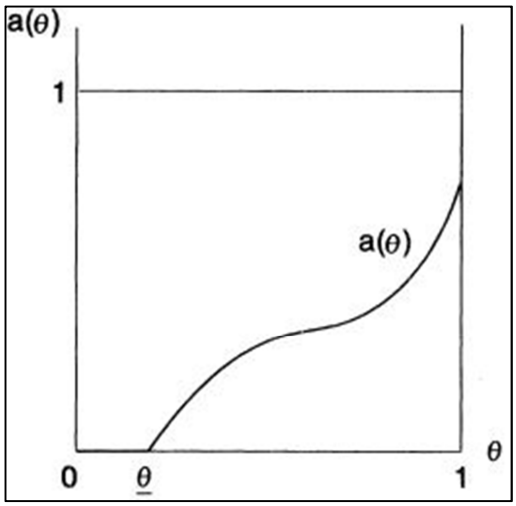

Figure 6:"The proportion of speculators whose short sales are sufficient to induce depreciation expressed as a function of the fundamentals" (Morris & Shin, 1998, p. 591)

The “unique optimal strategy” for the government is to abandon the exchange rate if the number of speculators is greater or equal to the critical mass. That is, if $\alpha > a(\theta)$.

Having derived the strategy of the government, the speculators’ strategy has to be characterized. For a given profile of strategies of the speculators, $\pi(x)$ denotes the number of speculators who attack the currency by a given signal x, with π being the aggregate selling strategy. Therefore, $s(\theta, \pi)$ describes the number of speculators attacking the currency when the state of the fundamentals is θ and the aggregate selling strategy of the currency is π. $A(\pi)$ describes the case in which the government abandons the currency peg if speculators follow strategy π. Therefore, the government will abandon the peg if $A(\pi) = \{\theta | s(\theta, \pi) \geq a(\theta)\}$.

This results in the actual payoff for an individual speculator attacking the currency, which is similar to the speculators’ payoff structure in Chapter 4.1. The payoff at the state θ and, given short sales of π, is denoted as $h(\theta, \pi)$:

$$h(\theta, \pi) \equiv \begin{cases} e^* - f(\theta) - t & \text{if } \theta \in A(\pi) \\ -t & \text{if } \theta \notin A(\pi) \end{cases}$$

As mentioned above, the problem is that the speculator cannot observe θ, but has to refer to the private signal x. The speculator knows that the actual state of the fundamentals θ must lie somewhere in the interval $[x-\varepsilon, x+\varepsilon]$. The expected payoff for attacking the currency then changes the equation $h(\theta, \pi)$ conditionally at the signal x. This results in $u(x, \pi)$:

$$u(x, \pi)$$

$$= \frac{1}{2\varepsilon} \int_{x-\varepsilon}^{x+\varepsilon} h(\theta, \pi) d\theta$$

$$= \frac{1}{2\varepsilon} \left[\int_{A(\pi) \cap [x-\varepsilon, x+\varepsilon]} \left(e^* - f(\theta) \right) d\theta \right] - t$$

Given a speculator's private signal x and the aggregated selling strategy $u(x, \pi)$, in order to obtain the expected payoff for attacking the currency, the speculator has to consider which state of the fundamentals is likely to be true. In addition, the speculator considers what other speculators might have received as signals. Thereafter, the speculator calculates for all possible states of the fundamentals the payoff for attacking the currency $h(\theta, \pi)$. In the last step "the speculator summates those payoffs and averages them over all possible states of the fundamentals given the received signal" (Mutgeert, 2013, p. 34).

By taking into account the fact that a speculator can ensure a secure payoff of zero by not attacking the currency, the rational decision conditional on the signal x depends on whether or not the equation $u(x, \pi)$ is positive. A speculator will attack the currency if $\pi(x) = 1$ when $u(x, \pi) > 0$, and not attack if $\pi(x) = 0$ whenever $u(x, \pi) \leq 0$.

4.3 Unique Equilibrium

With the set-up of the game and the strategies of both players having been derived, the main result of the Morris and Shin (1998) paper can be presented. This is effected in a brief manner in order to avoid repetition and an excess of formulas. All theorems and lemmata that follow in this section are directly related to the insights derived in the previous sections of the chapter, 4.

The theorem that has to be proven in order to produce a unique equilibrium is stated as follows: "There is a unique θ^* such that in any equilibrium of the game with imperfect information, the government abandons the currency peg if and only if $\theta \leq \theta^*$" (Morris & Shin, 1998, p. 592).

The proof of this theorem is presented in three lemmata. The first lemma deals with the speculators' decisions whether or not to attack the currency are strategic complements[14]. The second lemma refers to the payoff for the speculators. The payoffs are proven to decrease if the fundamentals become stronger. Hence, if the fundamentals are strong, the payoff for attacking the currency is lower. This reflects the resistance of the government in defending the peg if the fundamentals are better.[15] The third lemma is crucial to understanding the unique equilibrium. Morris and Shin (1998) prove that in a game with imperfect information there is a unique critical value x^*, in terms of which a speculator attacks if and only if the private signal x is below the critical

[14] The first lemma is presented in detail in Morris and Shin (1998, p. 592).
[15] The proof for lemma two is presented in the appendix to Morris and Shin (1998, pp. 596-597).

value. The reason the speculator only attacks if the signal x is below x*, is that x* represents the value that makes a speculator indifferent to either attacking or refraining from attacking the currency. Therefore, if the speculator wants to obtain a positive profit, he or she only attacks if $x < x^*$. Hence, x* is the solution for $u(x, I_{x*}) = 0$. As a direct result, Morris and Shin (1998) are able to replace the aggregate selling-strategy profile π with the aggregated trigger function I_{x*}. The function I_{x*} determines that all speculators act alike. If their private signal x is below the critical value x*, they attack the currency; and if their signal is above x* they do not attack. This can be demonstrated by the equation below in which 1 represents attacking the currency and 0 refraining from attacking[16].

$$I_{x*}(x) = \begin{cases} 1 \text{ if } x < x^* \\ 0 \text{ if } x \geq x^* \end{cases}$$

After deriving I_{x*}, the aggregate selling strategy of the currency π can be replaced, changing the equation $s(\theta, \pi)$ from Chapter 4.2 to $s(\theta, I_{x*})$. This makes it possible to define the proportion of speculators attacking the currency at a given θ, as displayed in the equation below (sourced from Morris & Shin, 1998, p. 593).

$$s(\theta, I_{x*}) = \begin{cases} 1 & \text{if } \theta < x^* - \varepsilon \\ \frac{1}{2} - \frac{1}{2\varepsilon}(\theta - x^*) & \\ & \text{if } x^* - \varepsilon \leq \theta < x^* + \varepsilon \\ 0 & \text{if } \theta \geq x^* + \varepsilon. \end{cases}$$

As can be seen in this equation, if the economic fundamentals are in such a ruinous condition that $\theta < x^* - \varepsilon$ is true, no speculator will receive a signal x above x*. Hence, every speculator will attack the currency, resulting in $s(\theta, I_{x*}) = 1$. The opposite is true if the economic fundamentals are in excellent shape, illustrated by $\theta \geq x^* + \varepsilon$. In this case, no speculator will attack, resulting in $s(\theta, I_{x*}) = 0$. The interesting option arises if the state of the fundamentals lies within the range $x^* - \varepsilon \leq \theta < x^* + \varepsilon$. In this case, some speculators will receive a signal above the critical value and some a signal below the critical value.

[16] The derivation of x* is presented in Morris and Shin (1998, pp. 592-593).

