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UNDERSTANDING AND MODELING CURRENCY CRISES AND CONTAGION

A thesis submitted to

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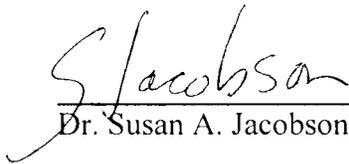for Graduation with Honors

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Section I: Introduction

Approximately four trillion dollars and 143 currencies trade daily in the foreign exchange market, making it the largest market of the world (Monetary and Economic Department, 2010; Frangos, 2010). Sometimes there are crises in these markets. The goal of this thesis is to explain currency crises and model how they move from country to country producing what economists call contagion. I will discuss a case study and use a cellular automata model to explain and model currency crises and contagion.

The foreign exchange market consists of a series of banks and their traders who conduct foreign exchange trades with their customers and each other. The trading with customers is the retail part of the market and the trading between the banks is called the interbank market (Pugel, 2009, p. 401, 403). In the foreign exchange market, the U.S. dollar is the most actively traded currency in the world followed by the euro, the Japanese yen and the pound sterling in fourth place (Bank of International Settlements, 2007).

One reason individuals, businesses and other organizations use the foreign exchange market and trade currencies is to enable them to interact with other individuals, businesses or organizations that use different currencies. For example, a firm in China that purchases an airplane from a U.S. producer can contact its bank and request quotations for selling yuan and obtaining dollars in the spot market, (which allows trades at today's price) because the U.S. producer will only take payment in U.S. dollars. However, 40% of foreign exchange trading is trading among the banks themselves in the

interbank part of the foreign exchange market (Pugel, 2009). People also speculate in the currency markets. Speculators make trading decisions based on signals of the future economic conditions that affect exchange rates in order to benefit from changes in the value of currencies (Madura, 2008). In addition, many international trades are in the futures market for exchanges sometime in the future, either to eliminate risks—to lock in a price today, for a necessary transaction in the future—or to speculate that the future spot price will be different than today's futures price.

The price of a currency is greatly influenced by its exchange rate system. In general, there are two kinds of exchange rate systems: fixed and floating. In fixed exchange rate systems officials declare a narrow "band" of exchange rates within which the rate is allowed to vary (Pugel, 2009, p. 410). On the other hand, floating exchange rate systems price currencies based on the interaction of private demand and supply for currencies.

Today most countries have floating exchange rates, but that was not the case 40 years ago. After World War II, world leaders met in Bretton Woods, New Hampshire, to create a fixed exchange rate system in order to promote trade (Lewis, 2007, p. 240). The crippled global economies left after WWII needed to start trading to come out of their economic and financial problems. Fixed exchange rates encouraged trade because they eliminated uncertainty about the prices of goods purchased from and sold to other countries. However, in the 1970s most countries gradually switched to floating exchange rates from fixed exchange rates (Bhandari, 1985, p. vii). Different economic conditions in the different countries that did not sync up with supply and demand necessary to maintain

the fixed exchange rates forced countries to go to floating exchange rates. Today, sometimes governments intervene to manage supply and demand and influence exchange rates. In addition, there are still some countries that have fixed exchange rates between their currencies and the U.S. dollar or the euro.

Looking at the daily newspaper postings of exchange rates, it is easy to see that in the short run floating exchange rates are highly volatile and it is difficult to understand why they change as they do. Economists explain exchange rate changes using supply and demand. There are three main factors that influence the value of an exchange rate: inflation, interest rates, and economic growth.

To illustrate how these factors influence demand and supply take for example the value of the dollar relative to the euro. U.S. consumers buy euros and sell dollars because they want to buy European goods, services, and assets, both financial and real. On the other hand, Europeans buy dollars and sell euros because they want to buy U.S. goods, services, and financial and real assets. If U.S. prices increase more than European prices, relatively higher inflation in the U.S., the demand for dollars decreases. This occurs because U.S. goods are now more expensive to Europeans and they buy fewer U.S. goods and fewer dollars, which leads to a depreciation of the dollar. If U.S. interest rates decrease relative to European interest rates, the U.S. dollar depreciates because Europeans demand fewer dollars. This occurs because investors are not interested in earning low returns on their investments. Similarly, if U.S. economic growth is slower than European economic growth, we expect a decrease in the demand for the dollar and thus depreciation of the dollar. A decline in the total economic output signals fewer jobs,

income and opportunities, which means less investment and consumption. In conclusion, the exchange rate value of a home currency rises in the short run when home prices rise relatively slower than foreign prices, when home interest rates rise relative to the foreign interest rates, and when an economy's output is rising (Pugel, 2009, p. 443).

Other than economic factors, another element that influences the value of a currency is speculation. Speculators can also drive exchange rate changes purely by expecting a future spot rate that is different from the current futures prices (Pugel, 2009, p. 443). In the long-run economic fundamentals predict relationships based on underlying forces that influence supply and demand.

Even though the developed economies have floating exchange rate systems, emerging markets still fix their currencies to promote trade and send a signal that they will have responsible monetary policy. To keep the exchange rate fixed, the central bank of the developing economy must replicate the monetary policy of the country to whose currency it's fixed. For example, developing countries that fix their currencies to the dollar are sending a signal that they will replicate the U.S. Federal Reserve monetary policy. The two fixed currencies do not move relative to each other, but do move relative to other currencies. However, fixing a currency has its drawbacks.

One of the major flaws of fixed exchange rate systems is currency crises. There have been 435 known currency crises across 195 countries from 1960 to 2006 (Pushan & Padmanabhan, 2009). These events produce levels of volatility in the currency and the economy, which cannot be controlled by policy makers in the affected economies.

Another problem is that these crises often spread from one country to another. Economists call this contagion (Pesenti & Tille, 2000).

In the course of this thesis, I plan to explain and model currency crises and contagion. The rest of the thesis is organized as follows: Section II provides a literature review of currency crises and contagion. Section III describes the case of currency crisis in East Asia. Section IV tells the story of Thailand before and during the crisis from the perspective of a typical news reader. Section V brings the reader to the present situation of the topic and Section VI tries to replicate the role of investors in these events using a cellular automata model. Section VII concludes.

Section II: Currency Crises and Contagion Literature Review

   Currency Crises

   When "investors flee a currency because they fear that it might be devalued" a currency crisis, also known as an exchange-rate crisis or a currency crash, occurs (Krugman, 2000, p. 1). Capital flight forces devaluation and leads to a currency crisis. Over the period from 1960-2006, it is estimated that there were 435 currency crises across 195 countries (Pushan & Padmanabhan, 2009). Recent incidents of currency turmoil were evident in the European Exchange Rate Mechanism in 1992-1993, the Latin American Tequila Crisis after Mexico's peso devaluation in 1994-1995, and the currency crisis in East Asia in 1997-1998 (Pesenti & Tille, 2000). Economists and academics agree in a broad sense on the nature of currency crises.

   One driver of currency crises is poor macroeconomic policy decisions (Krugman, 2000). In this case investors perceive poor policy will lead to currency devaluation, as a result, governments often attempt to defend a fixed exchange rate by raising interest rates and/or intervening in the currency market. But often the cost of defense (slower economic growth) is greater than the cost of letting the currency float, so they abandon the defense. The classic "foreign-reserve driven" model says that speculation of currency devaluation leads to a depletion of foreign exchange reserves (Krugman, 2000). The depletion of foreign exchange reserves is due to the selling of foreign currency held in the central bank in order to purchase the domestic currency and ensure that their exchange rate does

not fall below the fixed rate. Once the central bank runs out of foreign currency, it forces the central bank to give up its defense of the original parity (Krugman, 2000). Because investors know this, doubts can develop about the government's willingness to defend the parity.

Looking at the latest currency crises, Pesenti and Tille (2000) address the debate on what is truly causing currency and financial instability. They conclude both weaknesses in economic fundamentals and shifts in market expectations and confidence lead to crises. The first-generation, exogenous-policy models focus on the unavoidable result of unsustainable policies and fundamental imbalances unrelated to the actions of market participants (Pesenti & Tille, 2000). In this model "what matters for the analysis are the *future* policy stances that investors foresee" (Pesenti & Tille, 2000, p. 4). The second-generation, endogenous-policy models concentrate on the interaction between expectations and actual outcomes, in which market expectations directly influence macroeconomic policy decisions (Pesenti & Tille, 2000). Policymakers' actions are a response to macroeconomic shocks created, on a large part, by market participants (Pesenti & Tille, 2000).

A key point in the endogenous-policy models is the interaction between investor's expectations and actual policy outcomes, which can lead to self-fulfilling crises. For example, if foreign investors consider the possibility of devaluation in a nation's pegged domestic currency, they may begin charging a high-risk premium on their loans to that nation. The costs of borrowing increase significantly for the borrowing nation. Authorities may conclude that the costs of maintaining the currency pegged are too high

and prefer to devalue the currency to ensure demand and employment. Thus, the devaluation occurred as investors expected, leading to a self-fulfilling prophecy. This model though, does not describe what causes the shifts in investors' expectations (Pesenti & Tille, 2000).

After a currency crisis is created, they tend to manifest themselves in one or all the following forms. In the "macroeconomic policy-induced crisis," the domestic credit expansion by the central bank is inconsistent with the pegged exchange rate which makes it an exogenous-policy induced crisis (Radelet & Sachs, 2000). This leads to a gradual decline in foreign exchange reserves because the central bank will directly intervene by using its reserves to buy the home country's currency and prevent the further devaluation of their currency. However, the central bank becomes susceptible to an abrupt run, which drains the remaining reserves and drives the currency to a floating rate (Radelet & Sachs, 2000). The central bank is susceptible to an abrupt run because market participants and analysts have high anticipation of crisis and may withdraw their investments and loans. There is the possibility of official intervention through macroeconomic adjustments such as monetary policy in the form of interest rates or fiscal policy in the form of budgetary reductions. Internally, the country will see a slowdown in economic growth, a rise in unemployment, and the possibility of deflation due to the government's effort to place upward pressure on the currency's value.

In the endogenous-policy produced "financial panic" crisis, short-term creditors suddenly withdraw their loans requiring a lender of last resort (Radelet & Sachs, 2000). The panic occurs because short-term debts exceed short-term assets. Because no single

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private market creditor is large enough to supply all of the credits necessary to pay off existing short-term debts, there must be an institution that will (Radelet & Sachs, 2000). Additionally, it becomes rational for creditors to withdraw their investment when other creditors are doing the same thing. In terms of currencies, a financial panic signifies a decrease in the demand for financial and real assets in the affected economy, thus a decrease in demand for its currency, which leads to a depreciation in the currency's value.

A "bubble collapse" crisis, also endogenous-policy induced, occurs when speculators buy a financial asset, such as stocks, bonds, or currencies, at prices higher than fundamental values in the anticipation of a successive capital gain (Radelet & Sachs, 2000). In this event, participants are aware of the existence of a bubble and a probability that it might collapse (Radelet & Sachs, 2000). Official intervention can delay the bursting of a bubble, but this may lead to a deeper crisis later (Radelet & Sachs, 2000). The creation of the bubble in a country requires investors to demand the currency of the nation, increasing the value of assets dramatically due to over-optimism. But when the bubble bursts, asset prices decline and the currency is at a risk of collapsing due to the dramatic decrease in demand for the currency.

