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FINANCIAL LIBERALIZATION AND ITS IMPACT ON INTEREST RATE DETERMINATION: A CASE STUDY OF THAILAND

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAI'I IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ECONOMICS MAY 1995

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TO MY PARENTS

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throughout these years. Special thanks to Mr. Manabu Fujimura, my best friend, who always gave me encouragement whenever I needed.

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ABSTRACT

The main objectives of this study are to empirically investigate the determinants of the domestic interest rate in Thailand after the regulated interest rate ceilings have been removed since July 1989, and to test whether the deregulations of foreign exchange controls had significant impacts on the degree of openness (capital mobility) of the Thai financial market.

The model of the interest rate proposed here is modified from that of Edwards and Khan (1985), which is specified as a weighted average of domestic factors such as the expected inflation, money surprises, and the government budget, and foreign factors such as the foreign interest rate, and the expected change in the exchange rate. The weight is an index measuring the degree of financial openness which can be varied over time during the liberalization period. The study deals with several empirical issues, including seasonal adjustment, unit root and cointegration tests, and proxies for unobserved variables (expected inflation and money surprises). Possible problems of serial correlation and endogeneity bias associated with the cointegration regression are also corrected so that the asymptotically efficient estimation and valid inferences about the coefficient estimates of the long-run cointegration regression can be done. Finally, the recursive least squares estimation and dummy variables are used to test for parameter
constancy of the estimated model of domestic interest rates.

Major findings are as follows. The nominal domestic interest rate is I(1) while the expected rate of inflation is I(0). Thus they cannot be cointegrated, implying that the Fisher equation for the case of Thailand during the interest rate liberalization period did not hold. The nominal domestic interest rate is, however, cointegrated with the foreign interest rate (both adjusted and unadjusted by the forward premium), and the government budget surplus. The long-run level of the domestic interest rate is mainly determined by the foreign interest rate although money surprises have some significant impact in the short-run. The degree of capital mobility of the Thai financial market (the interbank market) found in this study is approximately .7. It increased gradually over time after the first deregulation of foreign exchange controls in May 1990.
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CHAPTER 1
INTRODUCTION

1.1 Scope and Objectives of the Study

Since the publications of McKinnon (1973) and Shaw (1973), financial liberalization has been regarded as a significant policy measure for economic development. An increasing amount of literature on financial liberalization has dealt with a variety of issues such as the correlation among real interest rates, saving, investment, and economic growth, the relation between financial intermediation and economic growth, and the effect of financial liberalization on money demand. In general, empirical evidence indicates that there is a positive correlation between economic performance and the degree of development of the financial sector, particularly the degree to which the interest rate is market-determined, in developing countries. (Edwards and Khan, 1985; Fry, 1988; Gonzales, 1988; World Bank, 1989; Laumas, 1990)

This finding has prompted the authorities in a number of such countries, including Thailand, to liberalize their financial markets during the 1980s.

Nevertheless, there is a dearth of literature on the subject of how interest rates are determined once the financial sector is liberalized. The concern on this issue has been highlighted by the experience of the countries of the Southern Cone of Latin America where interest rates increased
to remarkably high levels after the liberalization. In addition, many studies (for example, Gochoco, 1989; Edwards and Khan, 1985) suggest that high and volatile world interest rates have been transmitted to developing countries due to their more or less open capital markets. In Thailand, the comprehensive financial reform, including the removal of interest rate ceilings, the relaxation of foreign exchange controls, and the deregulation of financial institutions, was formally introduced in 1989. Has Thailand experienced the same pattern of interest rate movement as other liberalized developing countries? Did the liberalization measures significantly loosen the Thai capital market or was the Thai capital market opened before the liberalization? What are the determinants of domestic interest rates in the competitive market? The main objective of this study is to empirically test these issues by the development of a nominal interest rate model for Thailand. The recently developed technique, called "Cointegration", is employed in the estimation procedure. The method to correct for possible problems of serial correlation of the errors and endogeneity biases of the regressors in the cointegrating regressions are applied so that the asymptotically efficient estimation and inferences can be done.

1.2 Organization of the Study

The rest of the dissertation is organized as follows.
Chapter 2 provides general background on the Thai economy, financial system, exchange rate regime and the conduct of monetary policy since 1970. Chapter 3 discusses the objectives, areas, and the chronology of the comprehensive financial reform during the period of 1989-1993. Chapter 4 reviews the previous studies on interest rate determination and presents a model of interest rates for a developing country after the financial sector has been liberalized. The model takes into account the degree of openness of the capital account so that it can allow for the influences of foreign factors on domestic interest rates. Chapter 5 deals with empirical issues such as proxies for unobserved variables in the model (expected inflation, money surprises, and expected exchange rate changes), seasonal adjustment procedure, unit root and cointegration tests, and the estimation methods. Chapter 6 provides the results of the asymptotically efficient estimations of the long-run equilibrium cointegration equations, including short-run dynamic movement of the domestic interest rate, the tests of parameter constancy and the implications on the degree of financial openness. Chapter 7 includes conclusions and limitations of the study, policy implications, and suggestions for further research.
CHAPTER 2
GENERAL BACKGROUND ON THE THAI ECONOMY, FINANCIAL SYSTEM, EXCHANGE RATE REGIME, AND THE CONDUCT OF MONETARY POLICY

2.1 Overview of the Thai Economy since 1970

To give a general idea about the Thai economy, this section discusses the country's economic performance in terms of economic growth, internal and external stability during the last two decades.\(^1\) The discussion is divided into five sub-periods: 1970-1972 (the period preceding the first oil shock), 1973-1979 (the period during both oil crises), 1980-1984 (the period of external instability and baht devaluations), 1985-1989 (the period of economic boom), and 1990-1993 (the period of comprehensive financial reform).\(^2\)


Prior to this period, from 1961 to 1969, the Thai economy had performed very well. The average economic growth rate was 8.1% per annum. The inflation rate averaged 2.2% and the current account deficit was less than 1% of GDP. (see Table 1 in the appendix) The stability of the economy was partly

\(^1\) The country's internal and external stability are measured in terms of appropriate level of the inflation rate and the ratio of current account deficit to GDP, respectively. (Kirakul, 1994)

\(^2\) Materials in this section came mainly from Sriaroon (1993) and various issues of the Bank of Thailand Annual Economic Report.
due to the favorable international environment. Nonetheless, during 1970-1972 the Thai economy slowed to an average growth rate of 5.2 \% per year. The current account deficit increased to 2.3 \% of GDP owing to a decline in export prices of about 8 \% per year. Although export prices increased slightly in 1972, agricultural production declined because of adverse weather conditions.

2.1.2 The Period of 1973-1979: Oil Crises, Internal and External Instability

This period started with a worldwide shortage of primary goods, which pushed up inflation. The situation became worse when the oil prices jumped four fold in 1973. Since imported oil was the most important source of energy, Thailand experienced a high inflation rate of 15.5 \% in 1973, and 24.3 \% in 1974. Fortunately, investment demand and production in the industrial sector held up. Moreover, the rise in import value as a result of severe increase in oil price was more than offset by a rise in export value due to commodity price boom. Thus, the current account deficit was only 0.5 \% of GDP during 1973-1974. Although economic growth during subsequent period of 1975-1978 was still as high as 8.6\% per year, the current account deficit became larger and amounted to 4.3 \% of GDP. The factors that contributed to this large deficit were the withdrawal of American military bases from Thailand, resulting in a large reduction of U.S.'s spending in Thailand, and an expansionary government budget deficit.
In 1979, Thailand experienced high inflation again due to the emergence of the second oil shock and the increase in the domestic minimum wage rate. As a result, the cost of production increased dramatically, further increasing the inflation rate to 9.9%. Economic growth slowed down to 5.3% and current account deficit rose to 7.6% of GDP.

