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Theoretical Aspects of Currency Crises

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Abstract

The paper presents three generations of theoretical models of currency crises. The models were drawing on the real crises. The first-generation models were developed after balance-of-payment crises in Mexico (1973–82), Argentina (1978–81), and Chile (1983). The second-generation models arose after speculative attacks in Europe and Mexico in 1990s. Finally, first attempts to built the third-generation models started after the Asian crisis in 1997–98. The paper also explains the mechanism of currency crisis, provides an overview of the crises literature, and defines the types of crises. This work is intended to summarize the current level of knowledge on the theoretical aspects of currency crises.

Introduction

Financial crises are unique neither to the past nor current financial systems, and history serves with examples of crises at least since the beginning of capitalism in 17th century [1]. In 20th century, there were numerous financial crises to mention only the most famous of them: the sterling and French frank crises of the 1960, the breakdown of the Bretton Woods system in the early 1970s, and the debt crisis of 1980s. In the very recent 1990s, financial crises have occurred in Europe (the 1992–93 crises in the European Monetary System's exchange rate mechanism, ERM), Latin America (the 1994–95 "tequila crisis"), east Asia (the 1997–98 crises in Indonesia, Korea, Malaysia, the Philippines, and Thailand), as well as in Russia (1998). However, crises in the recent years have differed from those not even in the distant past in important aspects. Increased liquidity of international financial markets caused by financial innovations and integration of markets, expansion in corporate indebtedness, and fragility of banks and financial companies lead to spillover effects and contagious spread of crises. Therefore, crises have become both more pronounced and far reaching, not only to a single country or region, but also to the whole world economy. The models of crises were built based on the real events. The first-generation models were developed after balance-of-payment crises in Mexico (1973–82), Argentina (1978–81), and Chile (1983). The second-generation models arose after speculative attacks in Europe and Mexico in 1990s. The first attempts to built the third-generation models started after the Asian crisis in 1997–98.

The paper is constructed as follow. Part 1 provides overview of definitions of crises as well as explains the mechanism of crisis. As the broad scope of existing models makes necessary to concentrate on the main stream, Parts 2–5 describe the most pronounced models of currency crises, the canonical model of balance of payment crisis and its modifications, the second-generation model, and the third-generation one, respectively.

1. Defining and Understanding Currency Crises

Historically, financial crises were defined in two ways. The narrow definition, associated with monetarist school has linked financial crises with banking panics. Friedman and Schwartz [1963] stressed the importance of banking panics as a major

[1] Kindleberger [1978], Schwartz [1986].

source of contraction in the money supply, which, in turn, have lead to severe contraction in aggregate economic activity. Monetarists do not perceive as real financial crises events, in which, despite of a sharp decline in asset prices and a rise in business failures, there is no potential for banking panic and a resulting sharp decline in the money supply, and economic activity. Schwartz [1986] characterizes these situations as "pseudo-financial crises" [2].

The second, very general definition of systemic financial crisis outlined by Minsky [1972] and Kindleberger [1978] involve broad categories of crises, including sharp declines in asset prices, failures of financial and nonfinancial institutions, deflations or disinflations, disruptions in foreign exchange markets, or some combination of all of these [3]. The root cause of financial instability is the breakdown of information flows, which hinders the efficient functioning of financial markets. A crucial impediment to the efficiency of the markets is asymmetric information that leads us to three basic problems: adverse selection, moral hazard, and free-rider problem.

Asymmetric information theory provides more precise definition of financial crisis then Kindleberger-Minsky and not as narrow as Friedman-Schwartz do. A financial crisis is a nonlinear disruption of financial markets in which adverse selection and moral hazard problems become worse, so that financial markets are unable to efficiently channel funds to those who have the most productive investment opportunities.

Financial instability prevents the markets from channeling funds to entities with productive investment opportunities. Without access to these funds, the entities cut spending that results in a contraction of economic activity. Four factors typically help identify financial instability: increase in interest rates, asset market effects on balance sheets, problems in banking sector, and increase in uncertainty [4]. A higher interest rate leads to greater adverse selection that is the higher interest rate increases the likelihood that the lender is lending to a borrower representing a high credit risk. Because of the resulting increase in adverse selection, lenders will want to make fewer loans leading to a decline in lending that will decline investment and economic activity on the aggregated level.

The state of the balance sheet of both nonfinancial firms and banks is the most critical factor for the severity of asymmetric information problems in the financial system. Financial markets solve asymmetric information problem with the use of collateral that

[2] Government intervention in a pseudo-financial crisis is unnecessary and can be harmful since it leads to economic inefficiency as farms that deserve to fail are baaled out or because it results if excessive growth that stimulates inflation.

[3] Since any of tHese disturbances have potential serious consequences for the aggregate economy, it leads to expanded role for ggvernment interventions, which was criticized by Schwartz [1986].

[4] Mishkin [1994].

reduces consequences of adverse selection or moral hazard because it reduces the lenders' losses in the case of default. In practice, the net worth of firms serves as collateral that protects lenders from defaults on debt payments. The asset market effect on balance sheets can be best illustrated by a stock market crash. A sharp decline in the stock market (stock market crash) can increase adverse selection and moral hazard problems in financial markets because it leads to a large decline in the markets' value of firms' net worth [5].

The decline in assets value can occur, either because of expectations of lower future income from these assets, or because of a rise in market interest rates that lowers the present discounted value of future incomes. With a declining net worth lenders are less protected from losses and additionally exposed to greater risk of moral hazard for lending to firms that have now less to lose. The stock market decline leads to decreased lending and a decline in economic activity. As all the four factors initiating financial instability are interrelated they construct a vicious circle leading to financial crises. The increase in interest rates have a direct effect on increasing adverse selection problems, but it also leads to assets market effect through both firms' and households' balance sheets. A rise in interest rates and therefore in households' and firms' interest payments decreases entities' cash flow, which causes deterioration in their balance sheets. As a result, adverse selection and moral hazard problems become even more severe for the potential lenders leading to a decline in lending and economic activity.

Problems in the banking sector undermine the ability of banks to engage in financial inter-mediation leading to decline in investment and aggregate economic activity. Negative shocks to banks' balance sheets can take several forms. The increases in interest rates, stock market crashes, an unanticipated depreciation or devaluation, all can cause deterioration in nonfinancial firms' balance sheets and increases the probability of bank insolvency. The disappearance of a large number of banks in a short period of time means that there is a direct loss in financial intermediation done by the banking sector. The outcome is an even sharper decline in lending, investment, and economic activity. The worse can occur through the effect of bank panic, which results in a movement from deposits to currency with a decline in money-multiplier and money supply. The result is increase in interest rates, which increases adverse selection and moral hazard.

Increase in uncertainty makes harder for lenders to differentiate good from bad credit risks. Therefore, it makes information in the financial markets even more asymmetric worsening the adverse selection problem. The inability to solve this problem leads to decline in lending, investment, and economic activity.

Similar set of problems results from unanticipated changes in inflation and exchange rate. Most industrialized countries experience moderate inflation and many debt

[5] Greenwald and Stiglitz [1988], Bernanke and Gertler [1989], Calomiris and Hubbard [1990].

contracts are long term and have interest payment fixed in nominal terms. An unanticipated decline in inflation (because of either unanticipated disinflation or deflation) leads to a decrease in the net worth of firms. The value of firms' liabilities in real terms rises so as the burden of their debts, but there is no corresponding rise in the real value of firms' assets. The result is that net worth in real terms declines and an increase in adverse selection and moral hazard problems causes a decline in investment and economic activity.