The "moral hazard crisis" is an outcome of unstable policy. In this crisis banks borrow excessive amounts of money on the basis of public guarantees of bank liabilities rather than fundamental values, which prolongs the misallocation of resources (Radelet & Sachs, 2000). Sometimes banks use these funds in an overly risky or even criminal manner (Radelet & Sachs, 2000). However, the majority or all creditors are protected by

explicit or implicit guarantees (Radelet & Sachs, 2000). Nevertheless, there is high

anticipation of crisis by market participants and analysts (Radelet & Sachs, 2000). So any

sign of crisis leads to capital flight.

Contagion

A unique feature of the 1990s crises listed in the introduction of this section, is

their spillover across several neighboring countries, a phenomenon referred to as

contagion. Haile and Pozo (2008) define contagion as the likelihood of significant

economic changes in one country spreading to other countries; this can be either

economic booms or economic crises. In other words, contagion is "the spread of market

disturbances—mostly on the downside—from one country to the other, a process

observed through comovements in exchange rates, stock prices, sovereign spreads, and

capital flows" (Dornbusch, Park, & Claessens, 2000, p. 177). More specifically, Krugman

(2000) proposes that currency crisis contagion is "the way that a crisis in one country

seems able to trigger a crisis in another, even when the economic links appear to be

minor" (p. 4). Haile and Pozo (2008) point out the need to find out how crises spillover

across countries to find solutions for crisis prevention, management, and resolution.

The channels of crisis transmission or contagion are many. Calvo and Reinhard

(1996) first coined the term "fundamentals-based contagion" which focuses on spillovers

that result from the normal interdependence among market economies (as cited in

Dornbusch, Park, & Claessens, 2000). The fundamental causes of contagion include

global shocks such as major economic shifts in industrial countries and changing

commodity prices (Dornbusch, Park, & Claessens, 2000). A major economic shift in an

industrialized nation, for example an increase in the value of the U.S. dollar, can lead to a crisis in an emerging economy pegged to the dollar and transmit the crisis to other developing countries also pegged to the dollar. This occurs because as the value of the U.S. dollar increases so does the value of the currency of the emerging economy. This makes the price of goods, services, and assets more expensive and affects many aspects of the economy that lead to a crisis.

Another channel of transmission is trade links (Dornbusch, Park, & Claessens, 2000). Trade links refers to a common foreign trade transmission among a group of countries (Desai, 2003). Once a crisis has hit a country, any major trading partner of the country in crisis may experience a decline in exports to the crisis country, and a decrease in investment and capital inflows from this country. This in turns can affect the economic fundamentals of the trading partner. Due to these affects, any major trading partner may become susceptible to a speculative attack from investors, which produces the transmission of crises from country to country through trade links.

Additionally, competitive devaluations, such as sharp currency devaluations cause contagion (Dornbusch, Park, & Claessens, 2000). A country hit by a currency crisis experiences a drastic decrease in the price of its goods. This reduces the export competitiveness of any country the crisis nation competes with and puts a downward pressure on their currency. The competitive devaluation induces currency depreciations in other nations, transmitting the currency crisis that began in one country to other nations. Market participants also play a role in this channel of transmission. If market participants anticipate that a currency crisis in one country will lead to a game of

competitive devaluations, they will sell their holding of securities of the competing

countries, stop investing, or refuse to roll over short-term loans to borrowers in those

countries (as cited in Dornbusch, Park, & Claessens, 2000).

Financial links also cause contagion (Dornbusch, Park, & Claessens, 2000). Any

firms in countries linked in trade, investment, and financial transactions to the crisis

country would be unfavorably affected. This occurs because a currency crisis limits the

ability of the crisis country firms and investors to invest in other countries, extend credit,

and reduces any other capital flows abroad. Once a nation becomes a part of the global

market, any financial disorder in that nation can affect other nations. As a result, a crisis

in one country is reflected in other nations.

Additionally, similarities across countries in macroeconomic policies and

conditions, along with weakened fundamentals are causes of contagion (Desai, 2003;

Eichengreen, Rose, & Wyplosz, 1996). These include similar monetary and fiscal

policies, such as loose monetary and fiscal policy, and similar conditions such as inflation

rates, GDP growth, and employment levels. If an emerging nation is experiencing a

currency crisis, market participants will not only withdraw their funds from this nation,

but also from nations that have similar macroeconomic policies and conditions. Investors

make the rational conclusion that what is occurring in one country is likely to happen in

another nation due to the macroeconomic parallels, and even more so when weak

fundamentals are present. The withdrawal of funds from other nations provokes a crisis in

those nations that may have not occurred or may not have occurred so soon. As a result,

the speculative attack from investors is what makes similarities across countries in macroeconomic fundamentals a channel of crisis transmission.

The spread of crises is further attributed to the behavior of investors or other financial agents. Investors' behavior as a cause of contagion depends on the degree of financial market integration (Dornbusch, Park, & Claessens, 2000). Countries that are closely integrated into the global or regional financial markets are susceptible to common shocks or real shocks from other countries. This occurs because asset prices and other economic variables impact each other as explained above in the case of an increase in the value of the U.S. dollar. Investors' behavior can lead to contagion when investors decide to sell off securities due to liquidity and incentive problems (Dornbusch, Park, & Claessens, 2000). Incentive problems can be capital losses due to large declines in currency values which induce investors to pull out their investment (Dornbusch, Park, & Claessens, 2000). Investors also sell due to imperfect information and differences in investor expectations, sudden shifts in market expectations and confidence, and changes in the rules of the game (Dornbusch, Park, & Claessens, 2000). In the case of the last event, investors fear that countries will create policies putting restrictions on foreign private creditors through capital controls which would prevent investors from converting their foreign currency investments back to their own home currency (Dornbusch, Park, & Claessens, 2000). All cases lead to sudden withdrawal of funds from countries with similar characteristics (Dornbusch, Park, & Claessens, 2000). Further, common creditors may target banks in an infected country for fund withdrawal (Desai, 2003). Overall,

market participants' perception of the economic outlook in countries with similar features is a transmission channel of currency crises (Pesenti & Tille, 2000).

Due to imperfect information, there is a tendency of uninformed investors to follow the actions of the informed investors known as "herd behavior" (Dornbusch, Park, & Claessens, 2000). The tendency to herd increases as the number of investors and markets increases because it is more costly to stay informed. Thus following those most likely informed is the easiest strategy (Dornbusch, Park, & Claessens, 2000). This type of investor behavior reflects both rational and irrational behavior (Dornbusch, Park, & Claessens, 2000). Some investors may be aware of weak fundamentals in a market and rationally conclude that other markets with similar characteristics may face the same problems. Those investors who decide to follow the informed investors due to lack of information, producing a cascading behavior, may be acting irrationally because they are unsure of why they are acting the way they are. During a financial crisis, investor behavior is a key element in determining the potential for contagion across emerging economies (Dungey & Tambakis 2005, p. 17). This is true because the prices of financial assets are a result of their expected returns (Dungey & Tambakis, 2005). If the expectations of investors in different markets are in some way associated with one another, then an alteration in confidence in one market will extend to others (Dungey & Tambakis, 2005). The CA model in this paper focuses on this unique aspect of contagion along with neighborhood effects further explained in Section VI.

Research has found empirical evidence of contagion. Analysts compare asset prices before and during crises in different countries. They have found that increases in

asset prices are present in a set of countries before a crisis occurs. However, crises do not

occur in all nations at the same time. Contagion is manifested in the correlation of

variables such as interest rates and stock prices. This signifies that what happens in one

country can be found in another country in a matter of days or weeks.

Another evidence of contagion is shown by research on conditional probabilities

which "involves estimating the probability of a crisis conditional on information on the

occurrence of crisis elsewhere, taking into account fundamentals or similarities"

(Dornbusch, Park, & Claessens, 2000, p. 187). It has been found that the likelihood of

crisis is higher in a given country when there is a crisis in one or several other countries

(Dornbusch, Park, & Claessens, 2000).

Further empirical examination of contagion found that volatility spillovers show

that cross-market movements in asset prices can cause contagion as well (Dornbusch,

Park, & Claessens, 2000). Lastly, studies on capital flows show that contagion is

transferred through the actions of portfolio investors: price increases encourage

investment while price decreases reduce investment. Thus, findings show that buying

current winners and selling current losers is stronger during crises (Dornbusch, Park, &

Claessens, 2000).

Additional research on contagion found that contagion tends to be regional rather

than global because trade tends to be more intraregional than interregional. This supports

evidence that contagion has been primarily a regional phenomenon as shown by the

grouping of crises by continents or regions (Glick & Rose 1998; Haile & Pozo 2008).

Other findings show that that the probability of contagion increases when the crisis is

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associated with the common creditor channel, which is borrowing from the same banks and institutions (Kaminsky & Reinhart, 2000). The probability of a crisis in a given country further increases as the number of its neighboring countries in crisis increases (Haile & Pozo, 2008).

International financial regulators, such as the International Monetary Fund (IMF) and the Financial Stability Forum (FSF), react to crises, patching up the system once a crisis has hit (Dungey & Tambakis, 2005). There are though, a series of methods to prevent and contain crises. These are forms of capital account controls to regulate speculative flows. The first method involves coordinating the supervision of hedge fund activities (Desai, 2003). This would involve the temporary banning of their short selling of shares and would enforce greater transparency of their activities (Desai, 2003).

Another form of prevention is to follow the Basel Committee standards (Desai, 2003). The goal of the committee is to create stable global markets to prevent any drastic outflows and inflows of capital from any country (Desai, 2003). This committee provides authorities from nations a series of administrative standards and guidelines for banking supervision (Desai, 2003). Such guidelines require banks to maintain capital equal to at least four percent of their assets weighted by risk (Madura, 2008). Riskier assets require a higher capital ratio (Madura, 2008). The Tobin Tax is another method to regulate speculative flows (Desai, 2003). In 1971, Nobel Laureate economist James Tobin proposed a tax on transactions in currency markets (Desai, 2003). This tax would discourage short-term speculative inflows into a currency, with the goal of achieving international currency stability (Desai, 2003).

A form of containing and resolving a crisis is temporary debt repayment

suspension (Desai, 2003). Debt suspension can "moderate the frequency of financial

crises in emerging markets by placing the burden of debt restructuring on potential

investors" (Desai, 2003, p. 274). Further, it will allow borrowers to raise the necessary

cash without lenders mandating payment immediately (Desai, 2003). Collection action

clauses also attempt to resolve financial crises by allowing all bondholders to agree on

debt restructuring and binding all holders (Desai, 2003). These clauses though, cannot

prevent crises if creditors foresee financial problems with borrowers and decide to sell

their assets bringing a crisis sooner (Desai, 2003).

In order to prevent any type of contagious financial crises "countries may need to

adopt regionally or globally coordinated measures" but it may also depend on the

channels (Haile & Pozo, 2004, P. 573). Assuming that trade is a channel that spreads

financial crises, countries may need to diversify their trade and/or fix their exchange rates

within trading blocs (Haile & Pozo). If financial markets or activities are what spread

financial crises, countries may need to impose capital controls and/or use a lender of last

resort to neutralize the channel providing liquidity support (Haile & Pozo, 2008).

Additionally, both debt composition and exchange rate flexibility limit the extent of

contagion (De Gregorio & Valdes, 2000). For example, if local developers and

government borrow local currency at a fixed rate they are less likely to be impacted by

changes in the foreign currency value and increasing interest rates. Further, allowing the

local currency to float will enable economies to escape the contagion effect because they

can avoid having to defend a fixed rate.