2.1.3 The Period of 1980-1986: External Instability

The impact of the second oil shock on domestic prices still existed, inflation rates were as high as 19.7% and 12.7% in 1980 and 1981 respectively. In addition to the oil crisis, the restrictive monetary policies in the industrial countries to curb inflation and trade protectionism resulted in a severe current account deficit of 7.1% of GDP in 1981. To improve the current account balance, the government devalued the baht twice in 1981. However, the impacts of these devaluations on the current account lasted only one year. The current account deficit increased from 2.7% of GDP in 1982 to 7.1% of GDP in 1983. This brought about a third devaluation in 1984. (see more discussion on the baht devaluation in section 2.3.1) Despite the external imbalance, Thailand experienced high economic growth rates of 7.3 and 7.1 percent and achieved lower inflation rates of 3.8 and 0.9 percent in 1983 and 1984 respectively. The main reasons are as follows: first, the agriculture sector expanded considerably due to the favorable climate and high commodity prices in 1983, and second, an increase in domestic investment.
as a result of a stable cost of production. The country, however, experienced an economic slowdown during 1985-1986 to an average growth rate of 4.2%, the lowest rate in the decade. The inflation rate remained low at 1.9% in 1986 because of low petroleum prices.

2.1.4 The Period of 1987-1989: The Economic Boom

The economy started to recover in 1987 and enjoyed double digit growth rates for three consecutive years. These high growth rates were spurred by the expansion of non-agricultural production at rates of 11.8, 13.9, and 13.1 percent in 1987, 1988, and 1989 respectively. It is believed that the country experienced a structural change during this period. (Kangwanpornsiri, 1993) Investment expenditure as well as exports grew at dramatically high rates, exceeding 25 percent. However, the value of imports also increased, and at a much faster rate, inducing a large increase in the trade deficit. Fortunately, the trade deficit was significantly offset by a surplus in the services and transfer accounts which rose substantially due to the increase in income from tourism. The current account deficit was, therefore, relatively low. The balance of payments recorded a huge surplus because of a net capital inflow, especially from foreign direct investment which increased sharply in 1988 by more than 500 percent. (Sriaroon, 1993, p.54)

In sum, the country's economic boom during this period was a result of several important factors. First, the
realignment of major currencies starting in February 1985 greatly benefitted Thai exports as the value of the baht, which was mainly fixed to U.S. dollar, weakened steadily against the yen and major European currencies. Second, the relocation of investment from Japan and Asian NIEs to Southeast Asia countries, including Thailand, due to the increasing value of the yen and cheap labor costs in these countries. Third, the recovery of major crop prices since 1987. (Jitsuchon, 1991) In addition to these factors from abroad, a critical element of adjustment policies that helped Thailand’s remarkable economic performance during this period was the sustained improvement in public sector finances. The government budget deficit averaging 7 % of GDP at the beginning of the decade had turned to a surplus of over 4 % of GDP by the end of the 1980s. (Robinson, et.al., 1991)³


Despite the extraordinary performance of the Thai economy, there were some problems related to external and internal instability in 1990. The consumer price index increased to 6 % from the previous year because of the increase in income from real estate and security speculation

³ Although this turnaround was certainly facilitated by the buoyant revenue growth associated with vigorous economic expansion since 1987, the shift in public sector finances was more than just cyclical and involved conservative policies plus fundamental changes in expenditure control and in the budgetary process.
as well as a shortage in construction materials. The current account deficit rose sharply to 8.9% of GDP, mainly due to a slowdown in exports, an over 40% increase in the value of oil imports resulting from the Persian Gulf crisis, and the increase in interest payments and dividend remittances. Economic growth in 1991 decreased slightly, however, the country's stability in terms of inflation and the current account deficit improved from the previous year. The pace of economic expansion moderated further in 1992 in response to a slowdown in the world economy, to domestic political instability namely "the May Incident", and to the implementations of important monetary and fiscal measures during the first half of the year. The decline in domestic demand and the prices of imported oil and raw materials resulted in a lower inflation rate and an improvement in the current account deficit.

The Thai economy performed more strongly in 1993, at the growth rate of 7.8%, despite an unfavorable world economy, which included continuing recessions in Japan and in the European Community, and the emergence of new exporting competitors such as China and Vietnam. The pick-up in domestic expenditures did not exert much pressure on inflation, which declined to 3.3%, and the current account deficit fell further to 5.5% of GDP. Note that towards the end of the year, the financial system experienced remarkably high liquidity as a result of large capital inflows, due
mainly to an increase in portfolio investment, in non-resident baht deposits, and the issuance of new debt instruments.

Government budget surpluses have declined since 1992, due to the introduction of several fiscal reform measures such as the reduction in personal and corporate income taxes, the restructuring of tariffs on capital goods, and the replacement of business taxes by a value-added tax. These reforms, together with the slowdown in economic activity and tariff revenue, adversely affected government revenue. Government expenditures, on the other hand, expanded to restructure government wages and salaries, and to speed up investment in the infrastructure which had been delayed.

Thailand's annual economic growth, saving and investment rates, inflation, (ex-post) real and nominal interest rates, and nominal exchange rates during the periods of 1960-1991 are shown in figure 1, 2, 3, 4, and 5 in the appendix.

2.2 Financial System

2.2.1 Financial Institutions

Beside the Bank of Thailand (BOT), as the central bank, the Thai financial system consists of 29 commercial banks (15 domestic and 14 foreign banks), 94 finance and securities companies, 18 credit foncier companies, 12 life insurance companies, 18 credit foncier companies, 12 life insurance

4 One of the fifteen domestic banks, namely "Krung-Thai Bank", is owned by the government. Note that the government took over one financially trouble commercial bank, "Asia Trust Bank", (later renamed as "Sayam Bank") in 1984 and merged its assets with those of Krung-Thai Bank in 1987.
companies, 357 pawnshops, and a substantial number of agricultural cooperatives and savings cooperatives.\(^5\) (BOT, 1990) There are also several specialized financial institutions whose purposes and functions are explicitly indicated by their names. They are the Government Savings Bank (GSB), the Bank for Agriculture and Agricultural Cooperatives (BAAC), the Government Housing Bank (GHB), the Small Industries Finance Office (SIFO), and the Industrial Finance Corporation of Thailand (IFCT). Only the IFCT is privately owned, the others are owned by the government.

Commercial banks are the most important among the different types of financial institutions. They form the largest group in terms of total assets, total financial savings mobilized, and total credits extended. (see Table 2, 3, and 4) At the end of 1990, the commercial banking sector accounted for 70 percent of total financial assets in the system. Out of 29, 15 are local Thai banks which have extensive branch networks accounting for more than 95 percent of bank assets, and 14 are foreign banks which, are subject to a number of restrictions, accounting for only 5 percent.\(^6\) Currently, the banking system is highly concentrated. The five

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\(^5\) Credit foncier companies mainly provide loans for immobile properties such as land and houses.

\(^6\) Foreign banks are disadvantaged, compared to domestic banks, in the following ways: they are prohibited from opening new branches, being subsidiaries of parent companies, and are ineligible for the lower corporate tax rate. (Robinson, et.al, 1991, p.20)
largest domestic banks: Bangkok Bank, Krung Thai, Thai Farmers, Siam Commercial, and Thai Military, account for about two-thirds of total bank assets.

Finance and securities companies, which hold about 14 percent of total financial assets, are the second largest group of financial institutions. They are not allowed to offer checking accounts, so they obtain funds mostly through the issuance of promissory notes (with higher interest rates than those offered by commercial banks on their deposits) and through borrowing from commercial banks. Finance and securities companies emerged originally in the early 1960s as affiliates of commercial banks either to provide services that the parent bank could not undertake directly or to engage in higher-margin but higher-risk consumer finance. Their activities are short-term finance, hire purchase, underwriting and security trade, and other investment and advisory services.