As a result of this analysis, the number of speculators attacking the currency can be determined; s(θ, I_{x*}) decreases with rising θ, while, on the other hand, as mentioned in Chapter 4.2, the critical mass a(θ) of speculators needed in order to force the government to abandon the peg increasing in θ. In addition, it is clear that x* has to be of higher value than $\underline{\theta}$ - ε. This has to be the case because x* is a switching point between attacking and not attacking. If x* were a value lower than $\underline{\theta}$ - ε, attacking the currency would be the dominant strategy. Therefore, s(θ, I_{x*}) and a(θ) can only cross each other once. This intersection is defined as θ* and is the turning point that distinguishes a successful from an unsuccessful speculative attack. As a result, the government abandons the currency peg if s(θ, I_{x*}) > a(θ), which is the case if and only if $\theta < \theta^*$. On the contrary, the government maintains the currency peg if s(θ, I_{x*}) < a(θ), and if and only if $\theta > \theta^*$. This then proves Morris and Shin's (1998) theorem.

Figure 7 below illustrates this set of facts. As can be perceived, the economic-fundamental value θ* is the point at which s(θ, I_{x*}) and (θ) cross each other. Therefore, the value θ* seperates the fundamentals into two regions. In the one region, the values of the fundamentals definitely lead to a collapse of the currency; while in the other, the values of the fundamentals are strong enough to secure the currency.

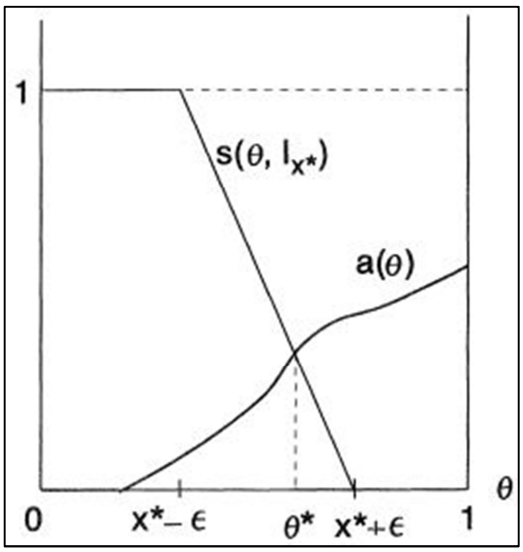

Figure 7: "The derivation of the cutoff point for the state of fundamentals at which the equilibrium short sales are equal to the short sales which induce depreciation" (Morris & Shin, 1998, p. 594)

4.4 Policy Implications

In their work, Morris and Shin (1998) identify three policy implications which have a direct effect on the occurrence of currency crises. The straightforward implication is that an increase in transaction cost has a direct influence on the strategy of the speculators. By increasing the transaction cost, the expected payoff for a speculator attacking the currency is directly reduced. As a result, fewer speculators will expect a positive payoff, which leads to fewer speculators attacking the currency at the same state of the fundamentals. This fact is displayed in Figure 7 by a shift of $s(\theta, I_{x*})$ to the left, and consequently to a decrease in the value θ^*. Therefore, according to Morris and Shin (1998), an increase in the transaction cost prevents currency crises.

The next implication refers to the aggregated wealth, or the international flow of "hot money," as well as increasing the total number of speculators. An increase in aggregated wealth has an influence on the number of speculators needed to force the government to abandon the peg. Hence, an increase of aggregated wealth decreases the critical mass $a(\theta)$. This is the case because the government's decision to either abandon or maintain the currency peg is based on the absolute level of short sales. If each speculator owns more wealth, fewer speculators are needed to achieve the same number of short sales. This is illustrated in Figure 7 by a downward shift of the $a(\theta)$ function. The downward shift of $a(\theta)$ leads to an increase of θ^*, which increases the range of fundamentals in which the government could abandon the currency peg. Therefore, under certain conditions, capital controls could be useful[17].

The most important implication refers to information structure. Especially in turbulent times, Morris and Shin (1998) suggest an important role for public announcements and transparency to the public. Such a public announcement should restore faith in the fundamentals and reduce the risk of speculators attacking the currency.

The problem is to incorporate the public announcement into the Morris and Shin (1998) model. Since there is no space for a simple public signal, public information would have to be incorporated into the private signal x. Yet this could be challenging. Other models, such as the later Morris and Shin (1999b) and the Metz (2002) model, work with public and private signals. Further-

[17] Whether capital controls are useful or not depends strongly on the level of noise in the private information and on transparency. More information can be found in Morris and Shin (1998, p. 596).

more, whether transparency always leads to a reduced currency crisis is investigated with the Metz (2002) model.

The next chapter comprises a review of the Morris and Shin (1998) model, and a comparison with the Obstfeld (1996) model.

5. Critical Review of the Morris and Shin Model

The Morris and Shin (1998) model presented in Chapter 4 generated several new insights into currency crises by introducing the concept of private noisy signals. Their model inspired several researchers to develop new models, increasing knowledge of currency crises. In order to fully understand the novelty of Morris and Shin's (1998) model, below it is compared with Obstfeld's (1996) model. Thereafter, critical thoughts and comments of other researchers on the Morris and Shin (1998) model are presented. Finally, the Morris and Shin (1999b) model is briefly investigated.

5.1. Comparison of Obstfeld (1996) and Morris and Shin (1998)

The main difference between the models lies, as mentioned above, in their information structure. In Obstfeld's (1996) model, public information about the state of the fundamentals is available. This public information is considered transparent and available to everyone, and hence is common knowledge, which leads to multiple equilibria. In Morris and Shin's (1998) model, information for speculators is based on private noisy signals about the state of the fundamentals. That is, the information is not transparent. With imperfect information the global game always produces a unique equilibrium. Furthermore, by referring only to private noisy information, Morris and Shin (1998) reduce the number of classifications of fundamentals. In the Obstfeld (1996) model, which includes common knowledge, there exist three different types of outcomes of a game, a tripartite classification; whereas in the Morris and Shin (1998) model, there exists only a two-part classification of the fundamentals. If the fundamentals are below or equal to θ^*, the currency will collapse; if the fundamentals are above θ^*, the currency will hold.

Furthermore, the perfectly homogenous information of the Obstfeld (1996) model leads to reasonable outcomes: either attacking or refraining from doing so. The heterogeneous imperfect information of the Morris and Shin (1998) model leads to unreasonable behavior. As can be seen in Figure 7, the number of speculators attacking linearly decreases with improving fundamentals. Even after the turning point of θ^*, there are still some speculators who attack the currency even though the endeavor is hopeless.

The final difference lies with the fundamentals and the manner of thinking about them. In the Morris and Shin (1998) model, the state of the fundamentals is drawn from nature. Furthermore, the state of the fundamentals determines the interval in which the private signals are spread. Therefore, the state of the fundamentals determines the maintenance or collapse of the currency, because speculators base their decision of whether or not to attack on the private signal (Mutgeert, 2013). This view of fundamentals, in which the state of the fundamentals is intrinsic to whether or not an attack will be successful or not, is shared by Morris and Shin (1998), Obstfeld (1996) and the first-generation models. The difference with regard to the Obstfeld (1996) model is that it assumes a market mood, which can lead to speculative attacks.

As can be appreciated, information structure is crucial to the outcome of the model. Comparing the models reveals that they both capture some parts of the reality. Morris and Shin's (1998) model captures the fact that agents decode the information individually and derive their own perception. Obstfeld's (1996) model mirrors the real world by reflecting public information from state authorities, the media, and experts. This led Morris and Shin to incorporate the new thoughts presented in Chapter 5.3.

5.2 Review of Morris and Shin (1998)

Morris and Shin's (1998) model has been influential in several subdisciplines of economics that involve speculation. The model has been in the focus of attention for many researchers who have pointed out several deficiencies. Following Mutgeert (2013), some of these thoughts are presented below.