Whatever the solution may be, during the 1990s emerging markets were being pressured by developed economies and financial regulators to avoid any form of capital controls (Desai, 2003). Today, the IMF recognizes that restrictions on capital inflows and outflows prepare a country for less damage in case of a crisis (Gjelten, 2010). Additionally, in the years after the currency crashes of the 1990s, the roles of the IMF, World Bank, and regional development banks were reformed by the Meltzer Commission (Desai, 2003). The Meltzer Commission was formed in 1998 by the U.S. Congress (Desai, 2003). The reforms include the creation of feasible and effective infrastructure and services that would permit market solutions and reduce the severity of financial crises (Desai, 2003). The commission expected fewer crises, and less moral hazard (Desai, 2003).

Section III: East Asian Crisis

From the summer of 1997 to the middle of 1998, five Asian countries experienced currency crises. What began in Thailand spread to Malaysia, Indonesia, South Korea and Philippines and to other continents as well. Economists and academics study this event to determine the causes of the crisis and the reasons for contagion.

Prior to the East Asian Crisis, Asian countries were achieving unbelievable economic growth through advances in technology and economic improvement. Countries including China, Hong Kong, Taiwan, Singapore, Indonesia, Thailand, Malaysia, Philippines, and South Korea, had "strong macroeconomic fundamentals of high growth and low inflation rates, high savings and investment rates, and low to nil budget and current account deficits in the years before the onset of the crisis" (Desai, 2003, p. 9). There are however, a few significant differences in macroeconomic conditions between the countries. For example, prior to July 1997, Thailand was one of the of the world's fastest growing economies, had low inflation rates, along with high savings and investment rates, but it also had one of the highest current account deficits (Desai, 2003). Table 3.1 illustrates the specific economic indicators of Thailand along with those of the countries in the region.

Table 3.1

Macroeconomic Indicators for East Asian economies: 1991-1996

Country	Growth rate (%)	Inflation rate (%)	Saving rate	Investment rate	Current account balance
					(% of GDP)
Indonesia	8.67	7.82	29.64	32.44	-2.8
Malaysia	8.65	4.20	31.21	38.99	-7.78
South Korea	7.40	5.99	34.81	37.01	-2.20
Philippines	2.80	10.13	18.34	22.64	-4.30
Thailand	7.99	4.98	33.86	41.06	-7.20
China	11.38	12.30	39.65	39.04	0.61
Hong-Kong	5.27	8.74	33.15	30.40	2.76
Taiwan	6.48	3.64	27.91	23.68	4.20
Singapore	13.35	2.36	49.05	34.79	14.25

Note. From Desai (2003), annual averages for 1991-1996.

Macroeconomic indicators for the different countries in Asia from 1991 to 1996, demonstrate the state of the economies before the crisis. Table 3.1 shows that the average annual growth rates for the Asian economies during this period range from 5 to 13 percent, excluding the Philippines. All of the countries, except for China, the Philippines, Indonesia, and Hong-Kong, exhibit relatively low single-digit inflation rates. Additionally, the saving rates are high, ranging from 18 to approximately 50 percent of gross domestic product. The investment rate for the first five countries, which is higher than domestic saving, shows foreign capital inflows supporting the growth of these nations. The negative current account balances for the first five nations, for example Malaysia and Thailand, who post current account deficits of 8 and 7 percent in 1996, meant more borrowing from abroad to finance the deficit.

During the period from 1990 to 1996 the exposure to foreign borrowing for the Asian countries led to large foreign debts for some of them. Table 3.2 on the following page shows the changes in critical variables between 1990 and 1996. It shows a rise in the foreign debt of Malaysia, South Korea and Thailand. The table also shows a rise in foreign short-term debt as a percentage of total debt, and as a percentage of foreign exchange reserves for Indonesia, Malaysia, South Korea, and Thailand. Foreign short-term borrowing amounted to almost one quarter of bank loans to the private sector for Indonesia, South Korea, Philippines, and Thailand. The rates of foreign short-term debt to money supply were excessively high for the first five nations, excluding Malaysia. In contrast, China, Hong-Kong, Taiwan and Singapore maintain stability of total foreign debt as a percentage of GDP during the same period. Foreign short-term debt as a percentage of total debt fell for Hong-Kong and Taiwan, and as a percentage of foreign exchange reserves it fell for China and Hong-Kong to 24 and 14 respectively. China, Hong-Kong, Taiwan, and Singapore maintained low short-term borrowing rates and rates of foreign short-term debt to money supply, excluding Hong-Kong in the latter.

Table 3.2

Foreign Debt in East Asian economies, 1990 and 1996

Country	Total Foreign Debt (% of GDP)	Foreign short-term debt (% of total debt)	Foreign short-term debt (% of foreign exchange reserves)	Foreign short-term debt/bank lending to private sector (%)	Foreign short-term debt/money supply (%)
Indonesia	66--57	16-25	149-177	21-26	86-146
Malaysia	36-40	12-28	10-41	6-12	10-35
South Korea	14-28	31-50	72-203	8-23	48-141
Philippines	69-50	15-19	152-79	52-20	116-89
Thailand	33-50	30-57	63-107	15-23	110-246
China	16-16	18-18	67-24	3-3	7-7
Hong-Kong	16-16	46-28	24-14	4-4	48-64
Taiwan	10-10	88-68	22-22	10-5	22-15
Singapore	10-10	17-17	2-2	2-2	8-8

Note. From Desai (2003), estimates are put together from IMF and Corsetti et al. (1998),

Radelet and Sachs (1998), Wade (1998), and Wong (1998)

Overall, the data represents the fundamentals of the East Asian economies

through macroeconomic indicators and measures. Gross domestic product (GDP), along

with growth, inflation, savings, and investments rates, and the economy's current account

deficit, in relation to GDP, are common economic indicators. The macroeconomic

measures, such as the ratios of external debt to GDP and money supply, and export

earnings to total debt, are measures affecting the health of the economy's current account

balance. Both indicators and measures reflect a country's potential to continue growing

while meeting its external debt obligations.

The variables are important because they demonstrate the potential threats of

domestic fiscal imbalances. Sizable current account deficits, as evident in Thailand and

Malaysia, make a country more vulnerable to currency crises and speculative attacks (Pesenti & Tille, 2000). When countries are unable to generate the sufficient export earnings to cover the current account deficits this affects the viability of their exchange rate system, which in the case of the Asian economies, was their ability to maintain a pegged exchange rate (Pesenti & Tille, 2000). When macroeconomic ratios are high, such as foreign short-term debt as a percentage of foreign exchange reserves and to money supply as demonstrated for some of the Asian economies in Table 3.2, it raises the probability that a government will have to apply an expansionary monetary policy. An expansionary monetary policy with a fixed exchange rate regime leads to a depletion of foreign reserves due to the defense of the exchange rate peg (Pesenti & Tille, 2000). The defense requires the central bank to buy home currency in order to maintain the pegged exchange rate. Due to the depletion of foreign reserves, the rate of domestic credit expansion is guaranteed to surpass the demand for the home currency (Pesenti & Tille, 2000). This then leads to the selling of domestic assets due to the decrease in yields (Pesenti & Tille, 2000). Domestic investors demand foreign currency to invest in foreign assets, which forces the domestic central bank to further reduce its foreign reserves (Pesenti & Tille, 2000). Every event ultimately leads to the depreciation of the domestic currency.

With the macroeconomic indicators and measures as they were for the Asian economies prior to 1997, a crisis should have been expected for Thailand, Malaysia, Indonesia, Philippines, and South Korea. Rates and ratios by 1996 were showing large debts and account balance deficits, nevertheless, banks and investors focused on growth.

On the assumption that Thailand's economy would maintain its soaring growth, banks made many risky loans. Commercial developers borrowed excessively without needing to prove that growth was feasible (Madura, 2008). To improve the country's infrastructure, the government borrowed heavily (Madura, 2008). Lastly, corporations' friendly relationship with banks, enabled them to capitalize on the growing economy without providing sufficient documentation to support their borrowing (Madura, 2008). Massive borrowing, along with the large inflows of capital, made Thailand susceptible to collapse. This is exactly what happened. In July 1997, foreign investors recognized the baht's potential weaknesses and decided to pull out their funds (Madura, 2008). This led to a huge increase in the supply of the Thai baht and a detachment from the dollar as foreign investors exchanged the baht for other currencies (Madura, 2008).

The government in Thailand attempted to intervene to prevent the decline of the value of the baht. Using the reserves from the central bank, the government spent more than $20 billion purchasing the baht in the foreign exchange market (Madura, 2008, p. 180). This direct intervention was an attempt to maintain the fixed exchange rate. However, the efforts were overwhelmed by market forces. A month later, the IMF and several other countries provided Thailand with $16 billion rescue package (Madura, 2008). The package required a series of changes: reduction in the current account deficit, a cap on the inflation rate, and supervision of the local banks, along with other requirements (Madura, 2008, p. 181).

Effects of the baht's decline in value began to trickle to neighboring nations. According to Dornbusch, Park and Claessens (2000) "Indonesia, Malaysia, and Thailand

[were] heavily dependent on Japanese commercial bank lending; a crisis in one or two of these countries spread to all three" (p. 188). This demonstrates that having a common creditor was one of the channels of transmission for the crisis. In July, the value of the baht declined by more than 20 percent against the dollar (Madura, 2008). During that same month, and the next, the values of the Malaysian ringgit, Philippine peso, Taiwanese dollar, and Indonesian rupiah declined as well. This was due to their similar economic conditions: relatively high inflation rates, large inflow of foreign capital that was inappropriately invested, and excessive loans (Madura, 2008). Consequently, the similarities led investors to realize that Thailand's crisis could also hit the other countries in Southeast Asia, and they decided to liquidate their investments (Madura 2008). The withdrawal of foreign investment further weakened the currencies because of the increase in supply and decrease in demand of their currencies.

Loans to corporations played a substantial role in the Asian crisis. Corporations borrowed money in foreign currencies and were unable to pay them back due to the substantial decline in their home currencies. For example, in South Korea, seven conglomerates collapsed due to $52 billion in bad debt (Madura, 2008). The strategy to borrow in foreign currencies, due to the lower interest rates compared to home countries, backfired on many Asian corporations. The weakening of the home currencies forced corporations to exchange larger amounts of their currency for the currencies needed to pay off the loans. At the end of the day, corporations incurred a much higher effective financing rate—the actual cost of financing—than they would have paid if they had

borrowed funds locally. The higher borrowing cost was added damage to the corporations (Madura 2008).

According to Desai (2003) Thailand, Malaysia, Indonesia, Philippines, and South Korea, were more crisis prone than China, Hong Kong, Taiwan, and Singapore. The first group, as shown by the data in Table 3.2, maintained massive short-term capital inflows in relation to foreign exchange reserves, which led to disproportional loans to domestic borrowers and an increase in money supply (Desai, 2003, p. 9). For example, during the crisis and within a nine-month period, the value of the Indonesian rupiah declined by more than 80 percent against the dollar (Madura 2008). Investors and businesses in these five countries sold the local currency because of expectations of further decline. These actions perpetuated the weaknesses, as the exchange of the currencies for other currencies placed more downward pressure on the value of the home currencies.