Contrary to the moderate or low-inflation industrialized countries, emerging-market countries experience high and variable inflation rates. The result is that debt and contracts are of very short duration. Therefore, a decline in unanticipated inflation does not have unfavorable direct effect on firms' balance sheets that it has in industrialized countries.

However, there is another factor affecting balance sheets in emerging-market countries that is not operational in most industrialized countries. That is unanticipated exchange rate depreciation or devaluation. With debt contracts denominated in foreign currencies by many nonfinancial firms, banks, and governments from emerging-market countries an unanticipated weakening of domestic currency increases (short-term) debt burden of domestic firms. Since assets are typically denominated in domestic currency, there is a resulting deterioration in firms' balance sheets and decline in net worth, which increases adverse selection and moral hazard problems that end up along the lines described above.

Propagation of financial instability differs in the financial markets of industrialized countries versus emerging-market countries. In industrialized countries, as inflation is under control, a devaluation does not lead to large increases in expected inflation and hence in nominal interest rates. Furthermore, to the extent that interest rate rise, the impact on cash flows and balance sheets is not strong due to longer maturity of debt contacts than in emerging-market countries. Usually, an industrialized country, which experiences devaluation after a (second-generation model of) currency crisis gets a boost to the economy because its high value-added exportables become cheaper.

When speculative attack against the currency (in the first-generation model) occurs in an emerging-market country, the central bank has a hard trade-off between increase of interest rates and sale of international reserves (and sterilizing their outflow through increasing domestic credit). If it raises interest rates sufficiently to defend the currency, the banking system may collapse. Once the investors recognize that fact and unwillingness of central bank to hike rates, they have even greater incentives to attack the currency because expected profits from selling the currency have risen.

The institutional features in emerging-market countries (short-term maturity of debt, significant amount of debt denominated in foreign currency and lack of credibility or high uncertainty) can interact with a currency crisis, which can lead to a full-fledge financial crisis.

Systemic financial crises are disruptions of financial markets that, by impairing markets' ability to function effectively, can have large adverse effects on the real economy. A number of broad types of economic and financial crisis can be distinguished [6]. Currency crisis occurs when there is a speculative attack on the domestic currency. Banking crisis refers to a actual or potential bank runs or failures that induce banks to suspend the internal convertibility of their liabilities or which compels the monetary authorities to intervene to prevent this by extending assistance on a large scale [7]. Debt crisis is a situation in which a country cannot service its obligations foreign or domestic, or both, whether sovereign or private. Balance of payment crisis is a structural misbalance between deficit in current account (absorption) and capital and financial account (sources of financing) that after exhausting international reserves leads to a currency crisis. Balance of payment crisis was a synonym of a currency crisis as the first-generation model of crisis was a result of balance of payment crisis.

Systemic financial crisis may involve these types of crises that are not mutually exclusive, but any of these crises does not necessarily lead to a full-scale systemic financial crisis. Elements of currency, banking, debt, and balance of payment crises may be present simultaneously, because they imply some degree of causality. However, it is not necessarily, because, for example a poor quality of the banking sector may not be revealed only until currency collapses. The same may be true for problems linked to corporate indebtedness.

Hence, currency crisis may either be a result or a cause of disturbances in the financial markets. Usually, exchange rate of domestic currency does not only reflect a micro- and macroeconomic fundamentals of every country, but is also vulnerable to external economic factors, as well as political developments domestically and abroad. Therefore, currency crisis is the clue of every category of financial crisis.

The main issue is how to determine when a currency crisis occurs. Generally speaking, changes in exchange rate regime may result from an unsustainable exchange market pressure that ends up in a regime-shift by monetary authorities and signals currency crises. The changes can either curb the regime, through abandoning external and/or internal convertibility of domestic currency and pegging it, or lessen the regime and floating domestic currency. These changes can be multiple and vary, but are relatively

[6] World Economic Outlook [1998].

[7] Eichengreen and Rose [1998].

easy to identify and need to be announced as acting law [8]. However, currency crisis cannot be identified either only with changes in exchange rate regime or changes in nominal exchange rate for two reasons. First, a regime change may not necessarily reflect problems with maintaining the current level of exchange rate. It can result from economical development and (gradual) shift to less restricted regime or political decision to join monetary union that tightens domestic currency volatility. And second, not all speculative attacks are successful. The excess demand for foreign exchange (in return for domestic currency) can be met through several operational channels of monetary authorities: exchange rate channel, interest rate channel, and reserve channel. Therefore, Eichengreen, Rose, and Wyplosz [1994] proposed an index of exchange market pressure (EMP) to combine all three channels of purely speculative pressures. A weighted average of exchange rate changes, reserve changes, and interest rate changes is measured relative to a foreign currency.

$$EMP_{i,t} = [(\alpha\%\Delta e_{i,t}) + (\beta\Delta(i_{i,t} - i_{r,t})) - (\gamma(\%\Delta r_{i,t} - \%\Delta r_{r,t}))],$$

where: $e_{i,t}$ denotes the price of a foreign currency in *i's* currency at time *t*; i_i and i_r denotes the short-term interest rates differential with respect to a reference currency; r_i and r_r denotes the percentage difference in the changes of ratios of international reserves to narrow money (*M1*); and α, β, γ are weights. The crisis is defined as an extreme value of the *EMP* index that reaches some level of standard deviation above the sample mean. Weighting the *EMP* index results from different volatility of the components, and weights are different for every country. Sample mean and benchmark standard deviation also differentiates among countries.

If any speculative attack is successful, devaluation (or depreciation) or revaluation (or appreciation) occurs that result in percentage changes of exchange rate of domestic currency relative to a reference currency, which is the foreign currency (or basket of currencies) possessing the highest weight in effective exchange rate index. Usually, this is U.S. dollar and/or euro, earlier the German mark and the French franc [9]. However, monetary authorities may accommodate exchange market pressure by running down their reserves and by rising interest rates.

The ratio of reserves to *M1* better identifies substitution of domestic currency (cash and demand deposits) with foreign currency (cash from reserves) than changes in nominal

[8] All members of the IMF are obliged to report changes in exchange rate regimes, see "Exchange Rate Arrangements" by IMF published on yearly basis.

[9] In Eichengreen, Rose, and Wyplosz [1994] German mark was the reference currency as the most stable among OECD currencies after the post-war period. Central African Monetary Area countries were pegging their currencies to the French franc since 1960.

level of international reserves from one side and the ratio of reserves to broad money aggregate *M2*, from the other side. The latter ratio would be distorted with situation within the banking sector. And obviously, short-term interest rates are more sensitive than the long-term ones. The operational channels of monetary authorities are not fully separate and in practice usually combination of them is adopted. Therefore, the *EMP* index covers all possible channels of interventions on exchange market registering currency crisis as extreme values of the index.

Being able to define the fact of currency crisis and understanding its economic consequences, the fundamental issue remains – what are the reasons of currency crises? Three types of the models of currency crises try to answer this question.