The Morris and Shin (1998) model is merely a one-period game that does not incorporate the ability of agents to learn. Speculators are only allowed to decide once, and simultaneously. Dasgupta (2000) and Corsetti et al. (2004) therefore incorporate strategic interaction in their models.

Dasgupta (2000) introduces a multi-agent sequential choice model in which speculators who decide later show herd behavior, following the speculators who decided earlier. Corsetti et al. (2004) investigate the impact large investors have on the behavior of a group of small investors. In their work, the group of small investors take action after the large investor, which allows them to observe the behavior of the latter. Their results show that, depending on the noise in the private signal, the large investor is able to influence the group of small investors. This is in line with Jeanne (2000) who highlights the danger of big players manipulating other players by means of their actions.

Another deficit of the Morris and Shin (1998) model is that it does not properly reflect the defense opportunities of the government. In their model, the government is not able to influence the decision making of the speculators. Daniëls, Jager, and Klaassen (2011) allow the government to threaten speculators with an increase in interest rates. By introducing this threat, the incentive for the government to defend the currency attack increases. With an increase in the interest rate, the government will be willing to use more capital to defend the currency and recapitalize itself. According to Daniëls et al. (2011), this option makes speculation riskier and leads to less speculation if the fundamentals are strong.

The final criticism presented here is that Morris and Shin's (1998) model does not allow for fluctuations in the fixed exchange rate. As Cukierman, Goldstein, and Spiegel (2004) indicate, the type of exchange-rate regime that is in place also has an impact on the occurrence of currency crises.

These critical thoughts demonstrate that in every model there are opportunities for improvement. Even Morris and Shin acknowledge the shortcomings of their model on several points. With this in mind, in their later models they incorporated different insights, as presented below.

5.3 The Morris and Shin Extensions (1999b, 2000)

The information structure of the Morris and Shin (1998) model, with merely one private noisy signal, does not appear to capture the diversity of information available to market participants. In reality, market participants do not obtain their information from only one state authority, such as the central bank. In fact, they receive the information from many different sources besides state authorities, such as "news wire services, in-house research, leaks from official sources, as well as

the press and broadcaster" (Morris & Shin, 1999a, p. 232). This being the case, uniformity of information should not be expected (Mutgeert, 2013).

In order to take the diverse nature of information into account, Morris and Shin (1999b, 2000) modified their 1998 model, allowing for public as well as private noisy information. Public information is transmitted by state authorities such as the central bank, the government or other policy makers. In the most cases, public information is considered common knowledge, although the degree of noise present means that in specific situations the public signal is not common knowledge. On the other hand, there is private information, which each speculator receives individually and which is not observable to other speculators. Private information can be obtained from sources other than state authorities, such as from the media or experts. By allowing for both a private and a public noisy signal, Morris and Shin (1999b, 2000) expose their model to a more diverse information structure. Therefore, insights from Obstfeld (1996) and Morris and Shin (1998) can be combined and the analysis is again open to self-fulfilling aspects.

Although the Morris and Shin (1999b) model was designed to analyze debt pricing, it has been modified and used by several researchers to explain currency crises. One of these is Metz (2002), whose model is the focus of the next chapter.

6 Metz (2002): Private and Public Information in Self-fulfilling Currency Crises

As stated in the previous chapter, the Metz (2002) model draws on the Morris and Shin (1999b, 2000) models. The basic model of Metz (2002) could be referred to as simple; however, by incorporating noisy private information as well as noisy public information, the information structure is far more complex than in the Morris and Shin (1998) model described in Chapter 4. In order to provide noisy information, two new variables that measure the precision of information are introduced. With the implementation of the two precision variables, one for the private and one for the public signal, the analysis becomes more detailed and complex, and a minor change in the precision of a signal results in various changes to strategy curves and the outcome of the game. The goal of the research is to analyze the implications of information dissemination on

currency crises in a second-generation model with self-fulfilling expectations. In order not to go astray, the presentation of the model focuses on the main messages, bearing in mind that the next step of the thesis is to incorporate cultural insights. In addition, the thesis avoids repeating general definitions that have already been explained in the chapter on Morris and Shin's (1998) model.

6.1 The Model

The Metz (2002) model considers a small open economy with two rational players, both of whom base their decisions on cost-benefit analyzes. The state of the fundamentals is again characterized by the value θ, with a high value for θ indicating sound fundamentals, and a low value poor fundamentals. The first player is the central bank, the state authority transmitting the public information, which has pegged the exchange rate of the country at a certain parity. The second player is a continuum of risk-neutral speculators in the foreign-exchange market, indicated by the interval [0,1]. Each speculator possesses one unit of the currency. The speculator can either short-sell his or her unit, that is, attack the currency, or refrain from attacking. If the currency attack is successful, the speculator receives a fixed payoff D, $D > 0$.[18] Each transaction on the market is associated with a transaction cost t, $t > 0$, reducing the payoff D. The transaction cost t, unlike in the Morris and Shin (1998) model, incorporates the normal transaction cost as well as the interest rate differential in the countries involved. In order to allow for attacks on the currency, the transaction cost is kept low, $t < D$. Therefore, the outcome for a speculator attacking the currency is either D - t, if the attack is successful, or -t if the attack is unsuccessful. The payoff for a speculator who does not attack is 0. Furthermore, the proportion of attacking speculators is denoted by l.

On the other side is the central bank. The Metz (2002) model does not incorporate welfare considerations for the central bank, so the central bank will defend the currency peg as long as its international reserves are above a certain critical level. This critical level depends on the central bank's evaluation of the fundamental state of the economy θ. Hence, if the fundamentals are sound, the central bank would be willing to defend the currency peg even if it requires the use of large amounts of international reserves. If, however, the state of the fundamentals is poor, the central bank will abandon the currency peg relatively quickly. Furthermore, in accordance with

[18] Metz (2002) assumes a fixed payoff D for reasons of simplicity. The actual payoff for a successful attack is still the difference between the fixed exchange rate and the decrease in fundamentals.

other second-generation currency-crisis models, it is assumed that the cost of defending the currency peg increases with an increase in the proportion of speculators attacking l, and decreases with increases in θ. The Metz (2002) model simplifies the scenario and asserts that the currency peg will be defended if $l < \theta$ and abandoned if $l \geq \theta$.

The structure of the game between the continuum of speculators and the central bank is described in what follows. Nature randomly selects the state of the economic fundamentals θ according to a uniform distribution over the real line, which is in agreement with Hartigan (1983). The central bank can observe the true value of θ directly, whereas the speculators cannot. Having done so, the central bank transmits the public signal y. This comprises the economic fundamental θ and a noise parameter v, denoted as $y = \theta + v$. Furthermore, the noise parameter is distributed normally with a mean of zero and a variance of $\frac{1}{\alpha}$, which leads to the notation $v \sim N(0, \frac{1}{\alpha})$, with $E(v\theta) = 0$ so that the noise parameter is independent of the true economic fundamental. The lower the variance $\frac{1}{\alpha}$, or the higher the value of α, the more precise the public signal y will be. The variable α is hence considered the precision of the public information. The variance $\frac{1}{\alpha}$ represents the monetary policy measurements of the central bank. That is, $\frac{1}{\alpha}$ explains, for instance, the prohibiting or publishing of statistical data, and the tolerance for faulty or preliminary statistics published by the central bank. In a more general manner, a high value of $\frac{1}{\alpha}$ represents a risky policy measurement, whereas a low value of $\frac{1}{\alpha}$ ensures that the signal y is close to the true fundamental θ. The central bank is able to choose the precision *before* it knows what θ is. Thereafter, the variance stays constant. Metz (2002) argues that this is plausible because the central bank's communication policy reflects institutions, which, in accordance to Williamson (2000), cannot be changed easily or quickly. Furthermore, the central bank has to inform speculators about the chosen policy measurements. Hence, the speculators will obtain the value of α and thereby know if the central bank has chosen a risky or a safe strategy. After the transmission of the signal y, the information becomes common knowledge to all market participants.