Hong-Kong, China and Taiwan though, were crisis-immune due to successful intervention methods. Hong Kong's stock market did decline by 10.2 percent on average, but the country maintained its pegged exchange rate to the U.S. dollar and increased interest rates to discourage investors from moving their funds out of the country (Desai, 2003). Similarly, China was not inflicted by the Asian crisis because its government controlled most of the banks, maintained the value of the yuan against the dollar, and helped maintain interest rates relatively low for firms to obtain funding (Desai, 2003). Ultimately, Desai (2003) says that these countries were able to avoid the financial crisis because of the resistance, management, and limited exposure to short-term capital

inflows. Similarly, Singapore bypassed the contagion because of its limited exposure to such inflows (Desai, 2003).

After affecting the five Asian nations, the Asian financial crisis began spreading to Russia and Brazil because the crisis caused investors to reconsider investments in countries with similar risk profiles. In August 1998, investors lost confidence in the Russian ruble and began transferring their funds out of Russia (Madura, 2008). The withdrawal of short-term funds also impacted the Brazilian Real in the following year (Desai, 2003). The weak fundamentals in Russia and Brazil resembled those of the crisis-prone East-Asian economies (Desai, 2003).

According to Pesenti and Tille (2000), using a traditional model of currency crises, which is based on the idea that weak or unsustainable economic policies are the sole cause of exchange rate instability, is not sufficient in explaining the Asian currency crisis. To truly understand what caused the turmoil, it is necessary to look at the interaction between policy and volatile capital markets. This demonstrates that weak policies make "a country vulnerable to abrupt shifts in investor confidence" (Pesenti & Tille, 2000). Pesenti and Tille (2000) identify two additional factors that help explain the severity of the Asian crisis: "inadequate supervision of the banking and financial sectors in the affected countries and the rapid transmission of the crises through structural links and spillover effects among the countries" (p. 3). Closely regulating the banking and financial sectors, preventing bad loans, requiring transparent financial statements, and demanding accounting standards in the East Asian region would have created stronger policies. These types of policies could have prevented the weak fundamentals that led to

the abrupt shifts in investors' confidence. Investors had invested large amounts of money into the Asian economies until the middle of 1997. At that moment, investors decided to reverse the pattern by withdrawing their funds at an unbelievable pace (Pesenti & Tille, 2000, p. 3).

Currency crises demonstrate how integrated economies are. In the case of the East Asian crisis, the problem began with weak fundamentals. The five major economies hit by the crisis allowed rapid capital inflow, risky lending by banks, and large foreign debts. A sudden shift in market expectations and confidence began in Thailand, triggered a crisis, and spread to neighboring countries. The channels of the East Asian crisis include financial links, similarities in macroeconomic conditions, and the market participants' perception of the economic outlook in these countries based on the similarities. Investors ultimately believed that the central banks would be unable to prevent the fall in the currency values, so they transferred their funds and created a greater downward pressure on the value of the currencies. This crisis demonstrates the results of poor macroeconomic policy decisions that spread across countries and ultimately continents.

Section IV: The Story of Thailand

Over a decade of study of the East Asian Crisis gives economists and academics a clear theoretical conclusion to what occurred in the region. The theoretical perspective however, is not exactly what occurred in the streets and what was reported in the news. This section narrates the story of Thailand prior to and during the crisis to focus on the factors that led to this event and the damage it produced for the nation.

Months before the crisis hit Thailand, the country experienced a mixture of growth and the beginnings of a downturn. For example, in June of 1997, Goldman, Sachs & Co. decided to invest $31.1 million in a Thailand-based hotel chain (Goldman, 1997). Less than five days later, Chevron Corp. announced a $1 billion joint venture with Petroleum Authority of Thailand for an aromatics facility (Chevron, 1997). Much of this major investment was driven by a new consumer attitude in the country. For example, during the previous five years, the "global MTV generation," composed of teenagers and young adults, developed in all emerging markets of the world (as cited in Wysocki, 1997). In Thailand in particular, by early 1997, companies such as Viacom Inc.'s MTV Networks, Citibank, and Levi Strauss & Co. capitalized on the new consumer attitude and spending power of the youth market (Wysocki, 1997). The youth market spent $150 on monthly cell phone bills, wore $75 jeans, and 98% of them were fans of MTV (Wysocki, 1997). In the construction sector, the building boom of the ten years from 1987 to 1997, left cities such as Bangkok filled with office and apartment buildings, golf courses, shopping malls, and entertainment centers (Mydans, 1997).

The tremendous growth came with a cost. The new investments in the country from outside investment reduced the stake of many domestic owners. The large spending of young adults through credit cards left parents with large debts (Wysocki, 1997). And the lenders that financed the construction expansion ended up holding bad loans.

As soon as the country realized its large debt, intervention began. The country began rescuing financial companies starting with the Bangkok Bank of Commerce in the summer of 1996, which cost taxpayers approximately $3 billion (Learning, 1997). In order to protect depositors in Thailand's finance companies, in June of 1997 the government forced 16 of the weakest finance companies to merge with larger financial corporations or suspend operations (Wong-Anan, 1997). Nevertheless, debt was not the only issue affecting the nation.

Prior to letting its currency float in July 1997, Thailand had not truly publicized the bad news (Sherer, 1997b). The borrowing streak of the previous decade was not managed properly and the consequences were already evident. Approximately 10,000 Thais were laid off from textile and footwear factories in early 1997 (Sherer, 1997b). Companies began shortening work weeks and cutting hours (Sherer, 1997b). The slow auto market in the country forced manufactures of Mitsubishi vehicles to terminate employees and cut back production of vehicles for the domestic market while increasing that for the foreign market (Mitsubishi, 1997). Fear kept building among many Thais as the growth rate of 1996 fell to 6.7 percent from the eight percent averages of the previous few years, and projections for 1997 were even lower (Mydans, 1997). Asian authorities had been paying attention to these events and began worrying about financial debt.

To assist with the current situation, in the middle of June of 1997, the government appointed a new finance minister. Thanong Bidya won cabinet approval after previous Finance Minister, Amnuay Viravan, resigned (Mydans, 1997). Mr. Bidya promised to revive the financial system by repackaging property loans and merging financial companies but there was no mention about floating the currency (Mydans, 1997). Nevertheless, popular press was and had been speculating about the abandonment of the dollar peg since the beginning of 1997. It is evident that Thai companies were paying really high interest rates in order for the country to keep its currency policy (Sherer, 1997a). A devaluation of the baht would boost exports and allow the country to lower its interest rates but would hurt companies with large foreign debt (Sherer, 1997a). One local finance executive predicted that by either letting the baht float or allowing greater daily fluctuations, the currency would depreciate at a really fast rate (Sherer, 1997a). Other analysts opposed a devaluation of the baht by either method and were convinced that with the current system devaluation was unlikely (Sherer, 1997a). Rumors of the devaluation of the baht caused the stock market to fall sharply. For example, shares of company Finance One PCL, Thailand's largest finance company, dropped 71% to 28 cents in the first week of June (World, 1997). The central bank however, denied any rumors of a change in their exchange rate system (Sherer, 1997a).

The rumors however became true. On July 2, 1997, Thailand's government allowed the baht to float (Thailand, 1997). Prior to this, the baht was pegged to a basket where the U.S. dollar counted for eighty percent, and the German mark and Japanese yen made up the rest (Sherer, 1997a). The baht was only allowed to fluctuate to plus and

minus two cents to the dollar on a daily basis (Sherer, 1997a). But the cost of the basket

peg became too painful, and the government hoped that by allowing the baht to float, the

country could worry about healing the economy instead of defending its currency. It was

the financial pressure that forced Thailand to float its currency because the government

could no longer bear the costs of supporting it (Lifebelts, 1997).

For months the central bank had to battle with currency speculators in order to

maintain the pegged value of the baht. For example, in May traders sold billions of baht

short, betting that it would decline in value (Sesit & Jereski, 1997). In a short sale a party

borrows assets from a second party, sells it to a third party, and plans to purchase the

same assets at a later date to return to the lender. The short seller hopes the price of the

assets decreases to purchase the assets at a cheaper price and gain from the sale. If the

price of the assets increases though, the short seller incurs a loss. Hedge funds run by

George Soros' lieutenant Stan Druckenmiller, Julian Robertson, and Bruce Kovner, along

with trading operations at dealers such as BZW, J.P. Morgan & CO., and Goldman Sachs

along with others, sold short large amounts of baht because it puts downward pressure on

its value. As a result, they planned to replace the borrowed currency at a cheaper price

(Sesit & Jereski, 1997). However, the Thai government and other Asian central banks

joined forces and spent approximately $12 billion buying baht and selling dollars (Sesit

& Jereski, 1997). Additionally, the Bank of Thailand ensured a reduction in the supply of

baht available to all speculators by preventing local banks and branches in the country

from lending baht to foreigners (McDermott, 1997; Sesit & Jereski, 1997). In the end, the

big traders did not receive the returns they expected (Sesit & Jereski, 1997). The central

bank had won this battle, but the country would no longer be able to continue these interventions.

The switch in the exchange rate system gave the country something new to worry about, the fall in the baht's value. The baht fell from four cents per baht to three cents per baht on the first floating date (Thailand, 1997). In order to avoid a steeper decline, the government raised its discount rate two percentage points to 12.5% and left exchange controls in effect in an effort to maintain foreign investment (Thailand, 1997; Lifebelts, 1997). Companies were quickly hurt by the floating of the baht due to the increase in borrowing costs and record foreign-exchange losses (Holman, 1997). As a result, the government provided $698 million in loans to these companies (Holman, 1997).

Only eight days after the currency began floating, *The Economist* compared Thailand to Mexico. In 1994, the Mexican peso experienced a dramatic collapse in its value which drove the economy into a catastrophic downturn. The IMF and other developed economies provided Mexico with a $40 billion bail-out loan due to its weak fundamentals and depletion of foreign reserves (Lessons, 1997). Journalists were commenting that Thailand might need a bail-out of its own (Lessons, 1997). The government however, said it would not seek any credit lines provided by the IMF or other countries. Eventually, as mentioned in Section III, the IMF and countries such as the U.S. gave Thailand a $16 billion rescue package (Madura, 2008).

In order to help Thailand, banks in Japan decided to continue lending in the country. There were thousands of Japanese manufacturers located in Thailand. Any withdrawal of investment by the Japanese could further hurt the baht, which could further

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affect the Japanese manufacturers (Sapsford, 1997). The economic turmoil did force

some Japanese auto makers to close factories, reduce production, and terminate jobs of

workers in Thailand (Shirouzu, 1997).

As Thais became more conscious about the situation, they decided to change their

consumer habits. The norm became to "'buy-Thai-eat-Thai'" (Utumporn, 1998). As a

result, companies like McDonald's advertised exporting products in order to help the

economy (Utumporn, 1998). The new marketing strategy was an effort to maintain

customers and present a patriotic image of the company.