2. The Canonical Model of Balance of Payment Crisis

In the mid-1970s, after a three decade period of price stability (during Bretton Wood system), fluctuation in commodity prices started to begin a concern of authorities and economists. Price stabilization, via the establishment of international agencies that would buy and sell commodities, was a major demand of supporters of the so-called New International Economic Order. This renewed an interest in theoretical models analyzing mechanisms of international price stabilization and speculative behavior.

Hotelling [1931] derived a model of exhaustible resource pricing, when the price of a resource should rise over time to the point at which there is no more demand. Speculators will hold the resource if and only if they expect its price to rise rapidly enough to offer them a rate of return equivalent (after adjusting for risk) to that on other assets. Therefore, Hotelling suggested the establishment of commodity boards.

However, Salant and Henderson [1978] argued that the establishment of the official price stabilization board that announces its willingness to buy or sell the resource at some fixed price changes the speculators' behavior. As long as the price is above the level that would prevail in the absence of the board – that is, above the Hotelling path – speculators will sell off their holdings of resource, as they can no longer expect to realize capital gains. Thus, the board will have to acquire a large stockpile. However, as the price of resource will rise above the board's target in the absence of the stabilization scheme, speculators will begin buying it up. And if the board continues to try to stabilize the price, it will quickly find its stocks exhausted. Salant and Henderson also built a model of speculative attack in order to analyze attacks on authorities-controlled price of gold that in effect forced the closure of the open market in gold in 1969 and ended the era of fixed exchange rates.

The gold standard and the system of fixed exchange rates among the most important industrialized countries (USA, the Great Britain, France, Germany, Scandinavian countries) prevailed from 1870 to 1914, than sporadically in 1920s, until it collapsed during the Great Depression. After the World War II, the Bretton Woods agreement modified the gold standard and set values of currencies of the International Monetary Fund (IMF) members in terms of the U.S. dollar, which was convertible into gold at a fixed price of $35 per ounce. In 1971, expansionist policy of the Nixon administration resulting from the growing costs of the Vietnam War led to a suspension of convertibility of dollars into gold and automatic sale of gold to foreign authorities in return for dollars. Since 1973, the major currencies of the industrialized countries operated under managed floating exchange rate system and many developing countries maintained fixed parities of domestic currencies towards the major currencies.

After Salant-Henderson model was drafted Krugman [1979] proposed to apply the model to the analysis of speculative attacks not against commodity boards trying to stabilize commodity prices, but against central banks trying to stabilize exchange rates. However, Krugman due to nonlinearities in his model was unable to derive explicitly a solution for a time of collapse of an exchange rate peg. Finally, the model of Flood and Garber [1984] derived a solution in a linear model with speculative behavior, and Blanco and Garber [1986] developed an early structural test of the first-generation model.

The first-generation models of currency crises evolved in response to crises in developing countries such as Mexico (1973–82), Argentina (1978–81), and Chile (1983). Generally speaking, first generation models show how an exchange rate peg combined with pre-crisis expansionary fundamentals, usually a persistence of the money-financed budget deficits pushed the economy into crisis, with private sector attempts to earn profit from inconsistency in domestic policy. This inconsistency can be maintained as long as the central bank has sufficiently large foreign exchange reserves to intervene in the market.

The canonical first-generation model relates to a small open economy whose residents have a perfect foresight and consumes a single, tradable good of a fixed domestic supply exogenously given at $\tilde{y}$. There are no private banks and money supply is equal to the sum of domestic credit issued by the central banks and the domestic-currency value of foreign reserves maintained by the central bank, which earn no interest. Formally, the model is defined by [10],

$$m_t - p_t = \phi\, \tilde{y} - \alpha\, i_t \qquad \phi, \alpha > 0 \tag{1}$$

[10] Flood and Garber [1984].

$$m_t = \gamma d_t + (1 - \gamma)\, r_t \qquad 0 < \gamma < 1 \tag{2}$$
$$d_t' = \mu \tag{3}$$
$$p_t = p^* + s_t \tag{4}$$
$$i_t = i^* - E_t\, s_t' \tag{5}$$

Where all variables except interest rates are measured in logarithms. Equation (1) defines real money demand as a positive function of income ($\hat{y}$) and negative function of domestic interest rate (i) [11]. Equation (2) is an approximation of log-linear accounting identity of money supply components, domestic credit (d) and international reserves (r), where domestic credit grows at constant μ in equation (3). In equation (4) and equation (5) domestic price level (p) and domestic interest rate (i) are defined by purchasing power parity and uncovered interest parity, respectively. In equation (4), foreign price level (p^*) is assumed constant. Spot exchange rate (s) is quoted as the domestic-currency price of foreign exchange, and foreign currency interest rate (i^*) is also assumed constant. E_t denotes expectation operator conditional on information available at time t, but under a perfect foresight $E_t\, s_t' = s_t'$. The level of income, foreign price level and foreign interest rate is assumed to be constant. Prime over a variable indicates a time derivative.

During a flexible exchange-rate regime, the quantity of international reserves is normally held fixed and the exchange rate is free to balance the money market. With a peg exchange rate ($s_t = \bar{s}$), it follows that $s_t' = 0$ and $i_t = i^*$. Central bank accommodates any change in domestic money demand through the purchase or sale of international reserves that taking (1) and (4) into (5) leads to

$$m_t = s_t - \alpha s_t' \tag{6}$$

The money stock (6) depends on changes in international reserves and the level of spot exchange rate that is pegged ($s_t' = 0$). From (2) and (6), the level of international reserves depends on spot exchange rate, level of domestic credit, and the share of its component in the money supply, $r_t = (s_t - \gamma d_t) / (1 - \gamma)$. Therefore, if domestic credit expansion exceeds the fixed money demand in equation (6) with $s_t' = 0$, international reserves are declining at the rate of credit expansion leading to a final depletion at a time

$$r_t' = -\mu / \theta\text{, where } \theta = (1-\gamma) / \gamma \tag{7}$$

In equation (7), reserves are declining proportionally to credit expansion. Obviously,

[11] This assumption excludes currency substitution and relates to the narrow definition of money.

as domestic credit grows at μ (constant) and there are no changes in the structure of money supply, meaning that reserves also rise, and θ is also constant, the reserves will not be depleted.

The problem is to forecast the time of collapse of the exchange rate regime. To define the timing, the idea of shadow exchange rate is crucial to assess the potential profits of speculators in a crisis. Suppose that the central bank is able to defend the peg exchange rate until it has reserves and than allows exchange rate to float freely. Rational agents expect that a decline in reserves at point t is inevitable, even without a speculation. Speculators working in a competitive environment and in an attempt to avoid losses or earn gains at a time of collapse will force the crisis before each other and before this point is reached. Formally, the time of the collapse happens at the point when "shadow floating exchange rate" appears. The shadow rate is the exchange rate that would prevail when $r_t = 0$ and the exchange rate would float freely thereafter, or putting differently, when speculative attack is successful. As long as the peg exchange rate is more depreciated than the implicit shadow rate, the exchange regime is not under attack. The shadow exchange can take the form

$$s_t = \kappa_0 + \kappa_1 m_t \tag{8}$$

In the post-collapse, floating regime, where $m_t' = \gamma d_t'$ and $d_t' = \mu$, the exchange rate depreciates steadily and proportionally to the rate of growth of domestic credit, $s_t' = \kappa_1 \gamma \mu$.

