Predicting Financial Crises Lecture Notes: Chapter 9

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Why the First-Generation Currency Crisis Model Was Challenged?

This chapter introduces the second-generation currency crisis model. The first-generation model failed to explain the currency crisis episodes that occurred after 1992, which prompted the development of the second-generation model to address its shortcomings.

Figure 1 is taken from Saxena (2004) and depicts Bolivia's economic performance before and after the currency crisis. Bolivia experienced a currency crisis between 1982 and 1985. The figure shows the trajectories of key macroeconomic variables—including the government budget, money supply, balance of payments, foreign exchange reserves, nominal interest rates, and nominal exchange rates—surrounding the crisis period.

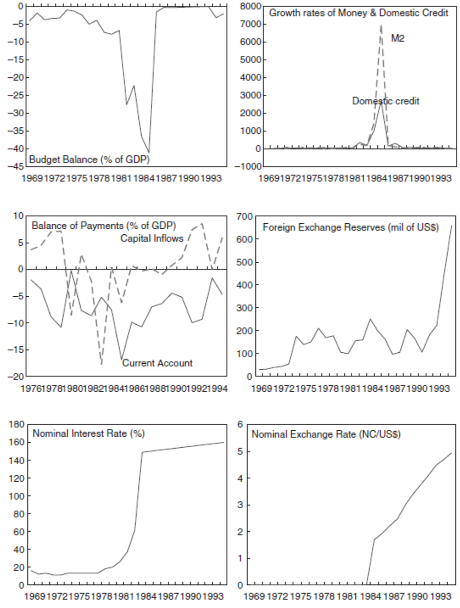
The government's fiscal position deteriorated rapidly before the crisis, with the fiscal deficit reaching as high as 40% of GDP. Domestic credit and the broad money supply (M2) also expanded quickly in the pre-crisis period. These trends in macroeconomic fundamentals signaled a severe deterioration, consistent with the predictions of the first-generation currency crisis model.

At the same time, the current account deficit worsened, reaching 15% of GDP. Capital inflows reversed sharply—from net inflows to net outflows—a phenomenon commonly referred to as a sudden stop. Nominal interest rates began rising even before the currency depreciation occurred. After the collapse of the fixed exchange rate regime, the nominal exchange rate continued to depreciate steadily.

Figure 2, also taken from Saxena (2004), illustrates France's economic performance before and after the crisis. The figure shows that, prior to the crisis, France did not suffer from a severe fiscal deficit. In 1991, the fiscal deficit was less than 2% of GDP. The deficit only widened further after the crisis had already begun.

Moreover, France's real exchange rate did not show significant appreciation in the lead-up to the crisis. However, GDP growth was sluggish before the crisis. At the same time, nominal interest rates were on an upward trend prior to the crisis, indicating that Germany's post-unification contractionary monetary policy was transmitted to other member states through the European Monetary System (EMS).

Figure 1: The performance of the Bolivian economy before and after the crisis



Crisis date: 1982-85

Figure 1. Bolivia: First Generation Model.

Source: Saxena (2004).

Figure 2: The performance of the French economy before and after the crisis

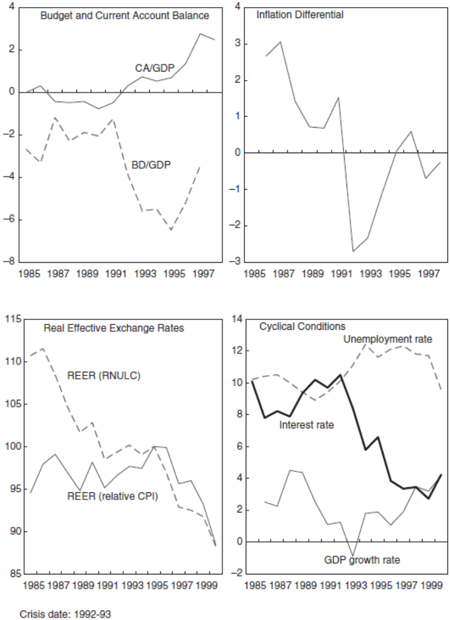


Figure 7. France: Second Generation Model.

Source: Saxena (2004).