The remaining financial institutions account for about 15 percent of the total financial assets in the system. Chief

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7 However, the financial reform package introduced in the early 1990s allowed commercial banks to engage in some activities previously preserved only for finance and securities companies. On the other hand, some activities previously preserved for only commercial banks, such as foreign exchange business, are now permitted for some finance companies that demonstrate sound management with an adequate capital base. (see details of deregulation of financial institutions in Chapter 3) This is to widen the scope of business of these financial institutions toward a universal type of banking system to promote competition and efficiency within the system.
among these are government-owned specialized institutions (mentioned above) which hold about 10 percent of total financial assets.

In addition, the Thai financial system also consists of a substantial "unorganized" (or non-institutionalized) sector. This sector includes all the financial transactions which do not go through organized or legally-recognized financial institutions. Such transactions include lending by private money-lenders, operation of the so-called "pia-huay" (or "rotating credit pools"), operation of private borrowing and lending among acquaintances with no formal contracts, etc.

Based on the 1980 Household Savings Survey conducted by the Bank of Thailand, it was estimated that about 16% of total household savings and 40% of total household borrowing belonged to the unorganized sector. However, in recent years the unorganized sector has diminished mainly because the access to the organized financial sector has been opened up as a result of increasing competition among financial institutions, and people have been more aware of the high risk of fraud prevalent in the unorganized sector. (BOT, 1990, p.3)8

The structure of the organized financial system in Thailand discussed above is shown in chart 1 in appendix.

8 See more detailed discussion of informal financial sector in Chandavarkar, A.G. 1987, "The Informal Financial Sector in Developing Countries: Analysis, Evidence, and Policy Implications", SEACEN Occasional Papers No.2
2.2.2 Financial Markets

Traditionally, financial markets can be broadly classified into two categories on the basis of maturity of different financial instruments. They are the money market, consisting of financial instruments with maturities of less than one year, and the capital market which includes both equity and non-equity (debt-instrument) markets. However, business and industrial sectors in Thailand have relied heavily on direct loans and overdrafts from commercial banks more than any other source of funds.  

To emphasize the importance of credits within the Thai financial system, and to avoid the difficulty of identifying short-term and long-term credits, it is more appropriate to define a credit market (which mainly includes direct loans, overdrafts, bills discounted, and leasing) separately from the above two markets. (BOT, 1990) The classification of financial markets in Thailand is shown in chart 2.

Financial instruments available in the money market are checking deposits, saving and time deposits, promissory notes issued by finance and securities companies, transferable certificates of deposits (TCDs), Treasury bills, repurchase

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9 At the end of 1989, loans and overdrafts account for about 42.8 and 28.9 percent of total commercial bank credits respectively. (BOT, 1990, p.32)

10 Short-term credits, especially overdrafts, are often rolled over such that they become long-term.
agreements, commercial bills, and interbank loans.\textsuperscript{11} Long-term instruments available in the capital market are stocks issued in the equity market, long-term bonds which have been issued only by the government and government enterprises, debentures, and floating rate notes. Treasury bills and government bonds, which are mainly held by BOT and commercial banks to satisfy legal reserve requirements, have recently been in short supply due to the government's sizable fiscal surplus.

The only active money markets are the interbank and the repurchase markets. The BOT operates the repurchase market in Thai government bonds as a mean of influencing liquidity in the banking system. All bids and offers of reserves are made in the market each morning, the BOT can choose to satisfy the short end of the market in whole or in part, or to leave unsatisfied bids or offers. Any unsatisfied or surplus of liquidity can be addressed by individual banks in the interbank market in the afternoon. The BOT does not intervene

\textsuperscript{11} The interbank loan market, sometimes called the "call loan" market, involves short-term (from one day to six months) lending between banks through the excess reserve deposited at the Bank of Thailand. Normally, large Thai banks are lenders while other small Thai banks, foreign banks, and finance companies are borrowers. The interbank market is similar in concept to the Federal Funds market in the U.S.

The repurchase market, which was established in 1979, is an alternative way that commercial banks can obtain short-term liquidity in addition to the interbank market, the treasury bill market, the Bank of Thailand's loan window, and the foreign money market. It also serves as a channel through which the Bank of Thailand can conduct its open market operations.
in the interbank market. (Easterly and Honohan, 1990) The other money markets and long-term debt instrument markets are very shallow, and secondary markets are almost nonexistent. This is mainly due to the absence of an active market in government paper and the legal restrictions on the issuance of long-term debt by corporations. In contrast, the stock market, founded in 1975, has grown steadily since recovering from a crash in 1979, with the ratio of market capitalization to GDP increasing from less than 4 percent in 1980 to 29 percent in 1990. (see Table 5)

2.3 Exchange Rate System and the Foreign Exchange Market

2.3.1 Brief review of exchange rate system and policies

Since 1970, Thailand has adopted five exchange rate regimes in different periods as follows: (Ganjarerndee and Sriphayak, 1987)


After the Second World War till the beginning of 1978, the value of the baht was effectively tied to the value of gold or the U.S. dollar at 20.80 baht per dollar. Under this

12 The primary market for commercial bills, though still small, has been growing very rapidly from the amount of 2.4 million baht in 1985 to 17.2 million baht in 1990. (see Table 5)

13 Only the companies that are listed or approved by the Securities Exchange of Thailand (SET), and companies awaiting acceptance for their securities to be listed on the SET, are allowed to issue long-term debt. This restriction, however, was relaxed by the Securities and Exchange Act promulgated in early 1992.
system, the Exchange Equalization Fund (EEF) determined the U.S. dollar rates at which it would buy from and sell to commercial banks. The Thai Bankers' Association then determined the rates applicable to any exchange transactions between commercial banks and their customers. During these periods, the government adjusted the value of the baht three times as follows:

- The baht was devalued in terms of gold, against non-US dollar currencies at the same rate as the devaluation of the US dollar by 7.89 percent on May 9, 1972 as a result of the Smithsonian Agreement and by 10 percent on April 10, 1973 when the floating exchange rate system was initially in effect in the U.S. This was a period of world monetary crises, and the break down of the gold standard exchange rate system. The objective of these two devaluations were simply to maintain the parity of baht and US dollar, at 20.8 baht per U.S. dollar, since US dollar formed the majority of Thailand’s foreign exchange reserves.

- On July 15, 1973, however, the baht was revalued against the US dollar by 4 percent from 20.80 baht to 20.00 baht per dollar when major currencies in Europe floated upward against the US dollar resulting in a depreciation in the real value of baht. Thus, the objective of this revaluation was to restore the real value of the baht vis-a-vis other currencies to its previous level.

b) Baht Pegged to a Basket of Currencies: March to
November 1978

On March 8, 1978 the Thai Currency Act was amended to be in line with the IMF agreement, which ended the fixed parity system. The baht was tied to a basket of currencies, i.e., a weighted average of the currencies of Thailand's major trading partners, including the US dollar, the Pound sterling, the Deutsche mark, the Japanese yen, the Singapore dollar, the Malaysian dollar (ringgit) and the Hong Kong dollar.

c) The "daily" fixing system: November 1978 - July 1981

Under this system which was introduced on November 1, 1978, the dollar rate was determined every day partly by the demand for and supply of foreign currencies suggested by delegates from commercial banks, and partly by the intervention of EEF to maintain an orderly market conditions. The U.S. dollar fixing rate was used as the base rate at which transactions between commercial banks and customers were conducted. Buying and selling rates applicable to customers' transactions in six other currencies were determined on the basis of the cross rates between the fixing rate for the U.S. dollar and the exchange rates of the currency concerned in the international markets.