Substituting it into (6) yields

$$s_t = m_t + \alpha \kappa_1 \gamma \mu \tag{9}$$

that after comparing it with (8) yields $\kappa_0 = \alpha\gamma\mu$ and $\kappa_1 = 1$. After rearranging (9) with (2) and assuming that γ is given in pre-crisis and post-crisis regimes we obtain

$$s_t = \gamma(d_0 + \alpha\mu) + \gamma\mu t \tag{10}$$

The pegged exchange rate regime collapses when the prevailing exchange rate $\bar{s}$ equals the shadow-floating rate (s_t) that is proportional to the level of domestic credit, its share in the money supply, and pace of its growth. If speculators attack at a level that post-crisis currency will appreciate, they will experience a capital loss on the reserves purchased from authorities. They will not attack until the level of domestic credit (d) exceeds the level when $s_t > \bar{s}$. It would signal a gain for speculators for every unit of reserve purchased from the authorities. However, speculators being able to calculate the gain will compete against each other and attack earlier and at the lower level of domestic credit (d_0). Therefore, the attack will take place when $s_t = \bar{s}$ at time t_c that from (10) yields, $t_c = (\bar{s} - \gamma d_0) / \gamma\mu - \alpha$.

Under the assumption of a peg exchange rate ($s_t' = 0$) $m_t = s_t$ and from equation (2) $\bar{s} = \gamma d_0 + (1-\gamma) r_0$, and the time of collapse is given by

$$t_c = \theta r_0 / \mu - \alpha \tag{11}$$

Where r_0 denotes the initial stock of reserves. The equation (11) shows that the higher the initial stock of reserves and/or the lower the rate of domestic credit expansion, the longer it takes before an exchange rate peg is attacked and collapses. In the absence of speculation ($\alpha = 0$), collapse of the peg exchange rates occurs after depletion of reserves. The larger the initial portion of domestic credit in the money stocks (higher μ) the sooner the collapse. Finally, the higher interest rate elasticity of money demand, the earlier the crisis. The speculative attack always occurs before the central bank would have run out of reserves without speculation. To determine the stock of reserves just before the attack (at time t_c^-), we calculate from equations (2) and (6), and as central bank accommodates any change in domestic money demand through the purchase or sale of international reserves $r_t = (\bar{s} - \gamma d_t) / (1 - \gamma)$, so that

$$r_{tc}^- = \lim_{t \to t_c} r_t = (\bar{s} - \gamma d_{tc}^-) / (1 - \gamma), \text{ where } d_{tc}^- = d_0 + \mu(t_c^-).$$

and after using (11) it yields,

$$r_{tc}^- = \mu\alpha / \theta \tag{12}$$

Prior to the collapse at t_c, the money stock is constant, but it composition varies, since domestic credit rises (at rate μ) and reserves decline (at rate μ/θ). As the speculative attack occurs both reserves and money stock fall by $\mu\alpha/\theta$. Since reserves are exhausted by the attack, the money stock is equal to domestic credit in the post-crisis regime. After the attack the exchange rate rises at the rate μ and as interest parity requires the domestic-currency interest rate will also increase by μ.

3. Modified First-generation Models

The basic theory of the first generation model has been extended in broadly categorized three directions. The first modification of the canonical model was active governmental involvement during the crisis or sterilization of reserve losses. The second group of modifications abandons all assumptions of the canonical model, especially on perfectly foreseen speculative attacks and introduces uncertainty. Finally, the third group combines policy switches as means to avoid crises, including the role of foreign borrowing and the imposition of capital control as well as examines real effects of (anticipated) exchange rate crisis. The latter modifications are more related with attempts to limit propagation of the crisis, and not with preventing the crisis *per se*. However, because the foreign borrowing and capital controls were the most widely implemented during the Asian crisis, Part 5 devoted to the third-generation model also deals with this modification.

3.1. Sterilization

In the 1990s crises, the money-supply effects of reserve loses were sterilized, allowing a smooth money growth through the attack period. Therefore, money supply and exchange rate as well as foreign price and interest rate level remain constant through the attack, and money market equilibrium follows,

$$\bar{m} - p^* - \bar{s} = -\alpha(i^*) \qquad (13)$$

What changes only is the structure of money supply, as in the case of capital outflow, declining international reserves are substituted with domestic credit. As the attack takes place, reserves are exhausted, exchange regime changes from peg to flexible, and the money supply grows at rate $\mu > 0$. Interest rate parity requires $i = i^* + \mu$, and flexible exchange rate $\check{s}$ also grows at rate μ. Therefore, money market equilibrium depends on pace of domestic credit growth as endogenous element of domestic policy and foreign price and interest level as exogenous factors. Spot flexible exchange rate is a function of domestic credit expansion as above. It follows,

$$\bar{m} - p^* - \check{s} = -\alpha(i^* + \mu) \qquad (14)$$

Subtracting equation (14) from (13),

$$\check{s} - \bar{s} = \alpha\mu > 0 \tag{15}$$

Equation (15) reveals that no mater how high monetary authorities set pegged exchange rate $\bar{s}$ or how significant international reserves always $\check{s} > \bar{s}$. The modified model shows that an exchange rate peg cannot survive if the authorities plan to sterilize reserve losses and speculators expect it. Equation (15) also stresses that with free capital mobility *ceteris paribus* there is no sufficient amount of reserves to support currency pegs. In practice sterilization shifts the attack from the money market to domestic bonds market as sterilizing attack on reserves usually involves authorities to expand domestic credit and using it to purchase domestic government securities [12]. Therefore, instead of interest rate parity condition in (5), we have a bond-based risked premium to the spread between domestic and foreign currency rates,

$$i = i^* + s' + \beta(b - b^* - s) \tag{16}$$

where $\beta > 0$ is a constant, and in logs b is the quantity of domestic government bonds and b^* is the quantity of foreign currency bonds in private hands.

Decline in authorities' reserves results in a growth of reserves in private hands, and as those reserves are interest paying foreign-currency securities, b^* rises. In the canonical model the attack was timed to avoid the consequences of an exchange rate jump. Now, since money supply is unresponsive to the speculative attack and since the exchange rate is still prohibited from an increase, the maintenance of money market equilibrium requires condition that domestic-currency interest rate will not increase at the time of attack. After an attack exchange rate reverts to its shadow value, $s_t = \check{s}$. At the attack $\check{s}$ jumps from zero to $\kappa_1\mu$ (as $\check{s} = \kappa_0 + \kappa_1 m_t$) and the risk premium jumps down by $\beta 2\Delta r$, where Δr is the size of the attack (and loss of reserves) and 2 stands as the attack is sterilized. Therefore, it is evident from (16) that the speculative attack will be timed as the upward jump in *s'* exactly matches the downward jump in risk premium. In practice, the authorities use high-powered money to buy domestic securities and compensate changes in money supply for the reserve loss, thereby decreasing the risk premium. Now, the attack takes place when the interest rates will not jump and that happens when $\kappa_1\mu = -\beta 2\Delta r$ and the attack size is $\Delta r = -\kappa_1\mu / 2\beta$. The time of the attack will also come earlier comparing with the canonical model.

[12] Flood, Garber, and Kramer [1996].