The economic patterns shown in Figure 2 suggest the need for a new theoretical framework to explain the 1992 EMS crisis, distinct from the traditional first-generation currency crisis model. This provided the background for the development of the second-generation currency crisis model.

Self-Fulfilling Crises and Multiple Equilibria

Before introducing the full model, I will first outline several key features of second-generation currency crisis models. The first feature is the concept of self-fulfilling crises and multiple equilibria. This feature is most effectively illustrated from a game-theoretic perspective.

Figure 3 is taken from Obstfeld (1996) and presents three different game-theoretic scenarios. Panel (a) represents a situation in which the government has ample foreign exchange reserves; panel (b) illustrates a case of insufficient reserves; and panel (c) depicts an intermediate case, where reserves are neither low enough to guarantee a speculative attack, nor high enough to deter one with certainty.

Importantly, “foreign exchange reserves” should not always be interpreted literally. The term often serves as a proxy for the broader economic fundamentals of a country. Accordingly, panels (a), (b), and (c) represent economies with strong, weak, and intermediate fundamentals, respectively.

Each of the games involves two speculators: Trader 1 and Trader 2. Each trader can choose to either continue holding the domestic currency—i.e., not launch a speculative attack (Hold)—or sell the domestic currency and initiate a speculative attack (Sell). The numbers inside each cell of the matrix represent the payoffs for the two traders, respectively.

Let us begin with panel (a). Since the government's economic fundamentals are strong, a speculative attack will not lead to a collapse of the exchange rate. Therefore, speculators have no incentive to attack. If both traders choose not to attack, they each receive a payoff of (0, 0). If both attack simultaneously, they both incur losses, resulting in a payoff of (-1, -1). If only one trader attacks, the attacking trader suffers a loss while the other does not—represented as (-1, 0) or (0, -1).

Figure 3: Multiple Equilibria in Currency Crises: A Game-Theoretic Illustration

		Trader 2: *Hold*	Trader 2: *Sell*
Trader 1	*Hold*	0, 0	0, -1
	Sell	-1, 0	-1, -1

(a) High Reserve game
($R = 20$)

		Trader 2: *Hold*	Trader 2: *Sell*
Trader 1	*Hold*	0, 0	0, 2
	Sell	2, 0	1/2, 1/2

(b) Low Reserve game
($R = 6$)

		Trader 2: *Hold*	Trader 2: *Sell*
Trader 1	*Hold*	0, 0	0, -1
	Sell	-1, 0	3/2, 3/2

(c) Intermediate Reserve game
($R = 10$)

Fig. 2. The extent of the government's commitment to defend the exchange rate determines the nature of possible equilibria.

Source: Obstfeld (1996).

In the game represented by panel (a), regardless of whether Trader 2 chooses Hold or Sell, Trader 1’s best response is to choose Hold. This is known as a dominant strategy. Similarly, no matter what Trader 1 chooses, Trader 2’s best strategy is also not to launch an attack. Therefore, the equilibrium of the game—and the unique equilibrium—is that both traders choose not to attack. As a result, the fixed exchange rate regime will be sustained.

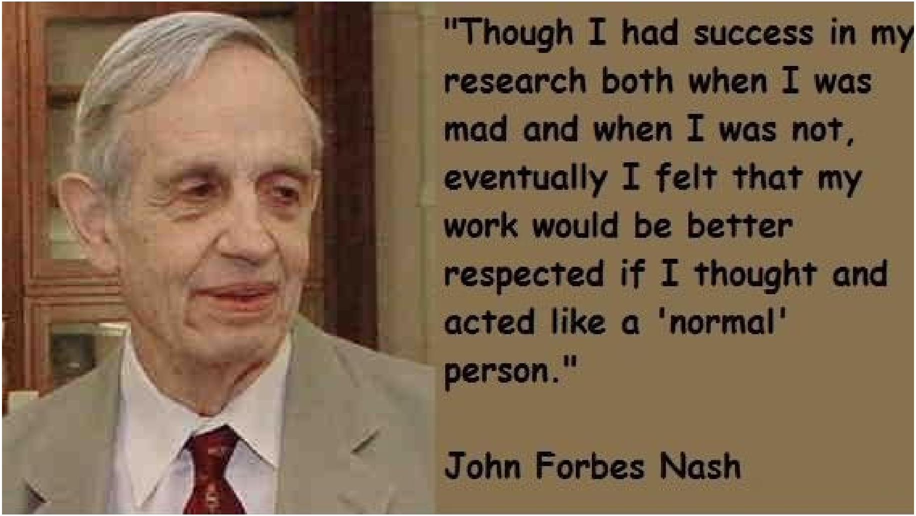
In the game represented by panel (b), the government’s fundamentals are weak, making a speculative attack profitable. Moreover, the more aggressively one attacks, the higher the payoff. If Trader 1 and Trader 2 attack simultaneously, both earn an equal share of the profit, shown in the diagram as (1/2, 1/2). If only one trader attacks, that trader earns a higher payoff alone—represented as (2, 0) or (0, 2).