On May 12, 1981, the government devalued the baht by 1.08 percent, from 20.775 baht to 21.00 baht per dollar. The main reason for this devaluation was the appreciation of US dollar due to the prevailing high interest rate in the United States during that period. On July 15, 1981, the baht was devalued
again by 8.7 percent, and the exchange rate jumped from 21 baht to 23 baht per dollar.

d) **Baht Pegged to the U.S. Dollar: July 1981-November 1984**

After the two devaluations, the value of the U.S. dollar in the international foreign exchange market continued to be high, thus forcing the EEF to release an unusual amount of dollars into the market. To promote the country's financial stability as well as to relieve the trade and payment problems, the daily fixing system was terminated in July 1981. Under the new system, the EEF was solely responsible for the determination of the U.S. dollar rate and offered to buy and sell an unlimited amount of U.S. dollars at the fixed rate of 23 baht per U.S. dollar.

e) **Baht Pegged to a Basket of Currencies: November 1984 to the present**

After maintaining a fixed exchange rate against U.S. dollar for three years, the continuous appreciation of the U.S. dollar abroad caused the Thai authorities to further devalue the baht by 14.8 percent from 23 baht to 27 baht per dollar on November 8, 1984, and changed the exchange rate system by pegging the Baht to a basket of currencies at the same time.

Under this system, the baht was again linked to a basket of the seven currencies mentioned above. The Baht's parity against these currencies fluctuated according to their
performances. For example, due to the recently dominant position of Japan in Thailand's external trade, the yen has been weighted as heavily as the US dollar. Apart from the weighted basket index, two other factors: the short term domestic foreign exchange supply/demand situation and the country's long term balance of payments position, were also taken into consideration. The Exchange Equalization Fund (EEF) can intervene in the market by determining the value of the baht occasionally when necessary.

The movement of nominal exchange rate, defined as a domestic price of U.S. dollar, during 1970-1990 is shown in graph 5.

2.3.2 Structure of the Thai Foreign Exchange Market

Participants in the Thai foreign exchange markets can be classified into four groups. First, the authorized agents which are commercial banks and money changers, including hotels and giftshops whose business are limited to buying and selling foreign currency notes and coins, and buying travelers' cheques. Second, customers, mainly consisted of importers, exporters and borrowers. Third, brokers who act as intermediaries in the interbank foreign exchange market. Fourth, the Exchange Equalization Fund (EEF) which was established in 1955. Its main function is to maintain the stability of the baht through the determination of the daily exchange rates. (Suwanmana, 1992)

The transactions among these participants can be divided
into three sub-markets as follows. First, the market between commercial banks and their customers is the biggest segment. Second, the interbank market helps reduce the surplus or compensate the shortage which arises from the transactions between each commercial bank and its customers. Its purpose is not only to serve the customer's needs but also to help commercial banks to manage their foreign assets and liabilities. And the last, consists of transactions between commercial banks and the EEF. Commercial banks will transact with the EEF only when they cannot match their needs in the interbank market, i.e., the EEF acts as the lender of last resort to commercial banks.

2.4 Overview of the Conduct of Monetary Policy

2.4.1 Monetary Targets

The objective of the Bank of Thailand in conducting monetary policy is to achieve economic growth and economic stability, both internal and external, which are measured in terms of the desired level of inflation and the ratio of current account deficit to GDP. To accomplish these ultimate goals, the Bank of Thailand uses multiple monetary targets as intermediate targets for the conduct of monetary

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14 According to the seventh national social and economic plan, the desired level of economic growth, inflation, and current account deficit per GDP are 8.2, 4.2, and 5.2 percent respectively.
policy.\(^{15}\) These targets are a money supply (both M1 and M2) target, a domestic credit target, and a monetary base target. (Wibulswasdi, 1986)

Since money supply (\(M^s\)) is linked to monetary base (MB) through the following relationship: \(M^s = m \times MB\) where \(m = \) money multiplier, the BOT can achieve the money supply targets by controlling the monetary base (or high-powered money) if the money multiplier is constant. This is true for the case of Thailand because factors which determine the money multiplier: currency-checkable deposits ratio, excess reserves ratio, and required reserve ratio, have been relatively stable. (Leemakdej, 1991)\(^{16}\) The monetary base can be defined from two sides of the Bank of Thailand’s balance sheet. In the asset side, monetary base consists of net foreign assets at the BOT, net credit from the BOT to government, and credit from the BOT to financial institutions. In the liability side, monetary base consists of currency in circulation, and deposits (reserves) of commercial banks at the BOT. To control the movement of monetary base, the authorities have relied on the BOT’s credit to commercial banks (which is the largest component of credit to financial institutions) since it is the only component that can be readily influenced

\(^{15}\) General criteria for choosing an intermediate target are measurability, controllability, and predictability (stable relation) of the target. (Mishkin, 1992, p.448-450)

\(^{16}\) See the derivation of the determinants of money multiplier in Mishkin (1992), p.344-351.
through day-to-day operations. For other components, their movements are largely beyond control of the BOT's short term monetary operations.\textsuperscript{17} Therefore, the BOT's credit to commercial banks is considered as an operating target. The authorities also use the movement of monthly interbank rates as an indicators of short-term liquidity condition in the banking system so that they can efficiently decide whether or not to intervene in the market in order to achieve monetary targets. (Easterly and Honohan, 1990)

2.4.2 Monetary Policy Instruments

Monetary policy instruments which the Bank of Thailand uses can be divided into quantitative (control of reserve money) and price measures (interest rate policy). (Kirakul, 1994)

a) Control of Reserve Money

To influence the availability of commercial banks' credit, the BOT uses the following types of instruments: the loan window, the refinance facility, the repurchase market, and reserve requirements.

The BOT influences transactions in the loan window by varying loan rates (bank rates) as well as setting a ceiling

\textsuperscript{17} Movement of net foreign assets component is determined by balance of payments factors and commercial banks' foreign exchange portfolio behavior while movement of net credit to government follows typical pattern once the fiscal and monetary authorities, at the beginning of fiscal year, manage to agree upon size of budget deficit and deficit financing process.
for each commercial bank’s access to the facility.\textsuperscript{18} Commercial banks can borrow through the loan window by putting government bonds as collateral and showing that they have no alternative source of funds, however, this facility is limited in duration (within 7 days) and generally at a penalty rate, i.e., higher than other money market rates. The refinance facility is designed to allocate financial resources to priority sectors by providing credits to commercial banks against their promissory notes at preferentially low interest rates.\textsuperscript{19} This is essentially a development financing function of the BOT. In 1989, this scheme was changed to improve the distribution of financial assistance (which was heavily skewed toward large exporters) and to lower the direct subsidy provided.\textsuperscript{20}

Open market operations in the repurchase market are the primary instrument of monetary policy. The market is conducted as a daily (Dutch) auction where participants, mainly commercial banks, generally bid for (sell government bonds and

\textsuperscript{18} "The bank rate" is the lending rate that the BOT charges commercial banks when borrowing through loan window.

\textsuperscript{19} Currently, the priority sectors eligible for refinancing are exports (which accounts for 90 percent of the total), manufacturing, agricultural production, the wholesale trade of agricultural products, and rural development.

\textsuperscript{20} The amount that commercial banks could borrow from the BOT out of the amount of commercial banks’loans extended under this scheme was lowered from 60-100 percent to 50 percent. At the same time, the preferential rates charged by commercial banks to customers was raised from not more than 7 percent to not more than 10 percent a year, while refinancing interest rates remained at 3-5 percent depending on the sector.
promise to buy back within certain period) or offer reserves (buy government bonds and promise to sell back) at a single interest rate. By netting the bids and offers, the BOT arrives at the net deficiency (excess demand) or surplus (excess supply) in which it can choose to satisfy or leave uncovered. In other words, it can choose to act either as a dealer, matching the lenders and borrowers in the market and charging commission fee (.001% of the transaction values) without intervention, or to intervene as a broker. (Kirakul, 1994) If the market-determined interest rate, in the view of the BOT, is too low, then it will also bid for reserves by selling additional bonds, leaving the market with unsatisfied demand for reserves (excess supply of bonds) at the end of the operation. The interest rate will therefore rise. The deficit banks may make up their deficit in the interbank market, without the BOT’s intervention, or eventually at the loan window. On the other hand, if the BOT thinks that the market-determined interest rate is too high, it will offer reserves by buying bonds from the deficit banks, leaving surplus banks with unsatisfied offers of reserves. The interest rate will thus go down as a result of intervention. (Easterly and Honohan, 1993)