3.2. Uncertainty

The second modification to the canonical model was abandoning the assumption of perfectly foreseen speculative attacks. Market participants are never sure when an attack will take place and by how much the exchange rate will change if there is an attack. Therefore, uncertainty becomes a crucial element. In option pricing terminology, the uncertain exchange rate peg provides a free call option given by the authorities to speculators. The peg exchange rate is a strike price and the quantity optioned is the amount of international reserves backing the peg exchange rate. When pricing an option as an asset, the mean and variance of that asset's price and other properties of the function of price distribution does matter.

For these reasons, most of the speculative-attack crisis literature in uncertain environment relies on specific examples of the distribution function for underlying disturbances [13]. In a model with full sterilization and a risk premium in an explicitly stochastic environment, the risk premium is derived from expected utility maximization and the money supply is held constant before, during, and after the crisis. With these assumptions, the interest parity relations becomes,

$$i = i^{*} + E_t\, \check{s}_{t+1} - \check{s}_t + \beta_t\, (b_t - b_t^{*} - \check{s}_t) \qquad (17)$$

which differs from equation (12) in two respects: it sets in the risk premium in a discrete-time stochastic framework rather than in a continuos time, in a perfect foresight; the coefficient β is superscripted by t (it can change period by period). If agents maximize expected utility, i.e. increase the expected wealth and decrease the variance of wealth, than $\beta_t = z\, Var_t\, (\check{s}_{t+1})$, where z is a taste-determined constant and $Var_t\, (\check{s}_{t+1})$ is a variance of a future shadow rate.

The model contains non-linearity in private behavior, which reveals multiple solutions. If agents expect more currency variability in future (a bigger $Var_t\, (\check{s}_{t+1})$), it affects the domestic interest rate through the uncovered interest parity relation and feeds into the demand for money, making the exchange rate more variable. The shift in expectations, therefore, alters the relevant shadow rate for determining whether an attack is profitable and changes the attack time. Crises can still be the outcome of inconsistency in macroeconomic policies (first generation models), but crises can now arise also from self-fulfilling prophecies about exchange-market risk for some or all fundamentals. The existence of nonlinearities in private behavior suggests that an economy can jump suddenly from no-attack equilibrium to attack equilibrium.

[13] Flood and Marion [1996].

3.3. Target Zone Models

Peg exchange rates are never completely fixed. There is a band of free fluctuation around the official rate and this rises a question of how the exchange rate behaves within the band. Krugman [1988, 1991] initiated the workout of models that are commonly called target zone models.

Target zone models assume that authorities are fully committed to maintain the band and follow policy aiming at fixing the money stock at such a level as to keep the exchange rate within the band. There are random disturbances in the money supply process. Suppose a random disturbance increases the money stock. In the flexible exchange rate system the exchange rate would depreciate. In target zone models with strong and credible commitment from the government, speculators realize that the future money stock is more likely to decline than to increase. As a result, the exchange rate is also more likely to appreciate than to depreciate in the future. Speculators, therefore, will be willing to sell foreign exchange today (expecting a lower price in the future). The exchange rate will appreciate.

The opposite mechanism is at work for shocks declining the money stock and putting appreciation pressure on the exchange rate. Maintaining the exchange rate within the band requires from authorities to increase money stock in the future and the exchange rate is more likely to depreciate than to appreciate. In an anticipation of that fact speculators will be willing to sell domestic currency (expecting a lower price in the future). The exchange rate will depreciate. This reasoning leads to conclusion that speculation will be stabilizing the exchange rate, and speculators substitute fully credible authorities in maintaining the exchange rate within the band.

If the authorities are less credible shock in the money stock will make speculators uncertain about interpretation. The shock may be a result of random disturbance that will be corrected by authorities in the future or may be a result of a change in policy. The latter implies an increase in the money stock (if exchange rate faced depreciation pressure due to a shock) and causes doubts about commitment of authorities towards the target zone regime. Speculators may interpret the weakening of currency as a signal of future problems with fundamentals. And they will buy foreign currency instead selling it. Therefore, speculation will be destabilizing factor.

The empirical evidence seems to indicate that the latter pattern is what it happens and speculation seems to be rather destabilizing factor than a stabilizing one. Therefore, domestic interest rates must be positively related to changes in the exchange rate within the band. If speculators stabilize exchange rate, interest parity condition would require domestic interest rate inversely related to the exchange rate.

Destabilizing effects of exchange rate movements within the band often led the authorities to intervene in the foreign exchange market long before the limit of the band is reached, limiting the variability of the exchange rate. Therefore, the existence of a band does not give much additional flexibility what leads to narrowing the width of the band.

4. The Second-generation Models

The second-generation models were developed after speculative attacks in Europe and Mexico in 1990s. The canonical-crises models describe authorities' policy in a very simplistic and mechanical way. In real life, the range of possible policies is much wider as authorities can lessen the balance of payment problems tightening fiscal policy, and central banks posses many more instruments other then exchange rate interventions to rigid monetary policy. However, there is always a cost to such policies, or rather a trade-off between short-term political and long-term economical goals. Therefore, the first- and the second-generation models differs in two important ways: authorities of the country experiencing a second-generation speculative attack are limited in their degrees of freedom due to political and economical constraints, and speculative attacks seem less directly related to economic fundamentals.

The second-generation model proposed by Obstfeld [1994] assumes, speculation against a currency creates objective economic conditions that make the devaluation more likely. The model draws on game theory with three players: authorities possessing a finite stock of reserves to defend currency regime and two players. The size of committed reserve stock defines the payoffs in the game, which two private traders play.

In a first game, called High Reserve game, the amount of authorities' reserves is higher than the combined stock of domestic money hold by both traders. Even if both players sell their resources to the authorities, their reserves remain at the level high enough to maintain the peg exchange rate and speculators receive a loss. The sole Nash equilibrium is the survival of currency peg.

In a second game, called Low Reserve game, the level of committed reserves is so low, that either one player can take out the currency peg. A trader who has sold all his domestic currency receives a capital gain (in domestic currency terms or avoid a capital loss in foreign currency terms) net of transaction costs. If both traders sell, each gets half the authorities reserves and shares capital gain. The unique Nash equilibrium is the collapse of exchange rate.

The most interesting is the third game, Intermediate Reserve, where neither trader alone can run the authorities' reserves although both can if they sell. The payoff structure is the following. Either player fails in the attack, bearing the loss, while gaining nothing if they hold domestic currency. But if both attack, each registers a gain. Therefore, there are two Nash equilibria: if both players sell the currency peg falls, but if neither player believes the other will attack, the currency peg survives. The result in such case will be the possibility of self-fulfilling currency crisis and the intermediate state of fundamentals (including authorities reserves) make the crisis possible, but not necessary.

In the canonical model fundamentals are either consistent with long-term currency regime or not. In Obstfeld [1994] the same is true for extreme values of fundamentals, but there is also a large room over which fundamentals are neither so strong as to make a successful attack impossible, nor so weak as to make it inevitable. In this case speculators may or may not coordinate their actions in order to attack equilibrium.