In this game, regardless of what Trader 2 chooses, Trader 1's best response is to attack. Likewise, Trader 2's best response is also to attack, regardless of Trader 1's choice. In other words, attacking is a dominant strategy for both speculators. Therefore, the equilibrium of the model is (1/2, 1/2), and the fixed exchange rate will collapse, giving way to a floating regime.

The situation in game (c) is quite different. The government's fundamentals are not strong enough to rule out the possibility of a speculative attack, but not weak enough to guarantee that an attack will occur either.

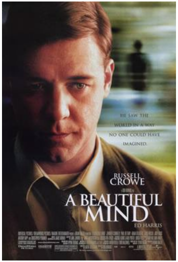
In this game, Trader 1 does not have a dominant strategy. Trader 1's best choice depends on what Trader 2 decides to do. The same is true for Trader 2. Therefore, game (c) does not have a unique equilibrium.

However, it does have two Nash equilibria: in one equilibrium, a speculative attack occurs and the fixed exchange rate collapses; in the other, no attack takes place and the fixed exchange rate regime survives.


"Though I had success in my research both when I was mad and when I was not, eventually I felt that my work would be better respected if I thought and acted like a 'normal' person."
John Forbes Nash

A Beautiful Mind (美麗境界) is a 2001 American biographical drama film based on the life of the American mathematician John Nash, a Nobel Laureate in Economics and Abel Prize winner. The film was inspired by the bestselling, Pulitzer Prize-nominated 1997 book of the same name by Sylvia Nasar. The film stars Russell Crowe as Nash.

[A Beautiful Mind (film) - Wikipedia]



Taking the kids to see my old office

A Nash equilibrium is a situation in which no player has an incentive to unilaterally deviate from their chosen strategy, given the strategy of the other player. The concept of Nash equilibrium does not explain how the equilibrium is selected. However, once a particular equilibrium is in place, no player is motivated to move away from it, since doing so would result in a worse payoff.

In game (c), the outcomes (0, 0) and (3/2, 3/2) are both Nash equilibria. Readers are encouraged to verify for themselves why neither Trader 1 nor Trader 2 would have an incentive to change their strategy in either of these equilibria.

In game (c), the two Nash equilibria are: one in which a currency crisis occurs—(3/2, 3/2)—and one in which it does not—(0, 0). The outcome depends entirely on the expectations of the speculators. If only one speculator attacks while the other does not, the one who acts alone incurs a loss, as illustrated by the outcomes (-1, 0) or (0, -1).

Thus, the equilibrium in game (c) exhibits the hallmark of a self-fulfilling crisis. If market participants expect the fixed exchange rate to collapse and initiate a speculative attack, the regime will eventually fail. Conversely, if speculators have confidence in the regime and choose not to attack, the fixed exchange rate will survive.

The above example illustrates a key feature of second-generation currency crisis models: the existence of multiple equilibria, rather than a single equilibrium determined solely by economic fundamentals. Moreover, the equilibrium outcome is influenced by <u>market expectations</u>, giving rise to the characteristic of a self-fulfilling prophecy.

This example also demonstrates that <u>multiple equilibria tend to arise when economic fundamentals are in an intermediate state</u>—neither strong enough to fully deter a speculative attack, nor weak enough to make a crisis inevitable.