In addition to the common public signal y, each speculator i individually receives a noisy private signal x_i, which represents the unknown state of the economic fundamentals. The private signal x_i is noted as $x_i = \theta + \varepsilon_i$, with $\varepsilon_i \sim N(0, \frac{1}{\beta})$, $\beta > 0$. In accordance with the public signal, the noise

value of the private signal is to be normally distributed with a mean of zero and a precision of β. Furthermore, the noise parameters ε_i of the private signal are supposed to be independent of each other and of the state of fundamentals. Hence, $E(\varepsilon_i \varepsilon_j) = 0$ for $i \neq j$ and $E(\varepsilon_i \theta) = 0$. Following the assumptions of the public signal, the noise parameters of the private signal are also common knowledge to all speculators. However, as long as the precision β of the private signal is finite, private signals can differ from each other and therefore speculators cannot know the signal received by other speculators. Consequently, the information set of each speculator i is based on the public signal and the private signal, and can be written as $I_i = (y, x_i)$. Based upon the information set I_i, all speculators simultaneously have to decide whether or not to attack the currency. The central bank, on the other hand, then observes the proportion of speculators attacking the peg l and thereafter decides whether or not to abandon the peg.

In order to derive the unique equilibrium, it is important to understand the common knowledge parts of the game. These are as follows: payoff D, cost t, the public signal y, and the precision parameters α and β. The true state of the fundamental θ could become common knowledge too. If the public signal becomes infinitely precise, $\alpha \rightarrow \infty$, the variance would become so small that the public signal y transmits only the true state of fundamentals. If the fundamental value θ becomes common knowledge, the outcome of the game would be the same as in the Obstfeld (1996) model with complete information, which leads to the tripartition of fundamentals and multiple equilibria. In contrast, the precision of the private signal does not lead to multiple equilibria, even if $\beta \rightarrow \infty$. The reason for this is that even if the private signal is precise, the true state of the fundamentals remains unknown. Therefore, the outcome of the model and whether it leads to a unique or to multiple equilibria depends on the structure and precision of the information.

For further analysis, the model is assumed to work with finite values for α and β in order to prevent θ becoming common knowledge.

6.2 Incomplete Information and the Unique Equilibrium

In order to investigate the unique equilibrium of the game, certain conditions have to be met. In accordance with Morris and Shin (1999b, 2000) the following is assumed:

"If private information is sufficiently precise relative to public information, i.e. $\beta > \frac{\alpha^2}{2\pi}$, there exists a unique equilibrium. It consists of a unique value of the fundamental index θ*, up to which the central bank always abandons the peg, and a unique value of the signal x*, such that every speculator who receives a signal lower than x* attacks the currency peg." (Metz, 2012, p. 89)

The logic behind these assumptions is similar to that of the Morris and Shin (1998) model. There exists a unique value θ = θ* which represents the point at which the central bank is indifferent to either maintaining and abandoning the peg, due to the assumption that the central bank abandons the peg if θ < θ*; and a unique value x = x* at which the speculators are indifferent to either attacking or not attacking. Hence, if all speculators with a lower value than x* decide to attack, this would lead to the outcome l = θ* and consequently to the central bank abandoning the currency.

In order to derive the equilibrium under the assumption, $\beta > \frac{\alpha^2}{2\pi}$, the values of θ* and x* have to be obtained. As a result of the noise parameters being naturally distributed, the conditional distribution of θ has to be normally distributed in the private and public information too. Therefore, the expected value of the unknown fundamental value of the economy conditional on player 's information is given as:

$$E(\theta|I_i) = \frac{\alpha}{\alpha+\beta} y + \frac{\beta}{\alpha+\beta} x_i = \theta^e(x_i)$$

with variance:

$$Var(\theta|I_i) = \frac{1}{\alpha+\beta}.$$

The posterior expectation $\theta^e(x_i)$ is the weighted average of the information speculator i receives. If the precision of the public information α increases, the public signal y becomes more important. On the other hand, if the precision of the private signal β increases, the private signal x_i becomes more important. Following, the indifference curve of the speculators is presented. To

this end, the public signal y is removed from the analysis – since it is common knowledge to all participants, it is not responsible for varying behavior of speculators.

The speculator has two options: either attack the currency or refrain from doing so. The speculator decides by a simple cost-benefit analysis whether the value of not attacking is greater than an uncertain payoff and the transaction cost. The case in which the speculator is indifferent to both options is represented as follows:

$$0 = D * Prob(attack\ successful|x) - t$$

Whether an attack is successful depends on the action of the central bank. The central bank will abandon the peg if the fundamentals are below or equal to θ*. This changes the equation above, with Φ denoting the cumulated normal density, to:

$$t = D * Prob(\theta \leq \theta^*|x)$$

$$t = D * \Phi(\frac{\theta^* - E(\theta|x)}{\sqrt{Var(\theta|x}})$$

$$t = D * \Phi(\sqrt{\alpha + \beta}\left(\theta^* - \frac{\alpha}{\alpha + \beta}y - \frac{\beta}{\alpha + \beta}x\right))$$

With the scenario in which the speculator is indifferent to each of the option having been derived, the options of the central bank have to be modeled. The central bank is indifferent to either abandoning or defending the peg if the proportion of attacking speculators l equals θ. This proportion is given for all speculators who receive a private signal smaller or equal to x*[19]. Therefore, the situation in which the central bank is indifferent can be described as follows:

$$l = Prob\ (x \leq x^*|\theta)$$

$$l = \Phi(\frac{x^* - E(\theta|x)}{\sqrt{Var(\theta|x)}})$$

$$l = \Phi(\sqrt{\beta}(x^* - \theta))$$

[19] Since ε is assumed to be independent of θ, the probability that one speculator observes the value x* corresponds to the proportion of speculators receiving a value of x*.

With the equations above, the indifference curves for the speculators, $x^{SP}(\theta)$, and the central bank, $x^{CB}(\theta)$, can be modeled:

$$x^{SB}(\theta) = \frac{\alpha+\beta}{\beta}\theta - \frac{\alpha}{\beta}y - \frac{\sqrt{\alpha+\beta}}{\beta}\Phi^{-1}(\frac{t}{D})$$

$$x^{CB}(\theta) = \frac{1}{\sqrt{\beta}}\Phi^{-1}(\theta) + \theta$$

The unique equilibrium can then be determined as the intersection point of the indifference curves. The equilibrium value of θ is determined as function of the payoff and cost parameters D and t, of the precision variables α and β, and of the public signal's value y, as is observable below:

$$\theta^* = \Phi(\frac{\alpha}{\sqrt{\beta}}\left(\theta^* - y - \frac{\sqrt{\alpha+\beta}}{\alpha}\Phi^{-1}\left(\frac{t}{D}\right)\right))$$

while x* can be obtained from equation $x^{SB}(\theta)$. Figure 8 illustrates the unique equilibrium.