The second-generation crisis require three conditions: a reason for authorities to abandon its exchange rate peg, a reason to defend it, and increasing cost of defending current regime when its collapse is anticipated or self-fulfilled. In order to have an incentive to attack the exchange rate regime, there has to be something awkwardly fixed in domestic economy. The reasons in favor or against maintaining the current (peg) regime are plentiful. Obstfeld [1994] based his example on unemployment and authorities willingness to relax monetary policy, which cannot be implemented as long as there is commitment to a peg exchange rate. The model's basis framework is drawn from Barro and Gordon [1983], but assumes an open economy. The authorities minimize the loss function

$$\alpha = (y - y^*)^2 + \beta\varepsilon^2 + C(\varepsilon) \tag{18}$$

where y is output, y^* the authorities' output target, and $\varepsilon \equiv e - e_{-1}$ the change in the exchange rate (the price of foreign currency). Output is determined by the expectations-augmented Phillips curve

$$y = \tilde{y} + \alpha(\varepsilon - \varepsilon^e) - u \tag{19}$$

where $\tilde{y}$ is the natural output level, ε^e is domestic price-setters' expectation of ε based on lagged information, and u is mean-zero shock. The assumption $y^* > \tilde{y}$ causes a dynamic inconsistency problem, which provides a reason why rational authorities might try to consider exchange-rate realignment costs. The authorities choose the new exchange rate e (and the change in exchange rate) after observing u. The new exchange rate is a function of authorities' output target, natural level of output, mean-zero shock, and expected changes in nominal exchange rate.

$$\varepsilon = [\alpha(y^* - \tilde{y} + u) + \alpha^2\varepsilon^e] / (\alpha^2 + \beta) \tag{20}$$

From (19) and (20) the authorities achieve an output level of
$y = \tilde{y} + [\alpha^2(y^* - \tilde{y}) - \beta u - \alpha\beta\varepsilon^e] / (\alpha^2 + \beta)$,
which is determined, among others by expected change in nominal exchange rate.

The policy loss function in flexible exchange rate regime is,

$$\alpha^{FLEX} = \beta/(\alpha^2 + \beta)(y^* - \tilde{y} + u + \alpha\varepsilon^e)^2 \tag{21}$$

And with no change to the exchange rate the policy loss function is,

$$\alpha^{FIX} = (y^* - \tilde{y} + u + \alpha\varepsilon^e)^2 \tag{22}$$

The both policy loss functions depend on a difference between targeted and natural level of output, expected change in exchange rate and a shock factor. Only the parameter $\beta/(\alpha^2 + \beta)$ establishes political cost or gain of either maintaining a fixed regime or a floating one. In the presence of fixed costs $C(\varepsilon)$ in equation (18), any devaluation leads to cost $C(\varepsilon) = \check{c}$, whereas revaluation costs the authorities $C(\varepsilon) = \underline{c}$. The designed level of ε is operative only when u is so high that $\alpha^{FLEX} + \check{c} < \alpha^{FIX}$ or so low that $\alpha^{FLEX} + \underline{c} < \alpha^{FIX}$, and the authorities decide to devalue or revalue domestic currency only under the above conditions, respectively. Devaluation thus occurs for $u > \H{u}$ and revaluation for $u > \underline{u}$, given u uniformly distributed on $[-\mu, \mu]$, where

$$\H{u} = 1/\alpha\, [\check{c}\,(\alpha^2 + \beta)]^{1/2} - y^* + \tilde{y} - \alpha\varepsilon^e\ , \quad \underline{u} = -1/\alpha\, [\underline{c}(\alpha^2 + \beta)]^{1/2} - y^* + \tilde{y} - \alpha\varepsilon^e.$$

The rational expectation of next period's ε, given price setters' expectation ε^e, is

$$E\varepsilon = E(\varepsilon \,/\, u < \underline{u})\ Pr\ (u < \underline{u}) + E(\varepsilon \,/\, u > \H{u})\ Pr\ (u > \H{u}).$$

The equation is a sum of probabilities of devaluation and revaluation of currency taking into account expectation based on lagged information of price setters. After computing on authorities preferences on change in the exchange rate ε,

$$E\varepsilon = \alpha / (\alpha^2 + \beta)\ [(1 - (\H{u} - \underline{u}) / (2\mu)\ (y^* - \tilde{y} + \alpha\varepsilon^e) - (\H{u}^2 - \underline{u}^2) / 4\mu] \qquad (23)$$

In full equilibrium $E\varepsilon = \varepsilon^e$ (in the graph form it would be a 45^0 line). To find fixed points of (23), let $-i^*$ denote the minimum possible level of ε^e (that is level at which nominal domestic interest rate is zero), and assume that $\underline{c}$ and $\check{c}$ are small enough that at $\varepsilon^e = -i^*$, $\underline{u} > -\mu$ and $\H{u} < \mu$. Since $d\H{u} / d\varepsilon^e = d\underline{u}/d\varepsilon^e = -\alpha$ *if* $\underline{u} > -\mu$, but $d\underline{u}/d\varepsilon^e = 0$ once $\underline{u} = -\mu$, and $d\H{u}/d\varepsilon^e = 0$ once $\H{u} = -\mu$, there could be three equilibrium at expected devaluation rates ε_1, ε_2, and ε_3 corresponding to three different probabilities and realignment magnitudes conditional on devaluation.

$$dE\varepsilon/d\varepsilon^e = \begin{cases} \alpha^2 / (\alpha^2 + \beta) & (\text{for } \underline{u} > -\mu) \\ \alpha^2 / (\alpha^2 + \beta)\ [\ \alpha/2 + \alpha/2\mu\ (y^* - \tilde{y} + \alpha\varepsilon^2)] & (\text{for } \underline{u} = -\mu) \\ \alpha^2 / (\alpha^2 + \beta) & (\text{for } \H{u} = -\mu) \end{cases} \qquad (24)$$

From these three solutions to (23) that cross with a line 45^0, the equilibrium 3 in (24) represents a situation in which domestic price-setters' expectation of the change in the exchange rate has risen so high that it is equal to depreciation expectation under a freely flexible exchange rate. The formal parameter restriction required under flexible rate (21) is

$$(\alpha^2 + \beta)/\beta\ (y^* - \tilde{y}) - \mu \geq 1/\alpha\ [\check{c}\ (\alpha^2 + \beta)]^{1/2}, \qquad (25)$$

which is more likely to hold if the devaluation cost $\check{c}$ is low, the slope α of the Phillips curve is high, inflation aversion β is low, and the credibility distortion $(y^* - \tilde{y})$ is big. This situation fits perfectly with undesirable income distribution from the authorities' perspectives (see, below). Therefore, if markets expect the floating exchange rate resulted in step-by-step depreciation of domestic currency, the (fixed) cost of devaluation will exist. Generally, in the model, authorities are powerless to enforce its preferred equilibrium as it depends on expectations. Seemingly, random (and small) event could cause abandoning of a peg.

There are many reasons that serve in favor of abandoning the peg and as alternative mechanism causing the currency crisis. A large public debt, with a short-term maturity and/or floating interest rate might tempt the authorities to deflate it as market expectations of depreciation hikes up domestic interest rate. The mixed currency structure of debt (domestic vs. foreign currency) can only worsen a crisis as for example, 1994–95 Mexican on default on tesobonos (dollar denominated domestic debt) only aggregated the currency crisis. With unexpected rise in interest rate (following depreciation) the authorities face alternative of costly bailout of banks (as economic entities can bankrupt) or quickly devalue. Unexpected rises in interest rate redistribute income in ways that government may find undesirable. For example, a hike in mortgage interest rates in Britain was a very powerful factor leading to withdrawal from ERM in September 1992.