Despite intervention by the government and the people, the baht continued falling

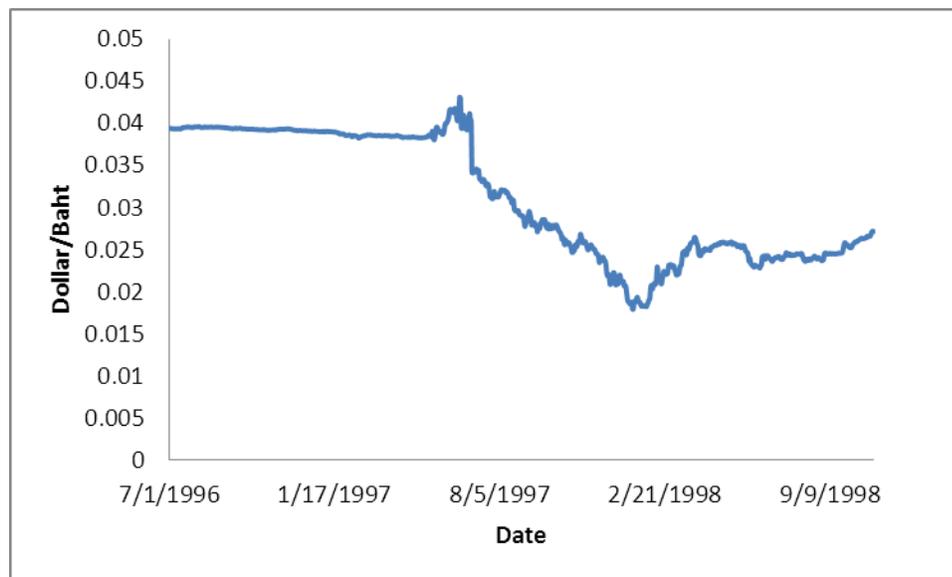and closed the year at two cents per baht (Historical, 1997).

Figure 4.1: **Thailand's Daily Exchange Rate Values, 7/1/96-10/31/98**

From Oanda.com: *Historical Exchange Rates* (1997)

Figure 4.1 shows the exchange rate of Thailand prior to the change in currency system

and the values of the floating rate up to the fall of 1998. After July 2nd, 1997, the figure

shows the drastic fall in U.S. dollar per baht. Until the first month of 1998, the baht did

not see any significant increase in its value. Even so, through the first three quarters of

that year, the baht was not close to reaching the pegged value it once maintained.

While Thailand experienced these events, so did four other East Asian economies.

The daily percent change of the exchange rate values of the Malaysian ringgit, Philippine

peso, South Korean won, and Indonesian rupiah demonstrate similar behavior to the

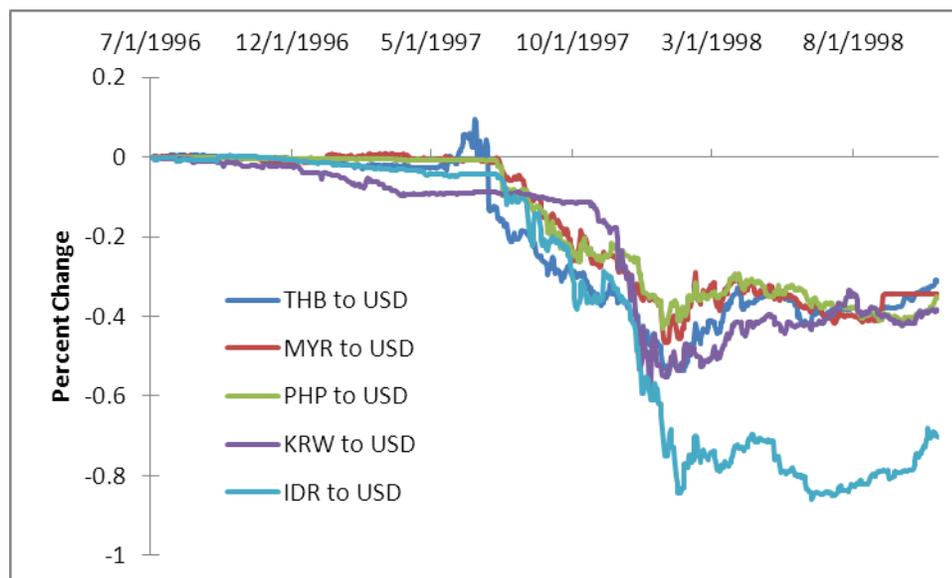exchange rate values of Thailand, which is evidence of currency crisis contagion.

Figure 4.2: **Daily Percent Change of Exchange Rate Values in Five**

East Asian Nations, 7/1/96-10/31/98 From Oanda.com: *Historical*

Exchange Rates (1997)

After Thailand allowed its currency to float on July 2nd, the Philippine peso came under

attack on July 7th (Lifebelts, 1997). By July 10th, both the Indonesian rupiah and

Malaysian ringgit weakened (Lifebelts, 1997). The South Korean won saw its most

significant drop in October of 1997. Figure 4.2 visualizes the fall in the value of the

exchange rates of Thailand, Malaysia, the Philippines, South Korea, and Indonesia as

percent change in the summer of 1997. Thailand had the largest drops in exchange rate

value, followed by South Korea.

By the end of 1997 the devastation was in the five nations. What was known as

the Asian miracle ended in a catastrophic crisis that began in Thailand and quickly spread

throughout Asia. Problems in the lending sector, stock market and with government

policies all contributed to the creation of the crisis. Many Thais were left without jobs,

with an oversupply of new buildings, and with a new national debt it would take years to

pay off.

Section V: Fast Forward to the Present

The foreign exchange markets continue to be the largest markets of the world and crises are a part of these markets. Emerging economies such as Thailand, South Korea, the Philippines, Malaysia, and Indonesia, demonstrate the characteristics and economic conditions that lead to currency crises. Even though the major crises took place over a decade ago, the phenomenon of herd behavior and contagion are still an issue. Today, not only emerging economies but developed nations, including the U.S. and the European Union, are subject to capital movements in reaction to weak economic fundamentals. Governments, economists and analysts know the causes and have witnessed the consequences of currency crises. Nevertheless, countries are still unsure how to deal with problems of investor behavior manifested through capitals flows and changes in currency values.

Banks and their traders, along with speculators, companies, and governments are using the foreign exchange market more than ever. The $4 trillion a day market attracts rich and poor investors alike (Lauricella & Kansas, 2010). Today, the foreign-currency market is more volatile (Levisohn, 2010). Markets are going up and down and investors are taking advantage (Levisohn, 2010). For example, in 2010, investors bet on the value of the dollar falling against currencies of emerging markets (Levisohn, 2010). They hedged against the falling dollar in 2010 because during the 2008 turmoil many people bought the safe haven dollar and now investors speculated people would sell dollars and

its value would weaken (Levisohn, 2010). Either way, investors are safe because they are able to buy insurance which allows them to sell and buy currencies at set prices (Levisohn, 2010). But that is not all they have done.

Due to investors' behavior, capital movements have taken a new turn. As a result of the global financial crisis of 2008, struggling, developed economies, such as the U.S., Europe, and Japan, decreased their interest rates to promote economic growth (Phillips, 2008; Lauricella & Kansas, 2010; Hong, Shaw, & Fung, 2010; Talley, 2011a). Thus, investors around the world moved their money to poor, high-yield emerging nations to earn higher rates of return (Phillips, 2008; Lauricella & Kansas, 2010; Hong, Shaw, & Fung, 2010; Talley, 2011a). In the last two years, the inflow of money allowed developing nations to drive global growth. For example, in the first quarter of 2010, capital inflows into China increased to $95.9 billion, while investors bought $29 billion worth of shares in India (Batson, 2010; Frangos, 2011a). Countries such as China, Brazil, India, and sub-Saharan African countries are achieving four times the economic growth rates of rich nations (Talley, 2011a). The same nations hit by the East Asian crisis are receiving large inflows of money. For example, since the start of 2010, global investors bought $9.5 billion in Indonesian government bonds (Frangos, 2011b). Additionally, net portfolio funds into Thailand equaled $5.6 billion (Phromchanya, 2010).

Nevertheless, emerging nations are now struggling to manage the vast inflow of money. In 2010, the money was necessary for growth. Now, most countries are stressed about inflation and the possibility of asset bubbles (Talley, 2011b). The continuous inflow of money has put upward pressure on the value of their currencies (Phromchanya,

2010). Strong currencies harm exporters and decrease the current account balance. This occurs due to negative net sales abroad as prices of domestic goods and services become more expensive for foreign consumers leading to a decrease in demand for their products. Continuous inflows also make emerging economies susceptible to volatile capital movements and the possibility of financial disorder. The issue now is finding the best way to moderate the enormous capital inflows.

One solution to the problem is a new set of capital controls supported by the IMF, Institute of International Finance, and Asian Development Bank (Anonymous, 2010). For decades, the IMF had opposed the use of capital controls (Davis, 2010). In 2010, the international organization began suggesting the use of capital controls to regulate the vast inflows of capital to emerging nations to limit financial damage when the flows reverse, a change that has many shocked (Davis, 2010). Explicit taxes, requiring interest-free foreign capital to be held at the central bank, withholding taxes on foreigners' investment, and taxes on short-term capital inflows are some restrictions that Brazil, Chile, Thailand, Malaysia and other countries have tried (Davis, 2010; Phromchanya, 2010). However, economists agree that such methods are not long-term solutions (Phromchanya, 2010).

Opponents of capital controls say restrictions on capital can drive the much needed investment to other countries, causing an appreciation of their currencies, and making exports less competitive internationally (Davis, 2010). They suggest strong fundamentals to protect an economy from external shocks rather than capital controls (Anonymous, 2010). Malaysia, for example, since imposing capital controls in 1998, has

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struggled to attract money into the country even after loosening many restrictions (Anonymous, 2010). An open capital market allows money to flow in when it's needed for growth and flow out in times of crises (Anonymous, 2010). An open capital account is the "rule of law," says an anonymous author in "Capital-Control Comeback" (2010). Nevertheless, Asian economies, such as Thailand and South Korea, learned from the 1997 Asian crisis and decided to use tight regulations on capital and stockpiled foreign currencies to cover foreign-currency debts (Phillips, 2008; Anonymous, 2010). Despite these interventions, there is a possibility that history may repeat itself.

Thailand, after facing a problem with a 13-year high value of the baht against the U.S. dollar, is now dealing with the withdrawal of foreign investment (Phromchanya, 2010; Frangos, 2011a). Indonesian government bonds and Philippines peso bonds are being pressured by investors (Frangos, 2011a). For South Korea, the won floats freely which has led to frequent and sometimes wild changes in its value and the country is afraid that any form of intervention may lead to market uncertainty (Lee, 2010). For all emerging nations, the main issue now is inflation, which is causing investors to flee (Hookway & Phromchanya, 2011). But inflation is not the only issue, staying competitive is pressuring many nations to intervene in the currency markets due to China's undervalued currency.

The new global concern has become the manipulation of currencies. This is the case of countries such as China, South Korea, Brazil and Japan undervaluing their currency, an issue now known as "the currency fight" (Talley & Crittenden, 2010;

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Ramstad, 2010). Leading the manipulation is China and other countries are taking their own actions to stay competitive (Ramstad, 2010).

China *is* driving the Asian region and the world through economic growth and large capital inflows, but its methods are being disputed by U.S. and European officials (Batson, 2010). The U.S. and particular European nations believe China is intentionally undervaluing its currency to increase exports (Ramstad, 2010). The developed nations are battling with China's trade surplus and blame the country for the global trade imbalance (Ramstad, 2010). China argues the Yuan, officially the renminbi, cannot be susceptible to external forces because any fluctuation would bring disaster to China and the world (Ramstad, 2010).

