DISSERTATION

CURRENCY BOARDS FOR DEVELOPING NATIONS: PAST EXPERIENCES AND FEASIBILITY FOR FUTURE ADOPTION

Submitted by

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In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

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Summer 2004

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ABSTRACT OF DISSERTATION

**CURRENCY BOARDS FOR DEVELOPING NATIONS:
PAST EXPERIENCES AND FEASIBILITY FOR FUTURE ADOPTION**

The objective of this study is to determine the importance of the economic discipline and interest rate arbitrage components in the mechanism that maintains the fixed exchange rate under a currency board arrangement. I argue that by understanding the mechanics of economic discipline and interest rate arbitrage, emerging economies are more likely to establish a successful currency board arrangement. A recent review of the literature has revealed the need to rigorously study the importance of these components of exchange rate maintenance in creating a successful currency board.

Measuring the preconditions that comprise the components of the exchange rate mechanism is done on a case study basis of Hong Kong, and Argentina. The levels of the preconditions are used for the empirical estimation of the functioning of the exchange rate mechanism. Econometric analysis is then used to determine if the preconditions explain the theoretical understanding of the exchange rate mechanism. Finally, based on the conclusions, a number of recommendations will be suggested to increase the likelihood that a currency board arrangement created in an emerging economy will be successful.

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AKNOWLEDGEMENTS

This dissertation is dedicated in its entirety to my father, Steven, whose footsteps I seem to always be following but whose shoes I could never fill, and my mother, Barbara, who has taught me much more than a Ph.D. ever could. Thank you both for your love and support throughout the years. I would like to express my appreciation to the rest of my family and friends. My special thanks are due to Brenda for her patience, love and support through the years that it took to complete this dissertation. My special thanks also are also due to Carie for her love and invaluable help to complete the final stages of this dissertation. I would also like to thank my sister, Erika and my brother, David for their support. In addition, my thanks go to my friends Jodi, Jenny and Keira for their support and encouragement through the years.

I would also like to sincerely thank my committee members for their extraordinary patience during my research and completion of the editing process. My special thanks go to my advisor Dr. L.S. Fan, who has been much more like a second father to me than an advisor. His patience, guidance, love, and support made this dissertation possible. My thanks go to the other members of my committee: Dr. C.M. Fan, for her extensive review of the theoretical portion of this dissertation, Dr. Harvey Cutler for his "tough love" and extensive review of my empirical testing, and Dr. John Olienyk for his advice on financial aspects of this research.

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Chapter 1. Introduction and Overview

With the breakup of the Soviet Union and the emergence of Asian, Eastern European and Latin American countries into the international economic arena, the need for these nations to provide a stable monetary unit has re-ignited the argument about whether to use currency boards or central banks. The use of a currency board arrangement (CBA) to stabilize the macroeconomy is not a new idea. Successful currency boards exist in several world economies, including Hong Kong and Estonia. The debate over the use of currency boards versus central banks has been fueled by the poor performance of central banks in many emerging countries due to their vulnerability to government pressure to finance excessive deficits and dissatisfaction with central banks' use of monetary policy.

Most of these emerging economies are jockeying for foreign direct investment (FDI) to facilitate their economic growth; however, they lack well-established financial markets to use the most important tool of monetary control - open market operations - to stabilize their economies and their currencies. Mundell (2000) emphasized the importance of achieving a stable and credible currency in his statement that "strong currencies are the children of empires and great powers." Therefore, to secure the flow of international capital, these countries must appear to have an economy in which their currency and prices are stable, and the monetary authority is not simply a puppet of the government. To promote currency stability and independence from government political

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pressures, some developing countries such as Indonesia and Venezuela have considered the use of currency boards.

Over the past decade, there has been renewed interest in this type of monetary arrangement. To pass judgment on proposals to extend the currency board system to other emerging economies, it is essential to determine what characteristics embody a successful currency board and how the mechanism of exchange-rate maintenance works. Most studies of CBA's lack a comprehensive section detailing the mechanism that maintains the exchange rate, and none of those studies provides an econometric analysis of that mechanism. Furthermore, no previous comprehensive list of characteristics essential to adopting a successful currency board has been made. Both of those tasks I will address in this dissertation.

1.1: The relation of this dissertation to existing literature

Prior to the 1980's, currency boards received little attention either as a viable monetary alternative to a central bank or as a subject worthy of literary exposition. However, in the past two decades, debate surrounding currency board efficacy has become a relatively hot topic, fueled by Hong Kong's successful return to a currency board system in 1983. The major published writings on currency boards were a series of articles written by John Greenwood in the 1970's in the Asian Monetary Monitor. In those articles, Greenwood, a strong advocate of the currency board system, discussed the theoretical underpinnings of the system, especially in relation to Hong Kong.

There has been a number of articles and books published since then regarding the theoretical aspects of the currency boards system. The chief advocate of the currency

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board system today is Stephen Hanke of Johns Hopkins University. Hanke has published numerous books and articles regarding the applicability and feasibility of currency board adoption for numerous countries and has advocated currency board adoption for Russia, Estonia and Indonesia. Hanke, along with Kurt Schuler and Anna Schwartz, has written some of the preeminent works on the history and structure of currency boards. Schuler's 1992 dissertation presented an extensive investigation of the historical features of a currency board arrangement.

Williamson (1995) looked at the advantages and disadvantages of currency boards. International Monetary Fund (IMF) staffers Enoch and Gulde (1997 and 1998) and Ghosh et al. (1997 and 1998) all have written articles discussing the use of currency boards as a panacea for macroeconomic problems ailing emerging economies. These articles have provided insights into some of the characteristics necessary for emerging economies to successfully adopt a currency board arrangement.

Numerous country-specific articles have been written examining the viability of currency boards. Adam Bennett (1992) of the IMF has extensively analyzed Estonia's currency board arrangement. Santiprabhob (1997), also of the IMF, examined the relationship between bank soundness and currency boards in Estonia, Hong Kong, Singapore, Lithuania, Bulgaria and Brunei Darussalam.

1.2: The remainder of this dissertation

Chapter 2 provides a definition and historical overview of currency boards and presents the popular arguments for and against currency board arrangements (CBA's). Chapter 3 discusses the place of currency boards in the macroeconomic model and

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introduces the mechanism that maintains the fixed exchange rate under a CBA. Chapters 4 and 5 provide case studies of Hong Kong and Argentina, respectively, which examines the components of the mechanism that maintains the fixed exchange rate. Chapter 6 is an econometric analysis of the mechanism that maintains the fixed exchange rate under Hong Kong's currency board. Chapter 7 concludes by again highlighting all the relevant information gathered in this dissertation regarding the results of the econometric analysis and its importance for emerging countries.

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Chapter 2. Origins and Characteristics of Currency Boards

2.1: What is a currency board?

A currency board is a monetary system in which the local value of a currency is controlled by rigidly fixing its value to a stable international currency such as the U.S. dollar or deutsche mark (Deane and Pringle, 1995). Currency boards issue notes and coins that are fully backed by a foreign reserve currency and fully convertible into the reserve currency at a fixed exchange rate on demand. This rule of convertibility is "an explicit legislative commitment to exchange domestic currency for a specified foreign currency, the reserve currency, at a fixed exchange rate" (Santiprabhob, 1997). A CBA fixes the value of domestic currency in terms of the anchor currency and must keep enough of the anchor on reserve to fully repurchase all of the local currency at the fixed rate. Therefore, the supply of domestic currency is endogenous and fluctuates automatically with demand. The supply of domestic currency contracts when the holders exchange it for the reserve currency. An alternative method of envisioning the role of a currency board is to think of domestic currency as a "voucher" that entitles the holder to a fixed amount of reserve currency (Stein, 1999a).

In all cases, the reserve currency is chosen for its expected stability. The reserves held by a currency board are usually low-risk, interest-earning securities or other assets payable in the reserve currency. Usually, reserves total 60-100 percent of local notes and coins in circulation. A typical currency board earns a profit from the return on the

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reserve-currency securities it holds, less the expense incurred from the maintenance of notes and coins in circulation (Hanke, Jonung and Schuler, 1993).

A currency board is an institutional extension of the pegged exchange rate system; however, as Ghosh, Gulde and Wolf (1998) explain, the legal arrangement of a currency board creates a crucial benefit that the pegged exchange-rate system lacks. "A currency board, by removing, or at least severely limiting the scope for discretionary credit policy, should result in even greater discipline and confidence than simply pegging the exchange rate." By constraining discretionary monetary policy, a currency board achieves a level of autonomy not possible under a pegged exchange rate system. Therefore, there is only one target of monetary policy in currency board countries: exchange rate stability. By maintaining this target, currency board countries believe that domestic inflation and interest rates will adjust to the fixed rate. This will appeal to foreign investors who fear fluctuations in exchange rates and excessive monetary expansion due to changing political attitudes. It is this feature of currency boards that has led to their revival as the monetary policy answer to the ills of small, mid-sized and even some large countries.

This is not a new solution to the old problem of monetary instability. Most currency boards were established by the British Empire between 1912 and 1945 in its colonies. The boards were modeled on the West African Currency Board, which served Gambia, the Gold Coast, Nigeria and Sierra Leone. It was predominantly British colonies that used currency boards during this period. According to Schwartz (1993), the British government's aim was to free itself from the recurring expense of shipping shillings for troop and other payments by establishing fixed rates of exchange between the shilling and the various coins used in different colonies. Once it had established a currency board

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in a distant colony, Britain no longer had to worry about costs arising from the transport of bank notes from Britain to the colonies. Using a currency board meant there was no need to change the existing local currency (Latter, 1993).

It was the job of the currency board to limit monetary growth, and it did so by supplying or demanding sterling for local currency. Basically, currency boards issued local currency against some collateral currency, usually British sterling, and guaranteed that each local note was fully backed by sterling held in the local bank. These "boards did not extend loans to governments, banks or non-financial firms" (Deane and Pringle, 1995). Local commercial banks took care of all normal bank-related functions. It was possible for the currency boards to be relatively profitable because they received interest on the reserves that were being held in the form of British securities.

However, in the 1960's, most of the British colonies gained independence and immediately abolished their currency boards. The one exception to this is, of course: Hong Kong, which has retained its currency board even after it gained independence from Great Britain on July 1, 1997. This is because Hong Kong was presumably allowed by China to keep its unique capitalistic system for the next 50 years. After the abolition of most currency boards in the 1960's, central banks became the trophy or symbol of independence in emerging economies.

The newly created central banks soon became puppets that were manipulated by politicians and dictators. This was the time in which central banks "provided the cash to pay the government's bills and slavishly followed politicians' dictates about who to lend to and at what rates" (*The Economist*, 1996). These central banks in emerging economies simply became the printing presses for the government, and it was this type of situation

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that caused inflation resulting in a financial crisis of epic proportions. Currently, as emerging Latin American countries recover from past financial hyperinflation, and as Asian and former Soviet republics emerge, these economies are again searching for the right formula for monetary stability.

Currency boards are being employed in approximately 16 countries or regions in the world. The most successful and prominent currency boards are in Hong Kong and Estonia. The most commonly used currency peg for these countries is the US dollar. The level of backing of domestic currency by the reserve currency varies greatly among countries. Some countries require 100 percent of the monetary base to be covered and then allow a variety of ways for the coverage to be made. The flexibility of the type of coverage required is a key feature in the success of currency boards for emerging economies. The coverage that most appropriately balances flexibility and credibility, given the specific credit capabilities of emerging economies, likely will be the most successful. Table 2.1 provides a look at countries currently using currency boards.

Although approximately 16 nations use currency boards to control the money in their respective countries, not all of those currency boards will be examined in this analysis. The countries that will be omitted include Saudi Arabia, Singapore, Antigua and Barbuda, Bosnia and Herzegovina, Brunei Darussalam, Djibouti, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines (for a detailed historical analysis of these countries, see Schuler, 1992). Saudi Arabia is omitted because its currency board is so unique and information limited. Singapore is omitted from the analysis because in the past decade, the Singapore monetary authority has begun to operate so much more like a central bank that it is usually not even

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considered a currency board. The reason for the omission of the others is mainly because these economies are so small that they lack the financial complexity necessary to make an analytical generalization regarding the monetary authorities' effectiveness.

Table 2.1 Currency Boards in the World: 2000

Country/region	Year Established	Peg Currency	Backing Rule
Antigua & Barbuda	1965	US $	at least 60% of currency & bank reserves
Argentina**	1991	US$	100% of monetary base, 1/3 can be in US government bonds
Bosnia & Herzegovina	1996	DM	N/A
Brunei Darussalam	1967	Singapore $	70% of its demand liabilities backed by external assets of which 30% must be liquid
Bulgaria	1996	DM	100% of monetary base
Djibouti	1949	US$	100% of currency
Dominica	1965	US$	at least 60% of currency & bank reserves
Estonia	1992	DM	100% of monetary base
Grenada	1965	US$	at least 60% of currency & bank reserves
Hong Kong	1983	US$	100% of Certificate of indebtedness
Lithuania	1994	US$	100% of currency & central banks liquid liabilities
St. Kitts & Nevis	1965	US$	at least 60% of currency & bank reserves
St. Lucia	1965	US$	at least 60% of currency & bank reserves
St. Vincent & the Grenadines	1965	US$	at least 60% of currency & bank reserves
Saudi Arabia	1952	US$	N/A
Singapore		US$*	*basket of currencies including US$

Source: Compiled from Santiprabhob (1997) and Enoch and Gulde (1998)

**Argentina no longer has a currency board

2.2: Currency boards vs. central banks

Although central banks are usually very familiar to most people, currency boards are not (even most economists are unfamiliar with them). The central bank of a nation is the

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primary national bank that lends to the government and other banks, sets monetary policy and regulates all other banks. A currency board, however, is not the primary bank of a nation, does not lend to the government and rarely lends to other banks. It does not establish monetary policies except to maintain the fixed exchange rate, and it does not regulate other banks except in a few rare instances. Figure 2.1 displays the relationship of currency boards to the different levels of government-controlled central banks.

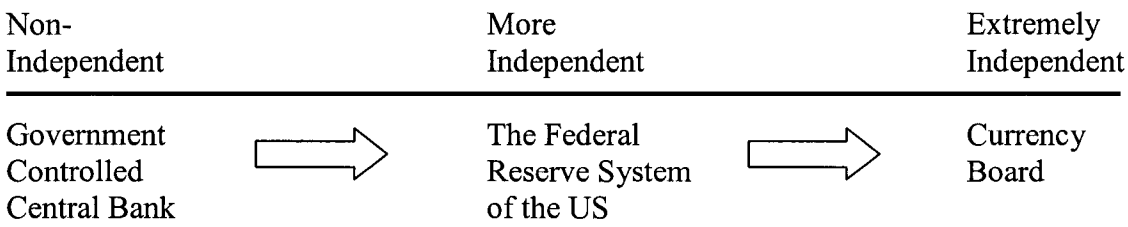

Figure 2.1 Degree of Independence of the Monetary Authority

The differences between central banks and currency boards are significant and have been discussed in detail by Hanke, Jonung and Schuler (1993), Schwartz (1993) and Ghosh, Gulde and Wolf (1998). Central banks have many characteristics that currency boards lack. Opponents of currency boards point to this lack as the reason they believe most currency boards will fail. However, proponents feel that it is the lack of central bank characteristics that contribute to the success of currency boards. Table 2.2 outlines the different characteristics of currency boards and central banks.

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Table 2.2 A Currency Board vs. A Central Bank

Characteristics	Currency Board	Central Bank
Supplies notes & coins	Usually	Always
Exchange rate type	Fixed w/ reserve currency	Fixed or floating
Level of foreign reserves	100%	Variable
Convertibility	Full	Limited
Type of monetary policy	Rule-bound	Discretionary
Lender of last resort capability	None	Full
Regulation of commercial banks	None	Usually
Visibility of operations	Transparent	Opaque
Level of political pressure	Low	High
Level of credibility	High	Low
Method of earning seigniorage	From interest only	Interest & inflation
Ability to create inflation	None	Full
Ability to finance gov't spending	None	Full
Preconditions necessary for reform	Limited	Many
Pace of monetary reform	Rapid	Slow
Size of staff	Small	Large

Source: Hanley et al. 1993

I will now examine the characteristics listed in Table 2.2 in more detail. A currency board usually supplies only notes and coins, but a central bank also accepts deposits. In the past, currency boards have accepted deposits; however, because deposits would be subject to the same reserve requirements as notes and coins, currency boards typically do not accept deposits (Hanke, Jonung and Schuler, 1993).

A currency board typically maintains a fixed or permanent exchange rate, which can be changed only in emergencies. The exchange rate is written into law and sometimes is added to a country's constitution. Most currency board countries have successfully maintained their fixed exchange rates, with Argentina being the only notable exception. A central bank may pursue either a fixed or flexible exchange rate system. If it follows a fixed or pegged exchange-rate system, this peg does not hold the same credible long-term

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guarantees that the peg does under the currency board system. Because the current exchange rate is not written into law, it may be changed by the government or the central bank at any time, and as such may fall under considerable political pressure. If speculative or political pressure to depreciate is severe, then the central bank will do so. This illustrates the main difference between exchange rate regimes under a currency board system and a central bank (Ghosh, Gulde and Wolf, 1998).

Most currency boards hold reserves in excess of 100 percent of liabilities, even though it is required by law to hold only 100 percent. Currency board countries' liabilities are the notes and coins in circulation as well as any deposits. Central bank countries, however, tend to have a variable level of foreign reserves because they typically are not legally required to hold any fixed or binding ratio of foreign reserves to liabilities (Hanke, Jonung and Schuler, 1993). Whereas currency board countries will hold foreign assets only against domestic liabilities, central banks will also hold mainly domestic reserves, such as government securities. The amount and type of reserves held also lends credibility to a country's ability to effectively defend its peg.

The rule of full convertibility in a currency board country means that notes and coins can be converted at any time from domestic currency to the reserve currency at the stated fixed exchange rate without limit. In most currency board countries, conversion from the reserve currency to the domestic currency can be done at local banks. However, exchanging domestic currency for the reserve currency can be done only by banks through the monetary authority, not by individuals through the monetary authority. In other words, individuals usually are not able to transact directly with the currency board. This is similar to what occurs in central banks. Typically, the currency board will

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exchange any amount of the reserve currency for domestic currency at the fixed rate; however, it will not exchange for other foreign currencies and plays no role in the determination of non-reserve currency exchange rates. Usually, commercial banks are free to trade non-reserve currency at the given market rates. Central banks usually have limited convertibility, and in some cases may have inconvertible or only partially convertible currencies (Hanke, Jonung and Schuler, 1993).

One characteristic of currency boards that is seen as both an advantage and disadvantage is its rule-bound monetary policy. A rule-bound monetary policy for currency boards means that the exchange rate and the reserve ratio cannot be altered, except in times of extreme emergency. Furthermore, the currency board is not allowed to change or manipulate the rules and regulations that affect commercial banks. In this respect, the visibility of operations of a currency board is completely transparent in that its every move is anticipated due to its adherence to the rules of its monetary policy.

A currency board simply acts as a "warehouse" that exchanges its notes and coins for reserve currency at the fixed rate and in quantities that the public and commercial banks demand. Currency board countries have an adjustment mechanism that reacts automatically to changes in foreign exchange. This mechanism works through changes in the money demand. The determination of money supply is left up to the market and, in most cases, the role of currency boards is passive in the face of any changes in money demand. For example, consider the situation in which demand for imported goods increases so that the current account goes into a deficit. This would cause money to flow out of the currency board country to purchase goods and services. This, in turn, would lead to a decrease in commercial bank reserves, further decreasing the commercial banks'

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ability to make loans. Loan scarcity would cause interest rates to rise, leading to a fall in incomes. As incomes fall, demand for goods in general falls, including demand for domestic notes and coins. This causes a fall in the prices of domestic goods relative to foreign goods, increasing foreign demands for domestic goods, which will return the domestic economy to a new equilibrium. These changes will also induce changes in employment and output (Hanke, Jonung and Schuler, 1993).

This example can be generalized to any country that does not pursue monetary policy action in the face of certain macroeconomic changes. However, the main point of this illustration is to show that this is the only way in which currency board countries deal with foreign exchange outflows and inflows, due to their rule-bound monetary policy. At no time will the currency board interfere in the normal market process to attempt to force the macroeconomy into equilibrium.

Central banks, on the other hand, can easily manipulate monetary policy. This means that their actions cannot always be anticipated and the motivations for the actions are not always clear. Consider the following simplified example of an increase in money supply in a central bank country with a floating exchange rate. If a central bank lends to the government and unexpectedly increases the monetary base, this will cause the reserves of commercial banks to increase, further increasing their ability to make loans. As a result, the exchange rate of domestic currency depreciates (Hanke, Jonung and Schuler, 1993). This example illustrates the differences between currency boards' and central banks' abilities to manipulate the money supply through monetary policy.

A typical currency board does not operate as a lender of last resort. It does not lend to commercial banks or other agencies to help them avoid bankruptcy. Currency boards

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also do not regulate commercial banks. Any regulation of commercial banks in a currency board system would come from some other governmental agency. A typical central bank, on the other hand, does function as lender of last resort and will bail out commercial banks in order to prevent bankruptcy. Central banks are also usually responsible for the regulation of commercial banks, which affords central banks another method of manipulation of the money supply through reserve requirements.

Because operations are transparent and monetary policy is rule-bound, typical currency boards are usually relatively free of political pressure. Being free of political pressure adds a great deal of credibility to a currency board, especially for those countries whose previous central banks were merely puppets of the incumbent political party. Central banks, on the other hand, have relatively low credibility because, as seen by the examples of Mexico, Brazil, the former Soviet Union and many other countries, when the government gets into financial trouble, it will often turn to the central bank for deficit financing by printing more money.

A typical currency board is legally prohibited from lending to the government; therefore, inflation cannot be created by the government's deficit spending by printing more notes. Central banks vary in their willingness to finance government deficit spending by lending to the government. For example, the extent of lending by the Federal Reserve Bank in the United States is relatively small; however, government lending by the central bank of the former Soviet Union is quite large.

The final characteristics mentioned in Table 2.2 make currency boards particularly attractive to developing countries. Given that currency boards provide rapid monetary reform with limited preconditions, ailing developing or transitioning countries can

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rapidly adopt a currency board with a small staff and quickly contain their monetary woes. To institute a central bank, on the other hand, requires meeting extensive preconditions for monetary reform, such as willingness by the government to cease financing government spending by inflation. Once a central bank is instituted, the rate of monetary reform is usually slow and requires a large staff to operate. In a developing or transitioning economy, finding qualified individuals to work in a central bank may not always be easy.

These characteristics highlight some of the concerns that a developing or transitioning country may have when contemplating the adoption of a currency board rather than a central bank. The next section discusses the recent appeal of CBAs.

2.3: The appeal of currency boards

Krauss (2001) suggests that the revival of currency boards is mainly due to the inflation-controlling properties of CBA's. He points to Argentina's use of a CBA in 1991 as a means to control hyperinflation and a sinking currency, as the point that marks global re-interest in the use of currency boards. Although Hong Kong has successfully used a currency board for numerous years, it wasn't until Argentina made the move to this form of monetary regime that other countries began to take notice. Since then Estonia also has moved to a CBA to control numerous problems, including inflationary problems. Both of these countries have successfully used CBAs to tame their hyperinflationary woes. It is this inflation-controlling property that is usually cited as the most appealing characteristic of a CBA.

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A substantial body of literature suggests that lower inflation is achieved under a fixed exchange-rate system than with a floating exchange rate (see Ghosh, Ostry, Gulde and Wolf, 1997; and Caramazza and Aziz, 1998). Kwan and Lui (1996) compared inflation performance in Hong Kong during its floating and fixed exchange-rate periods and concluded, using counterfactual simulations, that if Hong Kong had used a fixed exchange-rate system during the floating period, inflation would have been lower. In another study, Ghosh, Gulde and Wolf (1998) found that inflation under a currency board arrangement was lower than in countries with other, less extreme forms of pegged exchange-rate systems.

CBA's are appealing for controlling inflation as a permanent or temporary answer to macroeconomic problems. Some countries or systems, such as Hong Kong, believe that CBA's offer a more permanent solution to macroeconomic stability, and have not made plans to switch away from the use of a CBA. Estonia, on the other hand, established a CBA in 1992, and plans to use the CBA to create macroeconomic stability on the way to membership in the European Union. If the commitment to a CBA is sincere, the gains from this type of monetary arrangement can be obtained through its use as a permanent fix or a transition tool.

Using anchor currencies like the US dollar or the euro ensures that countries that anchor to these currencies will have roughly the same level of inflation as the anchor country. This is important for nations that have adopted a CBA because of the appeal of inflation control. For these countries, the threat of skyrocketing inflation is significant because of domestic government finance problems. The government turns to the central bank as a way to raise revenue through printing money. The move to a CBA prohibits

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deficit financing in this way and creates credibility in the monetary authority. The US and European Union have been notoriously watchful of inflation. This instills confidence that by pegging to these countries through the use of a CBA, other countries can inherit this same type of inflation level.

2.4: Popular arguments against currency boards

Many of the advantages of currency boards were highlighted in sections 2.2 and 2.3, and have been the subject of numerous studies including Walters and Hanke (1992), Hanke, Jonung, Schuler (1993), Williamson (1995), Ghosh, Gulde and Wolf (1998) and others. The most popular disadvantages will be highlighted and critically examined in this section.

For emerging economies, the task of choosing an effective monetary authority is daunting, and in many cases the future economic success of these countries hinges on this choice. The possible problems with currency boards have been the subject of much debate and were extensively covered by Hanke, Jonung and Schuler (1993) and Williamson (1995). The five main arguments against use of currency boards are the speculative runs argument, the lack of lender of last resort (LOLR) argument, the seigniorage argument, the fiscal discipline argument and the transition argument.

2.4.1: Speculative runs argument

The first argument against the use of currency boards is that a rule-bound monetary policy limits the scope of monetary operations in such a way that a currency board country is left vulnerable to speculative runs on currency (Kasa, 1999). The idea of

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speculative attacks on fixed exchange-rate systems has been extensively discussed and modeled by Krugman and Miller (1992), Hanke, Jonung and Schuler (1993), Williamson (1995), Obstfeld and Rogoff (1996), Kasa (1999) and others. A recent article argues the following:

> Currency boards and rigidly pegged exchange rates leave weak economies with an inelastic monetary system that is hostage to someone else's currency. To fortify a weak currency with a pegged exchange rate against speculative assault, there is only one policy instrument. The board must raise domestic interest rates so high that traders start buying the currency rather than shorting it. In the meantime, the high interest rates savage the local economy (Kuttner, 1998).

This argument involves the idea that currency boards are too rigid. By maintaining a fixed exchange rate, weak, emerging economies will be at the mercy of fluctuating international currencies. Those who argue against currency boards cite that, with the limited ability of currency boards to manipulate domestic monetary conditions, the local economy could become a sitting duck waiting for any "speculative runs" on currency.

Underlying the first critique is the idea that central banks with fixed or flexible exchange rates can intervene in the foreign exchange market to mitigate the effects of fluctuating international currencies. Bonser-Neal (1996) collected data from the United States, Germany and Japan from 1985 to 1991, and found that intervention by the central banks of these three economies did little to stabilize exchange rate volatility. In some cases, central bank intervention even increased volatility.

Hong Kong has weathered substantial speculative runs on its currency. One of the most significant runs occurred after the Asian financial crisis in 1997. Prior to the collapse of Argentina's CBA, the "Tequila Crisis" that affected Mexico and many

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surrounding countries also created a speculative run on Argentina's CBA. These speculative attacks will be discussed in greater detail in later chapters.

2.4.2: Lender of last resort argument

The second and most popular argument against use of currency boards is that under such an arrangement, a country loses its ability to act as lender of last resort, which, in the face of a banking crisis, can cause domestic banks to fail. Supporters of this argument believe that, without the ability to function as lender of last resort, a currency board leaves commercial banks in a position of restricted liquidity and exposes them to failure in the face of a financial crisis. Additionally, argument supporters believe that without lender of last resort powers, currency boards are unable to sterilize the money supply to change the amount of currency held by the public. This could lead to a nationwide deepening of a financial crisis.

Opponents of this argument usually reply in one of two ways. For example, Hanke, Jonung and Schuler (1993), state the following:

> Lack of a central bank as a lender of last resort does not seem to have harmed currency board systems. Failures by commercial banks have been minor in currency boards systems. No large commercial bank has ever failed in a currency board system, and losses to depositors from the few small commercial banks have been tiny (Schuler, 1992). Since the founding of the first currency board in 1849, there have apparently been no cases in which commercial banks in currency board systems have relied on central banks as lender of last resort.... Currency board systems have performed well without lenders of last resort.

Currency board proponents believe that the record of currency boards shows that, although they do not have the ability to act as lender of last resort, this has not been a significant problem for economies employing them.

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Many currency boards have taken steps to expand their financial tools to alleviate "lack of lender of last resort" fears. The Hong Kong Monetary Authority (HKMA) has used central bank-like maneuvers to alleviate financial pressure during the Asian and Mexican crises respectively (these situations will be discussed in later chapters). Not only can currency boards expand their financial tools to obviate the need for a lender of last resort function, the commercial banking system can also help.

Hanke et al. (1993) and others have also discussed other measures that can be employed to alleviate the need for a currency board to function as a lender of last resort. One possible alternative is to allow large international branch banks to operate in currency board economies. Hanke et al. (1993) found that "commercial banks that have international branch networks tend to be able to diversify their risks more than banks with domestic branch networks only, and hence tend to be less susceptible to failure because of localized economic shocks". Furthermore, Goodhart and Huang (2000) discuss using an international lender of last resort as a means to provide international liquidity to countries whose domestic LOLR capacities are diminished by pegged exchange-rate systems.

Providing private deposit insurance is another way to avoid the necessity of a lender of last resort function. Industrialized countries such as Germany and Switzerland both have this type of bank-funded deposit insurance which can be much less costly than government-funded deposit insurance such as the Federal Deposit Insurance Corporation (FDIC) that operates in the United States.

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2.4.3: Seigniorage argument

The third argument against the use of currency boards is based in the belief that, because currency board countries use foreign currency to back domestic money supply, they are unable to earn seigniorage. Seigniorage is the difference between the value of money produced and the cost of producing it, or in other words, it "represents the real revenues a government acquires by using newly issued money to buy goods and nonmoney assets" (Obstfeld and Rogoff, 1996). Cagan (1956) believed that most hyperinflations were started due to the governments need for seigniorage revenue. Seigniorage enables governments to increase purchases simply by printing more money. This is an important and potentially dangerous tool for developed economies and is even more important for developing economies. Table 2.3 below looks at seigniorage revenues as a percentage of government spending and as a percentage of GDP for a select group of developed countries.