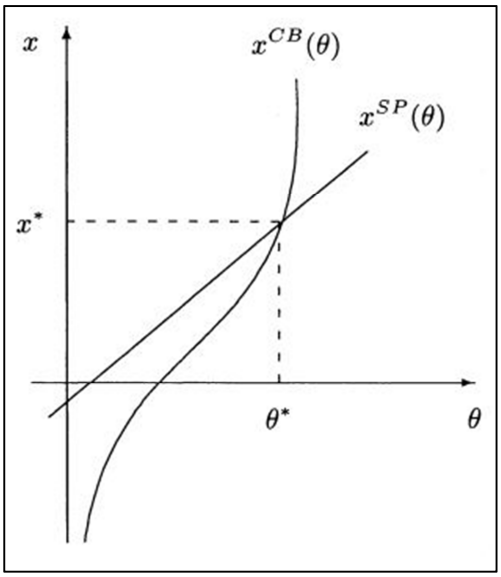

Figure 8: "Determination of the unique equilibrium" (Metz, 2002, p. 74)

From Figure 8, we can observe that the trigger point, in which the players switch their actions, is (θ*, x*). All speculators receiving a signal below x* will choose to attack as a dominant strategy, while all speculators receiving a signal above x* will not attack. The central bank reacts in a similar manner. If the state of the fundamentals is lower than θ*, it will abandon the currency peg; while if the state of the fundamentals is above θ*, it will defend the peg[20].

The uniqueness of the equilibrium illustrated in Figure 8 depends strongly on the assumption that $\beta > \frac{\alpha^2}{2\pi}$. This is the case if one indifference curve runs more steeply than the other throughout the entire range of possible values. If the assumption cannot be held, the outcome shown in Figure 9 occurs.

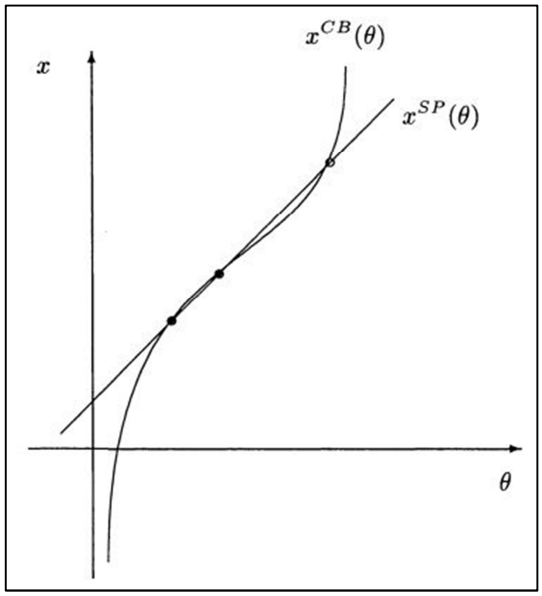

Figure 9: "Multiple equilibria" (Metz, 2012, p. 94)

As can be observed in Figure 9, if the assumption $\beta > \frac{\alpha^2}{2\pi}$ is not met, the game will have multiple, in this case three, equilibria as the outcome. That is, a unique equilibrium can only be sustained if private information is precise in relation to public information. Hence, a decline in β or an in-

[20] As Metz (2002) notes, it is important to understand that the values x* and θ* are derived from the common knowledge of all players. Hence, the equilibrium can be determined before the agents receive their information. For further insights, see Metz (2002, p. 73).

crease in α may lead to multiple equilibria. The relation $\beta > \frac{\alpha^2}{2\pi}$ and the outcome of the number of equilibria are presented in Figure 10.

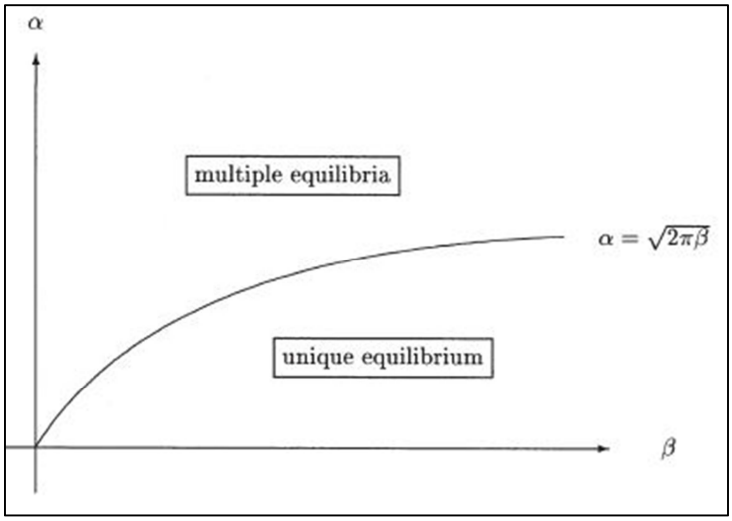

Figure 10: "Regions of unique and multiple equilibria" (Metz, 2002, p. 82)

As can be observed in Figure 10, if β declines and α stays constant, speculators are less able to coordinate their actions based on the precision of β. Therefore, multiple equilibria are likely to occur. In the extreme case of β approaching zero, the private information falls short and the outcome of the game would be determined solely by the public signal, as in the Obstfeld (1996) model. On the other hand, a decline in the precision of α draws more focus to the private signal, which makes a unique equilibrium more likely. It is the interaction of both precision variables that determine the number of equilibria and therefore the outcome of the game.

6.3 Comparative Statistics

The Metz (2002) model describes the influence and the alterations each variable causes, with respect to the likelihood of a currency crisis in the case of a unique equilibrium. The first effect is that an increase in transaction cost t reduces the probability of a currency crisis. This is in line with Morris and Shin (1998). Since transaction costs have a direct effect on the payoff, increasing transaction costs reduces the payoff and therefore the probability of a currency crisis. Consequently, an increase of the payoff D leads to an increase of the probability of a currency crisis.

The second proposition proved is that the public signal y negatively influences the probability of a currency crisis. The reason for this is that a higher value of the public signal y corresponds with a higher commonly expected economic state of the fundamentals. The higher the expected economic state is, the lower the turning point θ* will be, resulting in a reduction of fundamentals for which an attack is successful. The opposite, that a decrease in the value of the public signal y leads to an increase in the probability of a currency crisis, also holds.

The next proposition proved concerns the precision of β. Due to the great degree of complexity, the analysis that follows will be kept as simple as possible in order to aid understanding. The degree of precision of the variable β influences the equilibrium in three ways. The first is its direct effect on the private signal x. An increasing β leads to a higher density of private signals around the mean. The second effect concerns the variance of the fundamental index: $Var(\theta|I_i) = \frac{1}{\alpha+\beta}$; and the last refers to the posterior of the state of the fundamentals given by each speculators information: $E(\theta|I_i) = \frac{\alpha}{\alpha+\beta}y + \frac{\beta}{\alpha+\beta}x_i = \theta^e(x_i)$[21]. The three effects can be analyzed only by referring to the net effect. Therefore, the effect a change in the precision value of β has on the probability of a currency crisis depends on the turning point θ* and whether it is above or below the threshold function: $y + \frac{1}{\sqrt{\alpha+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)$. If the turning point is larger than the threshold, θ* > $y + \frac{1}{\sqrt{\alpha+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)$, the rising precision of the private signal decreases the probability of a currency crisis. On the other hand, if the turning point is smaller than the threshold function, θ* < $y + \frac{1}{\sqrt{\alpha+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)$, an increase in the precision of the private signal increases the probability of a currency crisis[22]. In order to understand the influence of β, it is essential to investigate the speculators' decision processes. Speculators desire to base their action on the realized but unobservable state of the fundamentals. Furthermore, speculators know that for a given set of fundamentals, it is possible to force devaluation by pressure alone. In order to pressurize the central bank, they have to coordinate their actions. If they were able to do so, they could bring the currency peg down, even with sound fundamentals. The private signal x, and consequently β, is the information that has a direct effect on the coordination ability of the speculators. In order to achieve

[21] The interplay of equations and the consequences it has for the equilibrium are complex. In addition to altering equations for the first and second effect, it plays a role if the state of the fundamentals is below or above the turning point θ*. For further information, see Metz (2012, pp. 98-100).
[22] For the mathematical reasoning, see Metz (2002, p. 78) and Metz (2012, p. 100).

similar actions, the information set has to be the same. The more precise the information in the private signal x is, the more narrow the information will be distributed and will therefore lead to more similar information. The speculator who receives a highly precise private signal will feel more confident because he or she can expect other agents to receive similar information. In addition to the direct effect of the signal x, both public and private information sets have an indirect effect on the coordination process. The higher the precision of one signal is, the weightier it will become in deriving the expected value of the unknown fundamental index $E(\theta|I_i)$.