The case of China is a unique one. The country is currently facing masses of pressure from both developed and developing economies to appreciate the Yuan. But China climbed to a world power due to its tight regulations. The Chinese government is trying to assist its manufacturing sector by encouraging the consumption of manufactured goods by foreigners through a cheap currency. If the government allows an increase in the value of the Yuan, the country would lose its comparative advantage in the manufacturing sector, risk a rise in unemployment, hurt its economic growth and cause many companies to collapse (Wilson, 2010; "Rmb to," 2011). In turn, this would lead to a slowdown in the global economic recovery.

To deal with both capital controls and the manipulation of currencies, government officials hope a solution will be discussed in the 2011 Group of Twenty (G-20) meeting. The international organizations and all nations are aware that capital controls are

changing how the market works; it is a new direction for the foreign exchange markets

(Hong, Shaw, & Fung, 2010). But there is a fear that financial regulators may not know

how to truly place capital controls and reduce foreign money flows (Fidler & Hilsenrath,

2011). As a result, the IMF is considering a set of guidelines for the use of capital

controls (Talley, 2011b). If approved, countries who seek emergency loans from the fund

are more likely to be subject to the new guidelines. The IMF is considering changing the

basic bylaws to give it more power and authority to require a member to either remove or

enact restrictions (Talley, 2011b). Either way, central banks are pushing the IMF to

develop instructions for financial regulators to follow when dealing with capital controls

(Fidler & Hilsenrath, 2011).

Even more important than an increase in power of the IMF, is the current

discussion among U.S. regulators about the foreign exchange market. As part of the

Dodd-Frank Act, which aims to regulate trading in all financial derivatives, U.S. policy

regulators are considering requiring more reporting of trades and more transparency of

the financial instruments used in the foreign exchange market (Martin, 2011). Up to now,

the currency market has been the most lightly regulated of all financial markets (Martin,

2011). Neither foreign exchange derivatives nor the currency market are explicitly part of

the Dodd-Frank Act (One Hundred Eleventh, 2010). Nevertheless, it has companies,

investors, and banks worrying about the implications of such changes (Martin, 2011). As

a result, in 2010 a new lobbying group representing banks in the foreign-exchange

division of banking was formed to convince regulators in the U.S. and European Union

that foreign-exchange derivatives are different from other markets and should not be included in the act (Martin, 2011).

In the last twelve months, capital controls, the manipulation of currency values and the foreign-exchange markets have become hot topics around the world. It is a fact that investors continue to play a major role in the global economy. Their actions can determine which countries grow and which do not. Will the G-20 meeting in November be able to resolve all of these issues? One direction is clear, countries are moving away from the free movement of capital to controlling capital in an attempt to avoid currency crises.

Section VI: Modeling Herd Behavior and Contagion

This chapter presents a cellular automaton (CA) model simulating the complex

dynamics of financial markets. Based on the "Majority Wins" rule, the "Financial

Market" model modifies the behavior of a set of particular cells to imitate the behavior of

investors in any financial market. More specific for this thesis, the CA model replicates

herd behavior creating a currency crisis and the transmission affect produced by

investors. This CA model is based on investors' interactions and uses simple rules for

representing their behavior.

Herd behavior is created by investors when "the optimal investment strategy

regarding a specific country involves following the lead of the investor most likely to be

informed of the prospects of that country" (Pesenti & Tille, 2000, p. 10). Thus the model

uses two types of investors informed and uninformed. Informed investors are those

investors who are informed of the nature of the country they are investing in. These

investors pay attention to the economic indicators of a country, along with

macroeconomic policies and conditions, changes in financial markets and financial

incentives. The goal of the model is to demonstrate how the uninformed investors

replicate the actions of the informed investors. Along with herd behavior, the model

shows the transmission of a crisis from country to country by linking states, producing

the contagion phenomenon.

Description of Model

The financial market is represented as a two-dimensional lattice. There are 10,000 cells and every cell on the lattice represents an investor. Each investor has a random neighborhood size as determined by a "square random small world" lattice (Bahr, 2008). The number of neighbors is defined by power-law distribution (Bahr, 2008). This distribution means that most cells have very few connections, uninformed investors, but a small number of cells have many connections, informed investors. The neighborhood connections are symmetric (Bahr, 2008). This means that if cell A is connected to cell B, cell B is also connected to cell A. All investors invest in a single country per generation. Generations represent time. A generation can represent a minute, an hour, a day, or any other unit of time. The state of the cells represents a country.

Herd Behavior

Before modifying the behavior of the informed investors, the model runs as a "Majority Wins" model. In the "majority rule," a cell makes its current opinion, or state, match the opinion of the majority of its neighbors (Bahr, 2008). In order to imitate the behavior of investors, the "Financial Model" rule includes specific instructions for informed investors. Informed investors make their current opinion, or state, based on financial factors. As previously stated, informed investors are the cells with the most number of neighbors. The cells with the most number of neighbors are also referred to as "opinion leaders" in this model. Their opinion is followed by its large number of neighbors, which are the uninformed investors. In order to find the informed investors, all the cells in the lattice are placed in an array, which is a static memory allocation. The

array is sorted, with the cell with the largest number of neighbors first, to the cell with the smallest number of neighbors last.

This function of the model shows how the actions of one or a few informed investors can change the actions of the majority of investors, leading to a currency crisis in a country. In models, such as the "Obesity Model" and "Alcohol Model," social force is used to manipulate the behavior of a cell (Bahr et al., 2009; Nowak & Lewenstein, 1996). Social forces are external influences such as news, TV commercials, newspaper articles, government incentives, laws, etc. that will change behavior (Bahr, et al., 2009; Bahr, 2008). For the purpose of this model, the variables driving investors' behavior are economic fundamentals, data releases, movements in financial markets, policy decisions and economic incentives. As a result, these variables grouped together will be called "Financial economic force." Financial economic force is a measure between negative two and positive two. It is applied to each state individually. Sometimes a small change in financial economic force can cause a drastic change in the behavior of investors (Nowak & Lewenstein, 1996).

For example, using the "Financial Model", a simulation with ten states, starting at approximately 1000 cells per state, is run for 500 generations without modifying any behavior. No behavior modification means the investors are using the "majority rule" to make their decisions. Once the "financial rule" is turned on, investors' behavior is based on herding. One informed investor, with 231 neighbors, is given a financial economic force of -0.024 at the 500th generation against state five, the state with the most number of cells. The following figure shows what happens to the state.
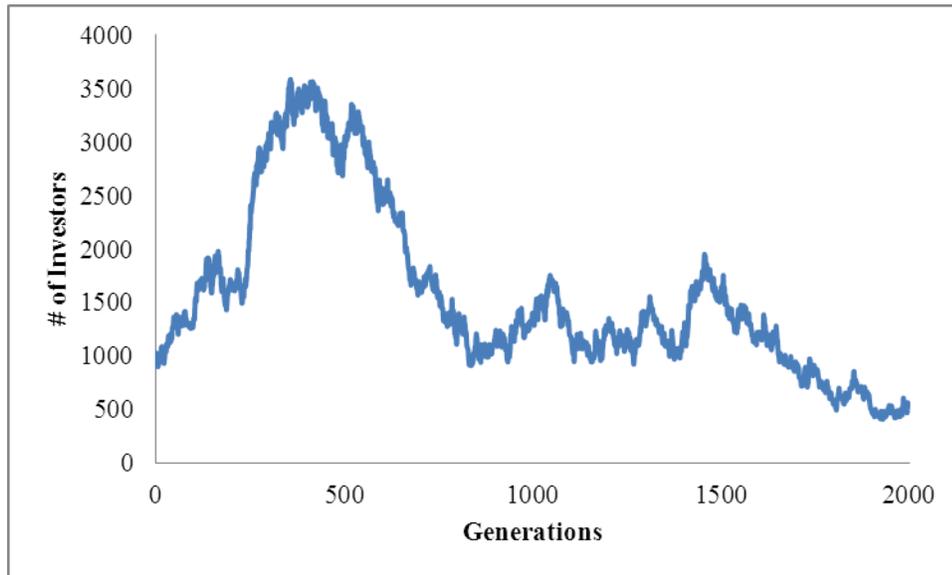
46

Figure 6.1: **Herd Behavior** One informed investor with 231 neighbors and -0.024 financial economic force against State 5, starting at the 500th generation

The figure clearly shows the influence of one cell on the entire lattice. It demonstrates that a small change on the financial economic force can create drastic changes in behavior, such as driving all cells away from a state. Because the neighborhood configuration is different every time the simulation is restarted, the top informed investor does not always have the same number of neighbors. As a result, there are 50 trials of this simulation, in which the top informed investor is given a -0.024 financial economic force against a particular state. On average, the leading state had 2,647 cells at the 500th generation. A financial economic force of -0.024 to the top informed investor with an average neighborhood size of 199 cells was applied. This led to a decline of the top state to an average of 984 cells by the 2000th generation.

Contagion

In order to include contagion in the model, a certain number of states are linked. This represents a high degree of integration, because whatever happens to one state is replicated by the other states. For example, if investors stop investing in state zero, which is linked to states one, two, and three, the investors will also stop investing in those states. There are two ways this can be done.

Version I

One way to include contagion in the model involves replicating state zero. If investors are moving away from state zero, they will also move away from the linked states and vice versa. Using this version of the model, a simulation with ten states, starting at approximately 1000 cells per state, is run for 500 generations without modifying any behavior. At the 500th generation, using the top six informed investors and linking states one through four to state zero, state zero is given a financial economic force of negative one. The following figures show the results of the simulation at the 500th generation, 1000th, and 2000th.
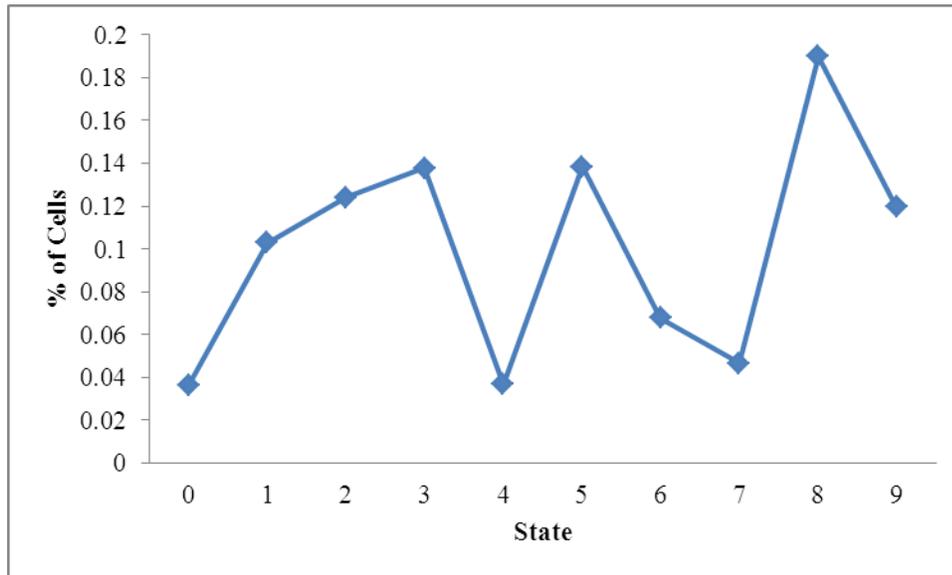
Figure 6.2: **Contagion at the 500th Generation** No behavior modification
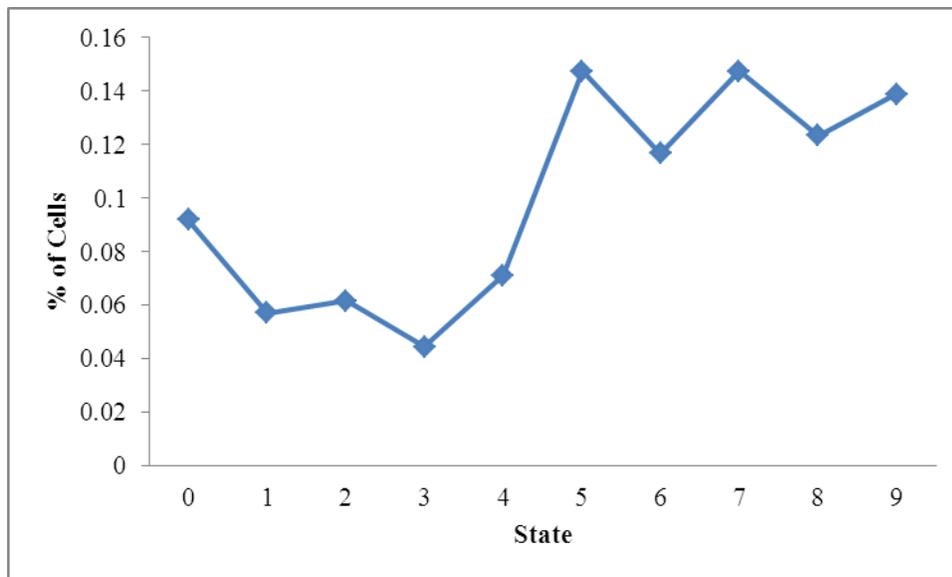
for 500 generations