Nevertheless, the authorities sometimes find it difficult to conduct a monetary policy (control money supply) through the open market operation (intervention) and at the same time try to keep the value of the Baht fixed to the U.S. dollar.
For example, an attempt to tighten money supply by open market sales of government bonds will result in a rise in domestic interest rates. If the financial market is relatively open, higher level of domestic interest rates, compared to the world interest rate will induce capital inflows. The value of the Baht tends to appreciate as a result. If the authorities wish to maintain the value of the Baht at a fixed exchange rate, they will buy foreign currencies. This will cause an increase in money supply and lower interest rates, offsetting the initial attempt of a tight monetary policy. However, the authorities may pursue a sterilized intervention by conducting additional open market sales of government bonds to keep the level of money supply as originally planned. (Chaiyasoot, 1992) Due to the recent strength of capital inflows in 1987, the BOT issued its own bonds and used them in these operations to sterilize the impact on domestic money supply. (Robinson, et.al, 1991)

In addition to the above instruments, the BOT imposes several reserve requirements on commercial banks and finance companies. First, the basic reserve requirement to hold an amount equivalent to 7% of total deposits in the form of deposits with the BOT (at least 2%), government securities (up to 2.5%), and vault cash (up to 2.5%). Second, to be eligible for the award of new branch licenses, commercial banks must satisfy a separate ratio, namely 16% of total deposits to be invested in eligible securities which includes government,
state enterprises, and IFCT bonds. Third, the local lending requirement, each bank branch established outside Bangkok must lend at least three-fifths of its deposit resources locally, i.e. in its own or adjacent provinces. These requirements are sometimes seen as forms of assured and fairly inexpensive finance for the government, rather than monetary control instruments. (Easterly and Honohan, 1990) Therefore, they have been gradually removed as parts of the comprehensive financial reform since the beginning of the 1990s. (see Chapter 3)

b) Interest Rate Policy

In the past, the authorities set ceilings on maximum interest rates for both commercial bank’s deposits and loans, and adjusted them according to liquidity conditions. These interest rate ceilings, however, have been gradually eliminated since 1989. At the present time, the BOT can only influence short-term interest rates in the money market through the bank rate and the repurchase rate. To determine the appropriate level of interest rates for the conduct of monetary policy, the authorities take the following three important factors into consideration. First, interest rates on deposits should be high enough to induce saving. Second, interest rates on loans should not be so low that credit demand becomes excessive nor so high that lending for investment is depressed. Third, with respect to capital
movements, domestic interest rates should not differ much from foreign interest rates. (Wibulswasdi, 1986, p.30)

In summary, the Thai monetary authorities use the above instruments to achieve operating and intermediate monetary targets which are closely linked with the desired level of economic goals. The connection can be shown below:

**Instruments → Operating Targets → Intermediate Targets → Goals**

- Loan window → The BOT's
- Repurchase credit to → Monetary Base
- Open Market operations → commercial banks
- Refinancing facility
- Reserve Requirements → GDP growth
- M1, M2 money → Inflation
- Monetary Base → Balance of Payments
CHAPTER 3
THE COMPREHENSIVE FINANCIAL REFORM
DURING THE PERIOD OF 1989 - 1993

3.1 Objectives/Reasons for Financial Reform

There were many factors, both domestic and foreign, that prompted the Thai authorities to formally introduce the financial liberalization program in the late 1980s.

The domestic factors were as follows: First, the rapid growth of the Thai economy since 1987, which averaged 10.5 percent per annum, created a need for more efficient domestic saving mobilization to keep up with the larger investment. (see Table 1) The second factor involved problems and constraints in the financial system such as a high concentration in the financial industry, small and shallow money and capital markets (nearly non-existent secondary markets), and the shortage of a financial infrastructure. These problems are mainly due to legal restrictions such as the laws governing financial institutions which strictly separate the scope of business among different types of financial institutions, government bond holding requirements for local lending and new bank branch openings. By phasing out these requirements, the authorities would be able to not only induce more efficiency in the financial system, but also facilitate the development of a transparent and active secondary market in government bonds. (Kiriwat, 1992)
third factor was the readiness of the country, in terms of strong fiscal and international financial positions, to liberalize. The government cash balance has been in surplus since 1988 and amounted to 5.2% of GDP in 1991. (see Table 6) In addition, the level of international reserves has increased tremendously from US$ 2,688.6 million in 1984 to US$ 18,416.4 million in 1991. (see Table 7)

In addition to domestic factors, pressures for liberalization also arose from abroad. The forming of various trade blocs, e.g. the Single European Market, NAFTA as well as GATT, has developed pressure on many countries, including Thailand, to deregulate their financial system. Furthermore, the globalization of the financial system has accelerated the rate at which Thailand undertook liberalization programs to increase the efficiency of domestic financial institutions. (Prukhamroong, et.al., 1994) Lastly, the movement toward market-oriented systems of the Indochinese countries has generated a great potential for Thailand to become a regional financial center because of its advantages in geographical position and a strong economy.

3.2 Areas and Measures of the Financial Reform

To enhance competitiveness, flexibility and efficiency of the financial system, the authorities initiated a comprehensive financial reform plan in 1989. It encompasses
four broad areas as follows: (Kiriwat, 1992; Wibulswasdi and Tanvanich, 1993)

3.2.1 Deregulation of the Financial System

Several regulations imposed on financial institutions since the periods of financial distress in the early 1980s have become obsolete and have hindered the current modernization process. The authorities consequently removed these legal barriers and allowed market forces to play a bigger role. The deregulation includes three major areas:

a) Interest rate liberalization has proceeded gradually, starting from the removal of interest rate ceilings on time deposits with a maturity more than one year in June 1989. The interest rate ceilings on short-term time deposits and saving deposits were subsequently eliminated. By June 1992, all interest rate ceilings, including lending rates, had been removed. The interest rate liberalization measure is aimed at enabling financial institutions to compete in a market-oriented environment and encouraging efficient fund management. (Kangwanpornsiri, 1993)

b) Deregulation of foreign exchange controls can be divided into three stages. The first stage was the announcement of the official acceptance of the obligation under Article 8 of the IMF's Articles of Agreement in May 1990. In practice, the exchange control system has already been in conformity with Article 8 for many years before the announcement. There have been no restrictions on payments for
current account transactions and no discriminatory currency arrangements or multiple currency practices. Thus, the announcement merely served to provide the public with the concrete recognition of the government's confidence in the country's financial stability. (Wibulswasdi and Tanvanich, 1993, p. 18) Commercial banks can now approve applications for all types of current account transactions involving foreign currencies on behalf of the Bank of Thailand.

Most of the exchange controls were lifted in the second stage, which took place in April 1991. The remaining restrictions include outward transfer of foreign exchange by the residents for direct investment above a certain limit and for the acquisition of real estate and investment in stock markets abroad. Foreign funds, on the other hand, have been allowed to move in and out quite freely. These deregulation measures are aimed at encouraging external trade and foreign investment. On April 30, 1992, further modification of the regulations were made to make the system even more flexible; for example, exporters were allowed to transfer funds for overseas debt payment more conveniently.

The third stage of exchange control deregulation occurred recently in February 1994. It involved increases in the limit on outward transfer of foreign exchange by residents for direct investment abroad, and the limit on baht notes to be taken to countries bordering Thailand. The limit on travelling expenses was also eliminated.
c) Deregulation of financial institutions includes two main measures as follows:

- Expanding the scope/types of business of financial institutions in order to move towards the goal of a universal banking system in which financial institutions can compete more freely and fairly in the same line of business. As a result of this policy measure, customers will benefit from a greater variety and better quality of financial services at cheaper prices. Financial institutions could also earn more profits from fee-based activities to supplement their interest income which is expected to decline due to greater competition after interest rate liberalization has been fully effected.