Table 2.3 Seigniorage Revenue for Selected Countries 1990 - 94

Country	% of Government Spending	% of GDP
Australia	0.95	0.31
Canada	0.84	0.09
Germany	2.89	0.56
Italy	3.11	0.32
Sweden	3.22	1.52
United States	2.19	0.44

Source: International Monetary Fund, International Financial Statistics 1999

A central bank can earn seigniorage by issuing new notes and coins. It can also earn seigniorage on the deposits that commercial banks hold with it and loans it makes. Usually, the deposits pay no interest or very little interest. Table 2.3 shows that, although

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seigniorage revenues do not make up a large percentage of government spending or GDP, this type of revenue provides a quick and easy form of obtaining revenue for the government. In the absence of inflation, seigniorage revenues allow the government to purchase goods and services with relatively little downside. However, one important source of seigniorage revenue can come through the creation of inflation. By increasing the nominal money supply, a central bank country can create inflation and therefore increase seigniorage revenue.

A currency board can earn seigniorage only from interest it earns from its holdings of securities in reserve currency. Therefore, there is a cost involved in using foreign currency in lieu of domestic assets to back the domestic money supply; a currency board cannot earn seigniorage from the creation of inflation. However, Williamson (1995) and others point out that it is possible for currency boards to create seigniorage revenue equal to or greater than that under a central bank. If the currency board engenders a level of confidence in the value of domestic currency in such a way that it is substituted for foreign currency, seigniorage revenue under a currency board could surpass that of a central bank. Furthermore, if the currency board chooses foreign assets that yield greater returns than domestic assets, then the level of seigniorage return will exceed that which could be achieved by a central bank.

2.4.4: Fiscal discipline argument

The fourth argument against currency boards is that emerging economies lack the fiscal discipline necessary to successfully maintain the currency peg in the face of political pressure. This is a potentially serious problem. If the government is subject to

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political pressure, the resulting fiscal policy could be destructive to a currency board. Moreover, if the government lacks the ability to instill confidence through prudent fiscal policy, exchange-rate pressure on a currency could result in an inability to maintain the peg. Many emerging economies have had central banks that have been at the mercy of changing political regimes. These countries have suffered political, economic and social turmoil that have created a lack of confidence in the government and the monetary authority. In many of these countries the use of alternate currencies has become commonplace as faith has been lost in value of the domestic currency.

Proponents of the currency board system argue that the rule-bound nature of a currency board contributes to a country enforcing fiscal discipline. Hong Kong's ability to maintain extreme fiscal prudence in the face of severe crises is due in large part to its colonial past. Argentina instituted a currency board during a time of crisis in 1991 and until 2001 was able to maintain fiscal prudence in adverse times.

A currency board cannot, however, ensure fiscal discipline in a country that is not concerned with a balanced budget. A government not concerned with a balanced budget might borrow abroad or domestically, causing it to pay perhaps damagingly high interest rates that could have devastating effects on the domestic economy. To help relieve this strain, the government could try to ease the pressure through an inflation tax (which would be permitted by a central bank), further ravaging the domestic economy. In the worst case, after the government has exhausted all options, it could go after the assets of the currency board. In the case where the currency board keeps assets in banks held abroad, the government could, in the extreme, replace the currency board with a

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central bank. In any case, radical actions by the government could have severe negative effects on people's confidence in the government and in turn the currency board.

This is why, as shown in the next section, a government contemplating the move to a currency board must be in a position to credibly pursue fiscal prudence. A currency board can be used to reinforce an existing commitment to fiscal discipline, but it cannot be used to create fiscal discipline in a country where discipline doesn't already exist. Once a currency board is in place, the transparency of operations makes this type of monetary arrangement relatively insulated from political pressure.

2.4.5: Transition argument

The final argument against currency boards addresses potential difficulties adjusting to a currency board system. The main problems in changing to a currency board regime are in obtaining the initial foreign reserves, and choosing a reserve currency.

Hanke et al. (1993) outline extensively the procedure used in procuring funds and calculating the amount necessary for initial foreign reserves. Obtaining the foreign reserves necessary to back the domestic money supply might be a difficult task in an emerging economy that has been battling inflationary pressures. Of course the amount of reserves necessary to run a currency board may vary depending on how the board is being established. If a central bank is being converted into a currency board, then the entire monetary base will need to be covered. If a currency board is being established without the conversion of a central bank, the initial reserves might be smaller. The recent experiences of Argentina and Estonia show that obtaining the necessary funds for initial reserves is feasible even under difficult circumstances.

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Choosing a reserve currency seems like a daunting task; however, the choice for most currency board countries has been clear. A peg currency is usually chosen for its stability. Not all countries in the world can have a CBA. There must be at least one country that has a central bank with prudent and effective monetary policies that control for inflation without stifling GDP growth. The two countries that are most often used as peg currency countries are the United States and European Union[1]. Both of these countries have central banks that are notoriously mindful of inflation. This is important because inherited inflation will be a possibility. Also, the anchor country must be a significant trade partner with the currency board country. A high degree of involvement between the two countries is ideal because their monetary policies will inadvertently be linked through the peg.

2.5: The special case of emerging economies

Do the potential benefits of a currency board outweigh the costs? The theoretical benefits of currency boards have been discussed in Ghosh, Gulde and Wolf (1998), Enoch and Gulde (1998), Hanke, Jonung and Schuler (1993), Santiprabhob (1997) and Williamson (1995), and they have been highlighted in previous sections. These advantages include better inflation performance without sacrificing higher output growth, and greater credibility, to name two. Costs associated with the adoption of a currency board were also covered in earlier sections. For most emerging countries, there is a fear that soaring inflation in the past will recur, and these countries are looking for some way to ensure future price stability and reduce exchange-rate risk. Many of these countries

[1] The establishment of the Euro as the currency of the European Union by the European Central Bank (ECB) gives the dollar stiff competition, but the Euro has substantially lost its value since January 1999.

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that previously had government-controlled central banks are now giving these central banks some degree of autonomy, in an attempt to remove the possibility of the central bank once again becoming the printing press of the government.

Emerging economies and other transitional economies are seeking a way to stabilize usually by controlling inflation and reestablishing confidence in the monetary authority. "For such countries, and especially those lacking a well-developed financial infrastructure including sophisticated financial institutions and broad and deep markets for foreign exchange, pegs can provide a simple and credible anchor for monetary policy" (Mussa, et al., 2000). One way to analyze the suitability of a currency board arrangement for an emerging economy is to look at the economic criteria thought to influence the appropriateness of adopting a fixed exchange-rate regime. A currency board arrangement is simply an extreme form of a fixed exchange rate. Mussa et al. (2000), Bratberg et al. (1999), Grafe and Wyplosz (1999), Caramazza and Aziz (1998), Honkapohja and Pikkarainen (1992), Savvides (1990), and Edison and Melvin (1990) have discussed the following conditions as likely to influence whether some form of pegged exchange-rate regime is judged to be suitable: low degree of involvement with international capital markets, high international reserves, high share of trade with the country to which it is pegged, size of the country, openness, a flexible and sustainable fiscal policy, and sound commercial banking system.

In order for emerging countries to determine if a CBA is suitable, they first must understand the role of the conditions mentioned above in the mechanism that maintains the fixed exchange rate. Chapter 3 will discuss the mechanism that is responsible for

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maintaining the fixed exchange rate and the role of the conditions mentioned above in this mechanism.

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Chapter 3: Role of the currency board arrangement in the macroeconomic model

The purpose of this chapter is to examine the role of the currency board arrangement (CBA) in a general equilibrium macroeconomic model. The role and implications of a CBA on other macro-variables and macro-policy instruments are analyzed in the IS, LM and BOP framework.

3.1: The Macro-Model

This model relates the equilibria in the real sector and money market, which form the basis for the IS and LM framework. A CBA works directly through the money market element of the general equilibrium model to maintain exchange rate stability and aid in achieving macroeconomic goals. It is important to understand the complete macro-model to understand how the exchange rate arrangement under a CBA works in facilitating the functioning of the entire macroeconomic model.

3.1.1: Money market equilibrium

The LM curve shows the various combinations of income (Y) and the interest rate (i) that produces equilibrium in the money market. When the supply of money (M_S) is equal to the demand for money (M_D), equilibrium occurs in the money market ($M_S = M_D$). The supply of money for a country can be examined through the following expression:

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$$M_S = a(BR + C) = a(DR + IR) \quad (1)$$

where BR represents the reserves of commercial banks (depository institutions), C represents currency held by the nonbank public, a is the money multiplier, DR represents domestic reserves and IR represents international reserves. BR and C are central-bank liabilities while DR and IR are central bank assets. Currency boards hold only the anchor currency as reserves so therefore DR = 0. The special case of currency boards necessitates another change to the money supply function in that the short-run and long-run money supply are subject to different conditions. Therefore, equation (1) can be rewritten to represent the long run as:

$$M_S^{LR} = a(BR + C) = a(IR) \quad (2)$$

where M_S^{LR} indicates that in the long run, money supply is subject to the multiplier times the level of international reserves, which are subject to the law of 100 percent convertibility. The short-run money supply (M_S^{SR}) is not subject to the law of 100 percent convertibility. The short-run money supply equation can be written as follows:

$$M_S^{SR} = g\,(a(IR);\, s) \quad (3)$$

where s represents a swap element particular to a CBA. Individuals must swap anchor currency for domestic currency to make domestic transactions. This affects the short-run supply of anchor currency but does not affect the long-run supply. The variable s is unique to a CBA in that because of the rule of 100 percent convertibility, domestic individuals will exchange anchor currency for domestic currency to make domestic transactions. Banks are required to hold a fixed amount of anchor currency as reserves. Therefore, any time there is an increase in the supply of anchor currency in the domestic economy, individuals will decrease their demand for anchor currency from commercial

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banks and increase the supply of anchor currency held by commercial banks as they swap anchor currency for domestic currency.

The demand for money can be expressed in the general form:

$$M_D = f(Y, i, P) \tag{4}$$

where Y is the level of real income in the economy, P is the price level and i is the interest rate. In the case of money demand, the nature of the impact of changes in the independent variables is indicated by:

$$\frac{\partial M_D}{\partial Y} > 0, \frac{\partial M_D}{\partial i} < 0, \frac{\partial M_D}{\partial P} > 0, \tag{5}$$

Income (Y) and the interest rate (i) are thought to be the two major influences on the demand for money. Holding constant all variables other than income and the interest rate, there will be a transactions demand for money fixed by a given level of income and asset demand for money determined by the domestic interest rate. In the case of currency board countries, analysis of the "money market" includes the examination of money supply and demand in two bank markets. The first market is the commercial banking system, which holds checking and saving deposits and makes consumer loans. Figure 3.1 illustrates the money supply-and-demand curves for the banking system.

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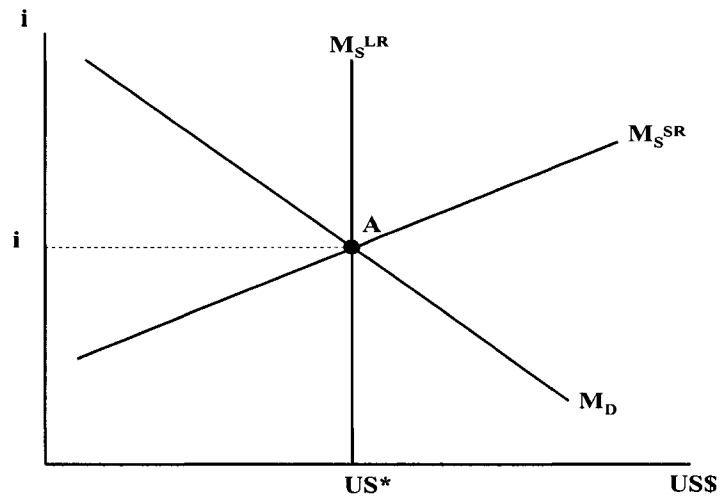

Figure 3.1 Money Supply and Demand in the Commercial Banking System and the Monetary Authority

The vertical nature of the long-run money supply curve denotes that the supply of money in the long run is independent of the interest rate. The quantity of long-run money supplied must back 100 percent of the domestic monetary base. The long-run supply of money is dependent on the amount of US dollars in reserves to back the domestic currency. If the quantity of reserve currency increases, then the monetary base will increase, signaling a shift of the long-run money supply curve to the right. The short-run money supply function is an upward-sloping function of the interest rate, signifying that as the interest rate increases, the quantity of money supplied also rises. The money demand curve is a normal, downward-sloping function of the interest rate, representing that the demand for money will increase as the interest rate falls.

Each commercial bank is required to hold an account with the monetary authority denominated in the anchor currency that must be cleared (returned to required reserve levels) at the end of the short-run time period. This account allows the monetary authority to control the liquidity in the interbank market. The interbank market

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represents the liquidity process between individual commercial banks and between the monetary authority and commercial banks. The interbank interest rate is the rate at which banks can borrow from the monetary authority or other banks. This rate facilitates interest-rate arbitrage in order to maintain parity between the market exchange rate and the official rate. The overnight interbank rate is the fastest to react when the market exchange rate deviates from the official rate because most banks must settle their accounts with the monetary authority by the close of business each day. If they are short of anchor currency in their accounts, they must take a loan on the interbank market, which will affect the interest rate.

The LM curve is derived from the various combinations of income and the interest rate that produce equilibrium in the money market (Figure 3.2). Factors that shift the LM curve are those factors that create changes in money demand and supply other than changes in Y. An increase in the demand for money will shift the LM curve to the left and a decrease in the supply of money will shift the LM curve to the right.

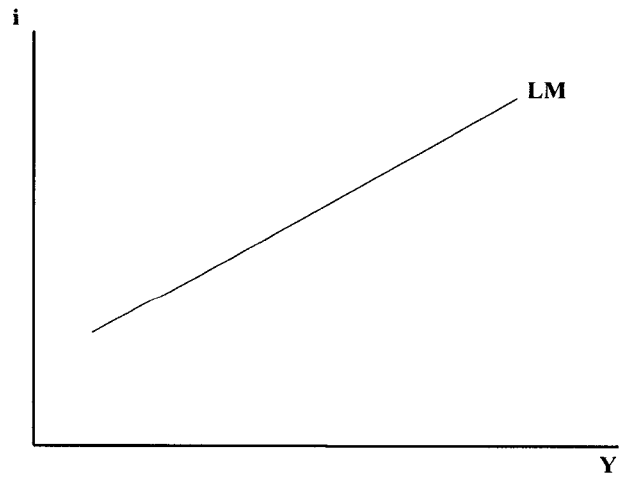

Figure 3.2 The LM Curve

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3.1.2: Equilibrium in the real sector

The combinations of income and the interest rate that produce equilibrium in the real sector of the economy determine the IS curve (Figure 3.3). In this model, this is equivalent to saying that the IS curve shows the combinations of income and the interest rate that make,

$$I + X + G = S + M + T \tag{6}$$

where I represents investment, X is exports, G signifies government spending, S is savings, M represents imports and T signifies taxes. In this model, most of the initial shocks to the system shift the IS curve, and the LM curve is the one to adjust to restore long-run equilibrium. Shifters of the IS curve include any autonomous change in I, X, G, S, T and M. An increase in I, X, G or a decrease in S, T, M shifts the IS curve to the right.

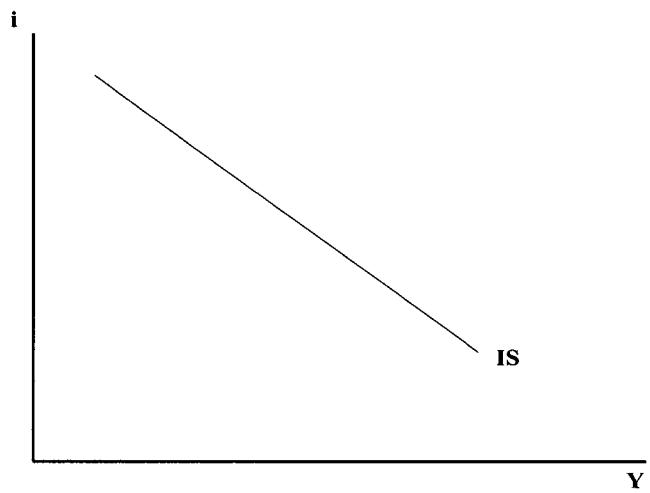

Figure 3.3 The IS Curve

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3.1.3 Equilibrium in the monetary and real sectors

Equilibrium in both sectors occurs when LM = IS, which is shown as point e in Figure 3.4. At point W, $I + X + G < S + M + T$, there is downward pressure on Y, and at $M_D > M_S$, there is upward pressure on the interest rate.

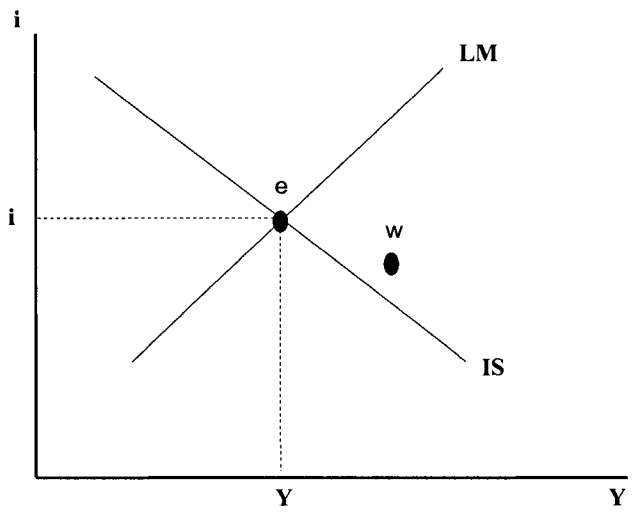

Figure 3.4 Equilibrium in the Monetary and Real Sectors

3.1.4 The External Sector Equilibrium

The external sector equilibrium is established where the balance of payments (BOP) is zero (Figure 3.5). The balance of payments consists of two components: the current account balance and the capital account balance. At equilibrium, BOP = 0. The BOP curve shows the various combinations of Y and i that produce equilibrium in the balance of payments. It is important to remember that a given BOP curve is drawn for a specific exchange rate. The less responsive that short-term capital flows are to the

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interest rate, the steeper the BOP curve; therefore, the BOP curve slopes upward when there is some impediment to the flow of short-term capital between countries.

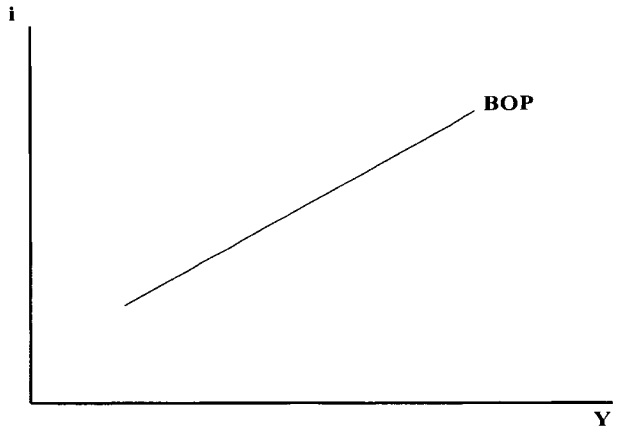

Figure 3.5 The BOP Curve

For example, an increase in the expected domestic profit that stimulates an inflow of long-term real investment (which creates an improvement in the capital account) will stimulate income. To maintain the pegged exchange rate, $\bar{e}$, the central bank will swap a sufficient quantity of foreign currency with domestic currency, thereby increasing the domestic money supply and facilitating the expansion of income. The increase in domestic income will stimulate an increase in imports, causing deterioration in the current account that exactly offsets the improvement in the capital account.

3.2: The mechanism that maintains the fixed exchange rate

Under a fixed exchange rate, the automatic adjustment mechanism is the change in the domestic money supply brought about by an underlying surplus or deficit in the BOP at the pegged exchange rate. Since the exchange rate cannot be changed under a pegged

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rate system, equilibrium combinations of income and the interest rate (where IS and LM intersect) must necessarily lie on the BOP curve dictated by underlying international economic considerations (Appleyard and Field, 2001). In specific, under a CBA the exchange rate is dependent on these three components:

$$e = f \text{ (interest rate arbitrage (LM), economic discipline (IS), cash arbitrage (LM))} \quad (7)$$

In most cases, shocks that initially move the system out of equilibrium come from the real sector moving the IS curve first, creating a shift in the BOP curve, and then the monetary sector adjusts through movements in the money supply in the interbank system, facilitating interest-rate arbitrage.

Economic discipline incorporates many of the instrument variables from the general macro model. Economic discipline describes the functioning of the macroeconomy under the general equilibrium framework. Encompassed in economic discipline is the role of the preconditions in facilitating the general equilibrium process. The cash arbitrage component facilitates the movement of the LM curve along with the interest arbitrage component. Volatility in the exchange rate will be modeled by examining the interaction between the three components in the IS-LM-BOP framework. The adjustment back to exchange rate stability will be modeled by examining the interest-rate arbitrage component and the movements in the money supply in the interbank market that generate the compensating movements in the LM curve. The interest arbitrage component is examined more closely as it is the workhorse of exchange

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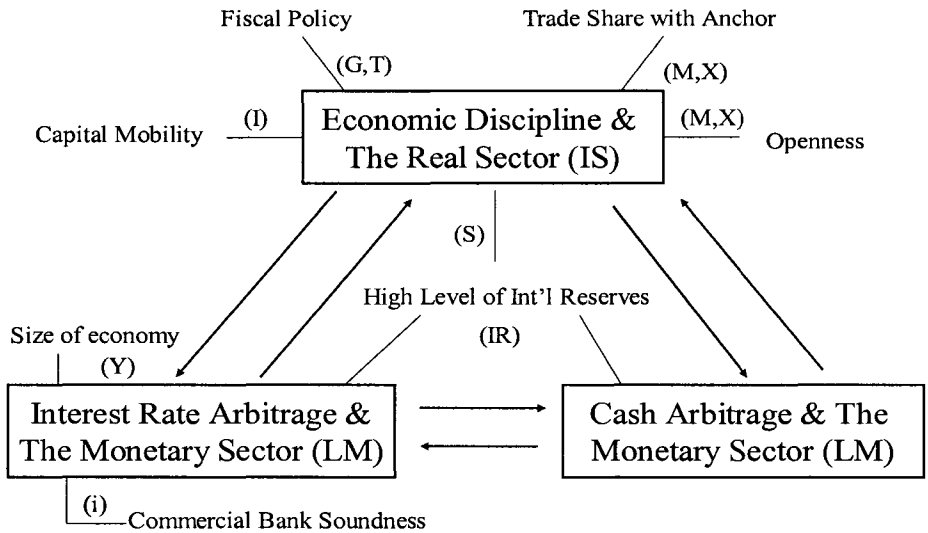
rate stability. Figure 3.6 relates the three components of exchange rate maintenance (economic discipline, interest rate arbitrage and cash arbitrage) to the preconditions that facilitate the functioning of each component.



Adapted from Tsang, 1999.

Figure 3.6 The Preconditions and the Exchange Rate Mechanism

The interaction of these three factors allows for a CBA to maintain the rigid link between domestic and anchor currency. The economic discipline component provides a successful economic environment for exchange rate maintenance through the movement of the IS curve. Figure 3.6 illustrates the relationship between the economic discipline preconditions and the factors that comprise the IS curve. The components of economic discipline are fiscal policy, trade share with anchor, capital mobility, openness and international reserves. Interest-rate arbitrage uses the commercial banking system to facilitate macro adjustments to the market exchange rate when it strays from the official rate, and cash arbitrage component makes micro adjustments to the market exchange rate

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when it deviates from the official rate. The most important component of this model is the interest-rate arbitrage mechanism, since it is the most active factor in Figure 3.6 that maintains stability in the fixed rate. The role of each of the three aspects in Figure 3.6 will be explained in detail and then the role of the economic discipline and cash arbitrage will be explained in relation to their role in facilitating interest-rate arbitrage.

3.3: Economic discipline

The important role that economic discipline plays in facilitating exchange rate maintenance was discussed earlier. Economic discipline reflects the economic atmosphere of the macroeconomy. Most of the conditions important for the adoption of a fixed exchange-rate system were discussed by Mussa et al. (2000) and others play a role in maintaining economic discipline which in turn affects the level of reserves. Each of the preconditions that influence economic discipline and abundant reserves is designed to foster an environment that allows a CBA to be successful.

In order to sustain a fixed exchange-rate policy, certain environmental economic preconditions or fundamentals are necessary. The importance of each of these preconditions can be discussed in relation to the models presented in Figure 3.6. The relation of each precondition to the model will be presented in this section, along with a literature review of the use of each precondition in fixed exchange-rate literature, and in later sections the role of some of the preconditions will be discussed in relation to their role in facilitating interest-rate arbitrage.

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3.3.1: Degree of involvement in international capital markets

In the early stage of literature regarding optimum currency areas, Mundell (1960 and 1961) argued that a high degree of capital mobility necessitates a fixed exchange rate. Although his view is not the currently popular view on the role of capital mobility in determining the likelihood of a fixed exchange-rate system, this view has been reinforced in several recent empirical studies (see Bratberg et al. 1999, Rose 1994, Honkapohja and Pikkarainen 1992, and Savvides 1990).

The prevalent view in regard to capital mobility is that a high degree of capital mobility makes it difficult to defend a fixed exchange rate, and in the case of perfect capital mobility, fixed exchange rates are costly to uphold (Obstfeld and Rogoff, 1996). Mussa et al. (2000) supports the popular view of a high degree of capital mobility in creating a situation that fosters flexible exchange rates in his theoretical argument on the preconditions necessary for the adoption of a fixed exchange-rate system. Earlier empirical studies by Bosco (1987) and Heller (1978) lend further support to the mainstream view in that they both find that increased capital mobility has a positive effect on the probability of adoption of a flexible exchange-rate regime.

This view follows from the idea that in many fast-growing emerging economies, pressure on the exchange rate in recent years has stemmed largely from greatly increased private capital inflows. When capital inflows accelerate and the exchange rate is prevented from appreciating, inflationary pressures build up and the real exchange rate will appreciate through higher domestic inflation (Caramazza and Aziz, 1998). Inflationary pressure can intensify exchange-rate pressure, creating speculation that the monetary authority will abandon the peg.

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This type of speculation can lead to self-fulfilling prophecies in which increased speculation creates a currency crisis, forcing the monetary authority to abandon the peg. In transition economies and those recovering from economic and political crisis, the banking system is not usually financially sophisticated enough to manage large inflows or outflows of capital. Even though this is the case, usually these types of economies encourage capital inflows through foreign direct investment (FDI).

Section 3.4 expands on the influence of capital inflows and outflows on the interest rate, which can have serious effects on the economy. Without the ability to sterilize capital flows, a balance of payments deficit or rapid capital outflows will automatically be translated into domestic liquidity contraction and higher interest rates, which is a function of the interest-rate arbitrage mechanism and eventually will contribute to a reversal of the deficit or outflows (Santiprabhob, 1997). But this process can strain the economy with "higher interest rates" and may require a tightening of fiscal policy (by decreasing G and/or increasing T), straining the limited arsenal of weaponry that the government has to combat rising inflation. In extreme cases where the commercial banking system does not have the sophistication to effectively facilitate interest-rate arbitrage, a high degree of capital flow fluctuation can have devastating effects on a country with a CBA, perhaps forcing the abandonment of the peg.

3.3.2: High international reserves (IR)

Most of the literature surrounding the potential for the adoption of fixed exchange-rate regimes does not focus on CBA's. In addition, most of the literature on fixed exchange rates does not involve an examination of the role of international reserves.

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However, few studies have provided theoretical explanations into the importance of the level of international reserves in a fixed exchange-rate regime. Mussa et al. (2000) and Batiz and Sy (2000) include an examination regarding the importance of international reserves in the maintenance of a fixed exchange-rate system. Flood and Rose (1997) found that there is no apparent tradeoff between exchange rate volatility and the behavior of international reserves, in that an increase or decrease in the level of international reserves did not increase or decrease the volatility in the exchange rate. Their study, however, was not related to currency board countries.

A currency board is required to swap unlimited amounts of domestic currency for the anchor currency and is legally required to have adequate coverage of foreign exchange reserves and other assets to meet the designated domestic liabilities, in order to facilitate the maintenance of the peg. Most currency board countries choose to hold a level of foreign reserves that exceeds the level of domestic liabilities, in case the value of the reserves has depreciated relative to other currencies. In order to be credible, a currency board must have a level of reserves in relation to the money supply or a monetary base large enough to sustain the peg and back the money supply.

Batiz and Sy (2000) argue that it is not the absolute level of reserves that matters when assessing a currency board's potential success in sustaining the peg; rather, it is the level of reserves relative to the money supply and in comparison to other countries. They believe that the adequacy of reserves is best measured by comparing international reserves to M1 and M2. This is obvious because international reserves back the domestic money supply and must be adequate enough so that if domestic individuals wanted, they could swap the entire domestic monetary base for the anchor currency.

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3.3.3: Openness (M and X)

In the literature, the degree of openness seems to be considered one of the most important preconditions. An economy is relatively open if its total trade (i.e., sum of exports and imports) constitute a large percentage of GDP. The more open a country, the more advantageous it is to fix the exchange rate (McKinnon 1963 and Krugman 1990). Complete openness means that the currency is fully convertible, implying that the monetary authority is just one of the many participants in the foreign-exchange market. The greater the convertibility of the currency, the more that currency is able to perform its functions of unit of account, medium of exchange and store of value. Fixed exchange-rate regimes require that the domestic currency is highly convertible. For many countries, as they become more open, the domestic currency becomes more convertible, and a consistent way to maintain macroeconomic stability is through fixing the exchange rate (Schuler, 1992).

There are a number of related methods to measure openness; however, the prevailing view on how to measure the degree of openness is to use the ratio of total trade to GDP (Bratberg et al., 1999). For many developing economies, it might be expected that the degree of openness would increase overtime, but Bratberg et al. (1999) found that this was not the case. Furthermore, their findings supported earlier literature from McKinnon (1963) and Krugman (1990) that increasing the degree of openness decreased the probability of adoption of a flexible exchange-rate regime. The positive relationship between openness and a fixed exchange-rate regime is also supported by the empirical studies of Honkapohja and Pikkarainen (1992), Savvides (1990) and Bosco (1987). This

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variable is also closely related to the share of trade (geographic concentration) with anchor country precondition in that it would be expected that as a country increases its degree of openness, greater importance will be placed on the trade share with the anchor country.