Figure 6.3: **Contagion at the 1000th Generation** Six informed investor

with -1.0 financial economic force against State 0, at the 1000th generation
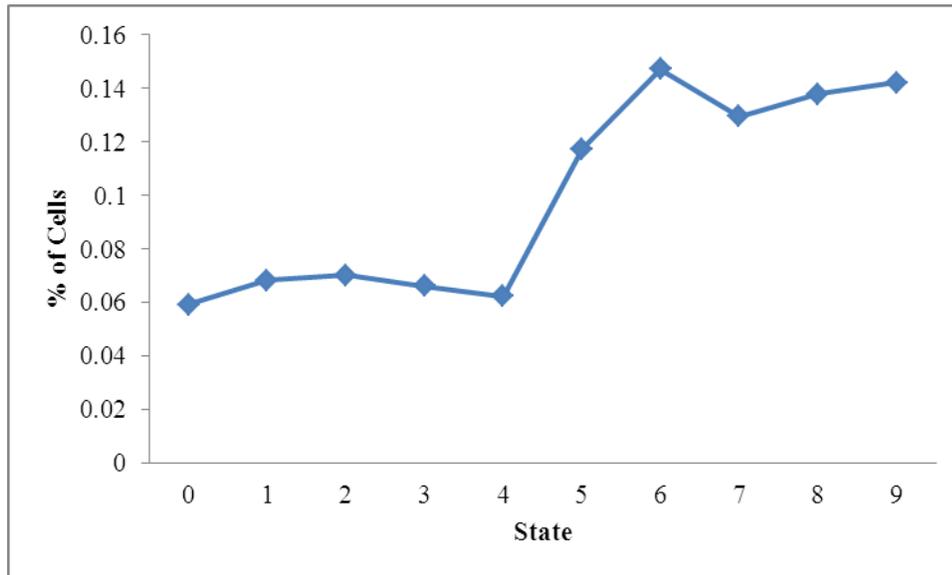
Figure 6.4: **Contagion at the 2000th Generation** Six informed investor

with -1.0 financial economic force against State 0, at the 2000th generation

The figures show how the force placed on the six informed investors against state

zero produced a decrease in the number of cells for that state and the linked states. Figure

6.2 clearly demonstrates that states zero through four have different percentages of cells

by the 500th generation. As the financial economic force is applied to only one state, the

rest of the states follow, producing contagion. Fifty simulations were run to test the

influence of informed investors and the contagion effect. As the number of informed

investors increases against state zero, the more the linked states act in concert and

maintain a steady and equal percentage of the cells in the lattice. The next figure shows
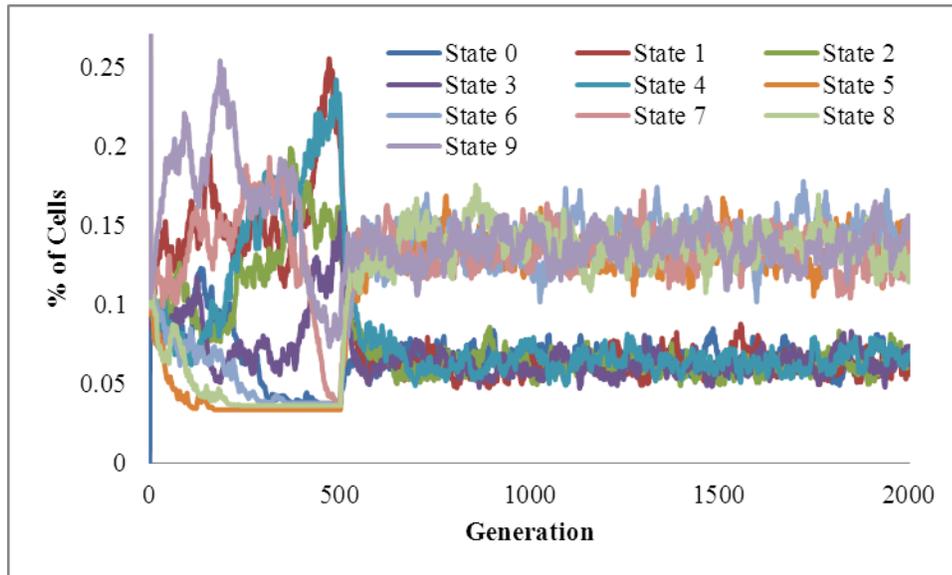
this event.

Figure 6.5: **Contagion Version I** Fifty informed investor with -1.0

financial economic force against State 0, for 2000 generations

Version II

Within the "Financial Model", another method of producing contagion involves

looking at the change in volume of each state. In this version, the investors consider the

change in the number of cells of the linked states individually, from the previous

generation to the current generation. Once the investors determine whether the linked

states volumes are increasing or decreasing, they choose whether to invest in those states

or not. Different from Version I, the investors do not simply look at what is happening to

one state, but what is occurring to the linked states as a whole.

For example, suppose that a small group of informed investors decides to stop

investing in state zero. For a couple of generations, the decrease in the volume of state

zero will be significant enough to move the informed investors, their followers and the

majority of the lattice from the linked states. Once the change in volume becomes

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smaller, the informed investors will begin investing in the linked states again. The model thus forms oscillations, showing how the investors move from a group of linked states to unlinked states and back and forth.

The following figure shows what happens to five states after they have been linked, states zero through four, with five informed investors with financial economic force of -0.512 against state four.
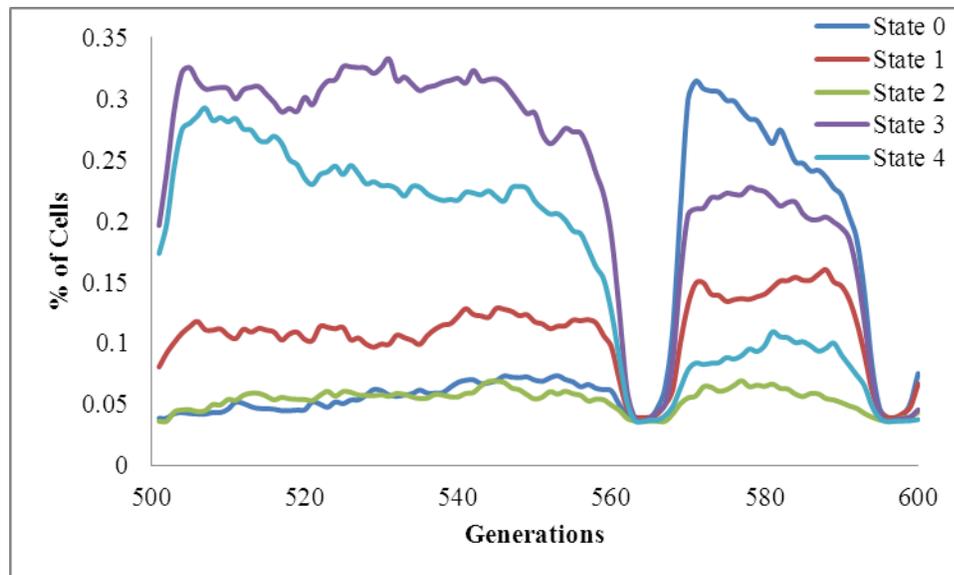

Figure 6.6: **Contagion Version II.** Five informed investor with -0.512 financial economic force against State 4

As the number of informed investors increases, the more the states move in concert and oscillations occur. The next figure shows the same modifications as Figure 6.6 but with forty-five informed investors, instead of five, against state four.
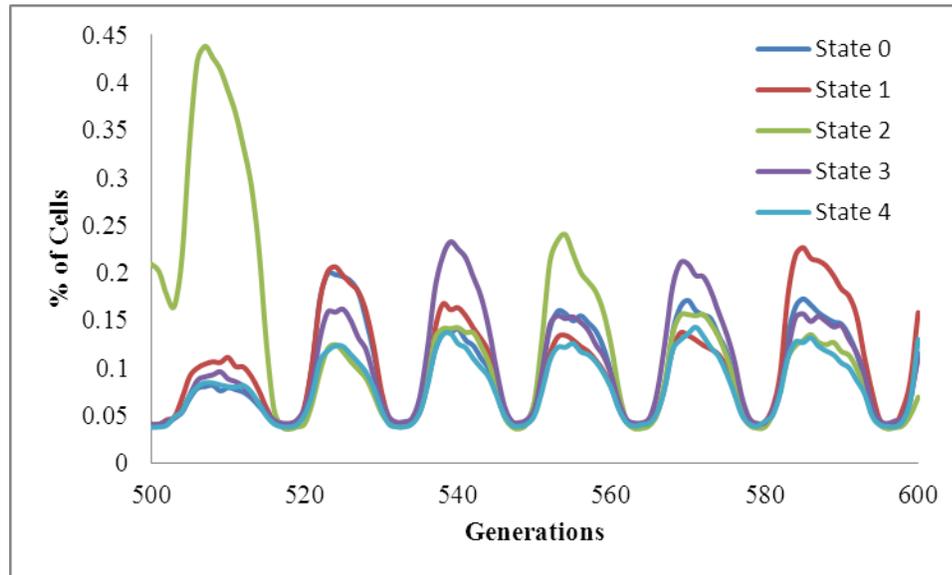
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Figure 6.7: **Contagion Forming Oscillations.** Forty-five informed

investor with -0.512 financial economic force against State 4

Unintentionally, the model here shows a cycle similar to what occurs in real

economics. For example, in the early 1990s, short-term debt of the five East Asian crisis

nations was funded by the excessive foreign capital inflow. In 1997, investors decided to

reverse the direction of their capital flows and the crisis occurred. For the last six years,

the flow of capital has been reversed once again. Section V recounts how the flow of

capital moved to developing nations during the global financial crisis. Today, emerging

economies are struggling with the inflow of capital and discouraging investors from

investing. To illustrate the movement of capital, Figure 6.8 shows the trend of short-term