Optimal Policy Choice, Market Expectations, and Multiple Equilibria

Another key feature of second-generation currency crisis models is the emphasis on currency depreciation as the result of the government's optimal policy decision. These models typically assume that the government has an objective function (or loss function) and seeks to maximize its utility (or minimize losses) subject to a budget constraint.

The utility (or loss) function reflects the government's policy goals, which are usually multiple—such as maintaining price stability (low inflation) and output stability (high employment or growth). However, these goals often involve a trade-off (取捨): achieving one objective typically requires sacrificing the other.

In addition to the features mentioned above, the model has another important characteristic: market expectations (or public expectations) can alter the government's budget constraint. Because expectations affect the conditions under which the government operates, different expectations lead to different optimal policy responses by the government. This is what allows the model to generate multiple equilibria.

At the end of this chapter, I will present a generalized version of a second-generation currency crisis model to illustrate how one can construct a DIY (do-it-yourself) version of such a model.

The features described above are fully embodied in one of the most important models in monetary economics: the Barro-Gordon model. In fact, second-generation currency crisis models are built upon an extended version of the Barro-Gordon framework.

The mathematical derivation of the Barro-Gordon model is quite interesting. However, I will not delve into the technical details here. Instead, I will use Paul de Grauwe's simplified version of the Barro-Gordon model to illustrate its key insights and significance.

One of the core components of the Barro-Gordon model is the short-run Phillips Curve (菲利浦曲線).

$$U = U_N + a(\dot{p}^e - \dot{p})$$

This curve indicates that, given a certain level of expected inflation, there exists a trade-off between inflation and unemployment. In other words, the government can reduce unemployment by one unit at the cost of increasing inflation by a units.

Figure 4 illustrates the Phillips Curve. In the diagram, each downward-sloping segment represents a short-run Phillips Curve, and its position depends on the level of expected inflation.

In the long run, expected inflation must equal actual inflation, so the Phillips Curve becomes the set of all points where $\dot{p}^e = \dot{p}$. In other words, it corresponds to the vertical line shown in the diagram. Therefore, in the long run, there is no trade-off between the unemployment rate and the inflation rate.

The second component of the Barro-Gordon model is the government's objective function, which can also be represented by a government preference (indifference) function. Figure 5 displays the government's indifference curves.

The government has two policy objectives: low inflation and low unemployment. Each point on the same indifference curve represents a combination of inflation and unemployment that yields the same level of utility for the government. The closer the indifference curve is to the origin, the higher the level of utility it represents.

The slope of the indifference curve reflects the relative weight the government assigns to the two policy goals.

Figure 4: Phillips Curve

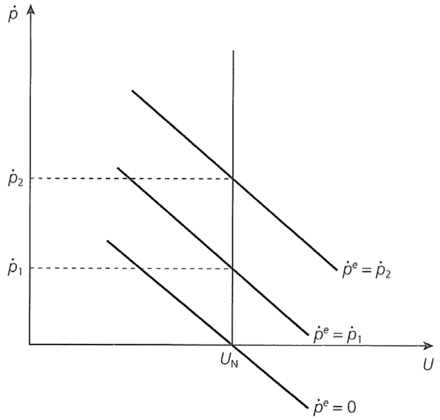


Figure 2.9 The Phillips curve and natural unemployment.

Source: de Grauwe (2016).

Figure 5: Government's Indifference Curve

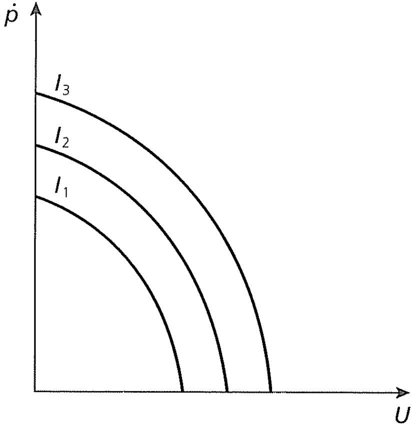


Figure 2.10 The preferences of the authorities.

Source: de Grauwe (2016).