3.3.4: Size of the economy (Y)

The smaller the country economically, the more advantageous it is to have a fixed exchange rate. Countries with small economies are less stable and more prone to speculation (Mundell, 1960). In addition, countries with small economies are not able to affect foreign prices, and therefore the terms of trade, by exchange rate policy (McKinnon, 1963). Consequently, the benefit of a change in the exchange rate can be questioned. For small countries, the cost of keeping the exchange rate fixed is therefore of a minor magnitude. Size of the country is simply measured by US dollar denominated GDP.

3.3.5: Share of trade with anchor country (M and X)

Numerous studies point to the important role that the share of trade with the anchor countries plays in the determination of fixed exchange-rate viability (Bratberg et al. 1999, Honkapohja and Pikkarainen 1992, Savvides 1990 and Bosco 1987). This is also a critical variable in the literature on optimum currency areas. In the determinants of fixed exchange-rate literature, this variable is known as geographical concentration and is measured by the percentage of the largest single export destination in total exports. Heller (1978) argues that a greater degree of geographical concentration calls for a fixed

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exchange rate. Early empirical studies support this belief; however, Bratberg et al. (1999) found the opposite to be true, although the variable was not significant in the study. Their findings were supported by similar results from Honkapohja and Pikkarainen (1992) and Savvides (1990) but again, the variable was not significant at any level.

The logic behind pegging the exchange rate to the currency of a major trading partner is that a country ensures that trade deficits will not be increased by fluctuations in the anchor currency. When choosing a peg currency, a country should choose its dominant trading partner to ensure that it will be minimally damaged by fluctuations in the value anchor currency. "Choosing the currency of the predominant trading partner is in most cases advisable, as it reduces exposure to swings in the import value of reserves" (Enoch and Gulde, 1997).

Furthermore, if the share of trade between the domestic country and the anchor country is relatively large, then when the anchor currency fluctuates relative to other currencies, so does the domestic currency. However, a major portion of the domestic country's trade will be unaffected. Therefore, fluctuations in the real, effective exchange rate will occur only between lesser trading partners, which will help to minimize any adverse effects of these types of fluctuations. If a country did not choose an anchor currency with which it has a large trade share, the result of fluctuating currencies could be devastating to the domestic economy and could create intense exchange rate pressure, eventually leading to devaluation.

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3.3.6: Flexibility and sustainability of fiscal policy (G and T)

Given that a country is limited only to fiscal policy variables as a result of certain assumptions and restrictions made by the necessity of maintaining the fixed exchange rate, fiscal policy becomes a crucial variable in maintaining economic discipline and providing abundant reserves. Manipulations of the macroeconomy are available only through fiscal policy changes, and fiscal surpluses are usually used to fortify the reserve position of the monetary authority.

Under a CBA, monetary policy instruments such as open market operations or direct adjustments to the interest rate cannot be used to stimulate the economy. Therefore, if the economy faces a destabilizing shock, the stability of the macroeconomy is heavily dependent on fiscal policy instruments. "The greater the role of fiscal policy in helping to adjust the economy to changing conditions the less the need for...large-scale intervention.... Appropriate and transparent economic and financial policies are critical for safeguarding macroeconomic stability" (Caramazza and Aziz, 1998). In many emerging economies, large capital inflows from FDI are seen as signs of economic success; however, this can also cause external debt problems and force the real exchange rate to appreciate excessively. To prevent this from happening, fiscal policy would have to be flexible enough to be tightened, which could potentially lead to sizeable budget surpluses.

The sustainability of any fiscal policy relies greatly on the amount of political support. CBA's are not permitted to extend credit to the government, which has led to lower rates of fiscal deficits on average in currency board countries while at the same time creating tension between the currency board and the government. Without extensive

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government support of the currency board, severe financial crisis could cause the government to look abroad for credit, which would undermine the credibility of the currency board to maintain the peg. A framework for assessing fiscal vulnerability has been proposed by Hemming and Petrie (2000), which involves measuring certain fiscal vulnerability indicators, such as total national debt and government budget deficits.

3.4: Cash arbitrage

The cash arbitrage process is a simple but effective way to correct small deviations between the market rate and the official rate, by allowing for the "fine tuning" of the market rate. This process requires that individuals are allowed to transact directly with the currency board; if individuals are not allowed to transact directly with the currency board, cash arbitrage is not possible (as in Hong Kong). Using the example of the exchange rate process in the CBA that operated in Argentina from 1991-2001 with the official exchange rate of 1 peso = 1 US$, it is possible to understand the cash arbitrage process. Suppose the exchange rate weakens to 1.5 pesos to 1 US$; this will cause individuals to go to the bank and convert their bank deposits into cash (e.g., 15 pesos). These individuals will then go to the CBA and change the 15 pesos into the anchor currency at the official rate (1 peso = 1US$), and get $15 US. They then sell the anchor currency ($15 US) on the foreign exchange market for the domestic currency at the spot rate of 1.5 pesos to 1 US$ and receive 22.5 pesos, making an arbitrage profit of 7.5 pesos.

"The selling pressure on the foreign currency will bring the market rate back to the level of its official counterpart" (Tsang, 1999). The ability to earn cash arbitrage

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profit keeps the market rate close to the official rate or in other words, makes the micro adjustments (fine tuning) to the market rate. If the market rate is different from the official rate and cash arbitrage profit can be made, individuals will do this until it is no longer profitable, meaning that the market rate has converged to the official rate or near the official rate. This process ensures that the market rate always stays close to the official rate. As long as the market rate remains close to the official rate, individuals will not be willing to incur the transactions costs of the cash arbitrage process to earn a small arbitrage profit.

The cash arbitrage process is not designed to make day-to-day or major adjustments to the exchange rate; that role is left to the interest-rate arbitrage mechanism. Consider the situation in which the cash arbitrage mechanism is the mechanism used to make day-to-day adjustments to the exchange rate and the interest arbitrage mechanism is not available. As the market exchange rate deviates from the official rate, speculators have incentive to not make immediate adjustments to the exchange rate so that cash arbitrage profits will be greater. This delay feeds speculation that the monetary authority will not be able to maintain the peg as the size of the cash arbitrage profit grows. Monetary authorities in a CBA recognize this problem and currently no CBA country uses only cash arbitrage.

Without a high level of international reserves, the banking system will not be able to facilitate the cash arbitrage process. The level of international reserves must be adequate enough so that if individuals sell domestic currency to commercial banks for the anchor currency, there is sufficient anchor currency to support the swap. Without the support of an adequate level of international reserves, the cash arbitrage component is

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not possible. A level of international reserves equal to or larger than the monetary base creates stability in the economy by lending credibility to the monetary authority's ability to defend the peg by facilitating currency swaps. Without adequate reserves, cash arbitrage may create a situation in which the exchange rate link is unsustainable and speculative pressures create a situation in which the monetary authority is forced to devalue.

3.5: The mechanics of interest rate-arbitrage

The interest rate arbitrage mechanism is outlined in Figure 3.7. Suppose for simplicity that there is a capital inflow from the anchor country, which could result from a rise in exports of domestic goods or a fall in imports of foreign goods. The capital inflow or outflow does not have to occur with the anchor country, but since capital inflows and outflows will be converted into the anchor currency at some point, it is easier to analyze the exchange directly with the anchor country. The capital inflow will result in an increase in reserves at commercial banks, leading to an increase in liquidity within banks and also on the interbank market. As liquidity increases, interest rates will fall, creating a better environment for banks to loan. Eventually, the demand for goods in general increases, including the demand for notes and coins. The price of domestic goods begins to rise, causing an increase in the domestic demand for foreign goods or a decrease in foreign demand for domestic goods increases. As this process continues, a counter flow of funds eventually will occur as individuals have more money due to increased loans and a fall in the interest rate, and it will eventually lead to a new, current account equilibrium. This process holds true in the reverse for a capital outflow.

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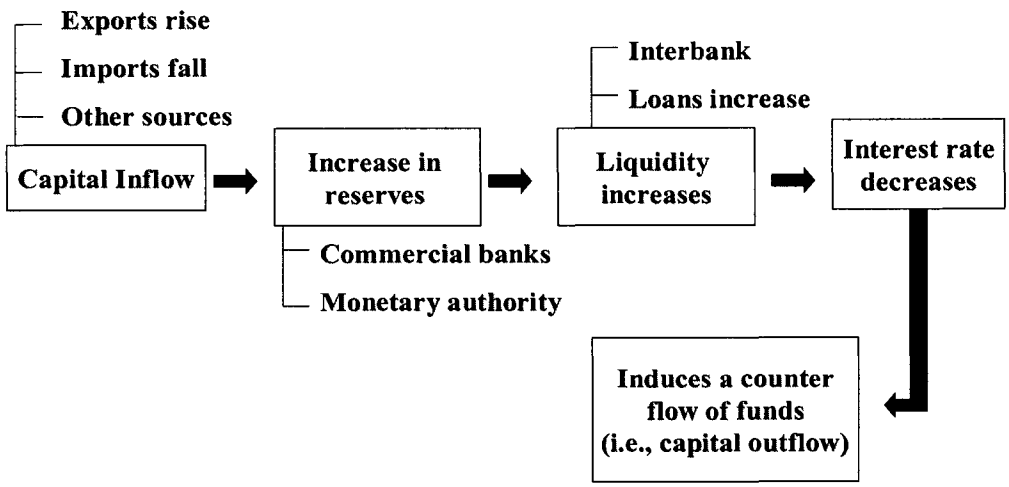

Figure 3.7 The Interest Arbitrage Process

Using the IS, LM and BOP analysis, suppose that there initially is an increase in foreign (US) income that leads to an autonomous increase in domestic exports, causing the IS curve to shift to the right ($I + X + G > S + M + T$) (Figure 3.8). This moves the economy from point S to point T. A BOP surplus now occurs, due to both the increase in exports (which improves the current account) and the higher domestic interest rate (i_1). The BOP curve also shifts to the right as a result of the increase in the exports. The economy moves to point Q; however, this does not represent equilibrium, because the LM curve still needs to adjust. If there is no sterilization, the BOP surplus leads to an expansion of the M_S, initiating the interest arbitrage process, which will eventually cause the LM curve to the right to LM_1 and create a new equilibrium point at Q.

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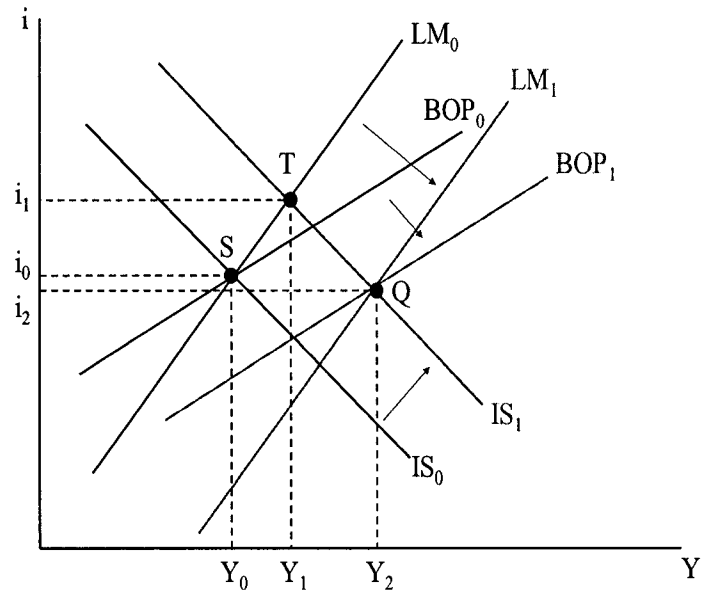

Figure 3.8 IS, LM, BOP

3.5.1: Interest-rate arbitrage, money supply and demand, and the LM Curve

The interest-rate arbitrage mechanism functions through two bank markets. As Tsang (1999) explains, this system relies on concurrent arrangements in both markets that push the exchange rate toward the parity rate if a deviation between the two rates occurs. This mechanism functions automatically without intervention from the monetary authority, and it is this mechanism that makes the economy converge to point Q in Figure 3.8.

Banks that are solvent and functioning properly to facilitate interest-rate arbitrage begin in equilibrium. As capital flows in and out of the economy, both markets go through the adjustment process to return the banking system to long-run equilibrium, completing the interest-rate arbitrage necessary to maintain stability in the exchange rate.

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The expansion of the M_S due to capital inflow is responsible for initiating the interest arbitrage process in the interbank market; however, the nature of 100 percent convertibility of the CBA creates a unique situation. Domestic residents see an increase in income (Y) and an increase in the interest rate (i) as a result of the initial increase in autonomous exports, which shifts the IS curve and moves the economy to point T. From equation 5, it is clear that an increase in income (Y) increases the demand for money, while an increase in the interest rate (i) has the opposite effect. Domestic individuals now have more of the anchor currency and will want to swap the anchor currency for domestic currency to conduct domestic transactions. The variable s in the M_S^{SR} equation represents the swap element. This element indicates that the money supply in the short run is affected by domestic residents increasing or decreasing their desire to hold the anchor currency. For example, an increase in the M_S^{SR} will be a result of domestic individuals dumping the anchor currency to hold more domestic dollars, and vice versa.

The return to equilibrium at point Q in the IS/LM/BOP (Figure 3.8) analysis as a result of a shift in the LM curve is explained in Figure 3.9. In the commercial banking system (panel a), an increase in exports leads to an increase in income Y which increases M_D to M_D', which results in a temporary equilibrium at point B. This increase in exports also creates two additional effects, including an increase in the interest rate and an increase in the need to swap the anchor currency for domestic currency. In the monetary authority market, an increase in the demand for money from commercial banks is met by banks making a currency swap against their reserve accounts at the monetary authority, which decreases the money supply to $M_S^{SR'}$ and moves the market equilibrium also to point B. The result is a higher short-term interest rate at point B.

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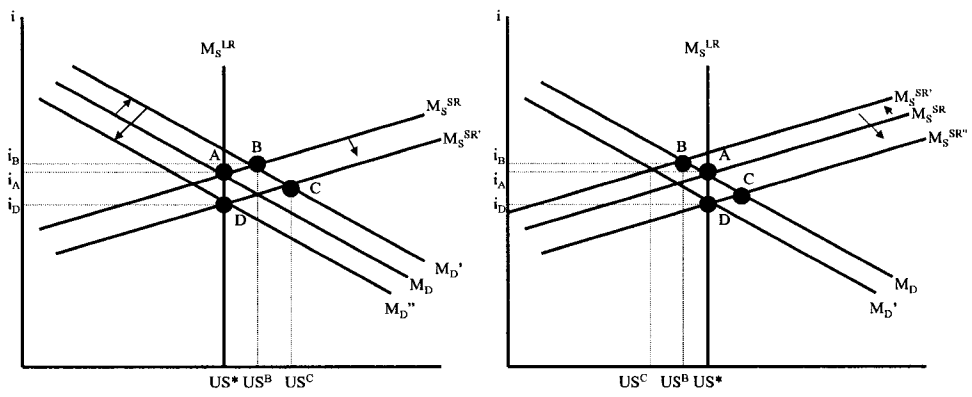

(a) Commercial Bank System

(b) Monetary Authority

Figure 3.9 Interest Arbitrage Process: Autonomous Increase in Exports

Domestic residents take their anchor currency to their commercial bank to swap for domestic currency to make domestic transactions, shifting the money supply curve to $M_S^{SR'}$ in panel (a) and moving the commercial banking system's equilibrium temporarily to point C. As individuals swap with commercial banks, this will necessitate that commercial banks swap with the monetary authority to meet the need for domestic dollars, shifting the money supply to $M_S^{SR"}$ in panel (b). The increase in income was initially caused by an increase in exports, so individuals as a result are flush with anchor currency and will reduce their demand for anchor currency from the commercial banking system, shifting the money demand curve to M_D" in panel (a). This moves the commercial banking system to a new equilibrium at point D. The reduction in the demand for anchor currency in the commercial banking system causes a decrease in demand for anchor currency from the monetary authority by commercial banks (M_D' in panel (b)). This returns the money market to long-run equilibrium at point D. Both the

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commercial banking system and the monetary authority return to a new equilibrium at a lower interest rate. This process shifts the LM curve to the right, returning the economy to equilibrium at a higher Y and lower i, and represents the automatic adjustment mechanism that maintains exchange rate parity.

The cash arbitrage system also plays a role in the mechanics of interest-rate arbitrage. As capital flows affect the exchange rate, creating a divergence from the official rate, there is arbitrage profit to be made. Continuing with the example of a capital inflow created by increased exports, the role of cash arbitrage can be understood. An increase in exports creates the situation in which anchor currency held by the public is traded for domestic currency, causing the exchange rate to appreciate or strengthen above the official rate. Individuals will begin to convert anchor currency into the domestic currency at the official rate ($\bar{e}$) and then transact in the currency market at the market rate (e) and earn arbitrage profit. The cash arbitrage and interest-rate arbitrage systems are simultaneously interacting to return the market rate (e) to the parity rate ($\bar{e}$). It is for this reason that Tsang (1999) argues that cash arbitrage need not actually take place but rather the possibility of it is enough to keep the banks quoting near the market rate.

When the cash arbitrage system is functioning efficiently, the deviation from the official rate will be smaller than when the cash arbitrage system is functioning inefficiently or absent from the arbitrage process (as is the case in Hong Kong). This is easily understood from the perspective of the CBA in that the longer or larger the market rate deviates from the parity rate, the more the monetary authority must pay in arbitrage profit. The exchange of domestic currency for anchor currency or vice versa will affect

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liquidity in the interbank market and change the interest rate faster than without the cash arbitrage mechanism.

Consider the movement from point S to T (Figure 3.8) caused by a capital inflow. This inflow of capital causes the exchange rate to appreciate ($e < \bar{e}$). It is important to remember that in this case, a falling e represents a currency appreciation. If $e - \bar{e}$ substantial, then arbitrage profit can be made and individuals will undertake the arbitrage process described in section 3.4. Individuals begin to buy and sell anchor and domestic currency, which speeds up the adjustment of the money supply and demand curves in Figure 3.9. Selling pressure on the anchor currency causes the money supply curve in the commercial banking market to adjust faster, as paying arbitrage profit begins to strain the commercial banking system. As the money supply curve adjusts in the commercial banking system, the money demand curve adjusts rapidly as commercial banks strain to clear their reserve accounts with the monetary authority after paying arbitrage profit in domestic currency. The availability of this process creates a situation in which banks are more mindful of deviations between e and $\bar{e}$ because these deviations are costly to the banks.

Over time a decrease in the interest rate (point Q) will induce a counter flow of funds. Low interest rates will cause the demand for goods in general (including notes and coins) to rise. This will cause the price of domestic goods to rise. Eventually, as this automatic process continues, the domestic demand for foreign goods will rise or the foreign demand for domestic goods will fall. The current account will return to a new equilibrium (Hanke et al. 1993). In other words, the automatic mechanism will create a counter flow of funds to bring up the interest rates without intervention from the

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monetary authority. Without intervention on the part of the monetary authority, the automatic return to equilibrium may involve days, weeks or months. The short run is simply the amount of time it takes to return the economy to exchange rate parity.

3.5.2: Interest- rate arbitrage and bank soundness

The automatic interest-rate arbitrage mechanism is the workhorse of exchange rate stability under a CBA. The exact mechanics of the interest rate arbitrage process is examined econometrically in chapter 6. The majority of the day-to-day volatility in the exchange rate is controlled by this mechanism, as well as the majority of significant adjustments to bring the market rate back in line with the official rate.

The interest-rate arbitrage mechanism can effectively maintain the exchange rate peg without cash arbitrage but the reverse is not true. A CBA can successfully maintain exchange rate parity with only the economic discipline and interest arbitrage component; however, it is not possible to sustain the link in the absence of the interest arbitrage component. The cash arbitrage system does not have the ability to make major adjustments to the exchange rate when it varies from the official rate without causing major damage to the commercial banking system. Paying cash arbitrage profit alone could ravish the commercial banking system, not to mention the fact that massive currency swaps could also create speculation that the peg was unsustainable, creating a bank run. Furthermore, in some economies like Hong Kong, where individuals are not able to transact directly with the currency board, the possibility of cash arbitrage does not exist. The interest-rate arbitrage mechanism depends on the soundness of the banking system. If the system is not sound, the mechanism can not operate properly and the CBA

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will eventually be forced to abandon the peg. It is important to first examine the role of the banking system.

Commercial bank soundness is critical for the success of a currency board for several reasons. First, due to the limitations imposed by the rule-bound nature of monetary operations under a CBA, the automatic interest-rate arbitrage adjustment process involving volatile day-to-day interest rates can be potentially devastating to weak banks, which can create systemic problems leading to a lack of currency board credibility. Second, its rule-bound nature also prohibits the currency board from acting as lender of last resort (LOLR) to weak banks. Enoch and Gulde (1997) summarize the important role of commercial banks in the paragraph below:

> Given the limitations of the CBA's support to banks, the credibility of the currency board will be higher if, from the outset, the banking system is seen to be sound, with no perception of any looming systemic problems. In addition, interbank markets take on a crucial role for the functioning of the banking system once the possibility of permanent central bank intervention through standing lending and deposit windows has been eliminated. Such markets are likely to function effectively only if the banking system is sound... For countries that have recently undergone severe banking crises, doubts about the soundness of the banking sector are arguably the most difficult obstacles towards making a CBA credible... It could be highly damaging to the credibility of a CBA if a banking crisis were to emerge soon after the CBA began.

The macro adjustment process to the market exchange rate in currency board countries involves commercial banks facilitating interest-rate arbitrage, convergence and financial intermediation. Because of this role, banks operating in a currency board country are likely to face high day-to-day interest rate and liquidity volatility. For example, interest rates may increase sharply to defend the fixed exchange rate in a currency board country that experiences systemic capital outflows. Interest rates that remain high for a long period may force small and undercapitalized banks into a position

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of insolvency due to the inability to stay liquid. The credibility and effectiveness of the CBA in maintaining low inflation should assist financial intermediation; however, the existence of unsound banks could slow the process. Furthermore, weak banks may not be in a position to help mitigate the effects of external shocks.

Both interest-rate arbitrage and financial intermediation facilitate the absorption of shocks to countries with a CBA. If banks are in a weak foreign asset position, they may not be able to help with the process of interest-rate arbitrage and they themselves may become victims of persistently high interest rates. Even the failure of a small bank can create system-wide credibility doubts that can lead to liquidity tightening and self-fulfilling prophecies of bank failures (Santiprabhob, 1997). Not only is the commercial banking system an integral part of interest-rate arbitrage, it is also necessary for interest rate convergence implied by the uncovered interest-rate parity (UIP).

Obstfeld and Rogoff (1996) provide a detailed explanation of the role of the UIP in interest rate convergence under a fixed exchange-rate system. Following their explanation, let i_{t+1} be the date t+1 interest rate on bonds denominated in the home currency, and let i^{f}_{t+1} be the interest rate on foreign-currency denominated bonds. Then the uncovered interest rate parity holds when,

$$1 + i_{t+1} = (1 + i^{f}_{t+1}) E_t \left\{ \frac{e_{t+1}}{e_t} \right\} \tag{8}$$

where $E_t \left\{ \frac{e_{t+1}}{e_t} \right\}$ is the expected value of the change in the exchange rate from the current period to the next period.

With perfect foresight, the UIP must hold via a simple arbitrage argument. For example, an investor can take one unit of home currency and buy $1/e_t$ units of foreign

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bonds that each pays principal and interest $1 + i_{t+1}$. This sum can then be converted back into home currency at the date t+1 exchange rate, e_{t+1}. The gross home-currency return is the right-hand side of the equation above, which of course, must equal the gross return on the left-hand side, $1 + i_{t+1}$. In a stochastic world, exchange rate risk (among other factors) can drive a wedge into the uncovered interest rate parity relationship. However, under a CBA exchange rate, risk is minimized because the peg between the two countries adds stability to the UIP. Therefore, a good indication of the functioning of the banking system is a measure of the difference between the domestic interest rates and the anchor countries interest rates, $i - i^f$. A large or increasing differential may signal increased stress on the commercial banking system and strain the exchange rate parity.

Section 2.4 of chapter 2 discussed the debate surrounding the idea of CBA's limited capacity as LOLR. This section also explained how many existing currency board countries have recognized the need to provide limited LOLR support to banks and alternatives to the monetary authorities of currency board countries providing this type of support to the extent similar to that of central bank countries. Commercial bank soundness is imperative if the limited LOLR facilities provided by CBA are to be successful. Since LOLR facilities are constrained, if a severe banking crisis were to occur, these facilities would not be able to provide sufficient liquidity to prevent widespread bank failures. Credibility of the CBA hinges on banks remaining sound and therefore not needing extensive systemic LOLR assistance even during times of crisis.

Diamond and Dybvig (1983) analyzed the possibility of a bank run under different types of monetary regimes and found that CBA's were the most susceptible to bank runs given the rule-bound nature of the arrangement. A bank runs occurs when

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individuals lose faith in the bank's ability to return their money and run to the bank to remove their deposits. As many depositors run to remove their deposits, the bank fails because it does not have enough reserves in its vaults to cover all of the deposits and the CBA will not function as lender of last resort. The presence of unsound banks in the commercial banking system can create a situation in which the interest-rate arbitrage mechanism can not function properly to clear the commercial bank market or the interbank market. If the markets do not clear, the exchange rate does not return to the parity rate and the environment is ripe for a bank run.

Bank unsoundness can take many forms, including a capital-to-asset ratio that is too low, an abundance of bad loans and numerous other reasons, which all can lead to bank insolvency. When banks are unsound and run the risk of becoming insolvent, they are unable to facilitate the interest-rate arbitrage process and this can lead to a breakdown of the exchange rate link to the anchor currency. Suppose that as the result of a booming economy, imports increase and commercial banks get caught up in the euphoria of a booming economy and increase lending to riskier borrowers. Suppose that these banks also have a low capital-to-asset ratio. This situation was not uncommon to US banks in the 1980's and Asian banks during the Asian financial crisis in 1997. As the economy takes a downturn, the banks are forced to write off some of their bad loans. However, since these banks are undercapitalized, writing of numerous high-risk, bad loans, leads the banks into positions in which they are unable to facilitate financial intermediation and the markets can not use interest-rate arbitrage to maintain the link. This is illustrated in Figure 3.10.

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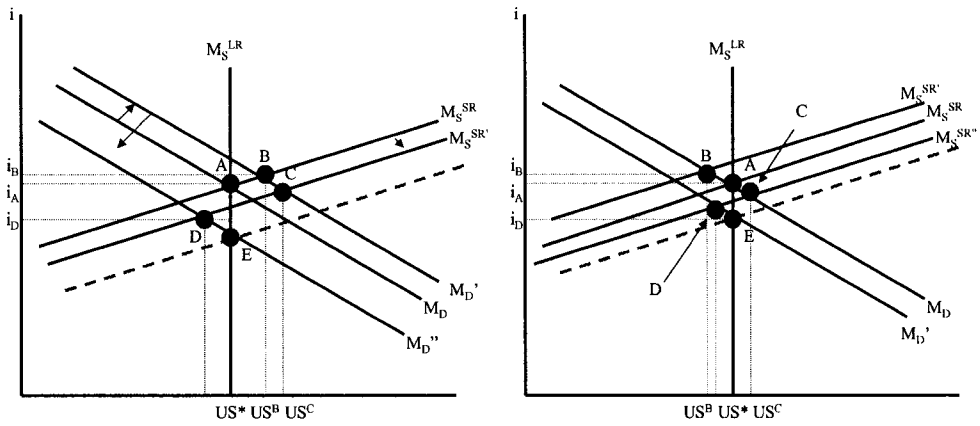

(a) Commercial Bank System

(b) Monetary Authority

Figure 3.10 Unsound Banks and the Failure of the Interest Arbitrage Process

The shifts in the money supply and demand curves are similar to those for Figure 3.9, with one significant modification. Point A represents initial equilibrium in both markets, because without large capital flows or a downturn in the economy to stress the system, the banks can operate successfully. As with the previous example, there is a capital inflow. This starts the same process described earlier, which leads to an increase in the demand for money in the commercial banking system. The difference between Figures 3.9 and 3.10 is created as a result of banks being undercapitalized. As individuals swap anchor currency for domestic currency, the resulting increase in the money supply curve is insufficient to return the economy to long-run equilibrium. Since the banks are undercapitalized, not all of the anchor currency that is received is swapped and some must be retained in the vaults of the commercial banks. In the commercial banking system, the M_S^{SR} increases to $M_S^{SR'}$ and the market equilibrium moves to point C, causing the interest rate to start its initial fall. This is the start of the process that shifts

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the LM curve. The strong increase in exports has increased the inflow of US dollars, and individuals flush with anchor currency decrease their demand for US dollars from commercial banks, which shifts the M_D to M_D" in panel (a) and equilibrium in the commercial banking system moves to point D. The fall in demand for anchor currency experienced by the commercial banking system is transmitted to the monetary authority, causing money demand to fall to M_D', moving the market to point D.

As a result of bank undercapitalization, the increase in the short-run money supply was insufficient to return the market to long-run equilibrium. In specific, the short-run M_S in both markets needed to increase to the dashed M_S curve to return both markets to long-run equilibrium at point E. As a result, the interest rate in the commercial banking system does not decrease enough to entice individuals to sell back the anchor currency for domestic currency. In the IS/LM/BOP analysis (Figure 3.8), this prevents the LM curve from shifting to LM' and returning the economy to equilibrium. The interest rate will stay higher than what is needed to return the economy to equilibrium. This results in a market exchange rate that deviates from the official rate.

3.5.3: Interest-rate arbitrage, economic discipline and the IS curve

Section 3.3 discussed the important role of many of the preconditions in maintaining economic discipline and affecting movement of the IS curve. This section further explains the role of some of the variables in determining the interest-rate arbitrage process. The IS function can be expressed as,

$$Y = \frac{1}{1-c(1-t)+m}\left[C_0 + I_o + X_o - c\bar{T} + \bar{G} - \alpha i\right] \qquad (9)$$

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where c is the marginal propensity to consume (MPC), m is the marginal propensity to import, t is the tax rate, $\overline{T}$ represents tax revenue, $\overline{G}$ represents government expenditure, C_O, I_O, X_O are autonomous expenditure and α represents the investment response i.