The effects of precision on the probability of a currency crisis become quite clear. The more precise the private signal is, the less weight the information of the public signal will attain. In case of sound fundamentals, in which $\theta^* < y + \frac{1}{\sqrt{\alpha+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)$, and an average precision of the private signal, speculators would shy away from attacking because the obstacles are too high. However, if in contrast the precision of β is very high, speculators will ignore public information and focus on private information. Hence, speculators would even be willing to attack if the state of the fundamentals were high, so that the risk of a currency crisis increases. In case of poor fundamentals and a low public signal, the reverse holds true. Here, speculators neglect the public information, which leads to a lower probability of attack.

The final proposition proved deals with the precision of the value α. In a manner similar to the precision of β, the value α also influences the equilibrium in three ways. The second and third effects are the same as in the previous case. The first effect differs and leads to a different threshold function: $y + \frac{1}{2\sqrt{\alpha+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)$[23]. Therefore, if the turning point is larger than the threshold, $\theta^* > y + \frac{1}{2\sqrt{\alpha+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)$, an increase in the precision of α leads to a higher probability of a currency crisis. On the other hand, if f, the turning point, is smaller than the threshold, $\theta^* < y + \frac{1}{2\sqrt{\alpha+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)$, an increase in the precision of the public signal leads to a decrease of the probability of a currency crisis. That is, the effect is the opposite of the β case. The public signal is common knowledge for all speculators and so does not have a direct coordination function such as private signal x does. As a result, the explanation is similar to the second proposition regarding

[23] For an in-depth explanation how the first effect differs from the β analysis, see Metz (2002, p. 80).

a stronger public signal. If the state of the economy is sound, $\theta^* < y + \frac{1}{2\sqrt{\alpha+\beta}} \Phi^{-1}\left(\frac{t}{D}\right)$, an increase in the precision of α, leads to a decrease of the probability. A highly precise public signal and a sound state of the fundamentals indicate to speculators that a large number of attackers is needed. Due to the indirect effect of a precise public signal α, speculators will grant more weight to the public signal, reducing their ability to coordinate. The opposite true holds for poor fundamentals.

To summarize the effects of α and β: if the fundamentals are in a poor state, the probability of a currency crisis increases with increased precision of the public information and with lower precision of the private signal. In case of sound economic fundamentals, the risk of a currency crisis increases with increased precision of the private information and lower precision of the public signal.

6.4 Outcome

In contrast to the multiple equilibria model of Obstfeld (1996), the Metz (2002) model generates clear policy advice. First, the transaction cost, similar to Morris and Shin (1998), reduces the probability of a currency crisis. Second, the stronger the commonly expected value of the economic fundamentals, the less likely a currency crisis becomes; and third, merely increasing the precision of information does not always lead to safer outcomes. In fact, the model generates situations which oppose the view that a central bank should always be highly transparent in order to prevent a currency crisis. Furthermore, Metz (2002) states that in order to provide thorough advice to the central bank on how to be behave, the exogenous conditions which influence the precision of parameters α and β must be discovered.

This thesis would like to continue her thought and make the criticism that, on the topic of currency crises, the majority of economic research often focuses on information and the information structure about the state of the economic fundamentals and neglects other aspects that might play a role. Metz (2002) mentioned in her model that the policy measurement of the central bank, which is crucial to the precision of the public signal, is shaped by institutions. As presented in Chapter 3, institutions are shaped by the country's culture. Therefore, this thesis argues that culture, in particular uncertainty avoidance, can be an explanatory factor. Consequently, the following chapter of this thesis incorporates the insights gained in Chapter into the Metz model. There-

after, the thesis attempts to predict the outcome for uncertainty avoiding and uncertainty accepting countries.

7 Cultural Effects in the Metz (2002) Model

This chapter introduces one possibility for incorporating a cultural perspective, as outlined in Chapter 3, into research on currency crises. The model of Metz (2002), presented in the previous chapter, is used. This model, with its differentiation between private and public information and the comparative statistics generated from it allow a closer investigation of the effect of culture. Maintaining the focus on uncertainty avoidance as a concept of culture, the Metz (2002) model allows for a diverse view of countries that are rather uncertainty avoiding and countries that are more accepting of uncertainty. Cultures that are fairly uncertainty avoiding will try to avoid ambiguous situations such as currency crises. Therefore, this cultural dimension is of importance when investigating currency crises, especially if, as argued in Chapter 3, the degree of a country's uncertainty avoidance has an effect on the occurrence of currency crises by means of the institutional channel and the behavioral channel. These channels affect information structure, as mentioned in Chapter 3.6. They influence the encoding and transmission of information by state authorities, media and experts, on the one hand, and on the other, influence the manner in which agents perceive and interpret information and by which criteria they choose their actions, the actions will be determined by their mental models, and thus by cultural norms (DiMaggio, 1994). As mentioned throughout the thesis, information structure and changes in the precision of information are crucial to currency crises and their outcomes. Referring to the Metz (2002) model, culture, especially uncertainty avoidance, could have an influence on the precision of transmitted private and public information.

7.1 Cultural Influences on Public Information

In the Metz (2002) model, public information is transmitted by the central bank. As she attests in her introduction, the "the central bank´s communication policy involves institutions that cannot be altered easily and quickly" (Metz, 2002, p. 67). This assertion is in agreement with Chapter 3, and with the idea that more embedded institutions change slower. Furthermore, Metz (2002)

states that the central bank can control the precision of public information in different ways. These include the economic concepts that are the basis of the statistical measurements of the central bank, whether faulty information is willingly or unwillingly produced, or whether data has been taken out of context in order to whitewash the issue. The central bank can control the amount of data by prohibiting or allowing the publication of preliminary or incomplete data.

However, Metz (2002) does not assess the reasons for the behavior of the central bank. This thesis explains the central bank's information policy by means of cultural insights and, in addition to Metz's assumptions, stresses the importance of culture and uncertainty avoidance to institutions such as the central bank. Uncertainty avoidance can influence the central bank through both channels discussed.

The institutional channel has an impact on the design of the central bank. As previously stated, uncertainty-avoiding countries shun ambiguous situations. One such situation is price instability, that is, inflation (Mutgeert, 2013). Therefore, the most important goal of a central bank is to maintain price stability. In fact, as De Jong (2002) states; the degree of uncertainty avoidance of a country can have a positive effect on the focus on price stability of the central bank. In order to maintain price stability, the central bank has to be credible and reliable (Mutgeert, 2013). Therefore, uncertainty-avoiding countries may implement strict rules and transparency laws in order to prevent the exertion of influence, especially from policy makers who, for instance, could attempt to portray the state of the fundamentals more positively. Hence, having an independent central bank is of importance for uncertainty-avoiding countries and according to Shimpalee and Breuer (2006) additionaly reduces the probability of a currency crisis. As a result, the precision of the public information is likely to be higher. This is in agreement with the insights from Chapter 3, where it was stated that uncertainty-avoiding countries tend to have stronger, more elaborate and stricter formal institutions, with the disadvantage that they are less flexible.