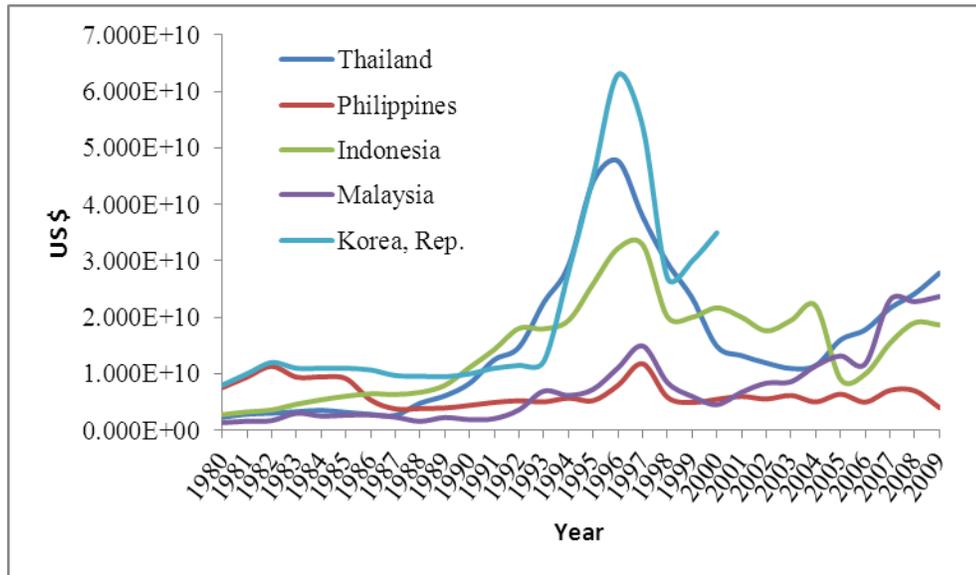debt of the Eastern Asian countries.

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Figure 6.8: **Short-term Debt of Eastern Asian Countries (1980-2009).**

Source: Global Development Finance, World Bank, 2011, and author's

calculations for South Korea from Liu, W. (2007).

Figure 6.8 shows a steady growth of foreign short-term debt from 1980 to 1994.

From 1994 to 1996 these countries started borrowing excessively. In 1997, the countries

collapse. Nevertheless, the figure shows a new growth of foreign short-term debt

beginning in the 21st century for Thailand and Malaysia, quickly followed by Indonesian

in 2005. This movement of capital back to the victims of the East Asian crisis shows a

possible cycle as illustrated by Version II of the "Financial Model." Therefore, if the

countries return to excessive borrowing, the global society can expect a downturn in the

flow of capital in developing nations and the possibility of currency turmoil.

Modeling the East Asian crisis

For the purpose of replicating the East Asian crisis, there are 10 states in the

model, which are 10 countries. Five states represent Thailand, Indonesia, South Korea,

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the Philippines, and Malaysia. From the data in Section IV, Thailand took approximately

193 days to reach its lowest exchange rate. During this period, investors sold their Thai

baht at incredible levels and fled the Thai market. Speculating that the same situation

would happen in Indonesia, South Korea, the Philippines, and Malaysia, investors

decided to sell securities and the currencies of those countries. After almost 200 days of

falling exchange rate values, the countries began to see their currencies stabilize, as

demonstrated in Figure 4.2 of Section IV. As a result, for the purpose of this model, it is

assumed that investors no longer sold those currencies.

Supposing that each generation is a day, the "Financial Model" can replicate this

event using Version I of the model. To begin, the five first states representing the five

affected countries have a larger number of investors compared to the other five states that

represent the countries investors fled to, such as the U.S. and European nations. The

following figure shows the output of using five informed investors, with a financial

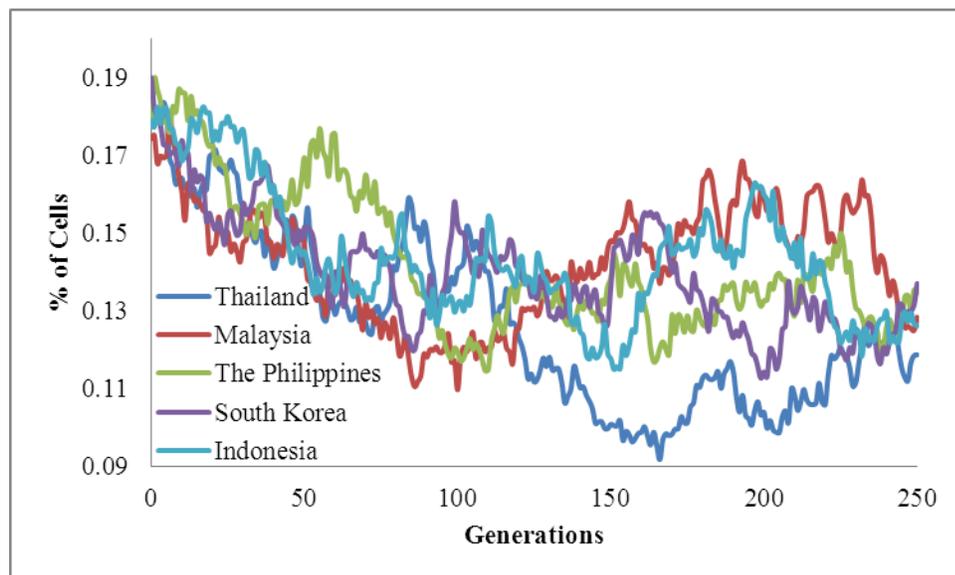economic force of -0.200 against Thailand (state zero).

Figure 6.9: **Herd Behavior and Contagion in the 1997 East Asian**

Crisis. Five informed investors, with a financial economic force of -0.200

against Thailand.

Figure 6.9 is not intended to replicate Figure 4.2.The model is simply showing the actions

of investors and their correlation to the fall of exchange rates. As the figure shows, the

"Financial Model" has successfully replicated the general behavior of investors and

countries before and during a currency crisis. When a couple of top investors decide to

flee a stock or currency, many investors follow their lead. Due to similarities between

nations, investors also decide to flee similar countries, producing contagion. Although the

model differs in particular details to the real events, the interactions of cells replicate the

same general conduct of herd behavior and contagion.

Section VII: Conclusion

Currency crises and contagion are not new topics to nations, economists, and analysts. More than ever, we are aware of what they are, why they occur, and the way they manifest themselves and spread. There are many examples to learn from. We are aware of the consequences they have and we understand methods of prevention and containment.

Currency crises are a result of currency flight: investors flee a currency in fear of devaluation. Fundamentally, poor macroeconomic policies and conditions are the reason for shifts in market expectations and confidence. There are also instances in which investors' expectations and actions lead to changes in policy, creating self-fulfilling crises. To avoid currency devaluation, governments intervene in the currency market. In defense of the currency by the central bank, the government spends its foreign exchange reserves. In other times, crises start when there is a sudden withdrawal of short-term creditor loans, known as financial panic crises. Bubbles collapsing also set off crises.

Crises often spillover across countries. A crisis can be transmitted across countries due to interdependence among market economies, similarities in macroeconomic policies and conditions, trade links, competitive devaluations, and financial links. The transmission of crises is largely attributed to the behavior of investors. Investors analyze the similar features between counties and decide whether to continue to invest in a country or withdraw their investment. Due to imperfect information, "herd behavior" is often common in the transmission of crises. Uninformed

investors follow the actions of the informed investors and withdraw their money or place their money wherever they see an informed investor withdraw it or place it.

There is empirical evidence demonstrating the existence of currency crisis contagion. This evidence includes comovements in exchange rates, stock prices, capital flows, and interest rates. The probability of a crisis occurring in a country increases if the economy shares a creditor with a crisis country. Further, the probability increases as the number of neighboring countries in crisis increases.

We are also aware that there are ways to prevent and contain currency crises. They involve placing capital controls, greater supervision of banks, placing a tax on currency transactions, and temporarily suspending debt repayment. To contain a crisis and avoid the infection of a crisis into a country, economies can diversify their trade, float their currencies, and encourage domestic rather than foreign borrowing.

The East Asian crisis is a good example of the causes of currency crises and their spread. The currency crises began in Thailand. Due to poor macroeconomic conditions, which included a large current account deficit, massive short-term capital inflows, poor banking supervision, and large borrowing by the government and corporations, foreign investors decided to sell the baht. The defense of the baht led to the depletion of Thailand's foreign reserves and the inability of domestic borrowers to repay foreign loans, thus producing a currency and economic crisis in Thailand. The similarities between Thailand, Malaysia, Indonesia, South Korea and the Philippines led investors to reconsider their investments in these nations causing the crisis to spread. Investors also

saw similarities between the Asian economies and Russia and Brazil. As a result, they withdrew their investments from there as well.

While macroeconomic indicators and measures give clear theoretical explanations of the causes and spreading of crises, news show the day to day impact on the people and the nations. In the case of Thailand, declining growth and signs of a downturn were present months before the fall of the baht. Consumption by Thais attracted large foreign investment, which led to a construction boom. But financial debt and lay-offs began surging, and economic growth declined significantly from the previous year. Changes in the government, such as the appointment of a new finance minister, and the decision to let the baht float hurt many domestic companies and increased the lay-offs. Borrowing costs immediately increased. The IMF and other developed economies stepped in, and Thailand was left with a devalued baht and $16 billion rescue package to pay back.

However, the current situation of the foreign exchange market shows that after more than a decade, countries are still susceptible to currency crises. Capital flows along with volatile currency prices are making many countries prone to crises. The 2008 global financial crisis increased the flow of capital to developing nations, similar to the 1990s. Again, these emerging nations are struggling to manage the inflows of money, leaving the possibility of history repeating itself.

Models, such as the one created in this thesis, can replicate previous crises, show the main factors driving such events, and suggest possible future events. The "Financial Model" successfully replicated herd behavior and the contagion phenomenon. In addition, the model demonstrates possible cycles in capital movements from developing

nations to developed nations and vice versa. These results correlate with the current events of capital movements and the struggles of the East Asian economies once again.

If history is about to repeat, are we truly aware and know everything there is to know about currency crises? Before this thesis I was not informed about the subject of currency crises and contagion. The content of this thesis and what I have learned in the last 14 months came from reading many theoretical chapters on currency markets, economic research papers, and *The Wall Street Journal*. Extensive reading from *The Wall Street Journal* gave me a new lens on the global economy. Research papers showed me the diverse number of methods to model currency crises. The theoretical reading expanded my understanding of international economics. Now, I am able to understand and analyze the complex causes of financial crises, the influences of investors, and the similarities across countries. Overall, the thesis gave me a better understanding of the influence of international organizations, the power of government intervention, and the differences between theoretical economics and actual events.

But now I question whether it is necessary for the common citizen to be aware of what truly causes these events. Will it make a difference? Economic crashes are being driven by investors as a reaction to government policies and actions and nations are still standing by shocked when a crisis occurs. News, reports, and analyses of these events are everywhere. Today more than ever international organizations and nations must come together to finally find a solution to this problem. I believe there is an answer out there and it may be as simple as ensuring transparency, placing guidelines, and maintaining strong macroeconomic fundamentals.

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