Because the CBA countries do no possess a useful monetary policy, the government can wisely manipulate the fiscal policy instrument set $(\overline{G},t)$ to create a favorable condition. Equation (9) can be rewritten as follows:

$$Y = \delta(t)\left[A - \alpha i : \overline{G},\overline{T}\right] \tag{10}$$

where δ is the expenditure multiplier. The tax rate can affect the size of the expenditure multiplier and government expenditure $\overline{G}$. A lump-sum tax (refund) can determine the level of total expenditure.

This section will examine the effects of fiscal policy under the fixed exchange-rate system provided by a CBA. Suppose, for example, that the government pursues an expansionary fiscal policy and decreases taxes, which shifts the IS curve to the right, putting upward pressure on domestic income and interest rates (Y_1 and i_1 in Figure 3.11). This comes about because the increase in the inflow of short-term capital more than offsets the increase in imports at the higher levels of Y and i. With a BOP surplus, the central bank is forced (as in the earlier example) to swap the surplus foreign currency for domestic currency to maintain the exchange rate, which causes the money supply to expand and the LM curve to shift to the right. The expanding money supply causes a further expansion of the economy to Y_2 and i_2.

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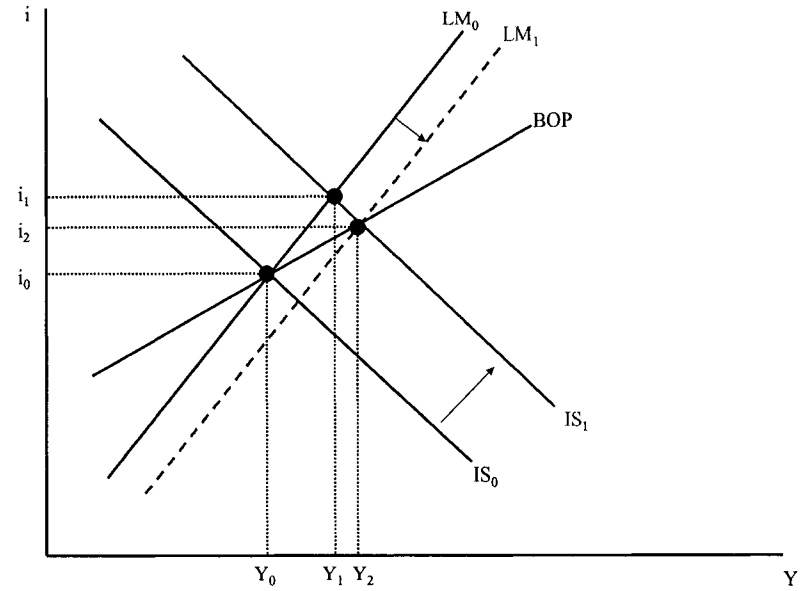

Figure 3.11 IS, LM, BOP with Expansionary Fiscal Policy

In this case, fiscal policy is complemented by the monetary effects associated with the automatic adjustment under a fixed exchange-rate system. This analysis of fiscal policy under fixed exchange rates leads to the conclusion that, to varying degrees, fiscal policy is effective in influencing income under fixed exchange rates. The argument is symmetric in nature, meaning that a reduction in government spending or an increase in taxes will move the IS curve to the left and will generate the opposite effects in terms of ultimate changes of the money supply in response to capital flows resulting frrm the pressures on the interest rate (Appleyard and Field, 2001).

Chapter 6 will provide an empirical estimation of the interest-rate arbitrage process. The analysis in that chapter will examine the signs and significance of each of the variables that determine the interest rate and the corresponding movement of the exchange rate. The purpose of that chapter will be to examine how well the empirical results match the theoretical expectations of the role of each variable in exchange

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rate stability. If a clear empirical understanding of the theoretical relationships emerges from chapter 6, then emerging economies will have the guidance they need to successfully run a CBA.

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Chapter 4: Case Study of Hong Kong

4.1: Background

The original currency board established in Hong Kong in 1935 was modeled after the colonial system. The Exchange Fund was established to handle the operation of currency board issues, which initially included the exchange of silver held by three note-issuing banks for Certificates of Indebtedness that entitled these banks to issue notes. In order to issue more notes, these banks were required to buy more Certificates of Indebtedness (Schwartz, 1993). This system was unique to Hong Kong in that the banks, rather than the currency board, issued notes. This basically allowed the Exchange Fund to function as the body that would back the sterling in exchange for non-interest-bearing Certificates of Indebtedness. Currently, the Exchange Fund uses foreign assets to back all Certificates of Indebtedness issued to the note-issuing banks as a backup for their currency (Santiprabhob, 1997).

In 1972, Hong Kong abandoned its link to sterling and decided to let the HK dollar float. This created increasing inflationary pressure, which culminated in 1973 with an inflation rate of 18.2 percent (see Figure 4.1 in appendix). For the next 10 years, the Exchange Fund balances of Hong Kong dollars (HK$) were in the control of note-issuing banks; these banks included Hong-Kong Shanghai Bank, Standard Chartered Bank and later in 1994, the Bank of China. As 1983 approached, the inflation rate began to climb again, largely as a result of uncertainties over the future political status of Hong Kong

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and massive speculative pressure built up against the HK dollar. As a way to stabilize the exchange rate and therefore inflation, the Hong Kong Monetary Authority (HKMA) decided to revert back to a CBA in October 1983. This was successful in lowering the average inflation rate. From 1972 to 1983, inflation in Hong Kong averaged 9.8 percent and after the CBA was re-instituted in 1983, the average rate of inflation from 1983 to 1999 was 6.7 percent. Inflation performance for Hong Kong has been better under the CBA arrangement (1983-99) than it was under the floating arrangement (1972-83).

In 1983, Sino-British negotiations on the impending repossession of Hong Kong by the Chinese caused a wave of capital flight and epic speculation against the Hong Kong dollar. In October 1983, as speculation against the Hong Kong dollar exploded and capital flight continued, authorities feared the worst for the Hong Kong financial sector, prompting the Exchange Fund to officially establish a currency peg to regain stability and restore confidence. The peg was established using the US dollar as the anchor currency and still remains the same today as was established in 1983, at HK$7.8= US$1.

This has been the most successful peg established in all currency board countries with the least amount of deviation from this set rate. Figure 4.2 in the appendix shows the market exchange rate between the Hong Kong dollar and the US$ since 1945 and highlights how well the Exchange Fund has been able to maintain the pegged rate to the US$ since 1983.

In the early years of the currency board, the Exchange Fund could manipulate bank liquidity and therefore influence short-term interest rates by using its reserves to intervene directly in the foreign exchange market or it could borrow and lend directly in the interbank funds market. Until 1987, these two, limited tools were adequate to control

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the exchange rate issues that arose during this time. One of several speculative attacks occurred in 1987 on the Hong Kong dollar, prompted by the quick depreciation of the US dollar. The weakening US dollar led to speculation that Hong Kong would revalue. In order to maintain the peg, the Exchange Fund was forced to intervene in the foreign exchange market, absorbing the surplus of US dollars (Kasa, 1999). The Exchange Fund's large reserves allowed it to successfully intervene in the market, cooling the exchange rate pressures and maintaining the target rate. In this case, by absorbing US dollars, the Exchange Fund was actually increasing its total amount of reserve currency.

This type of intervention opened the door for the Exchange Fund to increase the scope of its limited operations. This early attack on the Hong Kong dollar led to four reform measures to strengthen monetary management in Hong Kong. First, the Exchange Fund took steps to manage interbank liquidity. In 1988, the Accounting Arrangements Law was passed, which basically enabled the Exchange Fund to have total discretion over the net liquidity in the banking system (Kasa, 1999).

Secondly, in 1992, the Exchange Fund Ordinance was amended and HKMA was established to supervise the Exchange Fund. Also in 1992, the Liquidity Adjustment Facility (LAF) was established. The LAF is Hong Kong's version of a discount window and it provides several important functions in the supervision of interbank liquidity. Firstly, "...it enables banks to make late adjustments to their liquidity positions after the close of the interbank market..." secondly, "...it enables the HKMA to supply additional liquidity to or to absorb excess liquidity from the banking system..." and thirdly, "the LAF bid and Offer Rates effectively set the floor and the ceiling of the overnight Hong Kong dollar interbank interest rate (HIBOR)" (HKMA, 1997).

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The third step toward increased discretionary power began in the early 1990's and included allowing the Exchange Fund to perform open market operations, through the establishment of a government securities market. Because Hong Kong's government typically ran a surplus, there was no need to issue government securities; however, the existence of these securities allowed the Exchange Fund an indirect and efficient way to manage bank liquidity. As the HKMA increased its discretionary tools, the line between currency board and central bank began to blur. Open market operations are reserved for central banks and usually do not fall under the scope of policy instruments for currency boards. The increased scope of discretionary powers of the HKMA was a sign to speculators that perhaps in the face of severe pressure, Hong Kong would not be willing to defend the peg, and so the speculative attacks began.

There have been several serious tests of the resolve HKMA in which the Hong Kong dollar came under speculative attacks. All attacks have been unsuccessful in forcing the HKMA to deviate from the peg. The Tequila Crisis, which originally affected Mexico, had ripple effects felt in Hong Kong. However, none of these attacks has been more serious then the 1997 speculative attack on the Hong Kong dollar in the wake of the Asian crisis.

The origins of the Asian crisis date back much further than its May 1997 culmination when the Thai Baht came under severe pressure and was eventually forced to float. As Hong Kong was celebrating its return to Chinese rule in July 1997, the Baht severely sank in value. Hong Kong believed, as many other world economies did, that it would be immune to the affects of the Asian crisis. But they all were wrong. Debate surrounding the causes of the crisis points to many different sources. Most economists

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agree, however, that one of the central causes was weaknesses in the banking and financial sectors.

Although Hong Kong did not have the same weakness in the banking and financial sectors, it was still in a precarious position. It was in the midst of the Handover to Chinese rule. During this time, confidence was growing that the Handover would proceed smoothly and would allow Hong Kong to retain its unique independence that had allowed it to thrive. As a reflection of this confidence, residential property prices began to soar (up by 48 percent from the previous year) and the Hang Seng Index set a record level of 16,820 in August 1997. Hong Kong banks largely financed this boom in asset value (HKMA, 1998). As the asset bubble began to grow bigger and bigger, speculators knew it was unsustainable. In October 1997, as Taiwan gave up its defense of the dollar, speculators launched a massive attack on the Hong Kong dollar, betting that the asset bubble would force the HKMA to devalue.

Speculators began to sell Hong Kong dollars at a furious rate. Much of this attack was actually financed by Hong Kong banks. Due to the HKMA's transparent and rule-bound operating procedure, the HKMA did exactly what it was supposed to do: It sold a massive amount of US dollars. As the HKMA sold US dollars, it depleted the clearing balances that the banks maintain with the HKMA for settlement purposes. The resultant lack of liquidity caused interest rates to increase rapidly. These events culminated on "Black Thursday", October 23, 1997, when the (Hong Kong Interbank Offered Rate (HIBOR) reached 280 percent. Although the HIBOR subsided relatively quickly, a renewed attack on the link occurred in January 1998, which again caused the HIBOR to rise but not as high. Throughout both of these attacks and all previous attacks, the

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HKMA has maintained the link between the Hong Kong dollar and the US dollar, and proved to speculators that as a currency board, its only true target is to maintain and defend the link.

Hong Kong seems to have learned from these types of attacks and the HKMA still appears impenetrable. Although now under the control of China, Hong Kong has continued to thrive as a relatively independent economy. Hong Kong's economy is becoming increasingly dominated by the service sector and given that China is poised to become a larger player in the world economic arena, Hong Kong stands to benefit from increased trade activity.

4.2: Economic Discipline Preconditions

The sole purpose of the HKMA is to maintain the peg between the Hong Kong dollar and the US dollar, and in its pursuit of this goal it "uses a whole range of instruments in influencing the level of interbank liquidity to manage interbank interest rates, and consequently, maintain exchange rate stability" (HKMA, 1997). This section will focus on the level achieved of each of the preconditions, and furthermore, how Hong Kong is able to maintain the peg while promoting strong GDP growth, reasonable inflation rates and interest rates that mimic the peg country. Table 4.1 shows the average level of the market exchange rate between the Hong Kong dollar and the US dollar from 1983 to 1999.

The greatest deviation from the peg occurred in 1983, the year the peg was established, which is understandable given the difficulty of the necessary adjustment process. The average deviation from the fixed rate during this period was -0.06, or less

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than 1 percent of the set rate. This demonstrates that the HKMA has been remarkably successful in maintaining the peg, given that the deviations from the peg in the years other than the year of establishment have never exceeded 1 percent of the fixed rate. The rest of this section will examine the economic discipline preconditions.

Table 4.1 Market Exchange Rate HK$ per US$

Year	Market Exchange Rate	Deviation from Pegged Rate	Deviation as a % of Pegged Rate
1983	7.27	-0.53	-6.8%
1984	7.82	0.02	0.3%
1985	7.79	-0.01	-0.1%
1986	7.8	0	0.0%
1987	7.8	0	0.0%
1988	7.81	0.01	0.1%
1989	7.8	0	0.0%
1990	7.79	-0.01	-0.1%
1991	7.77	-0.03	-0.4%
1992	7.74	-0.06	-0.8%
1993	7.74	-0.06	-0.8%
1994	7.73	-0.07	-0.9%
1995	7.74	-0.06	-0.8%
1996	7.73	-0.07	-0.9%
1997	7.74	-0.06	-0.8%
1998	7.75	-0.05	-0.6%
1999	7.76	-0.04	-0.5%

4.2.1: Degree of involvement with international capital markets

Hong Kong has a high degree of involvement with international capital markets. For many emerging economies, this level of involvement would create serious problems because they do not have the financial sophistication to deal with major capital inflows or outflows. Chapter 3 discussed the possible repercussions for emerging or transitioning

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countries that encourage high levels of FDI creating large capital inflows. In 1983, when Hong Kong returned to a CBA, the banking sector was relatively well developed.

Capital inflows into Hong Kong are measured by looking at the credit side of the capital account, and outflows will be measured examining the debit side. The net capital account provides a look at whether a country has more inflows or outflows; however, it is poor proxy for analyzing the degree of involvement with international capital markets. In order to examine the total involvement in international capital markets, it is necessary to look at the absolute value of the total inflows and outflows, or in other words, combine the outflows and inflows (Table 4.2).

Table 4.2 Hong Kong's Capital Acount Inflows and Outflows (mil HK$)

	Capital Account					
Year	**Net**	**Credit**	**Debit**	**Total**	**% change**	**as % of GDP**
1978	-2224	2411	4635	7046	-	8%
1979	-3047	3323	6370	9693	38%	9%
1980	-3671	11339	15010	26349	172%	19%
1981	-6830	10299	17129	27428	4%	16%
1982	-11176	6215	17391	23606	-14%	12%
1983	-10212	5562	15774	21336	-10%	10%
1984	-4782	7929	12711	20640	-3%	8%
1985	-8405	7233	15638	22871	11%	8%
1986	-5704	6709	12413	19122	-16%	6%
1987	-8697	7320	16017	23337	22%	6%
1988	-9927	8356	18283	26639	14%	6%
1989	-12261	8999	21260	30259	14%	6%
1990	-17055	8123	25178	33301	10%	6%
1991	-10912	14500	25412	39912	20%	6%
1992	-15683	16056	31739	47795	20%	6%
1993	-27403	26844	54247	81091	70%	9%
1994	-30253	27880	58133	86013	6%	9%
1995	-33777	29097	62874	91971	7%	9%
1996	-10394	37549	47943	85492	-7%	7%
1997	33045	78862	45817	124679	46%	9%

Source: Asian Development Bank 1997

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Table 4.2 reviews capital flows in and out of Hong Kong from 1978 to 1997. The sign of the net column reflects whether Hong Kong has more capital inflows or outflows; however, it fails to reveal the total degree of involvement in the capital market for Hong Kong in any given year. By adding the absolute value of inflows (credits) and outflows (debits), it is possible to understand the total degree to which Hong Kong was involved in international capital markets; this is reflected in the total column. What is most noticeable from the table is the percent change in the level of involvement in capital markets over this time period. For example, from 1992 to 1993, Hong Kong's involvement in capital markets increased by 70 percent and then remained relatively constant, changing by approximately 7 percent until 1997, when it increased by 46 percent. This reflects a potentially serious annual fluctuation in the degree of involvement in international capital markets. For some emerging economies, this level of variability in the degree of involvement in capital markets could create significant problems for emerging economies that might find it difficult to handle substantial changes in capital inflows and outflows. However, even given these large fluctuations in the capital account, this movement is still a relatively small percentage of GDP, with an average for 1978-99 at 9 percent and since the establishment of the CBA, 7 percent.

4.2.2: High international reserves

Table 4.3 highlights the HKMA's total international reserves position from 1990 to 1999. The second column in the table shows the annual level of international reserves in billions of HK$. This is the level of reserves available to the HKMA in the event that intervention in the market is necessary to buy or sell Hong Kong and US dollars.

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The third column is the percentage change in the level of reserves over this period. As this column shows, in 1997 the change in reserves from the previous period were significant (46 percent), illustrating the HKMA's anticipation of possible speculative attacks commencing during that year. The effects of these attacks can be further illustrated by the 3 percent decrease in reserves for 1998. Since then Hong Kong has been able to begin rebuilding its level of reserves, as represented by an 8 percent increase from 1998 to 1999. Column 4 shows that total international reserves held by the HKMA are increasing as a percentage of GDP. Finally, column 5 illustrates that although international reserves are used to back the domestic money supply, the holdings of the HKMA in the last several years are sufficiently large enough to back four times the level of M1.

Table 4.3 Total Reserves held by the HKMA

		Total Reserves minus Gold		
Year	**in billion HK$**	**change**	**as % of nominal GDP**	**as % of M1**
1990	191.69	-	33%	-
1991	224.15	17%	34%	225%
1992	272.44	22%	35%	219%
1993	332.04	22%	37%	220%
1994	381.23	15%	38%	253%
1995	428.21	12%	40%	283%
1996	493.44	15%	41%	283%
1997	718.77	46%	54%	428%
1998	694.61	-3%	55%	434%
1999	748.15	8%	61%	405%

Source: IMF, International Financial Statistics

Hong Kong's holdings of international reserves are at least as large as the holdings of other prominent world economies such as the United States Germany, while still lagging behind Japan (see Figure 4.3 in appendix). In recent years, Hong Kong's level of

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reserves has actually out grown that of the United States and Germany. This is rather remarkable given that Hong Kong's economy is not nearly as large as these other economies. This fact can most likely be attributed to Hong Kong's fiscal prudence and diligent financial sector.

4.2.3: Openness

The prevailing view on how to measure the degree of openness is to use the ratio of total trade (exports + imports) to GDP (Bratberg et al. 1999). Section 3.3.3 provides a more comprehensive discussion of this precondition. Openness is a measure of the volume of trade in relation to the total amount of domestic production as measured by GDP or in other words, a measure of the importance of trade to a nation. A relatively open economy is one in which total trade makes up a large share of GDP. Several authors (see section 3.3.3) argue that as openness increases, so does the probability of a country adopting a fixed exchange-rate system. It is well known that Hong Kong is a highly open, developed economy that is involved in a significant amount of trade with the rest of the world.

The degree of openness has fluctuated since 1978; however, it is evident that Hong Kong was relatively less open prior to the peg (Table 4.4). The degree of openness for the United States is included in the table for comparison. In comparison to the US, Hong Kong is a highly open economy. This emphasizes the importance of trade in Hong Kong's economy and its large share of trade with the US. This is consistent with the idea that the probability of using a fixed exchange-rate regime increases as countries increase their degree of openness. Hong Kong's open economy is dominated by the services

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sector, which accounted for 85 percent of GDP, and industry making up the remaining 15 percent of GDP in 1998. Of the 85 percent, about 50 percent comes from the financial sector (25 percent), and trade and tourism (also 25 percent). The remaining portion of the 85 percent is broken down into 20 percent from community and personal services, and 9 percent coming from transport, storage and communication. Of the 15 percent accounted for by industry, 6 percent of GDP comes from manufacturing, within which 1.5 percent is due to apparel and textiles, and 1 percent comes from printing and publishing. The agricultural sector is very small (1 percent).

Table 4.4 Degree of Openness 1978-99

	Hong Kong					USA
Year	Exports*	Imports*	Total*	GDP*	Openness	Openness
1978	11126	12536	23662	18207	1.30	0.13
1979	14668	15929	30597	22350	1.37	0.15
1980	19720	22399	42119	28474	1.48	0.16
1981	21816	24768	46584	30546	1.53	0.16
1982	20893	23444	44337	31712	1.40	0.14
1983	21949	24005	45954	29253	1.57	0.13
1984	28314	28558	56872	32799	1.73	0.14
1985	30182	29701	59883	34873	1.72	0.13
1986	35438	35360	70798	40072	1.77	0.13
1987	48473	48463	96936	49294	1.97	0.14
1988	63182	63900	127082	58261	2.18	0.15
1989	73113	72149	145262	67162	2.16	0.15
1990	82143	82482	164625	74782	2.20	0.15
1991	98578	100274	198852	86037	2.31	0.15
1992	119532	123430	242962	100690	2.41	0.15
1993	135005	138596	273601	115951	2.36	0.15
1994	151393	161770	313163	130774	2.39	0.16
1995	173546	192764	366310	139165	2.63	0.18
1996	180526	198551	379077	154190	2.46	0.18
1997	187870	208623	396493	171041	2.32	0.18
1998	173693	184602	358295	162877	2.20	0.18
1999	173793	177108	350901	158955	2.21	0.18

Source: IMF International Financial Statistics 1999

*Values in million US dollars

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4.2.4: Size

Since 1983, the average growth rate of nominal GDP in Hong Kong has been 11.1 percent, 6.37 percent in the United States, 5.48 percent in Japan, 3.6 percent in Germany and 10.18 percent in Taiwan (see Figure 4.5 in appendix). Hong Kong, whether in spite of or due to the link, has economic growth that has outpaced the four other world economies. It has been argued by numerous authors that smaller countries are more likely to successfully maintain a fixed exchange-rate system and in particular, a CBA. These authors point to countries such as Brunei Darussalam that have been operating a CBA for over 20 years.

4.2.5: Share of trade with anchor country

Examining Hong Kong's top six major trading partners in 1999 provides an accurate analysis of the trade share with the United States (Table 4.5). Hong Kong's primary trading partner is China. China makes up the majority of trade with Hong Kong in the area of exports and imports. This is, of course, due to Hong Kong's relationship with China and its close geographic proximity. The United States, Hong Kong's anchor currency country, ranks second among exports and third among imports. It is also important to note that Hong Kong runs a trade surplus with the US and the UK, and runs a trade deficit with all of the other top six trading partners, including China, with which it runs the largest deficit.

Approximately 69 percent of Hong Kong's exports come from its top six trading partners including China, the United States, Japan, the United Kingdom, Korea and Singapore. Therefore, of the top six trading partners, the United States accounts for

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approximately 35 percent of exports, while China, Hong Kong's largest export country, makes up over 46 percent. Roughly 72 percent of imports come from the top six major trading partners and the United States accounts for almost 10 percent of the imports from the top six countries, with China again being the predominant partner. It is clear from Table 4.5 that the United States is one of Hong Kong's major trading partners.

Table 4.5 Hong Kong's Major Trading Partners in 1999 (million US$)

		Major Trading Partners					
Hong Kong	**Total**	**US**	**Japan**	**UK**	**China**	**Korea**	**Singapore**
Exports	173,793	41,502	9,413	7,212	57,994	2,748	4,182
exports as % of total		24%	5%	4%	32%	2%	2%
Imports	179,650	12,720	21,002	3,481	78,338	8,444	7,739
imports as % of total		7%	12%	2%	44%	5%	4%
Balance of Trade	-5,857	28,782	-11,589	3,731	-20,344	-5,696	-3,557

Source: IMF International Financial Statistics 1999

Historically, the United States always has been among one of Hong Kong's top trading partners (see Table 4.6 in appendix). The United States even outpaced China in the area of exports until 1988, when the US and China switched top positions. However, regarding exports, the United States has remained number one or two since 1978. In the area of imports, however, the US has since 1978 placed third behind China and Japan. As discussed earlier in the openness section, trade is very important in the makeup of Hong Kong's GDP, and to help preserve the anchor, it is important for the US to rank high among Hong Kong's trading partners.

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4.2.6: Flexibility and sustainability of fiscal policy

Analyzing the level of government debt as a percentage of GDP provides some insight into the flexibility and sustainability of fiscal policy. Governments that continually have high debt relative to GDP will be in a position of inflexibility due to the burden of the debt, and for emerging economies, a large debt ratio can also be seen as a signal that the current fiscal policy is most likely unsustainable. In either case, fiscal policy will be unable to aide in preserving the stability of the macroeconomy in the face of high government debt.

Since 1986, Hong Kong has enjoyed relatively substantial government surpluses, except in 1995 (Table 4.7). From 1980-85, Hong Kong experienced more deficits than surpluses. However, since the establishment of the CBA, Hong Kong has been relatively successful in maintaining a surplus. A surplus situation reinforces the credibility in the HKMA's to maintain the peg because the government will not create pressure on the exchange rate through deficit-financing measures. Furthermore, a government surplus allows flexibility in fiscal policy that cannot necessarily be achieved when the government is in a deficit position.

The third column provides a look at the size of the government deficit or surplus in relation to GDP, to provide a measurement of the relative magnitude of the surplus or deficit. Notably, 1997 had the largest surplus as a percentage of GDP since 1980, which is remarkable given the effects of the Asian crisis.

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Table 4.7 Hong Kong Government Surplus or Deficit in Million Hong Kong Dollars

Year	Surplus/Deficit	% of GDP
1980	3361	2.39%
1981	889	0.52%
1982	-6791	-3.57%
1983	-5837	-2.78%
1984	-192	-0.08%
1985	-1110	-0.42%
1986	3767	1.21%
1987	9129	2.36%
1988	13115	2.85%
1989	11063	2.11%
1990	3868	0.66%
1991	22507	3.37%
1992	21979	2.81%
1993	19164	2.14%
1994	10843	1.07%
1995	-3113	-0.29%
1996	25678	2.15%
1997	74893	5.64%

Source: Asian Development Bank

4.3: Interest arbitrage

4.3.1: Commercial bank soundness

Hong Kong currently has approximately 200 commercial banks, with the majority of these banks being international. Countries such as the United States, Germany, Japan, Australia, Denmark, Great Britain, Canada and others all have branch banks located in Hong Kong. The presence of foreign banks allows depositors to "flee to quality", rather than completely abandoning the system in the face of a banking crisis, reducing the effects of a crisis (Garcia-Herrero, 1997). Throughout the liquidity tightening of the Asian crisis, Hong Kong never has had a major bank fail, and the presence of numerous international banks helps to reinforce banks located in Hong Kong in times of crisis.

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Given that Hong Kong is one of the world's financial centers, the degree of commercial banking system sophistication falls in line with this role. It is important to remember that the role of the commercial banking system is to complete the automatic mechanism of macroeconomic stabilization through interest-rate arbitrage in order to maintain the peg. An analysis of interest-rate volatility will therefore provide a suitable measure on the functioning of the commercial banking system.

As discussed earlier, the Hong Kong interbank offer rate or HIBOR is the rate at which lending occurs between banks. Daily volatility in the overnight HIBOR can be substantial, represented by "Black Thursday", which signifies that the financial system is appropriately facilitating the process of interest-rate arbitrage. Fluctuations in the HIBOR act to manage liquidity in the interbank market, which in turn affects things like capital flows and the amount of money held by the public. It is in this way that the currency board can more readily defend the peg with a healthy banking system since this system automatically controls capital inflows and outflows with the interest rate. An indication of the soundness of the banking system is to compare the HIBOR and the US Federal Funds rate (see Figure 4.4 in appendix). The interest-rate differential between the HIBOR and the US Federal Funds rate is represented by the equation $i - i^*$, where i is the HIBOR and i^* is the Federal Funds rate. This differential has also diminished (Table 4.8).

It can be seen from the Table 4.8 that although there has been greater fluctuation in the HIBOR than the Federal Funds rate, the HIBOR has recently begun to more closely approximate the Funds rate. Successful defense of the peg will be reflected in how well the HIBOR mimics the Federal Funds rate, because as discussed in Chapter 2, a

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successful link between the two countries should cause interest rates to converge. This is a result of the uncovered interest rate parity (UIP). Given the close relationship between the HIBOR and the Federal Funds rate, it can be argued that the commercial banking system in Hong Kong is sound.

Table 4.8 Interest Rate Differential

	HIBOR	Fed Funds Rate	
Year	Hong Kong	U.S.	i - i*
1982	2	12.26	-10.26
1983	13.25	9.09	4.16
1984	7	10.23	-3.23
1985	7	8.1	-1.1
1986	10	6.81	3.19
1987	0.13	6.66	-6.53
1988	8.63	7.57	1.06
1989	9.63	9.22	0.41
1990	11.5	8.1	3.4
1991	4.63	5.69	-1.06
1992	3.81	3.52	0.29
1993	4	3.02	0.98
1994	5.44	4.2	1.24
1995	6	5.84	0.16
1996	5.13	5.3	-0.17
1997	4.5	5.46	-0.96
1998	5.5	5.35	0.15
1999	5.75	4.97	0.78

Source: IMF International Finanacial Statistics 1999

4.4: Conclusion

The purpose of this analysis was to establish baseline levels of all 10 preconditions in the Hong Kong economy under the CBA (Table 4.9). Since the preconditions are fundamental elements in building the instruments necessary for maintaining the target of

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the fixed exchange rate, it is essential to determine if a reasonable level of these preconditions can be established, which then can be used as a yardstick for other countries contemplating the use of CBA's. The following chapters will provide an analysis of the levels of the 10 preconditions in Argentina and Estonia to see if by comparing the levels in each of these countries, a comprehensive list of the levels of these conditions can made and used as yardstick for emerging economies.