The second impact uncertainty avoidance has is through the behavioral channel. As with the results of Inklar and Yang (2012), which present evidence that companies in high uncertainty-avoiding countries tend to delay their investment decisions until the future becomes more predictable, the members of the central bank could also act differently. De Jong and Van Esch (2013) investigated the influence of national differences in culture of two ECB board members on the ECB policy during the European sovereign debt crisis. The results indicate that even

though the central bank is independent, the behavior and actions of its board members depend on national differences (Mutgeert, 2013). Although the findings of De Jong and Van Esch (2013) were based on the cultural dimension of power distance, Mutgeert (2013) extends this and assumes that uncertainty avoidance plays a role as well. Mutgeert (2013) states that uncertainty-avoiding policy makers could be more rule-orientated and shy away from the manipulation of information. Accordingly, Mutgeert (2013) suggests that the central banks of fairly uncertainty-avoiding countries behave in a more rule-orientated and cautious manner and in this manner transmit more precise information. The opposite holds for uncertainty-accepting countries. Therefore, the impact of the behavioral channel is similar to that of the institutional channel. A higher degree of uncertainty avoidance increases the precision of the public signal through both channels.

Culture and its dimension of uncertainty avoidance are therefore one explanation for the design of a central bank and its communication policy. However, public information is not the only signal the speculators receive. Because public information is considered common knowledge in the Metz (2002) model, a stronger emphasis might be brought to bear on the private signal.

7.2 Cultural Influences on Private Information

In the Metz (2002) model, private information is information that is not common knowledge and is therefore of special interest. In order to understand the influence culture could have on private information, it is important to refer to Cheli and Della Posta (2007). Their research concerns the bias of private information. These results are useful for investigating the precision of private information, since every deviation from the true state of fundamentals, or bias, has an effect on precision.

Unlike the public signal, the private signal is not transmitted by state authorities. Instead, the private signal is published by other communication channels, such as by experts, the media, or by word of mouth. According to Cheli and Della Posta (2007), agents who receive information from these sources are likely to encounter a bias, which in general leads to a decrease of precision. Reasons for the bias can be diverse. The most important and unnoticed actor in this regard is the media. While the media can pressurize politicians with critical reports and force them to act according to its logic (mediatization, mentioned in Chapter 3.6), the opposite can be true too. In

countries where the press is restricted, policy makers have an extraordinary influence over what is broadcast. Even in liberal democracies, news is sometimes restricted, for instance, in order to maintain public safety. Furthermore, large companies may lobby and sponsor news in order to gain benefits. Selected experts who are invited by the media to clarify and assess current news, or to participate in talk shows, also have an influence. In addition, the rather new phenomenon of fake news may be of importance too. All these exemplary factors can influence the media and the information transmitted, leading to bias or loss of precision.

In addition to influences on the media, the producers and the audience of news require consideration. Producers of news likely come from a certain cultural background and could judge certain situations in different ways, either more optimistically or more pessimistically. Moreover, the media has to finance itself. The media has to publish the news in a manner that it appeals to the audience. In this context, the culture of a country, especially the aspect of uncertainty avoidance, could play a substantial role.

As a result, in uncertainty-avoiding countries, which shun ambiguous situations, the media and experts could interpret the economic situation in a more skeptical manner. Furthermore, because uncertainty-avoiding countries are more fearful of the ambiguous consequences of negative aspects of the economy, the media and experts may focus to a greater extent on the negative side of information provided by state authorities, such as the central bank, and disregard the positive aspects of the economy (Mutgeert, 2013). Speculators then receive this biased information and do not comprehend the entire picture (Mutgeert, 2013). The contrary could be the case in uncertainty-accepting countries. These countries do not try to prevent every ambiguous situation and therefore the media might judge the economic situation in a more balanced manner. Stated differently, the media might report on the negative aspects of the economy but could do so in a positive, optimistic way, focusing on the opportunities that arise, which leads to a more balanced perspective.

Besides the effect stated above, uncertainty avoidance may have another effect. Uncertainty-avoiding countries that shun ambiguous situations might try to gather more information. The anxiety that the uncertain situation causes may motivate speculators to gather more information. Since the Metz (2002) model includes only one official source of information, speculators will gather more information from the media and experts. The gathering of information due to anxiety may lead to greater bias and therefore to a loss of precision in the private signal. On the other

hand, the uncertainty-accepting countries do not withdraw from ambiguous situations. As stated in Chapter 3.3, the financial system of uncertainty-accepting countries tends to be a rather market-based than a bank-based one. Therefore, speculators in uncertainty-accepting countries may be more experienced in the evaluation of information from private sources, which could lead to an increase in the precision of the private information.

Finally, it is important to consider who the speculators are. For private and small speculators, the aspects identified above might be true but certainly not for large speculators[24]. Large speculators, perhaps international companies, tend to have their own experts and research departments creating their own information. Furthermore, in the rational professional decision-making process in a large company, cultural influences could be minimized. Nevertheless, these large speculators may take the country's cultural traits, especially uncertainty avoidance, into account when attempting to estimate the behavior of other speculators, and in order to derive their own strategy. Exemplary Chapter 7.4 will model a market sentiment for uncertainty-avoiding and uncertainty-accepting countries countries, which can be used as a possible reference for strategic business decisions, additionally it mentions failures of this strategy. A large speculator with proprietary information may have an incentive to act and to influence the other speculators, for instance by using the media. By manipulating the media, for instance by lobbying or financing, a large speculator could produce market sentiment which is favorable for him and finally provoke a currency crisis.

In summary, private information tends in general to be biased. Furthermore, in this thesis it is assumed that bias in fairly uncertainty-avoiding countries is greater, which leads to a decrease in the precision of the private signal. In comparison, due to more balanced news coverage and experience in the evaluation of private information, the opposite holds true in uncertainty-accepting countries.

[24] Note that the model of Metz (2002) assumes speculators of the same size, all of whom have only one unit of currency.

7.3 Uncertainty-avoiding and uncertainty-accepting Countries in the Metz (2002) Model

In order to incorporate the insights from Chapter 7.1 and Chapter 7.2 into the Metz (2002) model, a new variable c has to be defined. The variable c represents cultural effects on the precision of information. The variable can either increase or decrease the precision.

In chapter 7.1 of this thesis, it was assumed that more elaborate, rule-orientated institutions, and the cautious behavior of central bank board members leads to an increase of the precision of public information in uncertainty-avoiding countries. Consequently, in these countries the variance in public information transforms into $\frac{1}{\alpha+c}$. By increasing the denominator, the variance decreases, leading to a more precise public signal y. On the other hand, insights from Chapter 7.2 lead to a decrease of private information in uncertainty-avoiding countries. Therefore, the variance of private information transforms into $\frac{1}{\beta-c}$, which indicates a reduction of precision. In order to use the comparative statistics of the Metz (2002) model, the conditional requirement of a unique equilibrium has to hold. Therefore, $(\beta - c) > \frac{(\alpha+c)^2}{2\pi}$ has to be true. If this condition holds, the comparative statistics from the Metz (2002) model suggests that in fairly uncertainty-avoiding countries, the information structure leads to a reduced probability of a currency crisis where the fundamental state of the economy is sound, whereas where it is poor it leads to an increased probability of a currency crisis. If the condition does not hold, the outcome of the game would be a self-fulfilling multi-equilibria model, as in Obstfeld (1996).

The opposite holds true for uncertainty-accepting countries. In these countries, the insights from Chapter 7.1 lead to relatively reduced precision of the public signal, changing the variance of the public signal into $\frac{1}{\alpha-c}$. More balanced news coverage and experience in evaluating private information, as mentioned in chapter 7.2, lead to a rather precise private signal in comparison to uncertainty avoiding countries. Therefore, the variance of the private signal increases to $\frac{1}{\beta+c}$. Since, in this case, β increases, the condition for a unique equilibrium should be met. Hence, the comparative statistics from the Metz (2002) model suggests that in fairly uncertainty-accepting countries, the information structure leads to an increased probability of a currency crisis where the

fundamental state of the economy sound, whereas where it is poor it leads to a reduced probability of a currency crisis.