The logic of second-generation model of crisis arises from the fact that defending exchange rate parity is more expensive (via higher interest rates) if the market believes that it will ultimately fails. As a result, speculative attack on currency can develop either as a result of a predicted future deterioration in fundamentals, or purely through self-fulfilling prophecy. However, self-fulfilling crises models reveal an intermediate range in which crisis can happen, but need not. The question is how wide this range is. The improvements in technical efficiency of markets may be one of contributing factors to the higher frequency of currency crises in the 1990s. A situation, in which crisis can happen but need not to happen leaves speculators with only one option: selling domestic currency in order to avoid capital losses (or reap capital gains) if the exchange regime collapses, but will not suffer a loss if it does not. Self-fulfilling rational expectations and herding behavior imply the possibility of profitable market manipulation by large speculators taking short position in country's currency and triggering a crisis. In that sense, it suggests absence of any equilibrium, unless a (dis-)balancing factor is being introduced.

5. The Third-generation Models

The outburst of the Asian crisis in 1997–98 underlined an existing dispute between (modified) first-generation theorists and second-generation ones or fundamentalists versus self-fulfillers. Yet, the Asian currency crisis may be more a symptom than a cause of underlying weaknesses of real assets as capital and labor leveraged by volatile financial markets.

Clearly, the Asian crisis seems to have differed from Latin American crises in the 1980s or in Russia in 1998 in several fundamental ways. First, none of the first-generation crisis fundamentals, like high fiscal deficits, expansionary monetary policy, or high inflation seems to have been observed by the financial markets before the crisis. Second, the authorities in Asian countries did not face any dramatic trade-off between political and economic goals as in the second-generation models. Third, in all Asian countries there was boom-bust cycle in segments of the asset market (e.g., stocks, land prices, real estate) preceding the currency crisis. Fourth, the currency crisis was only part of a widespread financial crisis, including failures of financial institution, bank runs, and bankruptcies of many firms with a result of sever real downturn [14]. The proposed third-generation models concentrate on microeconomic weaknesses leveraged by high capital mobility, which leads to speculative attacks against existing exchange regimes.

In the post-crisis theoretical literature, there were proposed two major views. McKinnon and Phil [1996] as well as Krugman [1998, 1999] modeled "over-borrowing syndrome", and Corsetti, Pesenti, Roubini [1998] emphasized that moral-hazard-driven lending by unregulated banks and financial institutions could provide a sort of hidden subsidy to investment, which collapse was inevitable whenever authorities withdraw implicit guarantees. The subsidies represent hidden government budget deficit, and non-funded banks' liabilities represent a hidden government debt. Rational agent could expect that, if a financial crisis materializes, the government chooses to step in and rescue the elite firms. The currency side of financial crisis can therefore be understood as a consequence of the anticipated fiscal costs of financial restructuring, that generate expectations of a partial monetization of future fiscal deficits and a fall in economic activity by the required structural adjustment. Therefore, the poor supervision of expansionist financial intermediaries led to moral hazard, over-borrowing, over-investment, and asset-bubble environments, and the apparent soundness of macroeconomic policy was an illusion.

In an alternative view, represented by Radelet and Sachs [1998], a self-fulfilling pessimism of international lenders caused financial fragility of the countries. The authors stress that while there were significant underlying problems within the Asian economies at both macroeconomic and microeconomic level, the imbalance was not sever enough to cause a financial crisis of such magnitude. Radelet and Sachs blame a combination of few factors, as panic on the part of the international investment community, policy mistakes at the onset of the crisis by domestic authorities, and poorly designed international rescue programs, for turning the withdrawal of foreign capital into a fully fledged financial panic resulting into currency crisis, bank runs, massive bankruptcies, and political disorder.

Rapid reversal of private capital inflows into the five Asian countries the most hit by crisis (Indonesia, Korea, Malaysia, Philippines, and Thailand) was enormous and amounted to 11 percent of GDP from 1996 to mid-1997 (from $93 to –$12.1 billion, respectively). While direct investments remained constant at $7 billion, lending by non-bank private creditors dropped by roughly $5 billion (from $18.4 to 13.7 billion), but the bulk of the decline came from portfolio equity (from $12 to –11.6 billion) and commercial banks (from $55.5 to –21.3 billion). The sudden decline in bank and non-bank lending followed a period of significant increases in bank and non-bank claims

[14] Krugman [1998].

towards the Asian economies (by 26 and 28 percent from 1995 to 1996, and by 6 and 8 percent from 1996 to mid-1997, respectively). The claims of public sector to the Asian countries declined in the same period by almost 17 percent. The maturity structure of outstanding loans remained the same, but as the nominal value of short-term credits increased the ration of short-term debt to central banks' reserves worsened from 1.7 to 2.1 within 18 months [15].

Chang and Velasco [1998] attempts to explain currency crisis as a product of a bank run (modeled on Diamond-Dybvig [1983] and self-fulfillment of loss of confidence that forces financial intermediary to liquidate investments prematurely). As a result of withdrawal of foreign credits from the Asian countries, and in some cases deposits, banks were loosing liquidity and capitalization. Capital adequacy enforcement and tight credits attributed to bank closures and banking panics that spread from one country into another. The result was massive economical and political disorder that international financial institutions were not able to prevent.

Each explanation does not seem fully and uniquely adequate to explain the Asian crisis in-depth. However, the both major views seem to capture some aspects of the crisis. It could be that the Asian crisis was caused by a set of small events that at times have large consequences. These various types of reasons can be intertwined, and therefore are difficult to diagnose.

The Asian crisis dissolved yet another dispute over fundamentalists and self-fulfillers. Obstfeld [1994] argued that in second-generation models the timing of crisis was arbitrary and Krugman [1996] replied that self-fulfilling crisis would be rare events, as deterioration in the fundamentals through backward induction would always lead to occurrence of speculative attack as soon as it could succeed. Herding and contagion effects caused by the Asian crisis reveals the existence of multiple equilibria as the second-generation models predicted. If there are at least two Nash equilibria (as in the Intermediate Reserve game) many speculators following the herd and betting on a fall of the currency peg may cause the self-fulfilling currency crisis. Canonical and second-generation models assume that foreign exchange markets are efficient, making the best use of available information. The inefficiency of markets leads to the possibility of investors' herding behavior [16]. Based on individual rationality there were proposed two theories on herding. Chari and Kehoe [1996] argued that a bandwagon effect causes foreign exchange markets to overreact to news on national economic prospects. The bandwagon effect is driven by assumption that investors have private information. Being aware of that fact, other investors may follow the one who decided to sell.

[15] Radelet and Sachs [1998].

[16] Shiller [1989].

Another explanations focus on principal-agent problem as agents manage process of money investment rather then principals. When money managers are compensated based on comparison with other money managers, they have strong incentives to follow the herd even if they are wrong, than stay in market taking the risk to be right.

Explanation of contagion involves real (trade and financial) linkages between the countries. Successful speculative attack against the currency of country exporting goods that are substitutive to goods sell by not-attacked country forces the latter also to devalue in order to maintain its competitiveness. However, contagion also takes place among unlinked countries and at that point rational explanation for crisis or moral hazard approach ends and financial fragility approach starts. Drazen [1997] makes two arguments. The first is that countries are perceived as a group with some common, but imperfectly observed characteristics. The second is that political commitment to a peg exchange rate is itself subject to speculative attack and herding behavior.