Table 4.9 Baseline Levels of Economic Discipline Preconditions for Hong Kong

Precondition	Level
Involvement in Capital Markets	High
International Reserves (as % of GDP**)	43%
International Reserves (as % of M1**)	306%
Openness	Very Open
Size	+
Trade Share (Exports*)	1
Trade Share (Imports*)	2
Fiscal Policy Flexibility(deficit/surplus as % of GDP**)	1.52%

Source: IMF International Financial Statistics1999

*Index ranging from 1 to 3 according to the share of trade with anchor country 1 = 1st or 2nd partner; 2 = 3-6 partners; 3 => 6 partners

**Average over CBA or other relevant period

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Chapter 5. Case study of Argentina

5.1: Background

Prior to World War I, Argentina was viewed as the "land of opportunity" by investors and the public. Argentina was a resource-rich nation that was popular among Europeans who had transformed Buenos Aires into a city with a European feel. During this time, Argentina was a cosmopolitan country that attracted foreign investments dollars, which allowed it to retain a notable trade position. The 1930's proved difficult for Argentina, which had borrowed heavily in good times and found it difficult to repay the debt as the bad times of the Depression hit. However, by 1934, Argentina was once again on its feet as a result of a devalued peso, controls on capital flight and a moratorium on debt repayment. However, the policies used to pull Argentina out of the Depression in the 1930's helped to establish habits that proved increasingly destructive as time went by (Krugman, 1999).

In the foreign exchange market, emergency controls became a set of regulations that promoted corruption and discouraged enterprise due to their unbelievable complexity. Inefficient infant industries survived only on the support of import limitations that were initially designed to be temporary. Deficit spending skyrocketed as nationalized industries employed hundreds of thousands of people, but failed to produce. Corruption coupled with these other problems lead to inflation.

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The 1980's represented the pinnacle of bad times for Argentina. The Falklands War in 1982 was a disaster for Argentina, forcing the military government to step down, and a civilian government under Raul Alfonsin came to power. Alfonsin promised an end to the debt crisis and economic revitalization, and proposed the introduction of a new currency, the Austral, in order to do so. The Austral was an epic failure and by 1989, inflation had reached the hyperinflation level of 3,000 percent a year.

In 1989, Carlos Menem was elected the new president of Argentina. Menem was prepared to use drastic measures to control the economy and showed as much with his appointment of Domingo Cavallo as finance minister. Cavallo introduced sweeping changes that included the privatization of the country's inefficient state-owned sectors, including the railroads, factories, ports and the national airline. Both Menem and Cavallo believed the key to the Argentinean integration into the world economic arena was to rid the government of the provision of numerous public services that were overburdening the government and leading to the inefficient provision of these services. In 1990, just prior to the introduction of the CBA, there were approximately 120 state-owned enterprises that controlled a sizeable portion of the domestic economy. By the end 1994, only eight state-run companies remained in operation, and currently there are fewer than that.

As expected, the sale of numerous state-owned industries had a positive effect on GDP and a negative effect on employment. As was typical among state-run industries, there was large number of people employed in the state sector. As these industries were privatized, the ranks of the unemployed swelled. For example, in 1990, Argentina's state-owned petroleum company employed approximately 52,000 workers; after privatization in the same year, the number of workers fell to 6,000. The state-owned

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railroad employed approximately 87,000 people prior to privatization and 5,230 after (Keeling, 1997). The effects on unemployment as a result of the massive privatization of the state-run industries were devastating. In 1991 and 1992, as the sale of state-owned enterprises was at its peak, the growth rate of real GDP was the highest it had been in years, at 10.5 and 10.3 respectively. In addition to Menem's aggressive privatization scheme, numerous policies that were devastating to the profitable agricultural export sector were removed or drastically changed. Finally, a dramatic change in monetary policy was signaled by the introduction of a CBA in 1991.

Like other countries that use a CBA, the Argentines peg their currency to the U.S. dollar, at an exchange rate of $1US = 1peso, which means that for every peso the central bank issues, there must be a dollar held in reserves. At any time, the central bank stands ready to convert pesos to dollars at the fixed rate. The US dollar is used so often as a medium of exchange in the Argentine economy that many economists have suggested that the Argentines might just want to change from having their own domestic currency to using the US dollar. This idea will be discussed later in section 5.3 on "dollarization". The Argentines require the entire monetary base to be backed by the dollar, so direct backing is required for all balances held at the monetary authority or central bank as well as all notes and coins. However, in order to ease their potentially huge reserve-backing requirement, the monetary authority is allowed to keep one third of the reserves to be held in US dollar-denominated government bonds.

Argentina's move toward a CBA was in large part prompted by, among other things, its need to control inflation. From 1991 to 2001, the CBA in Argentina was relatively successful, most especially in the area of inflation. Inflation fell from

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hyperinflationary levels in 1989 and 1990, to moderate levels in 1999 (Figure 5.1 in appendix). There is a dramatic difference in not only the level but also the variance in the inflation rate before and after the introduction of the CBA.

Since the introduction of the CBA in Argentina in 1991, the average annual rate of inflation has been radically lower than prior to the adoption. In the 10-year period (1981-1990) immediately prior to the introduction of the CBA, the average annual level of inflation was 787 percent, which includes the astonishing level of 3,078 percent for 1989. From 1991-99, the average level of inflation was 24 percent; however, during the five years from 1995-1999, the average level of inflation was less than one percent. It appears that this type of stabilization was extremely successful in controlling inflation in Argentina during the CBA period.

Between 1991 and 2001, the CBA was able to maintain the peg to the US dollar, even in the face of substantial economic crisis. The Mexican crisis of 1994 was the first major test of the Argentine currency board. The "Tequila Effect" was the term used to describe the repercussions felt throughout the rest of Latin America as a result of the Mexican devaluation of the peso. As a result of enormous capital outflows and deposit withdrawals, Mexico decided to bail out failing banks, forcing the Mexican peso to devalue on December 20, 1994. The consequence of this move was the immediate and substantial capital outflows from Latin America. As capital flowed out of Argentina, the country was faced with the same situation as Mexico; however, instead of following Mexico's lead, Argentina adhered to the rule-bound nature of the CBA by defending the peg and letting banks fail. As a result of this maneuver, 25 percent of all financial

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institutions failed, causing depositors to lose their money and resulting in shrinkage of the money supply by 20 percent in three months (Zarazaga, 1995).

By refusing to act as a lender of last resort, the Argentine currency board proved it was credible, which led to increased confidence in its ability to maintain the peg. The effects of the Asian and Brazilian currency crises were also felt in Argentina but not as severe as the Mexican crisis. With substantial assistance from the World Bank and the International Monetary Fund, the CBA was able to weather these crises and maintain relative macroeconomic control. In 1999, despite the success of the CBA in Argentina, former President Carlos Menem announced that the government was looking into the possibility of moving to a dollarization regime. Many Argentines believed that even greater successes could be achieved under dollarization than what already had been attained under the CBA. Dollarization will be discussed in section 5.3, and is a radical way in which to gain strict macroeconomic control by using the US dollar as the official Argentine legal tender.

Political dissatisfaction with Menem forced him out of the presidency and in December 1999, Fernando de la Rua took office and continued discussions surrounding the possibility of dollarization. In March 2001, President de la Rua again asked Cavallo for help in reducing budget deficits and lowering interest rates. Cavallo was named economy minister, which is almost the identical position he initially held under the Menem presidency a decade earlier when he introduced the CBA. Initially, it looked as if Cavallo once again would save the Argentine economy. He proposed a mixture of tax and trade policy reforms, and tried to give the euro a role parallel to the US dollar. These reforms were unsuccessful and created a loss of confidence in financial markets, causing

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huge interest-rate premiums. The high interest rates began to foster the belief that Argentina would default on its debt. In December 2001, the Argentine government defaulted on its $132 billion public debt, and the currency board system was abandoned. President de la Rua and Cavallo resigned shortly thereafter.

Arguably, many factors contributed to the downfall of the CBA in Argentina. Some of these factors are found in the economic discipline component of the exchange-rate mechanism, most especially a lack of fiscal discipline. Many critics also pointed to the Brazilian devaluation of its currency in early 1999, forcing exporters to lose competitiveness. Additionally, the corruption of the "political class" and the inability to collect income tax contributed to the fall of the Argentine system. Section 5.2 will examine the economic discipline preconditions which will be used in the empirical chapter to perhaps shed light on the causes of the downfall of Argentina's CBA.

5.2: The economic discipline preconditions

5.2.1: Degree of involvement in international capital markets

Information on the capital markets in Argentina is scarce and unreliable. As a result, a meaningful analysis of the degree of involvement in capital markets is not possible. Most of the discussion surrounding the capital markets in Argentina involves the removing some of the capital controls that are in place restricting the amount of capital movement. By removing capital controls, one would expect that this would increase the degree of involvement in capital markets; however, due to a lack of data, this is only speculation.

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5.2.2: High international reserves

To gauge the level of international reserves in Argentina, it is necessary to look at the holdings of the Banco Central from 1990 to 1999 (Table 5.1). The second column in the table shows the annual level of international reserves in millions of pesos. This is the level of reserves available to Argentina in the event that it is necessary to buy or sell pesos and US dollars. The third column is the percentage change in the level of reserves over this period. In 1991, the year the currency board was established, total reserves rose by an extraordinary 135 percent. This represents Argentina's effort to bolster reserves to comply with the requirements of a CBA. As this column also shows, in 1995, there was no change in reserves from the previous period, illustrating in part the toll the Mexican crisis took on the reserves of Argentina in its defense of the peso. As Argentina recovered from the crisis, it was able to increase the level of reserves in 1996.

Table 5.1 Total Reserves held by the Central Bank of Argentina

Year	Total Reserves minus Gold in million Pesos	change	as % of nominal GDP	as % of M1
1990	2550.11	-	4%	83%
1991	6002.84	135%	3%	79%
1992	9880.75	65%	4%	87%
1993	13755.35	39%	6%	91%
1994	14328.40	4%	6%	88%
1995	14321.55	0%	6%	86%
1996	18129.60	27%	7%	95%
1997	22332.24	23%	8%	104%
1998	24786.81	11%	8%	115%
1999	26203.99	6%	9%	127%

Source: IMF, International Financial Statistics 1999

Column 4 shows that although reserves as a percentage of nominal GDP were small, they increased between 1991 and 1999. Finally, column 5 illustrates that until 1997,

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Argentina was not in a position to back the M1. This is important because a CBA must always be in a position to convert domestic currency into the reserve currency. Argentina's holdings of international reserves were substantially less than Hong Kong's as a percentage of GDP and M1, and significantly lag behind the holdings of other prominent world economies such as the US, Germany, and Japan (see Figure 5.2 in appendix).

5.2.3: Openness

The prevailing view on how to measure the degree of openness is to use the ratio of total trade (exports + imports) to GDP (Bratberg et al., 1999). Section 3.3.3 provides a more comprehensive discussion of this precondition. Openness is a measure of the volume of trade in relation to the total amount of domestic production as measured by GDP, or in other words, a measure of the importance of trade to a nation. A relatively open economy is one in which total trade makes up a large share of GDP. Several authors (see section 3.3.3) argue that as openness increases, so does the probability of a country adopting a fixed exchange-rate system.

During this period, Argentina was a relatively closed economy dominated by the services sector, which accounted for 64 percent of GDP in 1999. Industry made up 29 percent of GDP and agriculture accounted for the remaining 7 percent in 1999. The degree of openness fluctuated since 1989 but there was an upward trend in openness since the establishment of the CBA in 1991 (Table 5.2). This was expected, given that one of the many reforms enacted in 1990 along with the adoption of the CBA was to increase trade with other countries. The degree of openness for the United States is

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included in the table for comparison. The average level of openness during this period was .15 for Argentina and .17 for the US. Although trade has increased in Argentina, it is still considered a relatively closed economy.

Table: 5.2 Degree of Openness 1989 - 1999*

			Argentina			USA
Year	**Exports**	**Imports**	**Total**	**GDP**	**Openness**	**Openness**
1989	9573	3864	13437	81101	0.17	0.15
1990	12354	3726	16080	140658	0.11	0.15
1991	11978	7559	19537	190419	0.10	0.15
1992	12399	13795	26193.7	229138	0.11	0.15
1993	13269	15633	28901.4	236505	0.12	0.15
1994	16023	20162	36185.5	257440	0.14	0.16
1995	21162	18804	39966	258032	0.15	0.18
1996	24043	22283	46325.9	272150	0.17	0.18
1997	26430	28554	54983.9	292859	0.19	0.18
1998	26441	29558	55998.8	298948	0.19	0.18
1999	23333	24103	47435.9	283260	0.17	0.18

Source: DOT statistics and IFS

*All values in US dollars

5.2.4: Size

The radical transformation in inflation during the CBA period did not come at the expense of real GDP growth. The performance of real GDP was better during the currency board years than in the years prior to the CBA arrangement (see Figure 5.3 in appendix). From 1985-90, the years directly prior to the introduction of the CBA, the average growth rate of real GDP was -0.43 percent. From 1991-98, the years directly following the establishment of the CBA, the average growth rate of real GDP was

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6.11 percent. From this it becomes clear that inflation control under the CBA did not come at the cost of real GDP growth.

In 1991 and 1992, the dramatic increase in real GDP growth was largely attributed to the revenue received from the privatization of numerous state-owned enterprises. However, not all of the positive growth in real GDP can be attributed to privatization. In 1993, privatization still had a substantial effect on the growth rate of real GDP, but by 1994, privatization proceeds had virtually no effect on the growth rate of GDP. The "Tequila Effect" is responsible for the negative real GDP growth in 1995. However, with help from foreign, direct investment and successful monetary, fiscal and policy reforms, positive economic growth was once again fostered under the CBA (Enoch and Gulde, 1998).

The positive real GDP growth and moderate inflation growth from 1996-98 were all signs that the CBA was providing the economic stability necessary to transform Argentina into a promising emerging country. Positive real GDP growth and moderate inflation rates made this type of exchange-rate stabilization attractive and lent credibility to the CBA, between 1991 and 2001.

5.2.5: Share of trade with anchor country

There were numerous reforms that occurred in 1991 in addition to the establishment of the CBA, including a substantial policy movement toward the liberalization of trade in Argentina. In 1991, the Mercosur, a customs trade union, was formed between Argentina, Brazil, Paraguay and Uruguay, and became effective on January 1, 1996. To further promote free trade in the region, a "four plus one" free trade

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agreement, between the Mercosur and Chile, was initiated in October 1996, and Bolivia was added in April 1997. The Mercosur negotiates with other countries in the region to increase the scope of free trade in the area, in hopes of participating in a movement to have a free trade area for the Americas.

Examining Argentina's top six major trading partners in 1999 provides an accurate analysis of the trade share with the US (Table 5.3). Argentina's primary trading partner in 1999 was Brazil. Brazil made up the majority of trade with Argentina in the area of exports and imports. This was, of course, due to Argentina's close geographic proximity. The United States, source of Argentina's anchor currency, ranks second among exports and imports. Almost half of all of Argentina's exports come from its top six trading partners, including Brazil, the United States, Chile, France, Italy and Germany. Therefore. among the top six trading partners, the United States accounts for approximately 20 percent of exports, while Brazil, its largest export country, makes up over 49 percent. Approximately 62 percent of imports come from the top six major trading partners, and the United States accounts for almost 31 percent of the imports from the top six countries, with Brazil again being the predominant partner.

Table 5.3 Argentina's Major Trading Partners

		Major Trading Partners					
Argentina	**Total**	**US**	**Brazil**	**Chile**	**France**	**Italy**	**Germany**
Exports	23,966	2,482	5,870	1,739	365	762	701
exports as % of total		10%	24%	7%	2%	3%	3%
Imports	26,159	5,084	5,625	671	1,594	1,443	1,454
imports as % of total		19%	22%	3%	6%	6%	6%
BOT	-2,193	-2,602	245	1,068	-1,229	-681	-753

Source: Direction of Trade Statistics 1999

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Problems in Brazil, including the Brazilian crisis of 1997 and current economic difficulties, present potentially serious challenges for Argentina in the future. The macroeconomic environment in Brazil, Argentina's largest trading partner, is a key component of Argentina's own economic outlook. The collapse of the Argentine economy was fostered in part by the Brazilian currency devaluation, which dramatically affected trade between these two countries, hurting Argentina's exports to Brazil.

5.2.6: Flexibility and sustainability of fiscal policy

Analyzing the level of government debt as a percentage of GDP provides some insight into the flexibility and sustainability of fiscal policy. Governments that continually have high debt relative to GDP will be in a position of inflexibility due to the burden of the debt, and for emerging economies, a large debt ratio can also be seen as a signal that the current fiscal policy is most likely unsustainable. In either case, fiscal policy will be unable to aide in preserving the stability of the macroeconomy in the face of high government debt.

Since 1983, the Argentine government has run at a deficit (Table 5.4). The most substantial deficit occurred in 1996 in the wake of the Mexican crisis. Although the size of the deficit was small relative to the level of nominal GDP, the constant deficit raises concerns that fiscal policy may not be flexible or sustainable. However, like many Latin American countries, deficit spending and using the central bank as a printing press are policies of the not-so-distant past.

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Table 5.4 Argentina's Government Surplus or Deficit in Million Pesos

Year	Surplus/Deficit	% of GDP
1983	-0.01	-9.09%
1984	-0.03	-3.80%
1985	-0.28	-5.27%
1986	-0.24	-2.40%
1987	-0.63	-2.70%
1988	-1.49	-1.34%
1989	-21.46	-0.66%
1990	-226.06	-0.33%
1991	-963.02	-0.53%
1992	-73	-0.03%
1993	-1574	-0.67%
1994	-1885.7	-0.73%
1995	-1426	-0.55%
1996	-5233.6	-1.92%
1997	-4357.3	-1.49%
1998	-4148.1	-1.39%
1999	-8125.7	-2.87%

Source: IMF

Although Argentina's fiscal deficit was relatively small as a percent of GDP and appears to be manageable, the outlook for at least the medium term is not optimistic. As workers increase savings in private pension funds, contribution to social security and collections from labor taxes will continue to decline; at the same time, social expenditures are expected to continue to increase. Tax evasion presents another serious problem for the government because it further decreases legitimate government revenue. Provincial and state government corruption is also a significant problem for Argentina. Corruption increases costs to government through a decrease in legal revenue and increased suspicion by the public, which makes citizens less willing to pay lawful and necessary taxes. All of these factors create pressure on the Argentine government to increase fiscal deficits to meet social needs.

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5.3: Interest-rate arbitrage

5.3.1: Commercial bank soundness

The Mexican crisis took its toll on the commercial banking system in Argentina, in the form of a significant banking crisis. One positive effect of the financial problems as a result of the "Tequila Effect" was that the banks remaining after the Mexican crisis were more sound than prior to the crisis.

> Out of the 173 private financial institutions, some 123 survived the withdrawal of deposits and the liquidity crisis experienced between February and May 1995. Of the 50 banks that disappeared, 24 were absorbed by other banks, 19 banks were merged in 4 banks, and 11 were liquidated. Small and medium-sized private institutions (i.e., private domestic banks, cooperatives and credit unions each with less than 1.5 percent of total assets of the system) were those most adversely affected by the financial crisis. The deposits of these financial institutions fell by about Arg$4.5 billion of 30 percent during 1995, while deposits of big private banks increased by Arg$2.0 billion, or 14 percent. During the same period, loans extended by small and medium-sized private financial institutions shrunk by Arg$3.5 billion, or 21 percent, while those of big private banks increased by Arg$1.4 billion, or 8 percent (Canonero, 1997).

As discussed earlier, the money market interest rate is the rate at which lending occurs between banks. Fluctuations in the market act to manage liquidity in the interbank market, which in turn affects capital flows and the amount of money held by the public. It is in this way that the currency board can more readily defend the peg with a healthy banking system, since this system automatically controls capital inflows and outflows with the interest rate. An indication of the soundness of the banking system is to compare the Argentine money market rate and the U.S. Federal Funds rate (Table 5.5).

It is clear from Table 5.5 that prior to the introduction of the CBA in 1991, interest rates in Argentina were out of control. The effects of the CBA are clear: Interest rates in Argentina fell by remarkable levels from their 1990 astronomical level.

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Economic theory predicts that the interest rates in Argentina and the US should closely approximate each other. Obviously, prior to the CBA, the US Federal Funds rate was substantially lower than the Argentine money market rate. After 1991, the average deviation of the Argentine rate from the US rate was 10.35 percent and the average between 1995 and 1999 was 1.84 percent. This is truly a remarkable transformation, given the prior-interest rate situation.

Table 5.5 Interest Rates in the U.S. and Argentina

	Percent Per Annum	
	U.S.	Argentina
Year	Fed Funds Rate	Money Market Rate
1980	13.36	86.88
1981	16.38	185.25
1982	12.26	201.97
1983	9.09	738.97
1984	10.23	1182.3
1985	8.1	1161.16
1986	6.81	134.77
1987	6.66	252.77
1988	7.57	523.69
1989	9.22	1387180
1990	8.1	9695420
1991	***5.69***	***71.33***
1992	3.52	15.11
1993	3.02	6.31
1994	4.2	7.66
1995	5.84	9.46
1996	5.3	6.23
1997	5.46	6.63
1998	5.35	6.81
1999	4.97	6.99

Source: IMF, International Financial Statistics, 1980-99

The convergence of the Argentine money market rate with the US Federal Funds rate after the introduction of the CBA, lends support to the belief that the commercial banking system was attempting to make changes enabling it to perform its crucial role of

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interest-rate arbitrage in the automatic stabilization process of a CBA. Furthermore, maintaining stable interest rates prove to investors that the financial markets are capable of handling capital inflows, which is especially attractive to foreign investors. In order to increase confidence in the banking system's ability to weather a crisis, the central bank of Argentina had set up a repurchase agreement with a consortium of international banks to provide an $8 billion safety net in the event of a liquidity squeeze.

5.4: Dollarization

In January 1999, Argentine President Carlos Menem discussed the idea of moving to a system of official dollarization, even despite the success of the CBA. Menem had lingering doubts about the CBA, given interest-rate spikes during the Tequila Crisis in 1994-95 and the Asian and Brazilian currency crises since 1997. After Menem was removed from office, his successor, President Fernando de la Rua, resumed talks surrounding the movement to dollarization; however, the temporary success of the CBA in Argentina caused the dollarization movement to loose steam.

In the late 1980's and early 1990's, persistently high levels of inflation had eroded faith in the domestic currency as a store of value. Prior to the introduction of the CBA arrangement in 1991, the Argentine government was contemplating adopting a system of dollarization to cure its monetary problems. The discussion surrounding the merits of dollarization in Argentina has not been concluded and some still consider Argentina a good candidate to adopt a dollarization strategy. Argentina was heavily unofficially dollarized when the convertibility plan went into operation, and in fact, US dollar notes were estimated to exceed domestic currency notes and bank deposits combined. The

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extent of dollarization can be calculated as share of foreign currency deposits to the broad money supply (M2) for the period 1990-95 (Table 5.6).

Table 5.6 Argentina's Degree of Dollarization

Year	Foreign currency deposits as a % of Broad Money M2
1990	34%
1991	35%
1992	37%
1993	40%
1994	43%
1995	44%

Source: Balino, Bennett and Borensztein

From Table 5.6, it becomes obvious that Argentina is heavily dollarized. A high degree of dollarization can increase integration into international markets and provide a more complete range of assets for domestic investors. In the face of speculative attacks, a significant amount of dollarization can help to assuage the fears of foreign and domestic investors and help to slow capital flight. Table 5.6 also reveals that the level of dollarization has increased since 1990, which perhaps was an indication of the increased discussion surrounding the idea of a movement to full, official dollarization.

The idea of dollarization gained significant momentum for many of the same reasons surrounding the renewed interest in the idea of currency boards as a tool for macroeconomic stabilization. The European Union has intensified the interest in "optimum currency areas", which in turn has encouraged the idea of dollarization. Schuler (1999a) discusses several different types of dollarization, including unofficial dollarization, semiofficial dollarization and official dollarization. Unofficial dollarization

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occurs when much of the financial wealth held by people is in foreign assets even though foreign currency is not legal tender. Unofficial dollarization is difficult to measure since it can include holding foreign bonds and other nonmonetary assets (usually held abroad), foreign-currency deposits abroad, foreign-currency deposits in the domestic banking system, and foreign notes held by the public. To get an idea of the level of unofficial dollarization, Porter and Judson (1996) estimate that foreigners hold 55 to 70 percent of US dollar notes, mainly in $100 bills.

Semiofficial dollarization means that although foreign currency is legal tender and plays a dominant role in bank deposits, it still plays a secondary role to domestic currency in wage payments, taxes and everyday expenses (Schuler, 1999a). Official dollarization means that a country eliminates its own currency and adopts the US dollar as legal tender. Official dollarization has a great deal in common with a CBA. A CBA relates to the idea of dollarization in that a country that adopts a system of dollarization eliminates the need for domestic "vouchers" and simply uses the US dollar directly, instead of domestic legal tender. Like a CBA, the domestic monetary policy is tied to the anchor country and in effect eliminates any domestic monetary policy instruments.

Much of Latin America is already heavily unofficially dollarized, with Panama and Ecuador being the only two countries to officially dollarize. As discussed previously in this chapter, the 1995 level of dollarization in Argentina was 44 percent. Unofficial dollarization in 1995 was 82 percent in Bolivia, 31 percent in Costa Rica, 55 percent in Nicaragua, 64 percent in Peru, and 76 percent in Uruguay (Balino et al., 1999). The debate surrounding dollarization is as intense as the debate around the use of CBA's, and

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much of the arguments for and against are similar to the ones used in the discussion surrounding currency boards.

5.4.1: Arguments in favor of dollarization

Schuler (1999b) argues that the benefits of dollarization flow from using a currency that is presumably better than a domestic central bank could provide. There have been many proponents of dollarization who have argued extensively the benefits from adopting a policy of full dollarization, including Mundell (2000), who believes that the gains from dollarization include "a better monetary policy in addition to a gain of world class currency". Schuler (1999a, 1999b), Stein (1999a, 1999b, 2000), Eichengreen (2000), Calvo (2000), Mundell (2000) and others point to four general arguments in support of dollarization and some are identical to those used in favor of a CBA.

The first argument involves the idea that emerging economies that dollarize will face lower inflation and faster growth, and points to the experiences of currency boards as an example. Supporters of this view argue that local policy makers will not be able to abandon their commitment to the monetary policy of the US as a result of the relationship imposed by dollarization and this ensures that these countries will have a superior monetary policy. The second benefit achieved under dollarization (as well as a CBA) is greater fiscal discipline by limiting a country's ability to finance government spending by printing money. Furthermore, it is argued that by making it impossible to devalue, dollarization could increase fiscal discipline even more than under a CBA.

The third benefit of dollarization is that interest rates should be lower and less volatile. This is a result of an elimination of risk associated with the exchange rate, and a

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reduction of the inflation rate toward US levels. In addition, interest rates should fall because domestic investors will not have to pay premiums for loans in domestic currency as a result of having reserves in foreign currency. The final benefit deals with the idea that under dollarization, countries could deepen financial markets in the sense of reducing the risk of financial contagion, reducing the transaction costs of borrowing in foreign dollars and decreasing the cost associated with artificially diversifying assets (Stein, 1999a).

The benefits are not independent of the number of countries that participate and increase as more countries become dollarized. Mundell (2000) argues that as more countries dollarize there will be significant gains from trade, investment and most likely, economic growth. He goes as far as arguing the benefits of total global dollarization. However, the idea of dollarization is not without numerous critics, and the next section examines the arguments against the idea of dollarization.

5.4.2: Arguments in opposition to dollarization

Mundell (2000) points to three costs associated with the adoption of dollarization. When the arguments are identical to those posed earlier in section 2.4, reference will be made to that section and not discussed in this section. The first cost is the loss of seigniorage, which is a similar argument used against the establishment of a currency board. The second is the loss of a national symbol through the abolition of domestic currency. The third is the loss of sovereignty arising partly from the fact that the United States would not adjust its interest rate to take into account the policy interests of dollarized countries or in other words, dollarized economies would lose their independent

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monetary policy (Mundell, 2000). In addition to these costs, Schuler (1999a, 1999b), Stein (1999a, 1999b, 2000), Eichengreen (2000) and Calvo (2000) argue that other costs associated with the adoption of a dollarization regime include the loss of lender of last resort capacity and excessive pressure on U.S. monetary policy.

The loss of seigniorage is the same argument that was used in opposition to a CBA. However, under dollarization, the possibility of earning seigniorage is even more limited than under a CBA. In 1999, Argentina earned approximately $750 million in seigniorage, mainly from earning interest on its holdings of short-term U.S. denominated securities (Stein, 2000). If, for example, Argentina were to dollarize, it would trade in these securities for U.S. dollars and loose the ability to earn that seigniorage. In effect, the $750 million in seigniorage would be transferred to the U.S. through dollarization. The International Monetary Stability Act (IMSA) offers a way in which Argentina and other countries considering dollarization could earn some seigniorage through dollarization. The IMSA allows the Treasury Secretary to rebate 85 percent of the transferred currency profit back to the dollarizing country, and the remaining 15 percent would be used to finance countries that are already officially dollarized, cover operating costs; anything remaining would become profit for the US (Stein, 2000). This act is designed to help emerging economies make the transition into dollarization.

Many critics of dollarization point to the loss of a dollarizing economy's national currency as a loss of an important source of national identity and pride. Furthermore, for many emerging economies, a national currency is a political symbol of independence. They point to the fact that usually, prominent national leaders are displayed on the currency, evoking feelings of sovereignty. Proponents of dollarization argue that this is a

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small price to pay to gain the benefits associated with the use of the world's most powerful currency.

The next set of arguments is similar to those used against currency boards and will be discussed briefly (refer to section 2.4 for complete arguments). Under dollarization, the monetary policy of the dollarizing country becomes that of the US and all domestic monetary policy instruments will be rendered useless. For many emerging countries, the loss of monetary policy instruments is frightening and leaves them with feelings of being at the mercy of the US. The United States is not obligated to take into account the impacts of its monetary policy on dollarized economies, and could inadvertently negatively affect a dollarized economy by its use of certain monetary policy instruments.

Schuler (1999a, 1999b), Stein (1999b) and Mundell (2000) believe that many emerging countries have a poor history of monetary performance that impairs the credibility of their currency. They further believe that for these developing countries, a way in which to dramatically increase credibility, while encouraging growth and reasonable inflation, is to dollarize and use the monetary policy of the U.S. The monetary policy of the U.S. is sound and has helped to encourage growth and prosperity in such a way that the U.S. is the strongest economy in the world. Hong Kong provides an example of a country that has thrived using the monetary policy of the U.S.

In conjunction with the above argument, many opponents of dollarization argue that dollarized countries increase pressure on US monetary policy. They argue that dollarization in other countries makes it harder for the Federal Reserve to conduct monetary policy and furthermore, the US will feel pressure to take into account the needs of countries that have dollarized and therefore not always do what's best domestically.