- Restrictions on portfolio management of financial institutions were relaxed to create greater flexibility and efficiency in their operations. These measures consist of reducing the ratio of government bond holding as a branch opening requirement, changing the computation of the reserve requirement ratio from cash reserve to liquidity reserve, and replacing the agricultural credit requirement by the rural credit requirement, which is expected to be abolished in the medium term.

3.2.2 Improvement of Supervision and Examination of Financial Institutions

While structural regulations were being relaxed, prudential regulations were introduced to promote transparency of financial institutions' status so that the stability of the
financial system can be secured. To this regard, the most important measure was the adoption of the capital adequacy guidelines of the Bank for International Settlements (BIS) which has been in effect since January 1, 1993. According to BIS rules, commercial banks are required to maintain 8 percent of capital to risk assets ratio. (Kiriwat, 1992, p.20)

3.2.3 Development of the Capital Market and Promotion of New Financial Instruments

Thai businesses have been relying on commercial banks and finance companies for their credit needs. As the economy is growing rapidly, an alternative source of funds, namely "direct financing" through capital markets is needed. As a result, the authorities promulgated the Securities and Exchange Act (SEA) in conjunction with the amendments in the Public Companies Act and the Civil and Commission Codes in early 1992 to correct several weaknesses in the legal system regarding the issuing of debt instruments and their trading in the primary and secondary markets.\(^{21}\) The Act has introduced many changes in the security market as follows:

- The establishment of the unification of supervisory agencies, "the Securities and Exchange Commission" (SEC), to supervise all aspects of securities businesses.\(^{22}\)

\(^{21}\) The institutions directly related to the SEA include securities and finance companies, investment consultants, trustees, and credit rating agencies.

\(^{22}\) The authority and responsibility of the Stock Exchange of Thailand (SET) are transferred to the SEC. The only remaining responsibility of the SET is to oversee the
- The issuance of debt instruments can now be done by both public companies and limited companies while the issuance of stocks or equity instruments is still limited to public companies.\textsuperscript{23}

- The introduction of investor representative and trustee concepts in regards of secured bond and fund management.

- A mutual fund company is now regarded as a Thai juristic person, with a separate legal entity from a security company.

- With the permission from the SEC, over-the-counter markets can now be formed, along with futures and options markets, by at least 15 securities firms which need not be present members of the stock exchange market.

- The promotion of initiating new securities-related businesses such as securities clearing houses, share depository centers, and registrar services.

- With regard to investor protection, the SEA allows for the establishment of credit rating agencies.

3.2.4 Improvement of the Payment System

The new payment system introduced by the Bank of Thailand comprises three parts: Check clearing center with electronic clearing house system, Interbank Transfer which will initially be an off-line system and will be subsequently changed to an operational work of the Securities Exchange.

\textsuperscript{23} This initiative is expected to increase the supply of debt instruments in both the primary and secondary markets.
on-line system, and the electronic BOT-Net. The new system is expected to facilitate the expanding use of checks, credit cards, and other commercial papers, and to reduce the cost of business operations.

3.3 Detailed Chronology of the Liberalization of the Financial System

This paper focuses only on the first area of financial reform, the liberalization of financial system. Therefore, the chronologies of the liberalization in this area which are the liberalization of interest rates, foreign exchange controls, and financial institutions, are shown as follows.

3.3.1 The Chronology of Liberalization on Interest Rates

June 1, 1989: Removing the interest rate ceiling on time deposits with more than one-year maturity.

Mar. 16, 1990: Removing the interest rate ceiling on time deposits with one year maturity or less.

Jan. 8, 1992: Removing the interest rate ceiling on saving deposits.

June 1, 1992: Removing the ceiling on lending rate and interest rate ceilings on promissory notes offered by finance companies.

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24 The information in this section are obtained from Financial System and Development Section, Economic Research Department, Bank of Thailand.
Oct.27, 1993: Commercial banks are required to announce Minimum Lending Rate (MLR), Minimum Retail Rate (MRR), and the maximum higher rates from MRR.

Feb.23, 1994: Changing commercial banks’s calculation of MRR, from basing on total costs of six-month time deposits to basing on average costs of all types of deposits.

3.3.2 The Chronology of Liberalization on Foreign Exchange Controls

May 22, 1990: The First Stage of foreign exchange liberalization took place. Thailand officially accepted Article 8 of IMF Agreements and also relaxed foreign exchange controls as follows:

- Allowing commercial banks to process customers’ applications for the purchase of foreign exchange for trade-related transactions (current account basis) without approval from the Bank of Thailand.

- Raising the limit on foreign exchange purchase for service payments, for example, limit on travelling expenses was increased to US$ 20,000 per trip.

- Allowing commercial banks to approve outward transfers of foreign exchange for remittance of loans, sale of securities, or liquidation of companies not exceeding US$ 500,000 per transaction.

April 1, 1991: The Second stage of liberalization on foreign exchange controls includes
- Allowing a greater amount of outward transfer of funds (up to US$ 5 million) by residents for investments abroad.
- Allowing foreign investors to repatriate investment dividends and profits from the sales of stocks.
- Allowing Thai individuals to open foreign currency accounts under certain conditions.
- Allowing non-residents to open non-resident baht accounts.
- Replacing the original forms for notifying the authorities of foreign exchange movements with simplified format forms.

May 1, 1992: Further deregulation of foreign exchange controls includes:

- Allowing exporters to be paid in baht currency from a "non-resident baht account".
- Allowing exporters to use currency earned from exports to repay foreign debts without approvals from the central bank or to settle the amount owed to importers overseas without having to bring in the currency.
- Allowing the government and state agencies to deposit an unlimited amount of foreign currencies into their accounts.
- Allowing foreigners to deposit foreign currencies paid by Thai residents into their foreign currency accounts.

Sep. 14, 1992: Allowing commercial banks located in Vietnam and in the countries which have common border with Thailand to withdraw baht currencies from non-resident baht accounts, but
not exceeding the amount of outstanding balance, excluding borrowed funds.

**March 19, 1993:** Allowing baht currencies to be transferred to Vietnam and to the countries which have common border with Thailand up to the amount of 250,000 baht.

**February 2, 1994:** The Third Stage of liberalization on foreign exchange controls include several measures as follows:

- Increasing the limit on Baht currencies to be transferred to Vietnam and countries bordering Thailand to 500,000 baht.
- Raising the limit on outward transfer of funds by residents for direct investment or loans abroad to US$ 10 million a year.
- Eliminating the limit on travelling expenses in any forms.
- Permitting residents to use foreign exchange proceeds originating abroad to service their external obligations without having to surrender them.
- Allowing foreign currencies borrowed by residents from the Bangkok International Banking Facilities (BIBF), or borrowed by non-residents from authorized banks to be deposited into foreign currency accounts.

### 3.3.3 The Chronology of Liberalization on Commercial Banks and Other Financial Institutions

**Nov.3, 1987:** Permitting commercial banks to engage in following businesses: custodian services, loan syndication,
acquisition, merger or consolidation advisor and feasibility studies.

Apr. 5, 1990: Requirement for commercial banks’ net position on foreign assets was increased from 20 percent to 25 percent of capital funds.

Nov. 13, 1990: Branch opening requirement for commercial banks to hold government bonds as a proportion of total deposits was reduced from 16 percent to 9.5 percent.

Nov. 26, 1990: Requirement for commercial banks’ position on net foreign liability was relaxed from 20 percent to 25 percent of the capital funds.

Jan 1, 1991: Extension of the rural credit requirement to include credit for wholesale trade of agricultural products, and credit for industrial business in provincial promotion zones.

Jan 4, 1991: Changes in the calculation of commercial banks’ reserve requirement, from a weekly basis to a two-week basis.

May 20, 1991: Changes in the calculation of commercial banks’ rural credit requirement to a proportion of total deposits, excluding interbank deposits and deposits from government agencies and state enterprises, and to base it on deposits of all branches in the district, rather than of each branch.