Figure 6: Rational Expectations Equilibrium

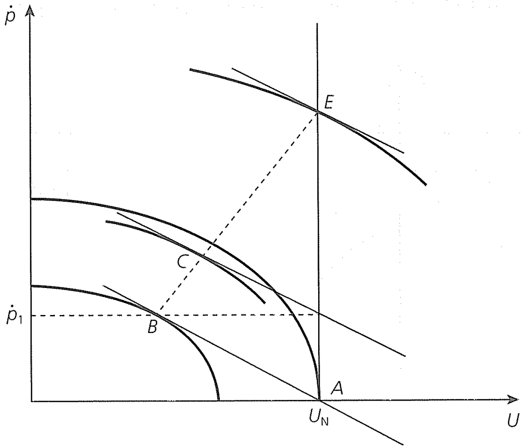


Figure 2.12 The equilibrium inflation rate.

Source: de Grauwe (2016).

Figure 6 illustrates the equilibrium of the Barro-Gordon model. Suppose the government initially announces that it will not generate inflation, and the public's expected inflation rate is also zero. In this case, the equilibrium would be at point A.

However, the government can in fact move to point B, creating an inflation rate of $\dot{p}_1$, and thereby achieving a higher level of utility. Once the public realizes this, their inflation expectations will also adjust upward to $\dot{p}_1$, causing the Phillips Curve to shift upward.

A similar dynamic occurs at point C, and the process continues iteratively until the final equilibrium at point E is reached. At point E, the public's expected inflation rate equals the actual inflation rate, and the government's objective function is also optimized.

Figure 6 shows that in the end, the unemployment rate remains unchanged, staying at the natural rate of unemployment. However, the inflation rate is greater than zero. This phenomenon is known in the literature as inflation bias.

The cause of this outcome lies in the fact that public expectations can alter the government's budget constraint, represented here by the short-run

Phillips Curve. At the same time, the government has an incentive to push unemployment below the natural rate, as doing so would yield a higher level of utility for the government.

Although the Barro-Gordon model incorporates the role of market expectations in determining equilibrium, it does not truly introduce multiple equilibria. Obstfeld (1996) extends the Barro-Gordon framework by incorporating the costs of maintaining a fixed exchange rate, thereby introducing the possibility of multiple equilibria.

However, Obstfeld's model is mathematically complex, often leading readers to focus on the technical details while overlooking the economic intuition behind the model.

Olivier Jeanne was the first economist to clearly identify the core essence of second-generation currency crisis models. He pointed out that such models can be reduced to a single equation—as long as the market expectation variable appears on both sides of the equation, and both sides are increasing functions of expectations, the model will naturally admit multiple equilibria. This was a profound insight.

In what follows, I will introduce Jeanne's (1997) model.

A Generalized Second-Generation Model

The following presentation is based on Jeanne (1997). The model assumes two types of policymakers:

Tough policymakers (or hawkish types 鷹派) are committed to maintaining the fixed exchange rate at any cost.

Soft policymakers (or dovish types 鴿派) will only maintain the fixed exchange rate if the net benefit is positive.

The proportion of soft policymakers in the population is denoted by μ.

The net benefit of maintaining a fixed exchange rate, $\mathrm{B_t}$, consists of two parts:

$$\mathrm{B_t} = \mathrm{b_t} - \alpha\pi_{\mathrm{t}-1}$$

$$\phi_t \equiv E_t b_{t+1}$$

$$u_{t+1} \equiv b_{t+1} - \phi_t$$

ϕ_t denotes economic fundamentals; $\pi_{\mathrm{t}-1}$ is the market (private) expectation at period (time) t-1 about the probability of an exchange rate depreciation at period (time) t. In other words, given better economic fundamentals and lower expected probability of an exchange rate depreciation, the net benefit of maintaining a fixed exchange rate will be larger.

Assume that the PDF function $f(\cdot)$ of the random variable u_t is continuous and symmetric. The PDF function is increasing in the interval $(-\infty, 0)$, and is decreasing in the interval $(0, \infty)$. We denote the CDF function (累積機率密度函數) of u_t by F.

Under the assumption of rational expectations, the probability of currency devaluation should equal the probability that the net benefit is negative and the policymaker is of the soft (dovish) type.

$$\pi_t = \mu \cdot \Pr[B_{t+1} < 0] = \mu \cdot Pr[\mu_{t+1} < \alpha\pi_t - \phi_t] = \mu \cdot F[\alpha\pi_t - \phi_t]$$

Jeanne (1997) derives the following two results:

【Proposition 1】

If $\mu \cdot \alpha \cdot f(0) < 1$, the devaluation probability is uniquely determined by (and strictly decreasing in) the fundamentals ϕ_t.