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Additionally, opponents of dollarization argue that the Fed will also come under pressure to lend support to troubled banks and supervise foreign banking systems.

Supporters of dollarization point to the fact that over the last several years, the greatest growth in foreign holdings of dollar notes has occurred and the Fed has successfully reduced inflation to less than 3 percent per year (Schuler, 1999b). Additionally, the Fed and the Treasury Department have clearly stated numerous times that the monetary policy needs of countries that dollarize will not factor into the monetary policy equation of the U.S. The Economic Growth and Price Stability Act is a proposed measure to ensure that the Fed remains resistant to all types of political pressure by mandating price stability as the long-term goal.

The idea that a dollarized economy will lose the ability to have the central bank function as lender of last resort is the same argument used in opposition to the establishment of a CBA. Previous sections discuss alternative methods to provide lender of last resort duties, including an international commercial banking system with numerous branch banks and an international bank like the World Bank that could be set up to function as lender of last resort in times of emergency. For Hong Kong, the lack of lender of last resort capacity has not proved to be a significant problem for the banking system.

5.5: Should emerging economies dollarize?

Emerging economies must choose between the use of a CBA and dollarization. Dollarization is fundamentally more extreme than the use of a CBA; however, some

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countries are prepared for drastic measures to control their macroeconomic problems. However, for many of these countries, moving to a dollarization regime is too radical and presents a one-way solution to their problems. It has been argued that using a CBA could be an intermediate step for emerging economies. For example, emerging economies could use a CBA for 10-15 years to stabilize prices and reduce inflation to reasonable levels while promoting GDP growth. Also during a CBA period, emerging economies could deepen financial markets and increase financial sophistication in hopes that eventually the move to a floating arrangement could be made and monetary policy instruments could be used to help control the macroeconomy. A CBA could be used for a period of time to create credibility in the monetary authority that could be crucial when the CBA is eventually abandoned in favor of a floating arrangement.

Even if a CBA is not used as an intermediate step for emerging economies, it does not have the one-way characteristic that dollarization poses. If, for example, an emerging economy moves to a dollarization regime and finds that the monetary policy of the U.S. is too dissimilar to its needs, it has very few options. The move toward dollarization has destroyed credibility in its national currency, so re-establishment of this currency could prove impossible. Furthermore, it has created a system that relies on a stronger international currency that will not be willingly traded for domestic currency, which essentially is valueless. The conversion to dollarization requires a great deal of effort and faith from the public, and making the transition back to a less dominant currency will most certainly prove difficult. Most emerging economies already are heavily dollarized and would be willing to move toward a system of dollarization, but may not be as willing to back from a system of dollarization.

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A CBA allows for the same benefits of dollarization. However, it does not have the same one-way feature and a country still retains a national symbol of pride in the domestic currency. A CBA system, which functions essentially under a system of "vouchers", provides an emerging economy with more macroeconomic options then dollarization. For example, if Hong Kong decides (like it has in the past) to move to a floating system, it can readily make that conversion, if it were dollarized. However, that would be impossible. It is for this reason that for most emerging economies, a CBA offers a better solution to macroeconomic problems than dollarization.

5.6: Conclusion

The purpose of this analysis was to establish baseline levels of the preconditions in the Argentine economy during the CBA period (Table 5.7). The levels of the economic discipline preconditions were collected along with commercial bank soundness information to estimate the functioning of the interest-rate arbitrage component in Argentina. Chapter 6 will provide an econometric analysis of the functioning of the interest-rate arbitrage component in Hong Kong and Argentina to determine if this mechanism functions to maintain the exchange-rate parity.

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Table 5.7 Baseline Levels of Economic Discipline Preconditions for Argentina

Precondition	Level
Involvement in Capital Markets	na
International Reserves (as % of GDP**)	6%
International Reserves (as % of M1**)	97%
Openness	Closed
Size	+
Trade Share (Exports*)	1
Trade Share (Imports*)	1
Fiscal Policy Flexibility (deficit/surplus as % of GDP**)	-1.13%

*Index ranging from 1 to 3 according to the share of trade with
anchor country 1 = 1st or 2nd partner; 2 = 3-6 partners; 3 = > 6 partners
**Average over CBA or other relevant period

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Chapter 6: Currency boards and economic stabilization: an econometric analysis

6.1: Introduction

Chapter 3 established the theoretical foundations for the empirical analysis, while chapters 4 and 5 examined each of the components (economic discipline and abundant reserves, cash arbitrage and interest-rate arbitrage) that maintain exchange-rate stability in Hong Kong and Argentina, respectively. A comparison of tabless 4.9 and 5.7 show noticeable differences between the levels of the economic discipline preconditions, especially in the areas of international reserves, openness and fiscal policy indicators (see Table 6.1 in appendix). This chapter will use econometric estimation to determine if these and other differences create different performance levels of the interest arbitrage mechanism in each country.

Relatively little empirical econometric analysis exists in the area of currency boards, most especially in the area of estimating the mechanism that maintains the fixed exchange rate under a CBA. Given that emerging economies may potentially adopt a currency board as its monetary institution, it is important to understand how the interest arbitrage mechanism operates. A CBA is a very special institutional framework, intended to create credibility and stability in the economy by fixing the value of domestic currency to a stable international currency. Thus, the single objective of domestic institutional policy is to peg the domestic currency to the chosen anchor currency ($e = \bar{e}$). In order to be able to sustain such a policy, certain economic environmental conditions are

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necessary, or at least useful, to maintain economic discipline and abundant reserves. Interest arbitrage, through the use of the interbank system, functions as the mechanism to make macro adjustments to the exchange rate when it diverges from the fixed rate.

Most of the debate surrounding a currency board's efficacy in controlling the exchange rate has been theoretical and not empirical. Empirical econometric analysis of this is scant and consists mainly of examining the determinants of countries with fixed exchange rates and not currency board institutions. A literature review of the determinants of fixed exchange-rate regimes is the starting point for this analysis and will ultimately provide the methodological and theoretical framework for this study. This section will provide a brief look at the literature of fixed exchange-rate systems in relation to the preconditions and the components that maintain the fixed exchange rate.

A substantial body of fixed exchange-rate literature is concerned with the criteria or preconditions of exchange-rate regimes necessary to predict whether a country is best suited for a fixed or flexible exchange-rate system. Mussa et al. (2000) provided a theoretical discussion of the determinants necessary for a country to successfully maintain a fixed exchange-rate system. Grafe and Wyplosz (1999), Bratberg et al. (1999), Edison and Melvin (1990), Edison (1989) and others, discuss the relative importance either empirically or theoretically of a variety of determinants necessary for a fixed exchange-rate regime. Most of the determinants fall under the umbrella of determinants theoretically discussed by Mussa et al. (2000). This section will briefly discuss some of the findings of the other empirical studies regarding the components of exchange-rate stability and the preconditions.

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Bratberg et al. (1999) empirically test a set criterion to determine the suitability of these criteria in predicting exchange-rate regimes and also provide a relative measurement of their findings to others. Using duration analysis, they test the importance of seven criteria in making the exchange-rate determination from 1973-95. These criteria include: degree of openness, country size, structural concentration of production, trade concentration, inflation rate differential to home country, degree of economic development and degree of capital mobility. Edison (1989) and Edison and Melvin (1990) provide an early literature review on the choice of these variables as determinants for exchange-rate regimes.

Bratberg et al. (1999) found that the most successful variables in their study were country size, inflation differential and production concentration. These variables were theoretically sign consistent and significant at the 5% level in several cases. Openness and geographical diversification show up with the wrong sign in several cases. These findings are consistent with numerous other studies (Honkapohja and Pikkarainen 1992, Savvides 1990, Bosco 1987). There are two major shortcomings of the papers that look at the determinants of fixed exchange-rate regimes. First, while currency boards are a rigid extension of a fixed exchange-rate regime, a lack of empirical analysis of these countries fails to address if CBA's differ from fixed exchange-rate regime countries. Second, most of these studies use various types of cross-sectional analysis and examine numerous countries at once. Few of these studies, with the exception of Bratberg et al. (1999), have used a time series approach to analyze a single country over time, to see if the relationship of these variables is time dependent.

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Empirical studies directly related to CBA's are rare. One such study tested the macroeconomic implications of a CBA following the methodology introduced by Blanchard and Quah (1989) and a technique similar in analysis to that written in a paper by Kwan and Lui (1996). Blanchard and Quah's (1989) initial intent was to reconsider the original analysis of Beveridge and Nelson (1981), who decomposed GNP into its temporary and permanent components. What Blanchard and Quah (1989) did was to "develop a macroeconomic model such that real GNP is affected by demand-side and supply-side disturbances. In accord with the natural rate hypothesis, demand-side disturbances have no long-run effect on real GNP. On the supply side, productivity shocks are assumed to have permanent effects on output" (Enders, 1995). Using a bivariate vector autoreggression (VAR), Blanchard and Quah (1989) successfully dissect real GNP and recover the two pure shocks. This type of structural VAR blends economic theory and time-series analysis in such a way that economic theories are incorporated into the VAR analysis through the contemporaneous relationship among the variables. From this structural VAR, the "dynamic response of each variable to various economic shocks can be obtained and the restrictions of the model tested" (Enders, 1995).

Kwan and Lui (1996) analyzed the parameters of the structural equations and the characteristics of supply and demand shocks to determine that "Hong Kong's currency board is less susceptible to supply shocks, but demand shocks can cause greater short-term volatility under the system". The essence of the Kwan and Lui analysis is to look at the effects on output growth and inflation through stationary and non-stationary shocks to AD and AS during different exchange-rate regimes in Hong Kong's past. They divided their sample in half, in which the period from 1975:1 to 1983:3 represents a period of

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relatively free-floating exchange rates and 1983:4 to 1995:3 represents the currency board period. The stationary or mean reverting shocks to AD originate from innovations in the components of AD and have only transitory effects on output. The non-stationary or non-mean reverting shocks to AS originate from factors that effect AS, such as changes in technology or productivity, and have permanent effects on the output level.

To incorporate the idea that the pre- and post-currency board periods were subject to shocks with different properties, they decided to run counter-factual simulations. In these simulations, Kwan and Lui posited that the best way to compare performance during the two different time periods would be to adopt a currency board regime in the first time period, formerly the free-floating period, and adopt a free-floating regime in the second time period, formerly the currency board period. These simulations show that "the difference in external environment during the 1970's and 1980's accounts for 42 percent of the reduction in inflation volatility, while the change in the monetary regime explains the remaining 58 percent of the reduction" (Kwan and Lui, 1996).

Rose (1996) attempted to explain exchange-rate volatility by examining Mundell's "Holy Trinity" of fixed exchange rates, monetary policies and perfect capital mobility. Rose incorporated in his study variables not necessarily implied by theory, but which were merely added ad hoc to the analysis. The fundamental basis for his study is the simple monetary exchange-rate model that begins with a structural money-market equilibrium condition and flexible prices. He concludes from his analysis that there is little evidence of an obvious tradeoff between the three components of the Holy Trinity. He did find that the inclusion of the official exchange-rate bandwidth variable, revealed a positive and significant relationship with the degree of exchange-rate volatility.

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From this he concludes that stated government exchange-rate policy affects exchange-rate volatility far beyond the effects of actual macroeconomic policy.

Duekerand and Fischer (2001) empirically study the mechanics of a successful exchange-rate peg in Austria and Thailand, and from this infer lessons for emerging markets. This study is especially pertinent to this dissertation because it emphasizes the importance of the interest rate in maintaining the exchange-rate peg. This paper examines unilateral pegs under a central banking system that is different than a peg under a CBA because the central bank has the power to use monetary policy to maintain parity between the market rate and the official rate. The authors conclude that Austria's exchange-rate peg has been successful because the Austrian National Bank kept domestic inflation close to the anchor (Germany) rate of inflation. They also conclude that the Thai peg to the US dollar was unsuccessful because Thailand purposefully did not remain close to the US level of inflation in 1995 in an attempt to profit from the inflation differential. This move made the peg unsustainable in the long run between the two countries and in 1998 lead to the abandonment of the peg.

In their model, Duekerand and Fischer (2001) explain that a central bank will implement monetary policy by setting a short-term interest rate as a policy target. In their model a central bank will focus on the interest-rate differential between domestic short-term interest rates and the equivalent short-term rate in the anchor country. Their results showed the important role of the interbank market in facilitating the interest arbitrage process and highlighted also the importance of several of the economic discipline preconditions, including similar shocks in domestic and anchor country, commercial bank soundness, and trade share with the anchor country. This study lends support to the

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importance of the interest-rate arbitrage and economic discipline components of maintaining a fixed exchange-rate system.

6.2: Econometric methodology

6.2.1: Theoretical background

6.2.1.1: Theoretical sign expectations

The theoretical framework for the empirical analysis was outlined in chapter 3. That chapter predicted the theoretical relationships between the variables that will be analyzed in this section. Using the IS/LM/BOP analysis, it is possible to predict the signs of the relevant variables in this analysis. The interest-arbitrage process is represented by movements in the interbank offer rate. From the graphical analysis provided in Figures 3.8 and 3.9, the theoretical relationships between the interest rate and some of the crucial variables in the system can be explained. An increase in export demand or a decrease in import demand creates a decrease in the interest rate; conversely, a decrease in export demand or an increase in import demand causes an increase in the interest rate. Similarly, an increase in international reserves decreases the interest rate. From the money supply and demand graphs, it easily can be seen that an increase in the supply of money decreases the interest rate. This lays the theoretical groundwork for the estimation of the interest-arbitrage equation. However, the estimation of the exchange-rate equation requires an understanding of how the exchange rate is measured.

The exchange rate is measured as home currency to US dollars. For example, in the analysis for Hong Kong, the exchange rate in the current period is measured as e_t = HK$/US$. Therefore, an appreciation of Hong Kong currency causes e_t to fall. This

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provides the framework for understanding the relationship between the key variables in the system and the exchange rate. It is important to remember, however, that the crucial relationship is between the exchange rate and the interest rate. Chapter 3 used the example of an increase in exports as the initial shock that created movement in the IS curve that necessitated a reaction from the money market and an eventual shift of the LM curve. An increase in export demand appreciates the home currency, which would cause e_t to fall and vice versa. An increase in import demand depreciates home currency and causes e_t to rise. An increase in the level of international reserves or the money supply depreciates the home currency and causes e_t to rise (Mishkin, 2004).

6.2.1.2: Stationarity

Stationarity in economic time series analysis can be a serious issue. Usually, economists deal with non-stationary time series data. Regressing a stationary system on a non-stationary system can lead to spurious results. It is important to examine the idea of stationarity before proceeding with further econometric analysis.

If a variable is stationary, it will fluctuate around a constant long-run mean or in other words, it is mean reverting, has a finite variance that is time invariant, and has a theoretical correlogram that diminishes as lag length increases. In economic analysis, stationary series are ones that when shocked, temporarily feel the effects of the shock; however, the effects of the shock eventually dissipate and the series returns to its long-run mean level (Enders, 1995). The following equation is a representation of a stationary series:

$$Y_t = a + \gamma y_{t-1} + \epsilon_t \qquad 0<\gamma<1$$

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Figure 6.1 provides a graphical representation of a stationary series.

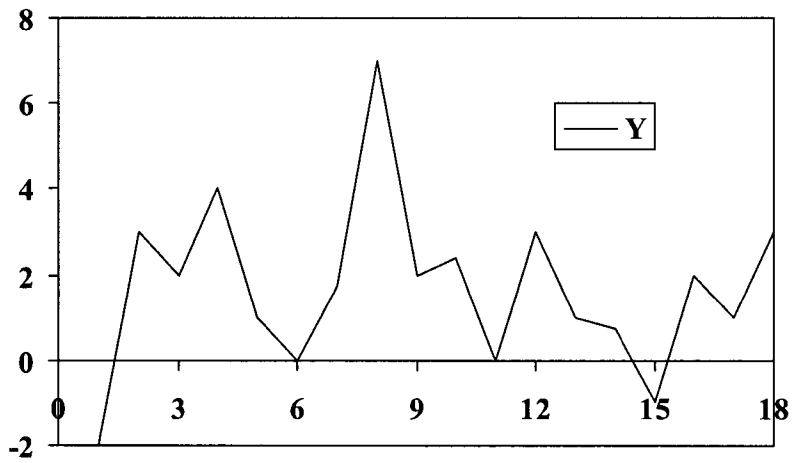

Figure 6.1 Stationary Series

A non-stationary series does not have a long-run mean to which it reverts, but it does have a variance that is time dependent and becomes infinitely large as time goes to infinity, and it has theoretical correlellogram that does not diminish as lag length increases. Again when used in economic analysis, a non-stationary series will be permanently affected by shock, and will achieve a new long-run mean level as a result of the shock (Enders, 1995). The following equation is a representation of a non-stationary series:

$$Z_t = b + \gamma z_{t-1} + \epsilon_t \qquad \gamma=1$$

Figure 6.2 provides a graphical representation of a non-stationary series.

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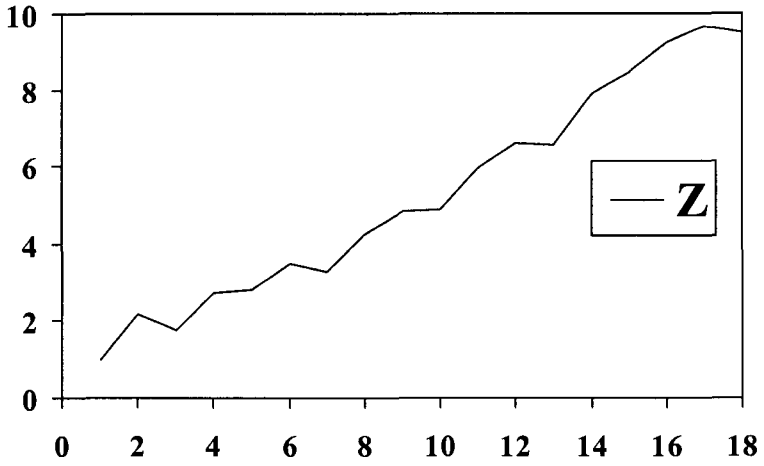

Figure 6.2 Non-Stationary Series

Enders discusses the issue of how to deal with non-stationary series in the context of the standard regression model. He first considers the following regression:

$$Y_t = a_0 + a_1 Z_t + e_t,$$

which under the assumptions of the classical regression model, requires that Y_t and Z_t series be stationary, and the errors must have a zero mean and finite variance. Using Monte Carlo simulations, Granger and Newbold estimated numerous regressions in the form of the equation above and found that the equation was meaningless and the relationship between the two variables was spurious because the residual series e_t was non-stationary. If e_t in the equation above has a stochastic trend, any deviation from the model is permanent because the error in any period t never decays (Enders, 1995). The presence of trends in time series data used in economic analysis can present serious problems.

As a result, it is important to examine the properties of e_t and test variables for stationarity before running a regression. If the variables are stationary, the assumptions of the classical regression model hold and the Ordinary Least Squares (OLS) model is

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appropriate. Econometricians have developed several techniques to determine whether a variable is non-stationary or in other words, if $a_1=1$ in the equation above. The Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, are methods that can be used to test for the presence of unit roots.

6.2.1.3: Cointegration

In the presence of unit roots, there are several different ways to manipulate the series in order to achieve stationarity. The simplest way to do this is by first differencing the series before running it in the regression. However, this technique is not without problems. Achieving a stationary series under this technique may result in a loss of valuable information regarding the relationship between the variables. Another way in which to analyze non-stationary series is to check for a cointegrating relationship between the two variables. If both Y_t and Z_t from the equation above are non-stationary, integrated of the same order and their linear combination, $Y_t - a_0 - a_1Z_t = e_t$ is stationary, then the long-run relationship between Y_t and Z_t is a cointegrating relationship. In other words, if Y_t and Z_t are cointegrated, e_t represents their deviation from each other over time. Cointegration, however, depends on the series being integrated of the same order; if this is not the case it might be concluded that the series are not cointegrated. This emphasizes the importance of first testing each series for the existence of unit roots prior to running any regressions.

Engle and Granger (1991) developed a methodology to estimate a cointegrating relationship when both of the variables are CI(1,1), meaning that the variables are

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cointegrated of order one. We estimate the long-run equilibrium relationship in the following form:

$$Y_t = B_0 + B_1 X_t + e_t$$

We then use the estimated residuals ($\hat{e}_t$) of the long-run relationship. If $\hat{e}_t$ is found to be stationary, then Y_t and X_t are CI (1,1). We could perform a DF test on the residuals to determine their order of cointegration as follows:

$$\hat{e}_t = a_1 \hat{e}_{t-1} + \epsilon_t$$

Subtracting $\hat{e}_{t-1}$ from both sides yields:

$$\Delta\hat{e}_t = \gamma\, \hat{e}_{t-1} + \epsilon_t \text{ where } \gamma = (a_1 - 1)$$

The null hypothesis of a unit root (a_1) is equivalent to testing $\gamma = 0$; if it is not rejected, one concludes that the e_t contains a unit root. Thus, Y_t and X_t are not cointegrated. If, however, e_t in the equation above is not white noise, an ADF test can be used instead. We therefore estimate the following autoregression:

$$\Delta\hat{e}_t = \gamma\, \hat{e}_{t-1} + \sum_{i=1}^{n} a_{i+1} + \Delta\hat{e}_{t-i} + \epsilon_t$$

If we determine that both variables are cointegrated, we construct the error-correcting model (ECM). The follow ECM was developed by Engle and Grange in 1987:

$$\Delta Y_t = \alpha_1 + \alpha_y \hat{e}_{t-1} + \sum_{i=1} \alpha_{11}\,(i)\, \Delta Y_{t-i} + \sum_{i=1} \alpha_{12}\,(i)\, \Delta X_{t-i} + \epsilon_{yt}$$

$$\Delta X_t = \alpha_1 + \alpha_x \hat{e}_{t-1} + \sum_{i=1} \alpha_{21}\,(i)\, \Delta Y_{t-i} + \sum_{i=1} \alpha_{22}\,(i)\, \Delta Y_{t-i} + \epsilon_{xt}\,.$$

One would expect from the outset that a fixed exchange rate is stationary, and that many of the variables that determine the fixed exchange rate are non-stationary. However, since applying a normal regression analysis on non-stationary variables might

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lead to spurious results, one is compelled to use cointegration methodology. Therefore, if cointegration exists, the interest-arbitrage mechanism could be used to explain the movements in a fixed exchange rate under a CBA.

The idea of cointegration is that these variables (i.e., the exchange rate and the interest rate) are hypothesized to be linked by some theoretical economic relationship and therefore should not diverge from each other in the long run. This relationship was introduced and formalized in chapter 3. If there is cointegration among the vectors of variables, it implies the existence of an error correction mechanism (ECM) or vector error correction mechanism (VEC). The ECM for a fixed exchange rate and the interest rate implies that the theoretical relationship of short-term variations in the interest rates correcting to return the long-run market exchange rate to the official rate holds. When one believes that a long-run theoretical equilibrium exists among time series variables, cointegration is a way in which one can investigate this relationship. Cointegration allows for the discovery of the economic phenomena that motivate the concurrent long-run movement of certain series, even though in the short run, these series may drift apart. Since our purpose is to find a common trend among these series, the presence of cointegration indicates a linear combination of these non-stationary series.

6.2.1.4: Data description and hypothesized equilibrium relationship

We used six variables in the system: domestic to anchor exchange rate, interbank interest rate, level of international reserves, level of exports to the anchor country, level of imports to the anchor country, and domestic level of M1. We obtained the data from the International Monetary Fund's International Financial Statistics and the Direction of

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Trade Statistics. The sample period for Hong Kong is from 1983 to 2000 and consisted of 66 observations for each variable. The sample period for Argentina is from 1989 to 2000 and consisted of 38 observations. We then take the log of each variable (except the interest rate). The reason for taking their natural logs is that economic time series data tend to exhibit variation, which increases mean and dispersion in proportion to their absolute level (Nelson and Plosser, 1982).

Our hypothesis is that the interest-rate arbitrage mechanism is the predominant factor in returning the market exchange to the official exchange rate. The interest arbitrage mechanism is the most important factor in maintaining exchange rate stability due to the structure of the CBA. This mechanism is used by all CBA's to maintain the exchange-rate parity and in Hong Kong, it is the sole mechanism responsible for the link. It is the operation of the interest-rate arbitrage mechanism that reflects the condition of the CBA. If the interest-rate arbitrage mechanism is functioning properly, the effects of the other variables will guarantee that the interest rate and market exchange rate do not drift apart in the long run, also ensuring that market exchange rate remains close to the official rate in the long run. Hence, the interest rate and the exchange rate are cointegrated. Cointegration among these variables suggests that they share a long-term relationship that allows for the prediction of the success of a CBA in emerging economies.

6.2.2: Testing for Stationarity

In order to test for cointegration among the variables, we must first test for stationarity. We employed two different tests to determine whether the variables are

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stationary or non-stationary, including the ADF and the PP. The following equation represents the application of the ADF to test the null hypothesis of a unit root ($Ho: \rho = 1$) by estimating an autoregression of Δy_t on its own lags and y_{t-1} using OLS:

$$\Delta y_t = \alpha_0 + \rho y_{t-1} + \sum_{j=1}^{p} B_j \Delta y_{t-j} + e_t$$

By testing, the null hypothesis in this manner, it is possible to determine if the y_t series has a unit root and if the classical regression model can be used. The PP test provides an additional test of stationarity by providing a more generalized version of the Dickey-Fuller test. The Dickey-Fuller tests assume that errors are statistically independent and have a constant variance of the errors; however, Phillips and Perron developed a generalization of this test to allow for milder assumptions concerning the distribution of the errors (Enders, 1995).

By modifying the DF t-statistics and taking into account the less restrictive nature of the error process, one can obtain the PP test statistics, which can be applied in the same manner as the DF statistics (Enders, 1995). Table 6.2a shows the results of the ADF and the PP tests of all applicable preconditions for Hong Kong.

Panel A of Table 6.2a shows the results of the tests with the quarterly series for Hong Kong in levels, and panel B shows the results of the first difference of the same series. In panel A, most of the variables are non-stationary according to the ADF test. In panel B, first differencing the variables leads to stationarity for most of the variables. International reserves is the only variable that is perhaps not difference stationary under the ADF test; however, the PP test does confirm the difference stationarity.

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Table 6.2a Results of the ADF and PP tests on Quarterly Data for Hong Kong

Panel A Level

		ADF		PP		Critical Values					
						Intercept			Trend & Intercept		
Variables	Lags	Intercept	Trend & Intercept	Intercept	Trend & Intercept	1%	5%	10%	1%	5%	10%
xrate	2	-1.37	-0.73	-7.97	-10.78	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	3	-1.92	0.21	-8.07	-10.5	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	4	-1.7	0.59	-8.24	-10.35	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	5	-1.55	0.49	-8.42	-10.29	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	6	-1.01	0.39	-8.6	-10.27	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
HIBOR	2	-2.25	-2.32	-3.38	-3.44	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	3	-3.19	-3.02	-3.4	-3.47	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	4	-3.96	-3.78	-3.45	-3.54	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	5	-2.42	-2.43	-3.42	-3.51	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	6	-2.38	-2.46	-3.42	-3.51	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
Exports	2	-2.51	-0.9	-1.96	-1.9	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	3	-3.63	0.18	-2.54	-1.69	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	4	-0.83	-1.68	-2.06	-1.95	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	5	-2.02	-1.34	-1.97	-2.07	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	6	-3.17	0.38	-2.11	-2.04	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
Imports	2	-1.9	-0.82	-1.92	-1.42	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	3	-2.58	-0.13	-2.23	-1.23	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	4	-1.01	-2.07	-1.96	-1.48	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	5	-2.01	-1.26	-1.97	-1.5	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	6	-2.65	0.18	-1.99	-1.53	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
Intlr	2	-0.48	-3.12	-0.09	-2.12	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	3	-0.42	-3.38	-0.17	-2.22	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	4	-0.33	-3.4	-0.22	-2.27	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	5	-0.2	-3.12	-0.24	-2.28	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	6	0.09	-2.42	-0.22	-2.25	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
M1	2	-2.63	-0.56	-2.58	-1.07	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	3	-2.8	-0.71	-2.66	-1.05	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	4	-3.02	-1.17	-2.67	-1.08	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	5	-2.82	-1.48	-2.66	-1.11	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	6	-2.56	-1.07	-2.75	-1.1	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2

Panel B First Difference

								Critical Values		
Test		xrate	HIBOR	exports	imports	intlr	M1	1%	5%	10%
ADF	Intercept	-6.96	-5.39	-9.9	-7.34	-3.41	-4.95	-3.5	-2.9	-2.6
	Trend & Intercept	-7.63	-5.44	-11.63	-8.18	-3.47	-5.86	-4.1	-3.5	-3.2
PP	Intercept	-43.95	-9.79	-11.75	-11.97	-5.35	-10.91	-3.5	-2.9	-2.6
	Trend & Intercept	-48.21	-9.75	-12.78	-12.65	-5.37	-12.19	-4.1	-3.5	-3.2

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A remarkable result from this analysis is that the Hong Kong-US exchange rate is non-stationary. This result is surprising because one would expect a fixed exchange rate to be mean reverting to the level of the official rate. However, this test reveals that the Hong Kong-US exchange rate is indeed an I(1) process. This result, along with the non-stationarity of the other variables in the system, allows us to use a vector autoregressive methodology. This is not the case when the data was run for Argentina.

Argentina was tested in the same manner as Hong Kong and it was determined that the Argentine-US exchange rate and the interest rate were stationary under the ADF and PP tests (see Table 6.3a and b in appendix). Borderline stationary variables include international reserves and M1. These variables were marginally non-stationary under the ADF, stationary under the PP. The level of exports and imports were all non-stationary under both tests. The non-stationary variables were all difference stationary. The stationarity of the exchange rate and the interest rate rules out using the same type of econometric analysis for both countries. The analysis used for Argentina consists of a simple OLS regression.

6.3: VAR methodology for Hong Kong

A vector autoregression (VAR) analysis provides the proper technique to incorporate economic theory and multiple time-series analysis. This first step in a VAR analysis is to make sure that the model incorporates the proper number of variables.

Choosing the appropriate lag length is crucial to a properly specified equation. Too few lags lead to a misspecified equation and too many lead to a loss of additional degrees of freedom. Two tests will be performed to determine the appropriate lag length.