These results are an explanation of why countries react differently to currency crises, though their economic fundamentals are exactly the same. This is in line with Li and Inclan (2001), who state that the specific design of an institution might not be good for every situation.

7.4 Cultural Influence and Market Sentiment

The insights from Chapter 7.3 can be used in order to evaluate information and to derive a market sentiment σ for the different states of the fundamentals in uncertainty-avoiding and uncertainty-accepting countries. This type of analysis may also be conducted by a large or normal speculator in order to understand the market sentiment and develop a strategy. In order to derive the market sentiment σ, the probability of a currency crisis as well as insights from Chapter 3 are taken as indicators.

The market sentiment in an uncertainty-avoiding country can be modeled as presented below. Following Chapter 7.3, poor economic fundamentals lead to an increased probability of a currency crisis, while sound economic fundamentals lead to a reduced probability of a currency crisis. Hence, for poor fundamentals, a negative market sentiment can be expected, and for fairy sound economic fundamentals, a positive market sentiment can be expected. Additionally, in Chapter 3.5 it is suggested that in economically prosperous times, inflexible institutions could, in comparison to uncertainty-accepting countries, hamper economic growth and therefore again lead to a negative market sentiment. A graphical illustration is presented in Figure 11.

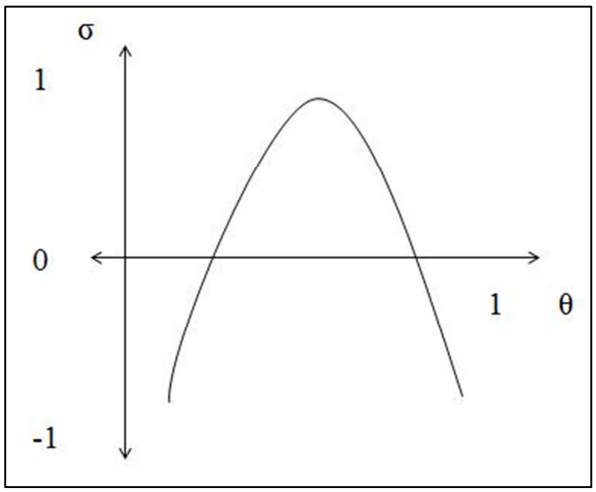

Figure 11: Modeled market sentiment of a uncertainty avoiding country

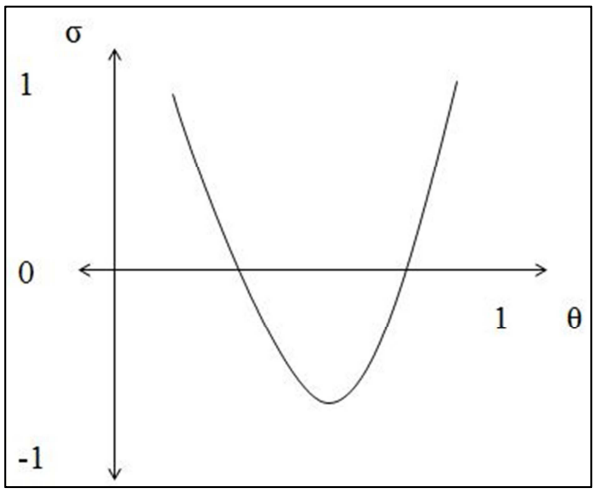

Figure 12: Modeled market sentiment of a uncertainty accepting country

The opposite holds true for uncertainty-accepting countries. As displayed in Figure 12, poor economic fundamentals are associated with good market sentiment and positive economic data with a negative market sentiment. Furthermore, in Chapter 3.5 it is suggested that in times of prosperity, the flexible institutions and market orientation of the financial system lead to more innovation and inventions. Hence, sound economic fundamentals again lead to positive market sentiment.

As a result, the cultural variable, or the degree of uncertainty avoidance, plays an important role in ascertaining the probability of a currency crisis and therefore in the expected market sentiment. Hence, speculators have to take the degree of uncertainty avoidance into account when generating their strategies. Nevertheless, if they derive their decision from analysis such as the one above, they have to be cautious. The pitfalls in these kinds of analysis are that speculators could stereotype certain cultures and therefore arrive at the wrong conclusions concerning, for instance, the country's degree of uncertainty avoidance. Evaluation of certain situations, such as the appointment of a risk-accepting board member to the central bank, could be over- or underestimated, with severe consequences. If the evaluation is over- or underestimated, it could lead to a speculative attack without an economically fundamental reason for it.

8 Conclusion

This thesis conducted an extensive literature review of currency crises and culture in economics. The historical development of currency-crisis models has been presented as have the functioning of key currency-crisis models, such as the multi-equilibria model of Obstfeld (1996), and the unique equilibrium model of Morris and Shin (1998). Furthermore, the way culture, or more precisely uncertainty avoidance, influences institutions and therefore economic outcomes and currency crises through institutional and behavioral channels has been calculated.

By incorporating cultural insights into the Metz (2002) model, presumptions made by Metz could be explained. Moreover, these insights do not detract from Metz's conclusions. Rather, they support them by making them more plausible and realistic. By incorporating a cultural dimension, which affects the precision of information, into the Metz (2002) model, differences in uncertainty-avoiding and -accepting countries could be explained. These insights clarify why countries react differently to currency crises though their economic fundamentals are exactly the same. Furthermore, on basis of the probability of a currency crisis and cultural insights, market sentiment could be predicted for uncertainty-avoiding and -accepting countries.

Uncertainty-avoiding countries tend to have a higher probability of a currency crisis if the state of the fundamentals is poor, and a lower probability of a currency crisis if the state of the fundamentals is sound. On the other hand, uncertainty-accepting countries tend to have a higher probability of a currency crisis if the state of the fundamentals is sound, and a lower probability if the state of the fundamentals is poor.

The introduction of a cultural variable, which affects the precision of information, therefore has to be taken into account by the speculators in order to derive a strategy. Incorporating a cultural dimension into a strategy can be difficult, since over- or underestimations occur easily.

9 Discussion

This chapter provides the opportunity to assert critical thoughts discovered during my master's thesis and to inspire further research. The first thought deals with uncertainty avoidance and the willingness to attack the currency in general. Currently, the willingness to attack derives from a cost-benefit analysis, which is based on the possible payoff for a speculator. A highly uncertainty-avoiding person might not take the risk and attack the currency. The outcomes are highly ambivalent, not merely as to whether the attack prevails or not, but for the entire economy. Furthermore, a currency crisis could be followed by a debt or other crisis and lead to loss of investment and bank accounts, as well as unemployment and, especially in developing countries, could pose a risk to the state as a whole. Therefore, basing a decision whether or not to attack a currency merely on a payoff equation might not reflect the entire array of thoughts of an investor.

The second thought is more technical and concerns the incorporation of uncertainty avoidance into the Metz (2002) model. The strength of the cultural variable c has to be further investigated, as does whether the condition of the unique equilibrium can be met. Furthermore, whether it should remain one cultural variable or not requires consideration. Allowing for two cultural variables, one for public information and one for the private information, may also be viable, especially when it is recalled that embedded institutions require time to transform. Society and its institutions could develop in different directions or at different rates.

The last thought concerns the media. The influence of uncertainty avoidance or culture on institutions is discussed quite frequently. Less research can be found regarding uncertainty avoidance and the media. Often uncertainty avoidance can be linked to marketing, which has an influence on the media, though only indirectly. For this reason, I recommend further research linking culture, the media and currency crises.

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