May 23, 1991: The required minimum value of assets held by foreign banks was raised from 5 million baht to 125 million baht, but they can include a wider variety of assets.
Jun. 5, 1991: For the branch opening requirement, commercial banks were allowed to hold bonds issued by state enterprises as well as government bonds.

Jun. 23, 1991: The "cash" reserve ratio requirement at 7 percent was replaced by the "liquidity" reserve ratio, and commercial banks were allowed to hold other liquid securities. Of the 7 percent, at least 2 percent must be held in cash at the Bank of Thailand, vault cash can be as high as 2.5 percent and the remaining can be government securities and other securities such as BOT securities, debentures, bonds and other debt instruments issued by state enterprises.

Sep. 13, 1991: The branch opening requirement for commercial bank holding of government bonds was reduced from 9.5 percent to 8 percent of total deposits.

Dec. 12, 1991: Finance and security companies were allowed to engage in leasing business.

Jan. 1, 1992: The definition of "rural credit" was extended to include credit for export of agricultural products.

Feb. 14, 1992: Allowing the initiation of 7 more mutual funds under the condition that the fund managers be legal financial institutions with registered capital not less than 100 million baht.

Feb. 14, 1992: The branch opening requirement was reduced again from 8 percent to 7 percent of total deposits.

Mar. 18, 1992: Commercial banks were allowed to operate:
- as a sales agent for debt instruments of government and public enterprises,
- provide information services including economic, investment and financial information,
- financial advisory services.
Mar. 24, 1992: Finance companies were allowed to operate:
- as underwriters and sales agents for government bond and debt instrument of state enterprises,
- information services,
- sponsoring service including preparation of documents required by the Security of Thailand (SET) to be the company on the listed in SET.
Mar. 24, 1992: Security companies were allowed to provide:
- custodial services,
- information services,
- sponsoring services.
Apr. 10, 1992: Under the Amended Banking Act (No. 3) of 1992, commercial banks were allowed to issue negotiable certificates of deposit (NCD).
Jun. 1, 1992: Commercial banks were allowed to operate the following business:
- arrangement, underwriting and debt instrument dealing
- secured debenture holder representatives
- mutual fund supervisor
- registration for securities
- selling agent for investment units.
Jun. 22, 1992: Finance and credit foncier companies were required to increase their minimum paid-up capital to enhance their efficiency in administration.

Jul. 22, 1992: Finance companies were required to have registered and paid-up capital not less than 100 million baht by Jul. 1, 1993 and not less than 150 million baht by Jul. 1, 1994. Security companies were required to have registered and paid-up capital not less than 50, 75, and 100 million baht by Jul. 1, 1993, 1994, and 1995 respectively.

Jul. 1, 1992: Commercial banks were allowed to issue negotiable certificate of deposits (NCD) with minimum requirement.

Aug. 1, 1992: Credit foncier companies were allowed to hold debt instruments, guaranteed by Ministry of Finance, of not more than 20% of its capital.

Sep. 8, 1992: The Ministry of Finance approved the proposal for the setting up of Bangkok International Banking Facilities (BIBFs).

Sep. 18, 1992: Finance companies and finance and security companies were allowed to operate the business of:
- debenture holder representatives
- mutual fund supervisor under certain requirements

Sep. 23, 1992: Commercial banks were allowed to hold Industrial Finance Corporation of Thailand (IFCT) debenture or IFCT secured bond as parts of liquidity reserve requirement.

Oct. 15, 1992: Finance companies were allowed to:
- engage in foreign exchange services,
- issue negotiable certificate of deposits,
- arrange underwriting and debt instruments.

Oct. 22, 1992: The ATM service hours were extended to 24 hours a day.

Nov. 4, 1992: The branch opening requirement for commercial banks to hold government bonds as a proportion of total deposits was reduced from 7% to 6.5%.

Jan. 1, 1993: Commercial banks were required to maintain 8% of capital to risk assets ratio, according to the Bank for International Settlement (BIS)'s rules.

Jan. 1, 1993: The definition of "rural credit" was extended to include credits for industrial and mineral businesses, public utility, housing, education and health.

Feb. 14, 1993: The branch opening requirement for commercial banks to hold government bonds as a proportion of total deposits was reduced from 6.5% to 5.5%.


May 17, 1993: The branch opening requirement for commercial banks to hold government bonds as a proportion of total deposits was eliminated.

Aug. 26, 1993: The Securities and Exchange Commission (SEC) allowed commercial banks and finance companies with more than 500 million baht of registered capital and 5000 million baht
of net assets to engage in security business only debt instrument trading.

Nov. 20, 1993: Insurance companies were allowed to engage in leasing business, and mutual fund and pension fund management.

Jan. 24, 1994: Commercial banks were allowed to include foreign securities and ACN notes issued by IFCT in their required liquidity reserves.

Apr. 1, 1994: The required ratio of capital to risk assets for commercial banks was increased from 7% to 7.5%.

May 4, 1994: BIBF businesses were allowed to open new branches in the province.

Jun. 1, 1994: Commercial banks were required to maintain a net position on foreign assets of 25% and on foreign liabilities of 20% of tier 1 of capital funds.

Jul. 1, 1994: Finance companies were required to maintain 7% of capital to risk asset ratio.
4.1 Empirical Survey on the Constancy of the Real Interest Rate and the Interest Rate Determination

a) The Case of Developed Countries

Since 1970, many empirical studies have investigated the behavior of real interest rates which Irving Fisher (1930) assumed to be constant in his empirical studies of inflation.\(^{25}\) Fisher posited that a rise in expected inflation causes a percentage point for percentage point increase in the nominal interest rate, leaving the real rate of interest unchanged. In other words, a long-run equilibrium relationship exists between the two non-stationary series: nominal interest rates and expected inflation. Arguing that inflationary expectations are rational, Fama (1975) tested the joint hypothesis of market efficiency and the constancy of real interest rates and could not reject the hypothesis. However, most of subsequent empirical studies such as Nelson

\(^{25}\) The basic form of the Fisher equation estimated in many empirical studies on real interest rates is \(i_t = a + b\pi^e_t + z_t\) where the constant term "\(a\)" represents the constant ex ante real rate of interest, \(i_t\) is the nominal rate of interest, and \(\pi^e_t\) is the actual (ex post) rate of inflation. The error, \(z_t\), is a linear combination of a "rational" inflationary forecast error and a disturbance term accounting for all movements in nominal interest not explained by variation in expected inflation. A typical test of the Fisher hypothesis involves testing that "\(a\)" is constant and "\(b\)" equals 1. (Bonham, 1991, p.1487)
and Schwert (1977), Garbade and Wachtel (1978), Levi and Makin (1978), and Tanzi (1980) rejected the hypothesis of constant real interest rates while tending to support the hypothesis that nominal market interest rates include an efficient inflationary premium. (Makin, 1982, p.207) More recent studies (MacDonald and Murphy, 1989; Bonham, 1991) applied cointegration tests of the long-run relationship between nominal interest and inflation. Assuming a stationary real interest rate, MacDonald and Murphy could not reject the null hypothesis of no cointegration for the case of the U.S. during the period of flexible exchange rate regime but they did find some evidence of cointegration during the period of fixed exchange rate regime. Bonham (1991), on the other hand, argued that the real interest rate is a non-stationary process; he used two proxies for real interest rates in the cointegrating Fisher equation. He rejected the null hypothesis of no cointegration for both periods.

Recently, researchers are more concerned about the factors causing the movement in real interest rates, instead of only testing the constancy hypothesis. Since the ex-ante real rate is unobservable, Mishkin (1984, 1986) deals with this problem by assuming that the expectations of inflation are rational, thus ex-post real rates differ from ex-ante real

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rates only by white noise inflationary forecast errors. Variables that explain systematic movements in observable ex-post real rates can therefore be linked to ex-ante real rates. An alternative strategy, adopted by Makin (1982, 1983), Peek (1982), and Hoffman and Schlagenhauf (1985), is to model ex-ante real rates as functions of hypothesized determinants of real rates (for example, expected inflation, money surprises) and substitute this result into a standard Fisher equation. The relationship between real rates and hypothesized determinants can be drawn from the estimation of reduced form equations of observable nominal interest rates.