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The first test involves performing the ADF and the PP tests on the lags of all of the variables in the system going back six periods. The second test involves testing the lag length of the variables in the VAR system.

In order to implement this method, variables must be non-stationary and the proper lag length (p) must be selected using the two most popular information criteria in economics, the Akaike Information Criterion (AIC) and the Schwartz Bayesian Criterion (SBC). This test is done in specific to the VAR analysis. In general for this analysis, the determination of the proper lag length is through the use of the multivariate generalizations of the AIC and SBC:

$$\text{AIC} = T \log |\Sigma| + 2N$$

$$\text{SBC} = T \log |\Sigma| + 2N \log(T)$$

where $|\Sigma|$ = determinant of the variance/covariance matrix of the residuals

N = total number of parameters estimated in all equations.

Using this technique to estimate the appropriate number of lags involves the choice of the model having the lowest AIC or SBC value (Enders, 1995). Enders suggests that lagging back 12 periods is the most appropriate starting point when using quarterly data. However, the limited length of the data set truncates the starting point to three lags. With 66 observations, the AIC and SBC select order two. Now that the appropriate lag lengths of the relevant variables have been determined, a more thorough discussion of VAR analysis can provide the remainder of the model specification. The AIC and SBC will determine correct model specification in the VAR model as well.

Numerous authors provide extensive analysis and discussion surrounding the VAR technique. Enders (1995) provides a thorough analysis of the VAR methodology

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and Lutkepohl (1993) devotes an entire book to this type of multiple time series analysis. This section will briefly outline the VAR methodology.

Intuitively, one would expect that a VAR analysis of the deviation in the exchange rate would be more appropriate specification of the model since the time path of the exchange rate is affected by the time path of all the other variables and vice versa. A VAR analysis allows for these variables to be treated symmetrically and incorporates the possible endogenous nature of all variables in the model. For example, Enders (1995) discusses a simple bivariate first order structural VAR example using the following system:

$$y_t = b_{10} - b_{12}z_t + \gamma_{11}y_{t-1} + \gamma_{12}z_{t-1} + \epsilon_{yt}$$

$$z_t = b_{20} - b_{21}y_t + \gamma_{21}y_{t-1} + \gamma_{22}z_{t-1} + \epsilon_{zt}$$

where it is assumed that both y and z are stationary and the error terms are uncorrelated white noise disturbances with standard deviations σ_y and $\sigma_{z,}$ respectively. The structure of the VAR system integrates feedback since y_t and z_t are allowed to affect each other. For example, $-b_{21}$ is the contemporaneous effect of a unit change in y on z, and γ_{11} is the effect of a unit change in the lagged value of y on its present value. In this case, ϵ_{yt} and ϵ_{zt} are pure shocks or innovations in y_t and z_t, respectively. For example, these error terms could represent demand or supply side shocks to the system. This type of analysis is very useful in the examination of CBA because of the endogenous nature of many of the variables that determine the exchange rate.

It is necessary to transform the equations above into a more useable or reduced form in order to remove the contemporaneous effect of each of the variables on the other. The use of matrix algebra helps to transform the structural VAR equations in the standard

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form VAR equations. Enders (1995) describes how the above equations can be re-written in compact matrix form as this:

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}\begin{bmatrix} y_t \\ z_t \end{bmatrix}=\begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix}+\begin{bmatrix} \gamma_{11} & \gamma_{12} \\ 21 & \gamma_{22} \end{bmatrix}\begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix}+\begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$$

or $Bx_t = \Gamma_0 + \Gamma_1 x_{t-1} + \epsilon_t$

where,

$$B=\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}, \qquad x_t=\begin{bmatrix} y_t \\ z_t \end{bmatrix}, \qquad \Gamma_0=\begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix}$$

$$\Gamma_1=\begin{bmatrix} \gamma_{11} & \gamma_{12} \\ 21 & \gamma_{22} \end{bmatrix}, \qquad \epsilon_t=\begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$$

Premultiplication by B^{-1} allows one to obtain the model in standard form:

$$x_t = A_0 + A_1 x_{t-1} + e_t$$

where,

$$A_0 = B^{-1}\Gamma_0$$
$$A_1 = B^{-1}\Gamma_1$$
$$e_t = B^{-1}\epsilon_t$$

This information can be used to rewrite the structural VAR into the standard form VAR:

$$y_t = a_{10} + a_{11}y_{t-1} + a_{12}z_{t-1} + e_{1t}$$

$$z_t = a_{20} + a_{21}y_{t-1} + a_{22}z_{t-1} + e_{2t}$$

There are important differences to note between the structural equations and the standard form equations. First, the standard form equations lack the contemporaneous value of the variables on the RHS. Second, the error terms are composites of the two innovations ϵ_{yt} and ϵ_{zt}, in that the contemporaneous effects of the time t value of the variables and the errors are encompassed in the structural VAR error term. A VAR analysis provides a

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way to analyze the variables as a system in which each time path of each variable has an effect on the contemporaneous value of all the other variables.

We used a vector error correction (VEC) model, which is a restricted VAR designed for non-stationary series that are cointegrated. The VEC has cointegration relations built into the specification so that it restricts the behavior of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. The cointegration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments (Eviews 4, 2000). The equation for a simple VEC can be written as:

$$\Delta y_t = \alpha_y (y_{t-1} - \beta z_{t-1}) + \epsilon_{yt}$$

$$\Delta z_t = \alpha_z (y_{t-1} - \beta z_{t-1}) + \epsilon_{zt}$$

The α's in both equations are speed-of-adjustment variables. The α_y in the first equation measures the speed of adjustment of the y variable toward equilibrium. In the same respect, the α_z in the second equation measures the speed of adjustment of the z variable toward equilibrium. This relationship is represented by the restricted coefficients of the cointegrating vectors. A cointegration test was run to determine the number of cointegrating relationships; Table 6.4 provides the results.

The Trace test indicates two cointegrating equations at the 5 percent level and one cointegrating equation at the 1 percent level. The max-eigenvalue test also indicates two cointegrating equations at the 1 percent level. The following equations show the restricted equations for Hong Kong (Table 6.5).

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Table 6.4 Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5% Critical Value	1% Critical Value	Max-Eigen Statistic	5% Critical Value	1% Critical Value
None**	0.496465	119.575	94.15	103.18	45.28269	39.37	45.1
At most 1*	0.427242	74.29236	68.52	76.07	36.78124	33.46	38.77
At most 2	0.21723	37.51112	47.21	54.46	16.375	27.07	32.24
At most 3	0.171164	21.13612	29.68	35.65	12.39034	20.97	25.52
At most 4	0.099413	8.745777	15.41	20.04	6.91076	14.07	18.63
At most 5	0.02742	1.835017	3.76	6.65	1.835017	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5% (1%) level

Table 6.5 Restricted Equations for Hong Kong (standard error)

1.0EXHKUS	- .006INTLR	+.008EXPORTS	+ .01IMPORTS	-.004M1	$=\epsilon_{HK1}$
	(.00082)	(.00235)	(.00281)	(.00256)	
1.0HIBOR	- 1.55INTLR	+ 8.86EXPORTS	- 4.04IMPORTS	+.43M1	$=\epsilon_{HK2}$
	(.62979)	(1.79878)	(2.14918)	(1.96187)	

If $\epsilon_{HK1} > 0$, the system is above equilibrium. To return to equilibrium, the variables EXHKUS, EXPORTS and IMPORTS should fall or the other two variables in the equation, INTLR or M1, should rise, or a combination of these movements could occur. In the speed of adjustment (Table 6.6), all variables except IMPORTS have the right sign, and IMPORTS is not significant. The combination of these variables returns the exchange-rate system to equilibrium, which in this case means returning the exchange rate to near the official rate.

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The second equation represents the money market adjustment process for the interest-arbitrage mechanism necessary to maintain the exchange-rate peg. Again, if $\epsilon_{HK2}>0$, then the system is above equilibrium. To clear the market, the variables HIBOR, EXPORTS and M1 should fall or the other variables in the equation, INTLR or IMPORTS, should rise, or a combination of these movements could occur. In the speed of adjustment table, HIBOR, EXPORTS, IMPORTS and M1 all have the right sign.

However, INTLR shows up with the wrong sign and is insignificant along with IMPORTS in the second equation. The combination of HIBOR, EXPORTS, IMPORTS and M1 seems to function properly and clear the market, but INTLR does not function properly to aide in facilitating interest arbitrage and clear the market.

VEC provides a way of combining the advantages of modeling both level (long-run) and differences (short-run). Speeds of adjustment are meant to capture the long-run relationship between the cointegrated variables. Table 6.6 shows the speed of adjustment of the exchange rate and the interest rate:

Table 6.6 Speeds of Adjustment for Hong Kong's System

Variable	Equation 1	Equation 2
D(exchange rate)	-0.17 (.09)	0.00001 (.00014)
D(interest rate)	213.55 (87.32)	-0.25 (.12)
D(international reserves)	12.75 (6.54)	-0.004 (.0097)
D(exports)	-20.19 (8.91)	-0.03 (.013)
D(imports)	-0.94 (6.39)	0.002 (.0094)
D(M1)	7.83 (3.88)	-0.02 (.0057)

Standard errors in ( )

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6.4: OLS Results for Argentina

An OLS model was used to estimate the Argentine system. The equations estimated under this technique included the same variables that were used to estimate Hong Kong's system. For a complete description of the OLS methodology see Gujarati (1995). Table 6.7 shows the results for the estimation of the Argentine system. An important result in the first equation is that the interest rate appears with the right sign and is significant. Exports also have the right sign but are insignificant. International reserves, imports and M1 all have the wrong sign and are insignificant. In the second equation, which estimates the interest-rate arbitrage component of the system, the only significant variable is the exchange rate, and it shows up with the right sign. International reserves and exports also show up with the right sign but are insignificant. Imports and M1 show up with the wrong sign and are insignificant.

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Table 6.7 Regression results for Argentina's system

	Dependent Variable	
Variable	**Exchange rate**	**Interest rate**
Exchange rate	-	-1043.65
	-	(156.34)
Interest rate	-0.0006*	-
	(8.35E-05)	-
International reserves	-0.003	-6.21
	(.003)	(4.68)
Exports	-0.0006	-3.35
	(.002)	(3.06)
Imports	-0.0005	-0.32
	(.003)	(4.02)
M1	-0.004	8.63
	(.006)	(8.05)

Standard error in ( )

6.5: Conclusion

For Hong Kong, we concluded that the six variables have a unit root and thus are integrated process I(1). In addition, evidence was found that these variables are cointegrated. The results above suggest that the money market is functioning as theoretically expected to return the market to long-run equilibrium. Therefore, the variables exhibit long-run integration with each other. Their variability therefore is fundamentally linked. The results are consistent with theory that hypothesizes that the interest-arbitrage mechanism corrects deviations between the market exchange rate and the official rate. The only variable that did not perform at theoretical expectations was the level of international reserves. Several factors may be responsible for the wrong sign on the level of international reserves. The main factor is most likely the unique arrangement that Hong Kong has with the note-issuing banks in that they actually control

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the level of international reserves in the interbank market. This factor could distort the functioning of the market in such a way that this variable appears to be functioning counter to theoretical expectations. Additionally, international reserves are influenced by the level of fiscal surplus or deficit and that information was not included in the analysis, and this could also explain the sign.

For Argentina, we concluded that the six variables in the system were not cointegrated. The results above suggest that the money market is functioning as theoretically expected to return the market to long-run equilibrium. However, several of the economic discipline variables were not functioning properly and this could be indicative of some of the problems of the Argentine system. The collapse of the CBA could be more a result of the lack of economic discipline in this system instead of the improper function of the CBA. The econometric results of this section suggest that Argentina's economic discipline problems (covered in chapter 5), such as large fiscal problems and insufficient international reserves, are most likely the cause of the collapse of the CBA, and not improper functioning of the interest-arbitrage mechanism.

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Chapter 7. Conclusion and Recommendations

7.1: Conclusion

From the case studies and the empirical statistical results obtained, a number of concluding remarks can be made:

- Hong Kong has successfully operated a CBA since 1983. Part of this success is a result of the proper functioning of the economic discipline component of the exchange-rate mechanism. The Hong Kong economy met most of the economic discipline preconditions that Mussa (2000) and others argued were important to maintain a fixed exchange-rate system. Hong Kong has a high level of international reserves by several measures, enjoys a large share of trade with the anchor in the area of exports and imports, and is a relatively open economy. The attainment of these preconditions has facilitated the functioning of the maintenance of the fixed exchange rate.

- The interest-rate arbitrage mechanism in Hong Kong is consistent with the empirical results. The theoretical understanding of the money supply and demand curves in the commercial bank and interbank markets provided the conceptual foundation from which it was possible to empirically estimate the functioning of the interest-rate arbitrage mechanism. The

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results of the empirical analysis strongly support the conceptual and theoretical understanding of the movements of the money supply and demand curves. The results of the empirical analysis provide concrete support for the understanding of this system and the success of Hong Kong.

- The Argentine system was plagued with numerous problems. The initial case study showed that many of the economic discipline preconditions fell short of the expectations of Mussa (2000) and others for successfully adopting a CBA. For example, the level of international reserves was inadequate to back the entire monetary base. The recent crisis and collapse of the CBA in Argentina is in part explained by the lack of adequate levels of the economic discipline preconditions and the improper functioning of the interest-rate arbitrage mechanism. The interest-rate arbitrage component in Argentina is not functioning properly to clear the money markets and effectively return the market exchange rate to the official rate. One could speculate that it is the cash arbitrage system in Argentina that may be providing assistance to the money markets to keep the rates close; however, this offers no long-term solution to sustaining the peg.

- Related to the previous points, this analysis has established an initial (and wide) upper and lower band of the components necessary to achieve a CBA. Replicating the success of a highly industrialized economy like

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Hong Kong may be difficult if not impossible for emerging economies. However, understanding the level of the components that make the CBA successful is crucial. In the same respect, understanding the levels of the same components that have created an unsuccessful CBA is also necessary to alert emerging economies to potential future problems. This information could also be used to predict success of a CBA, before a country establishes one. If the levels of the economic discipline preconditions and the interest-rate arbitrage components are more in line with the case of Argentina than Hong Kong, a CBA will most likely not be successful.

- The difference in the market exchange rate and the official exchange rate are greater in Hong Kong than in Argentina. This could be a result of the lack of the cash arbitrage system in Hong Kong, which makes micro-adjustments to the exchange rate. The cash arbitrage system, however, is not strong enough to maintain the fixed exchange rate without the presence of the interest-rate arbitrage mechanism. This speculation is supported by the theoretical discussion of Tsang (1999).

7.2: Recommendations

Faced with the issues explained above, I recommend the following possible policies to guide emerging economies in the adoption of a currency board arrangement:

1. Prior to establishing a CBA, the level of each economic discipline precondition should be measured and the functioning of the interest-rate

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arbitrage component should be understood. The experience and performance of the CBA in Hong Kong can be used as a road map for emerging economies to follow. Emerging economies do not have to replicate the performance of the CBA in Hong Kong, but what this analysis has provided is an indication of the level of the economic discipline and interest-arbitrage components necessary to successfully operate a CBA. Comparisons can now be drawn between the level of functioning of the interest-rate arbitrage mechanism in new CBA's and can help to guide policy to ensure that the CBA continues to operate successfully. In the same respect, the experience of Argentina can be used as a guide to dangers of an ailing system. The failure of the Argentine system also provides useful insights for emerging economies.

2. Ensure that the commercial banking system is operating properly. Interest rate arbitrage is possible only if the commercial bank and interbank systems are running efficiently. An unsound banking system is sure to create a situation in which the CBA is unsustainable, especially as interest rates adjust to defend the peg. Many emerging economies may have unsophisticated banking systems that can still facilitate interest-rate arbitrage, as long as the system is sound. Bank practices must be closely monitored to decrease the probability of risky behavior by banks that could jeopardize their ability to complete financial intermediation. The interbank market must also be able to provide liquidity in that market, which may require intervention on the part of the monetary authority. In the short-term, this may require some type of

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discount window or other facility to ensure that banks in a liquidity crunch can receive a last-minute loan.

3. Ensure that many of the economic discipline preconditions can be met. Create fiscal policies that are consistent with supporting the rule-bound nature of the CBA. Fiscal policy is one of the few tools that will be available to manipulate the macroeconomy. Fiscal policy must be flexible and sustainable and not overburdened by debt or corrupt policies. Under the currency board system, fiscal surpluses are used to bolster international reserves, which are essential to the exchange-rate maintenance process. Furthermore, fiscal policy actions can manipulate most of the other variables in the economic discipline section, which makes this precondition especially important in the success of a CBA. Policies to increase labor-market flexibility and decrease unemployment without increasing government debt will improve the possibility of success of a CBA in emerging economies.

4. It is important that the anchor country is chosen wisely. The anchor should be a major trading partner that suffers the same types of shocks. The exchange rate link binds these countries in a way that emphasizes the importance of trade and macroeconomic shocks.

5. Estimate the cash arbitrage system. The purpose of this dissertation is to estimate the role of the interest-arbitrage component of the exchange-rate mechanism, since it is the workhorse of exchange-rate stabilization. Estimating the cash arbitrage system is outside the scope of this analysis.

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Despite the poor performance of the Argentine system, the cash arbitrage system hypothetically aided in maintaining a market rate similar to the official rate. Estimation of the cash arbitrage system could yield additional information that could facilitate a more optimal functioning of the CBA.

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THE APPENDIX

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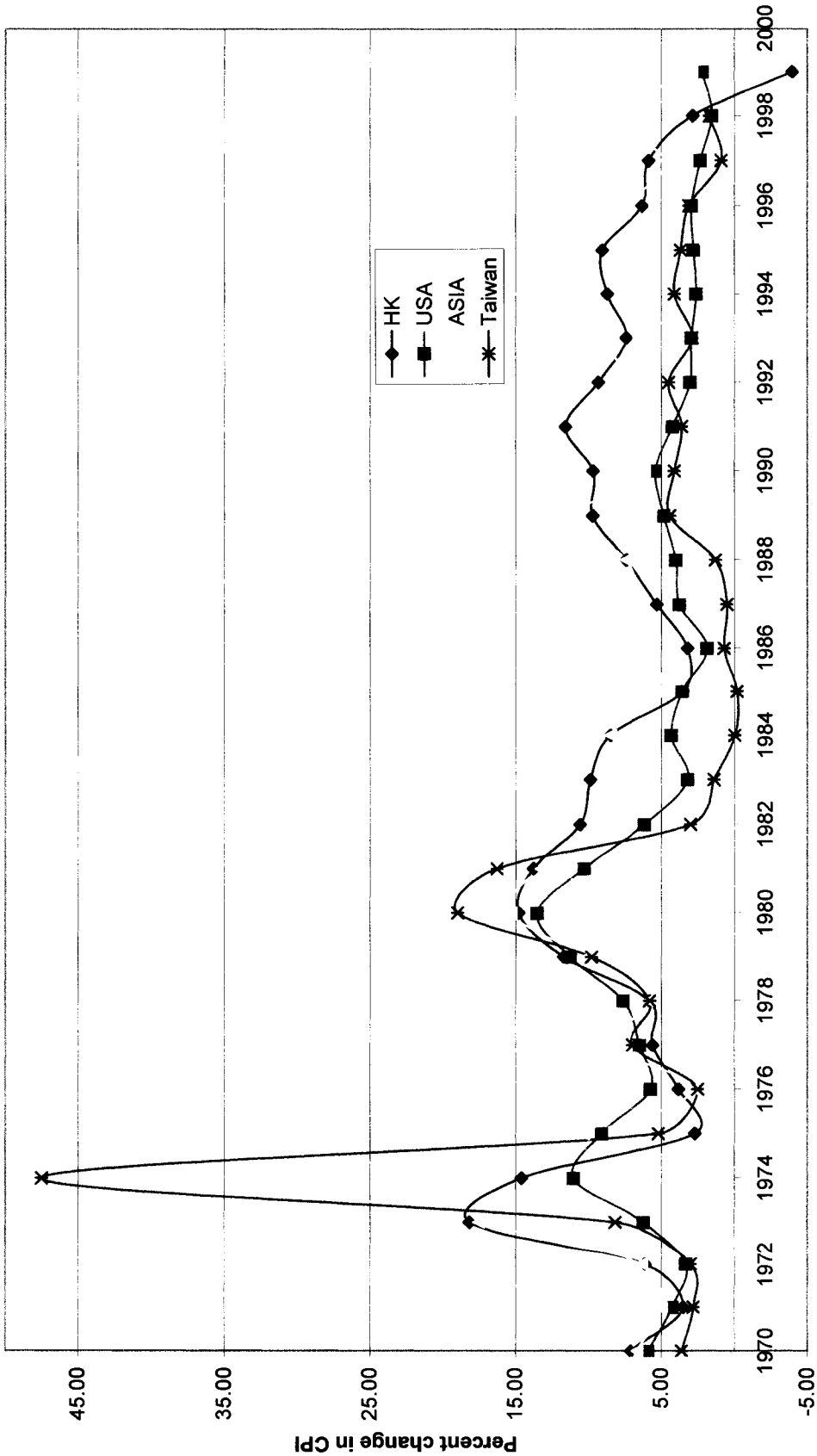

Figure 4.1 Inflation for Hong Kong, USA, Asia and Taiwan

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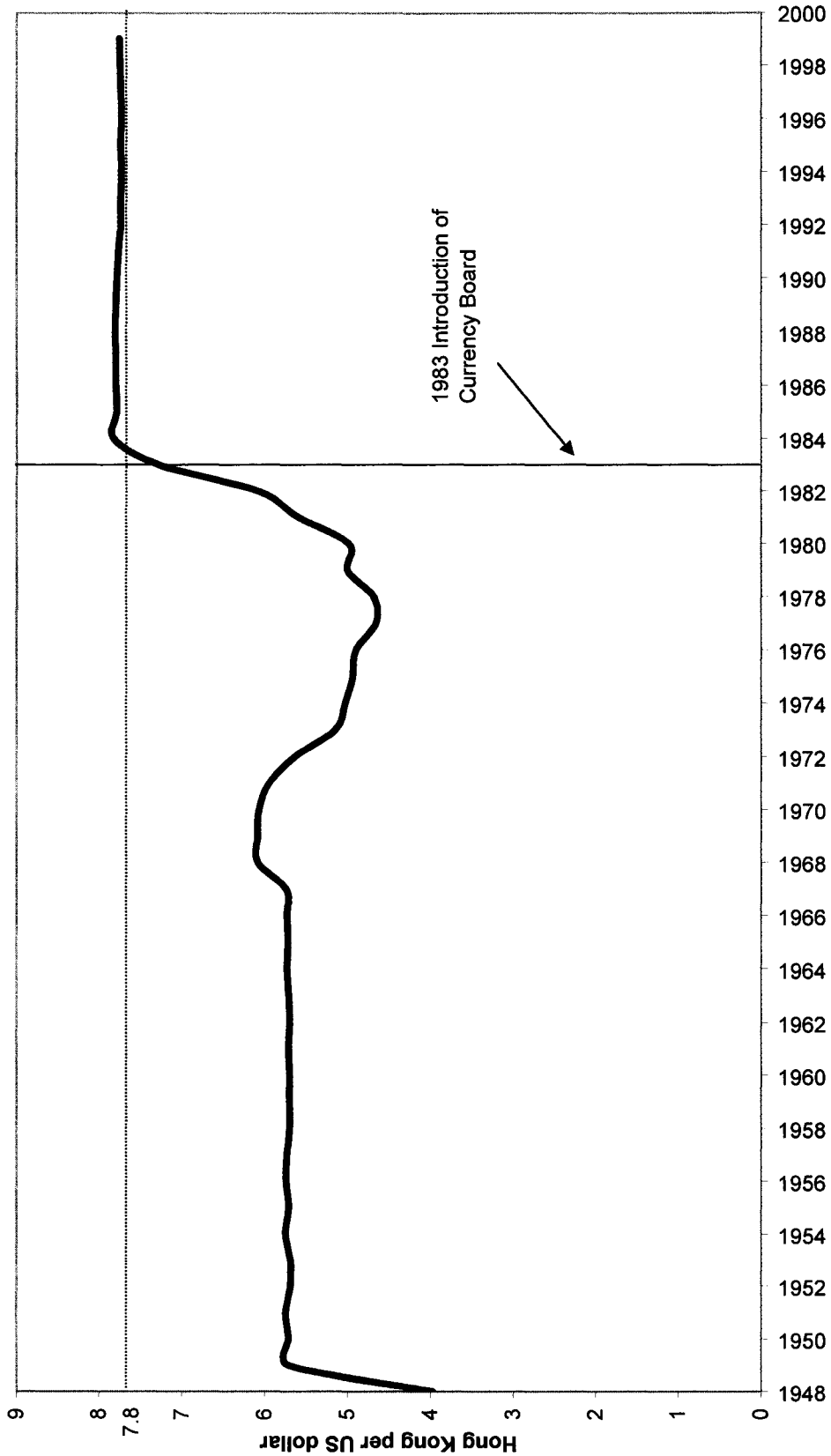

Figure 4.2 Market Exchange Rate for HK$ & US$

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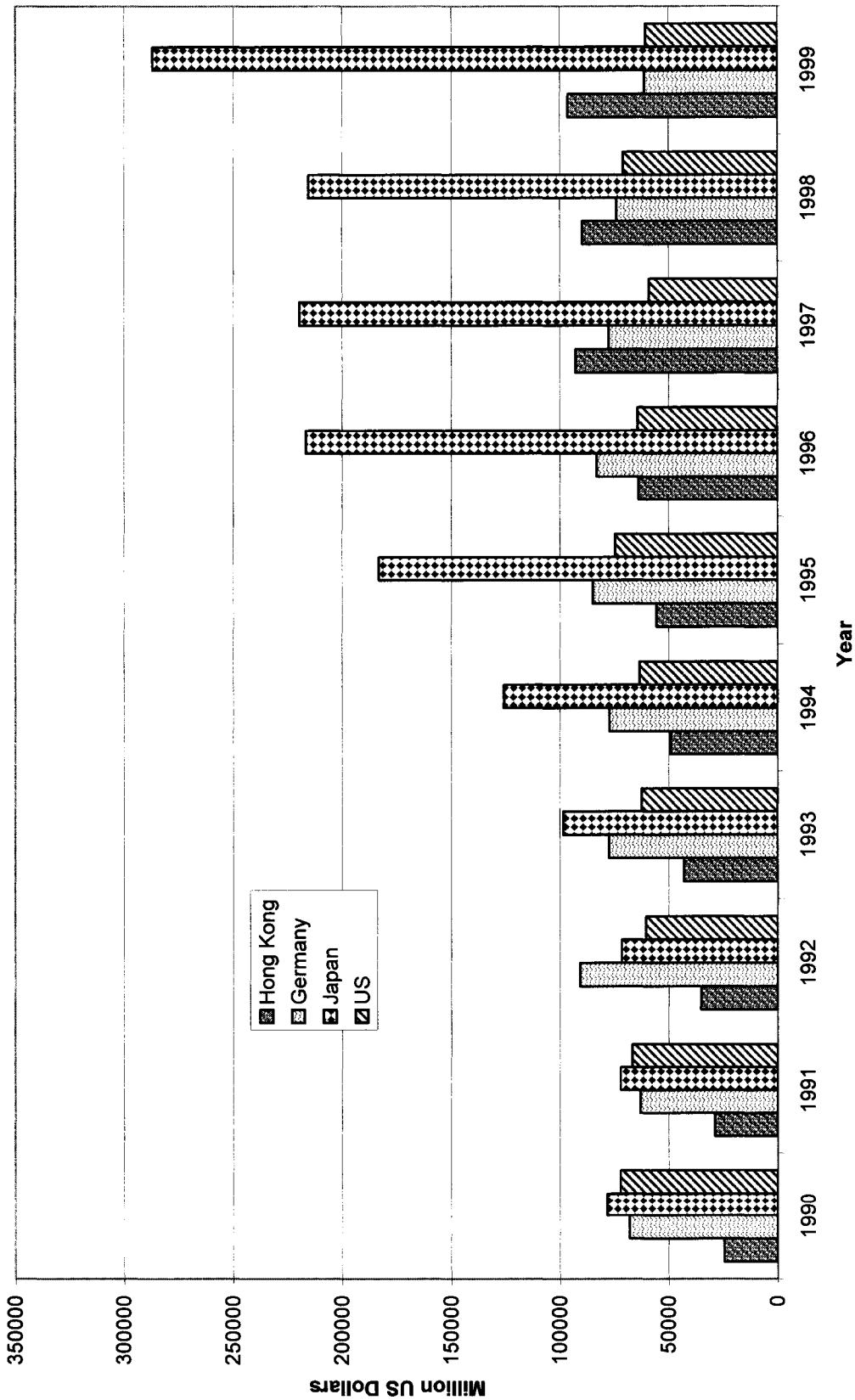