【Proposition 2】

If $\mu \cdot \alpha \cdot f(0) > 1$, there are two critical values of the fundamentals such that: if $\phi > \bar{\phi}$ or $\phi < \underline{\phi}$, the devaluation probability π_t is uniquely determined by (and strictly decreasing in) the fundamentals ϕ_t and if $\underline{\phi} < \phi < \bar{\phi}$ the devaluation probability π_t may take three values $\pi_1(\phi) < \pi_2(\phi) < \pi_3(\phi)$.

We use Figure 7 to illustrate the equilibrium solution of the Jeanne model. The left-hand side of the equation is the 45 degree line, while the right-hand side is the C_ϕ curve.

The slope of that curve is equal to $\mu \cdot \alpha \cdot \mathrm{f}(\alpha\pi_t - \phi_t)$. According to the assumptions we make on $f(\cdot)$, the slope's maximum value is $\mu \cdot \alpha \cdot \mathrm{f}(0)$, exactly when $\alpha\pi_t = \phi_t$.

If $\mu \cdot \alpha \cdot \mathrm{f}(0) < 1$, which means that the slope of every point on the C_ϕ curve is less than 1, so that the value of π_t will be determined solely by ϕ_t, with the property that the larger the ϕ_t, the smaller the π_t.

If $\mu \cdot \alpha \cdot f(0) > 1$, which means that the slope of C_ϕ curve at $\alpha\pi_t = \phi_t$ is greater than 1, so the curve has three intersections with the 45 degree line.

Figure 7: Equilibrium Solution in the Jeanne (1997) Model

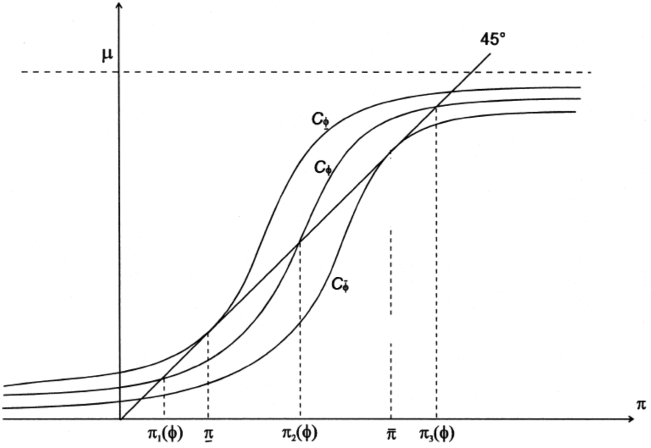


Fig. 1. Eq. (3).

Source: Jeanne (1997).

$\bar{\phi}$ and $\bar{\pi}$ can be solved jointly by the equations below:

$$\begin{cases} \bar{\pi} = \mu F(\alpha\bar{\pi} - \bar{\phi}) \\ 1 = \mu\alpha f(\alpha\bar{\pi} - \bar{\phi}) \\ \alpha\bar{\pi} > \bar{\phi} \end{cases}$$

The solution obtained after computation is:

$$\bar{\phi} = \mu\alpha F\left[f^{-1}\left(\frac{1}{\mu\alpha}\right)\right] - f^{-1}\left(\frac{1}{\mu\alpha}\right)$$

Analogously, $\underline{\phi}$ and $\underline{\pi}$ can be solved jointly by the equations below:

$$\begin{cases} \underline{\pi} = \mu F\left(\alpha\underline{\pi} - \underline{\phi}\right) \\ 1 = \mu\alpha f(\alpha\underline{\pi} - \underline{\phi}) \\ \alpha\underline{\pi} < \underline{\phi} \end{cases}$$

The solution, after rearrangement, is:

$$\underline{\phi} = \mu\alpha F\left[-f^{-1}\left(\frac{1}{\mu\alpha}\right)\right] + f^{-1}\left(\frac{1}{\mu\alpha}\right)$$

Due to time constraints, we will leave the bank run model for the next lecture.

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