The proposed third-generation model by Krugman [1999] attempts to capture micro- and macroeconomic relations and seems to operate on consistent general economic relations contrary to other models that rely more on patchwork of small models. Krugman [1999] considers open economy producing single good using labor and capital (Cobb-Douglas production function). The residents of the economy are divided into two classes: workers playing passive role and spending all their income and entrepreneurs saving and undertaking domestic investments (domestically and abroad). There is a unitary elasticity of substitution on good produced by the country, with a share μ of consumption and investment spending on imports, $1-\mu$ on domestic goods. If the foreign elasticity of substitution is also 1, the value of domestic exports in terms of foreign goods is fixed at X, and the value in terms of domestic goods is pX. Where p is the relative price of foreign goods, i.e. real exchange rate, which is defined as follows

$$p_t = \{y_t[1 - (1 - a)(1 - \mu)] - (1 - \mu)I_t\}/ X \qquad (26)$$

A share $(1 - a)$ of domestic income accrues to workers who must spend it, C and I is investment and consumption expenditures in terms of domestic goods. From (26), the higher is investment, the more appreciated is the real exchange rate. The ability of entrepreneurs to invest is limited by their wealth. Assuming that lenders impose a limit on leverage, entrepreneurs can borrow at most m times of their initial wealth, $I_t \leq (1-m)W_t$. They may choose not to borrow up to the limit and they will not borrow beyond the point at which the real return on domestic investment equals that on foreign investment. Because a share μ of investment falls on foreign goods, the price index for investment relative to that of domestic output is $p^{-\mu}$. The return on investment in terms of domestic goods (G_k) and labor (L) is therefore,

$$1 + r_t = G_k \, (I_{t-1} \, p^{-\mu}, L) \tag{27}$$

To determine the limit of real return on domestic investment contrary to the foreign one is to compare the foreign real interest rate (r^*) with the return achieved by converting foreign goods into domestic (at time t), and then in next period ($t+1$) from domestic into foreign ones. As a unit of foreign goods can be converted into p_t units of domestic goods at t, the return can be converted into $1/p_{t+1}$ units at the next period. Therefore, the return on domestic investment must be at least at the level of return on foreign bonds,

$$(1 - r_t)(p_t \,/\, p_{t+1}) \geq 1 - r^* \tag{28}$$

And the investment cannot be negative $I_t > 0$.

The entrepreneur wealth is defined $W_t = ay - D - pF$, where y is entrepreneur's income available at technological parameter a, D and F is net debt of domestic entrepreneurs indexed to domestic and foreign goods, respectively. As the limit of domestic entrepreneurs borrowing from foreigners depends on their wealth, the limit of each individual entrepreneur depends on the level of such borrowing in the whole economy. And the volume of capital inflows affects the terms of trade and the valuation of foreign-currency-denominated debt (or foreign-goods-denominated debt). The financial crisis will be brought out by a decline in capital inflows that adversely affect the balance sheets of domestic entrepreneurs, reducing their ability to borrow and hence further reducing capital inflows. From (26) and definition of wealth, the relationship between investment and the wealth of entrepreneurs implies that

$$dW \,/\, dI = (1 - \mu)F \,/\, X \tag{29}$$

and since the ability of entrepreneurs to borrow depends on their wealth

$$dI_f \,/\, dI = (1 + m)(1 - \mu)F \,/\, X \tag{30}$$

where I_f is the "financeable" level of investment if leverage limit is binding. If $dI_f \,/\, dI$ is less than 1, economy with a high rate of return on investment may find that adjustment in its capital stock is delayed by financing constraints. But if dI_f / dI is greater than 1, there will be multiple equilibria, and possibility that loss of lender confidence can trigger the financial collapse. At high level of I, the constraint on investment level is determined by the rate of return constraint. At low level of expected I firms are bankrupt and cannot invest at all. In an intermediate range I is constrained by financing (and is steeper than a 45^0 degrees line between expected and actual investment schedule). Therefore, the three equilibria are at work.

The intermediate equilibrium will be unstable under any plausible mechanism of expectation formation mentioned above. It leaves two possible outcomes: high level of I and low level of I. At the former level, investment takes place up to the point of equal domestic and foreign rates of return. At the latter, lenders do not believe in collateral of domestic entrepreneurs and it means a depreciated real exchange rate, which implies their bankruptcy. The switch in investors' moods resulted in a switch from high-level I into low-level I. This does not mean that previous investments were unsound. Instead it reveals the financial fragility problem ($dI_f / dI > 1$). Besides, the criterion has nothing to do with maturity mismatch. The factors that can make financial collapse are: high financial leverage, low marginal propensity to import, and large foreign-currency debt relative to exports. The Asian economies were peculiar because of the combination of these factors and their growing weight during last decade.

Summary

In the canonical first-generation models (Krugman [1979], Flood and Garber [1984]), a government with persistent money-financed budget deficit and limited stock of reserves pegged its exchange rate, that ultimately was unsustainable with investors anticipating collapse and speculating against the currency when reserves fall to some critical level. In the second-generation models (Obstfeld [1994], [1995]) authorities were facing a trade-off between short-term macroeconomic flexibility and long-term credibility choosing whether or not to defend a pegged exchange rate. The crisis arose from the fact that defending parity is more costly (e.g., through higher interest rates) if markets believe defense was ineffective. Speculative attack on currency can develop either as a result of an anticipated deterioration in fundamentals, or purely through self-fulfilling prophecy. The so-called third-generation model being built after the Asian crisis may have been only incidentally about currencies, and instead was mainly about corporate governance, bad banking, its microeconomic, and than macroeconomic consequences.

The three types of the mainstream currency crises models present how theoretical framework developed from macroeconomic approach as in the canonical model, to microeconomic understanding of investors' behavior, and finally attempting to combine pieces into macro-microeconomic third-generation models. The sophistication of models followed the understanding of economic problems as well as evolution of the whole economy, especially thrive of financial markets. However, the elegance of mathematical models with their assumptions and simplifications cannot neglect the simple economic logic or economic rules that still remain the same. The main lesson from the history and models of crises is wrong economic policy always cause troubles. What has changed is smaller margin of errors for policy decision-making process as is quickly verified by financial markets. The latter may make mistakes and tend to overreact, but primary causes of any crisis always result from authorities' policy.

The theory leaves still many questions open to mention only three. One of the most important from theoretical and practical point is possible consequence of currency crisis for economy that implies introduction of appropriate stabilization programs. The striking contrast between the first- and the second-generation models were revealed in the consequences of the crises. Countries experiencing second-generation crises recovered faster than the first-generation crises ones. This argument can work in favor of more speculative than fundamental reasons of the second-generation crises. However, the short-history of recovery after the third-generation model of the Asian crisis presents a mixed picture. And performance of the Asian countries significantly differs, as purely economic fundamentals seem to be very different in individual countries. The second broadly discussed problem is liberalization of financial markets and capital flows. There is one fundamental problem with the advocates of restrictions on capital mobility. They were usually in favor of free capital movement (heavily) relying on financial markets as long as it paid off and as they provided financing to doubtful political decisions from economic perspective. The third open question is the role of international financial organizations and private sector in prevention of crises' contagion and spillover and/or financing rehabilitation programs.

The currency crises will remain the element of a market economy, as long as there will be any downward rigidity in the markets and more than one currency to speculate on.

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