Figure 4.3 Total International Reserves for Selected Countries, 1990 to 1999

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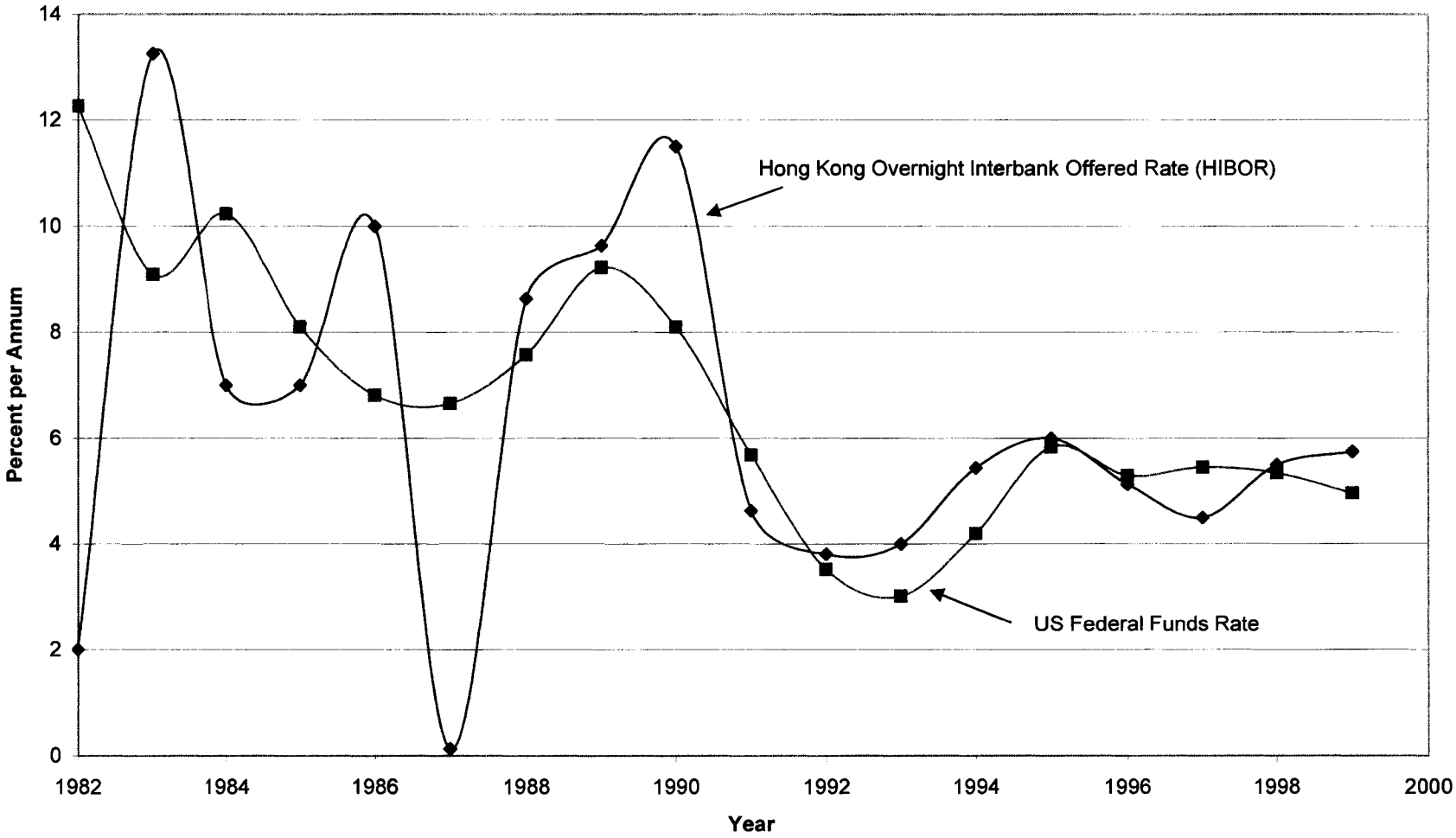

Figure 4.4 Comparison of Interest Rates in Hong Kong and the US, 1983 to 1999

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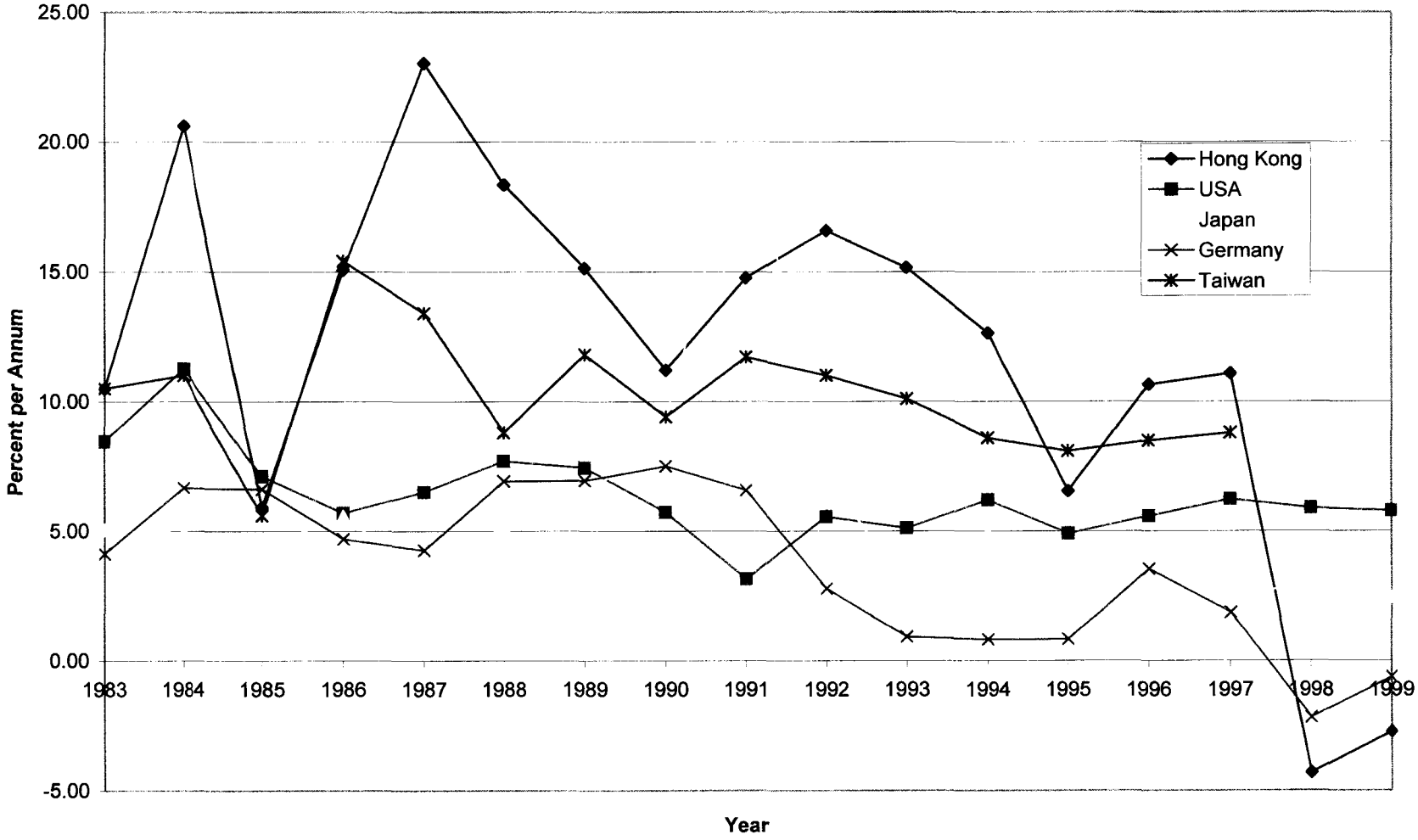

Figure 4.6 Growth Rate of Nominal GDP for Selected Countries

Table 4.6 Share of Trade with the United States in Million US dollars

	Exports				Imports			
Year	Total	US	% of total	Rank	Total	US	% of total	Rank
1978	11126	3490	31%	1	12536	1605	13%	3
1979	14668	4144	28%	1	15929	2068	13%	3
1980	19720	5157	26%	1	22399	2653	12%	3
1981	21816	6056	28%	1	24768	2589	10%	3
1982	20893	6040	29%	1	23444	2538	11%	3
1983	21949	7069	32%	1	24005	2638	11%	3
1984	28314	9405	33%	1	28558	3121	11%	3
1985	30182	9301	31%	1	29701	2815	9%	3
1986	35438	11108	31%	1	35360	2980	8%	3
1987	48473	13511	28%	1	48463	4141	9%	3
1988	63182	15689	25%	2	63900	5302	8%	3
1989	73113	18505	25%	2	72149	5933	8%	3
1990	82143	19817	24%	2	82482	6653	8%	3
1991	98578	22391	23%	2	100274	7576	8%	3
1992	119532	27583	23%	2	123430	9128	7%	3
1993	135005	31159	23%	2	138596	10271	7%	3
1994	151393	35179	23%	2	161770	11565	7%	3
1995	173546	37851	22%	2	192764	14882	8%	3
1996	180526	38369	21%	2	198551	15658	8%	3
1997	187870	40949	22%	2	208623	16200	8%	3
1998	173693	40700	23%	2	184602	13767	7%	3
1999	173793	41502	24%	2	177108	12897	7%	3

Source: Direction of Trade Statistics and Asian Development Bank

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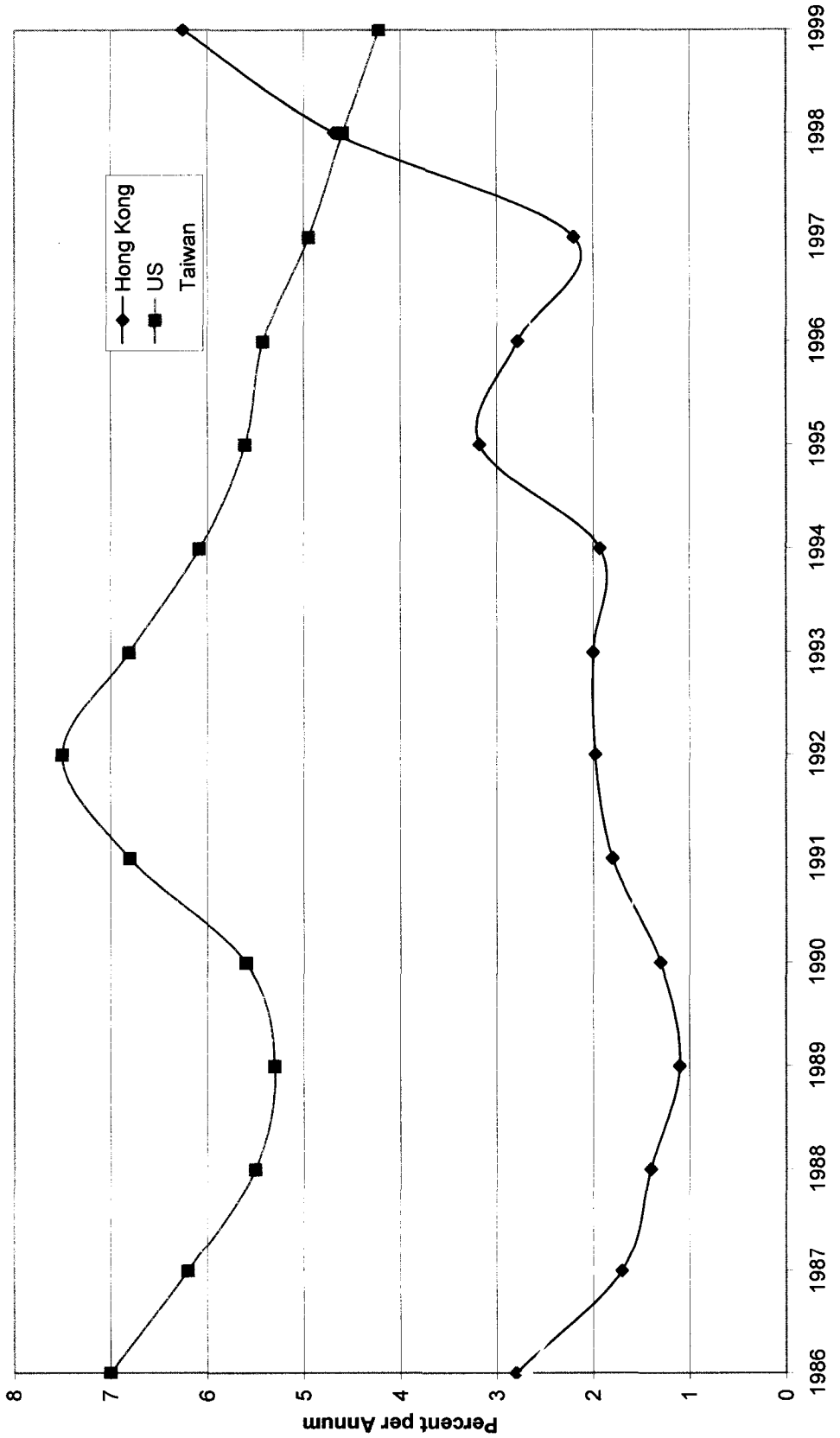

Figure 4.7 Unemployment Rates in Hong Kong, Taiwan and the US

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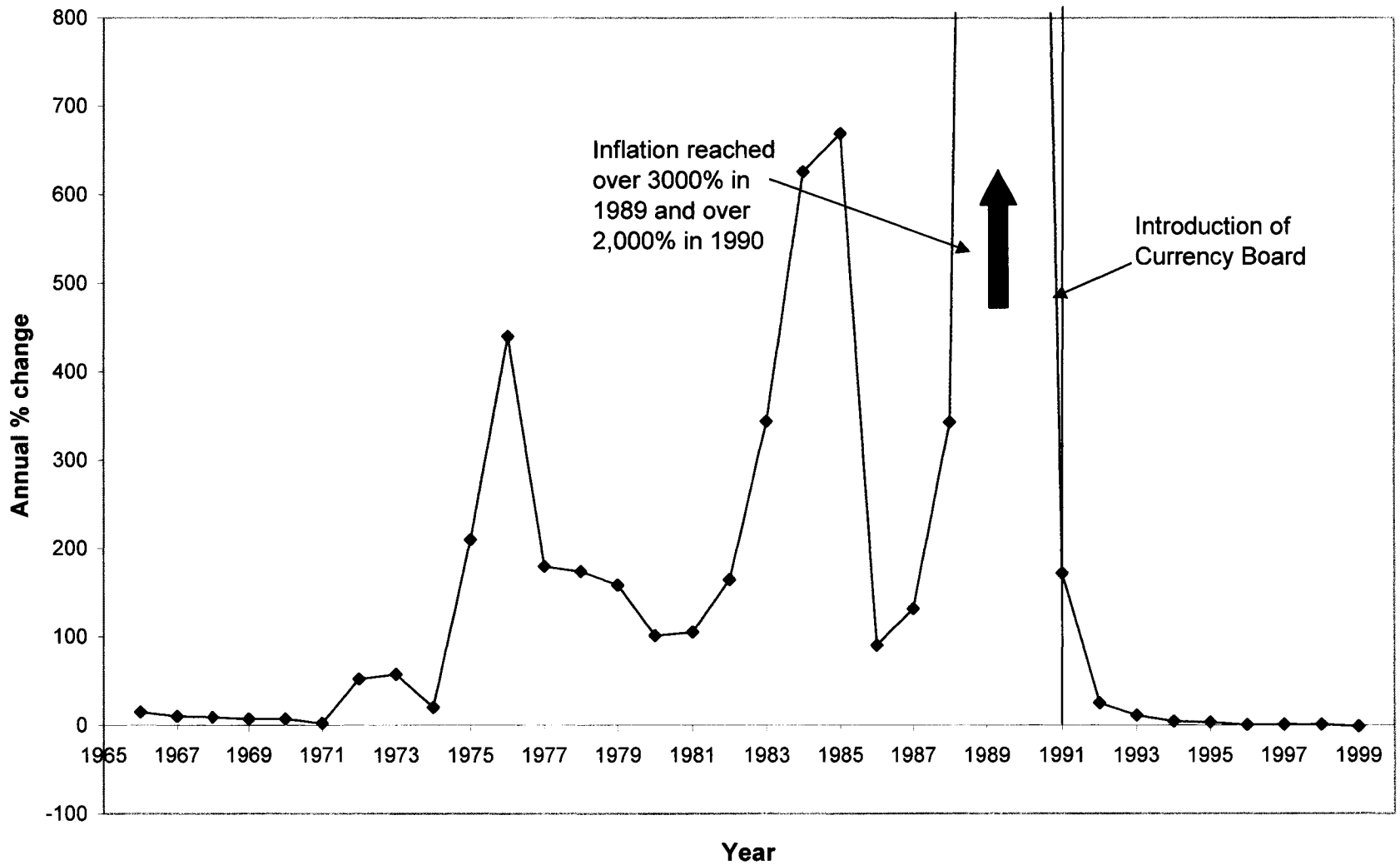

Figure 5.1 Argentina Inflation, 1966 to 1999

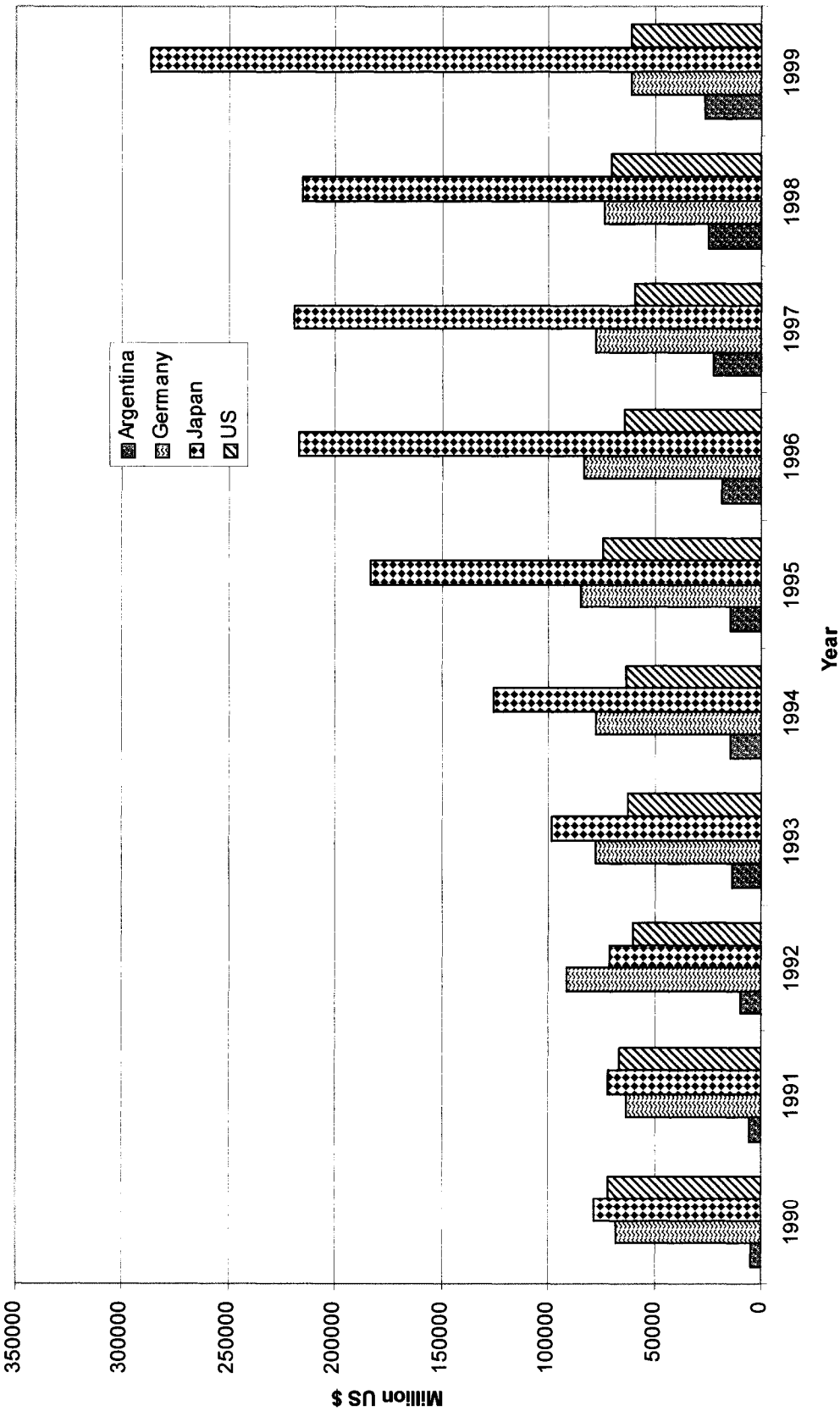

Figure 5.2 Argentina's Total Reserves Minus Gold, 1990 to 1999

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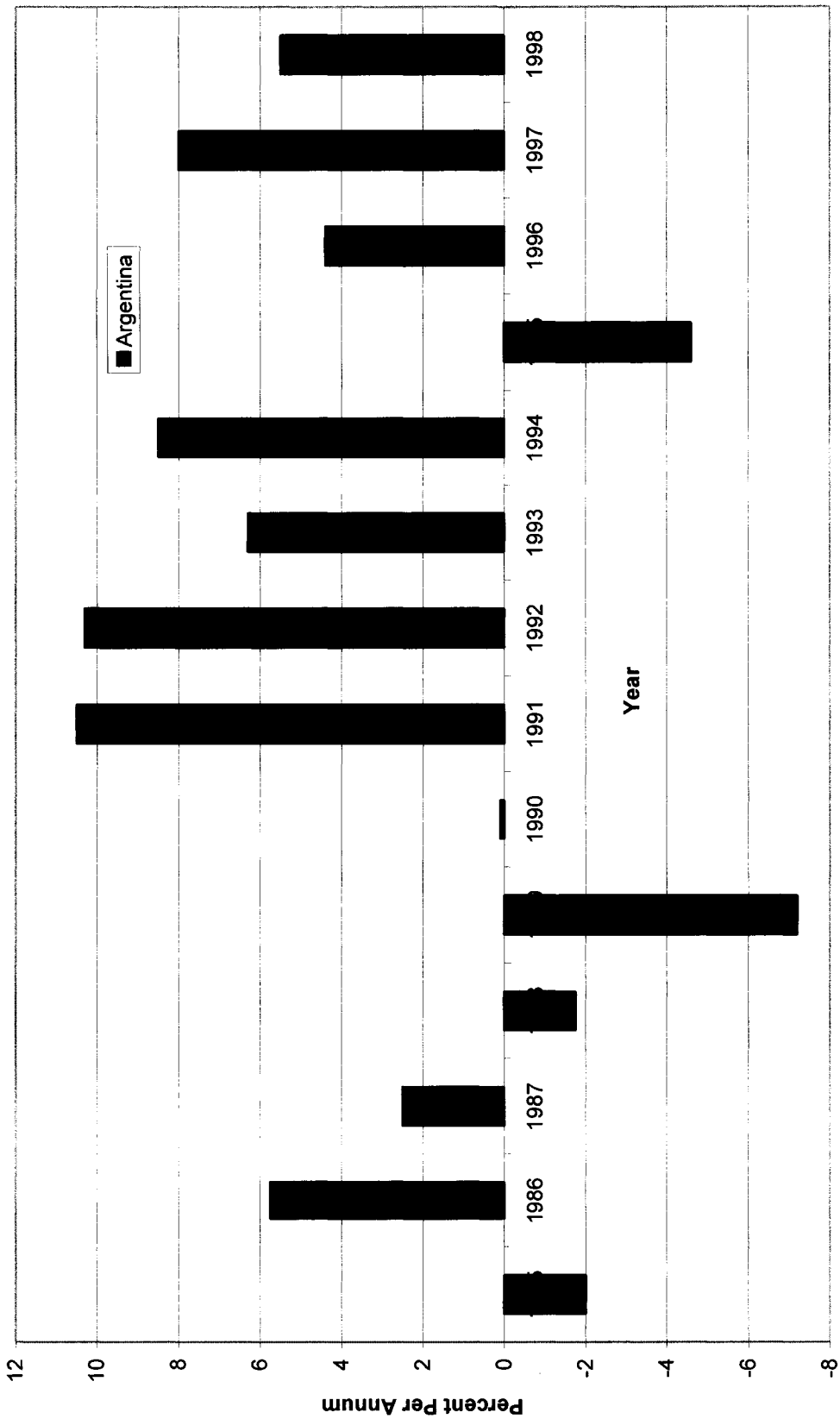

Figure 5.3 Real GDP Growth in Argentina

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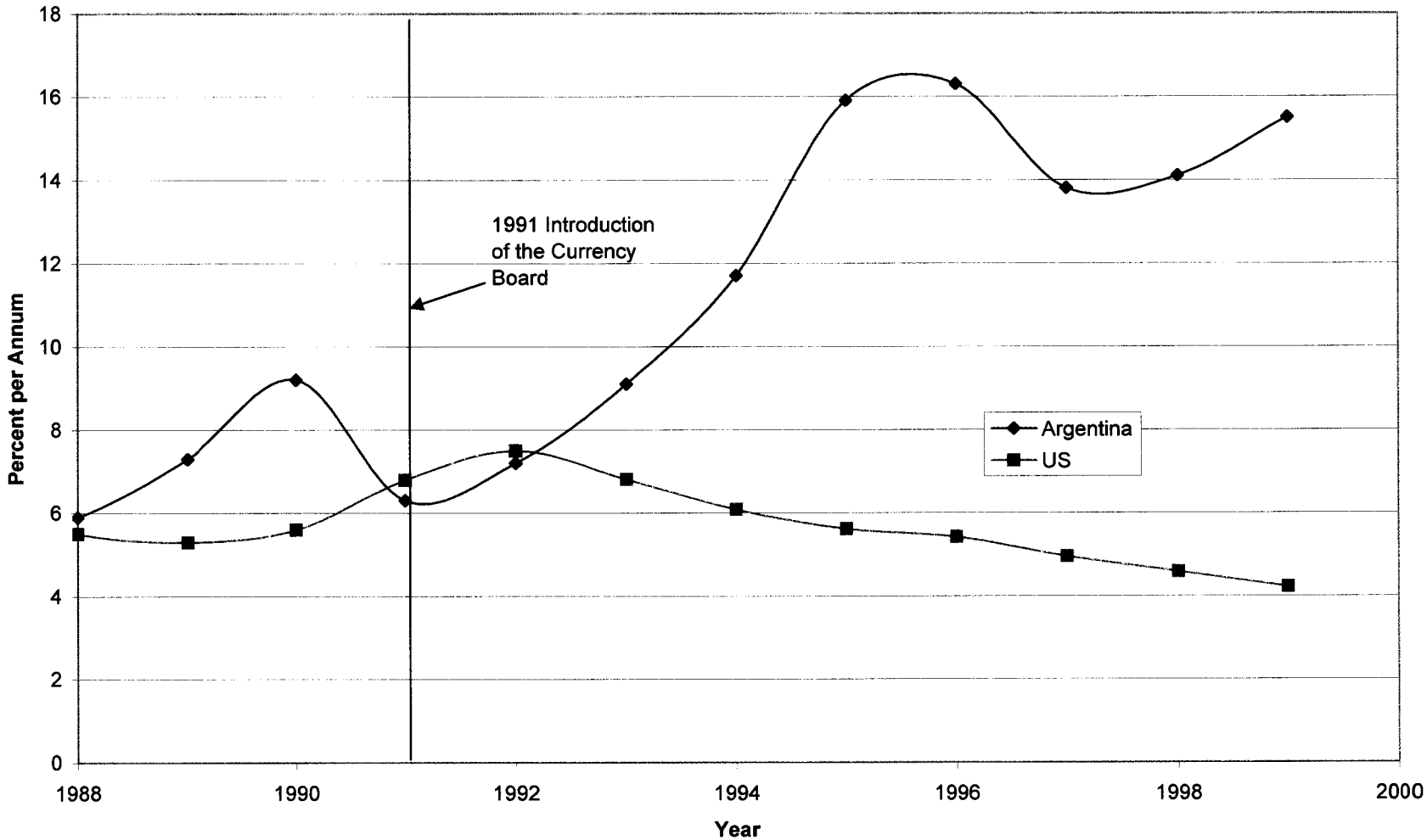

Figure 5.4 Unemployment in Argentina and the US, 1986 to 1999

Table 6.1 Comparison of Hong Kong and Argentina

Precondition	Hong Kong	Argentina
Involvement in Capital Markets	High	na
International Reserves (as % of GDP**)	43%	6%
International Reserves (as % of M1**)	306%	97%
Openness	Very Open	Closed
Commerical Bank Soundness (interest rate similar to anchor)	Yes	Yes
Similar Shocks as Anchor	Yes	No
Size	+	+
Trade Share (Exports*)	1	1
Trade Share (Imports*)	2	1
Fiscal Policy Flexibility(deficit/surplus as % of GDP**)	1.52%	-1.13%
Labor Market Flexibility (unemployment rate**)	2.50%	12%

*Index ranging from 1 to 3 according to the share of trade with
anchor country 1=1st or 2nd partner; 2 = 3-6 partners; 3 = >6 partners
**Average over CBA or other relevant period

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Table 6.3a Results of the ADF and PP tests on Quarterly Data for Argentina

Panel A Level

						Critical Values					
		ADF		PP		Intercept			Trend & Intercept		
Variables	Lags	Intercept	Trend & Intercept	Intercept	Trend & Intercept	1%	5%	10%	1%	5%	10%
xrate	2	-6.42	-6.06	-9.89	-8.15	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	3	-12.44	-12.73	-11.44	-9.34	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	4	-3.19	-3.46	-12.74	-10.34	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	5	-4.97	-5.11	-13.94	-11.27	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	6	-120.91	-113.32	-15.07	-12.14	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
Interest rate	2	-620255.5	-5842984	-339436	-365239	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	3	-3952686	-4135996	-321481	-346971	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	4	-3.7	-3.89	-311308	-337405	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	5	-3.98	-4.11	-304817	-332037	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	6	-3.38	-3.29	-300366	-329070	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
Exports	2	-0.7	-2.49	-0.96	-3.04	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	3	-0.17	-1.97	-0.86	-2.96	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	4	0.032	-2.34	-0.93	-2.98	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	5	0.015	-2.75	-0.92	-2.93	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	6	0.003	-3.35	-0.9	-2.87	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
Imports	2	-2.48	-1.45	-2.64	-1.61	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	3	-2.45	-1.58	-2.73	-1.56	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	4	-4.67	-3.1	-2.77	-1.54	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	5	-4.62	-3.29	-2.85	-1.5	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	6	-4.61	-3.31	-2.94	-1.47	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
Intlr	2	-3.95	-3.66	-3.64	-4.37	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	3	-4.79	-3.64	-3.88	-4.38	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	4	-2.73	-1.66	-3.94	-4.38	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	5	-1.91	-1.76	-4.05	-4.39	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	6	-1.9	-1.7	-4.06	-4.4	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
M1	2	-5.69	-6.66	-13.42	-9.53	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	3	-3.35	-4.13	-17.51	-12.92	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	4	-3.62	-3.6	-14.38	-10.68	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	5	-1.55	-1.89	-15.86	-12.31	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2
	6	-2.15	-1.86	-14.48	-11.31	-3.5	-2.9	-2.6	-4.1	-3.5	-3.2

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Panel B First Difference

Test		xrate	Interest	exports	imports	intlr	M1	Critical Values 1%	5%	10%
ADF	Intercept	-11.28	-15.87	-5.54	-4.36	-5.88	-4.64	-3.5	-2.9	-2.6
	Trend & Intercept	-10.6	-17.44	-5.53	-4.9	-6.75	-3.87	-4.1	-3.5	-3.2
PP	Intercept	-15.48	-15.6	-8.71	-6.89	-8.64	-5.48	-3.5	-2.9	-2.6
	Trend & Intercept	-15.55	-16.51	-8.81	-7.53	-9.74	-6.63	-4.1	-3.5	-3.2

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