We discuss two empirical studies based on the latter approach. Makin (1982, 1983) derives a reduced form equation for the nominal interest rate from a structural model, which consists of standard IS-LM equations and real output equations, expressed in terms of money surprises. From the reduced form equation, he tests four hypothesized impacts of monetary surprises, anticipated inflation, inflation uncertainty, and the exogenous demand shock, caused by the

27 This conclusion is derived from the following equations:
Fisher Equation: \( r_{R_t} = i_t - \pi^e_t \) --------------------------eq.1\
Rational Expectation: \( \pi^e_t = E(\pi_t|St-1) = \pi_t + \epsilon_t \) ----------eq.2\
Ex-post Real Rate: \( eprr_t = i_t - \pi_t \) --------------------------eq.3\
Substituting \( i_t \) from eq1) and \( \pi^e_t \) from eq.2) into eq.3),
yields
\( eprr_t = r_{R_t} + \pi^e_t - \pi_t = r_{R_t} + \epsilon_t \)
where \( eprr_t = \) ex-post real rates, \( r_{R_t} = \) ex-ante real rates, \( \pi^e_t = \) expected inflation, \( E(\pi_t|St-1) = \) mathematical expectations operator conditional on the information set \( St-1 \), \( \epsilon_t = \) white noise (inflationary forecast) errors. (Mishkin, 1986)
shift in IS curve, on the movement in after-tax real interest rates in the U.S. during the period of 1959-1981. Monetary surprises are represented by residuals from a univariate ARMA model of money growth, ARMA(1, 5).\textsuperscript{28} The exogenous shift factor to the IS curve is proxied by government deficit, the ratio of total private and public borrowing relative to GNP, and exports.\textsuperscript{29} Expected inflation is taken from the survey data, called "Livingston Expectations Data", and inflation uncertainty is measured by the squared deviations of actual from expected inflation.

The estimated results show that the ratio of total borrowing to GNP and anticipated inflation are positively correlated with real interest rates while monetary surprises and inflation uncertainty are negatively correlated with real after-tax interest rates. He, therefore, concludes that inflation control programs involving monetary restraint may lead to temporary, unavoidable high interest rates because they are initially surprises to the public. Furthermore, an increase in the fiscal deficit which induces a higher ratio of

\textsuperscript{28} ARMA(1,5) represents $m_t = a_1m_{t-1} + e_t + c_1e_{t-1} + c_2e_{t-2} + c_3e_{t-3} + c_4e_{t-4} + c_5e_{t-5}$ where $m_t =$ money growth rate, $e_t =$ "white noise" error term.

\textsuperscript{29} He actually used the ratio of total funds raised (by both government and private sectors) in U.S. credit markets relative to GNP as a measure of total borrowing relative to GNP, which is a proxy for the economy's ability to absorb debt. The data were obtained from the U.S. Federal Reserve Board's Flow-of-Funds Accounts in Federal Reserve Bulletin, Table 1.58.
total borrowing to GNP can raise the real rate as a result of the crowding out effect. Although Makin (1982) suggests many useful findings, his analysis is based on a long-run static model of a fully closed economy. Another study by Hoffman and Schlagenhaulf (1985) examines the determinants of real rates in four industrial countries during the period of 1960-1982. They derive a semi-reduced form equation for the real rate from a structural model and test similar hypotheses as Makin (1982, 1983). However, their model includes dynamic specification of the real rate. The semi-reduced form is shown below:

\[ i_t = \xi + \sum_{j=0}^{N} \alpha_i \pi^e_{t-j+1} + \sum_{j=0}^{N} \beta_j (m^e - m^e_t) e^{t-j} + \sum_{j=0}^{N} \theta_j v^2_{t-j} + \sum_{j=0}^{N} \gamma_j i_{t-j} \]

where \( \pi^e_t, (m_t - m^e_t), \) and \( v^2_e_t \) represent the expected rate of inflation, unanticipated monetary growth, and inflation variance respectively. In fact, the major contribution of their study is the estimation procedure that accounts for econometric problems associated with generated regressor models.\(^30\) The presence of inflation variance in the estimated equation above results in inconsistent OLS estimators. (Pagan, 1984) Therefore, they suggest the use of

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\(^30\) Pagan (1984) demonstrated that in general, the use of fitted values and residuals as proxies for expectations and unanticipated shocks in an OLS framework results in consistent estimators. However, the standard variance-covariance formula is often inappropriate, yielding misleading test statistics and erroneous inference. Furthermore, in the presence of an inflation variance regressor, the OLS estimates are no longer consistent.
instrumental variables estimation technique where those explanatory variables in the right hand side of the above equation are replaced by constructed instrument variables.\footnote{see the details of instrument variable estimation technique in Hoffman and Schlagenhauf (1985, pp. 287-89).}

b) The Case of Thailand (a Developing Country Case)

Based on a partial equilibrium approach of the simple loanable fund theory, Dasri and Underwood (1981) examine the movement of a short-run nominal interest rate (7-day interbank lending rate) in Thailand during 1977-1979. Using the loanable fund theory, they derive the reduced form for a domestic short-term lending rate as a function of a foreign loan rate (one-month Eurodollar lending rate), the expected inflation rate, a composite domestic deposit rate, productivity, and expected changes in the exchange rate.\footnote{The real baht level of investment requested for the Board of Investment promotion privileges, six month earlier, is used as a proxy for productivity or economic activity. For the expected changes in the exchange rate, a monthly forward premium on U.S. dollar is used as a proxy.} The estimation results show that 75 percent of foreign interest rate changes is passed on to the Thai lending rates, a rise in administered deposit rates depresses the lending rates, and the monthly forward premium (which reflects expected change in the exchange rate) positively influences domestic lending rates. Nevertheless, they surprisingly find that the influence of anticipated inflation, which is assumed to be rational, on domestic lending rates is small and close
to zero though the Thai financial markets during those periods were still rather closed.\footnote{See explanation and other details in Tumnong Dasri and John M. Underwood, "Thailand’s Interest Rate Structure and the Transmission of World Interest Rate Changes to Thailand: Mechanism & Implications" Bangkok, 1981 (mimeographed).}

Dejthamrong (1988), in a more recent study, develops a model of the interest rate for a small open economy under a fixed exchange rate regime. His analysis is based on a general equilibrium approach where the equilibrium interest rate is determined by the market-clearing conditions in all markets, the commodity market, the money market, the foreign exchange market, and the labor market. He also incorporates into the model the Darby-Fisher hypothesis, interest parity and purchasing power parity as well as the role of Central Bank in foreign exchange market intervention.\footnote{The Darby-Fisher hypothesis states that the after-tax nominal rate of interest equals to the after-tax real rate of interest plus the anticipated rate of inflation. This can be written as: $i_t = (r_{at} + \pi_t^e)/(1 - \tau)$ where $i_t$ = nominal interest rate, $r_{at}$ = after-tax real rate of interest, $\pi_t^e$ = anticipated rate of inflation, and $\tau$ = marginal tax rate on interest income.} The reduced form equations for three endogenous variables: the nominal interest rate, the price of exports, and the price of imports, are consequently derived. However, in the case of a small country like Thailand, the country does not have power to influence the price of exports in the world market. Therefore, the price of exports is given.

In his empirical section, he focuses only on the
estimation of the reduced form equation for the nominal interest rate which is specified as a function of all predetermined variables. It is written as follows:

\[ i_t = \alpha_0 + \alpha_1 \pi^e_t + \alpha_2 i^*_t + \alpha_3 D_t + \alpha_4 ERT_t + \alpha_5 G_{t-1} + \alpha_6 R_{t-1} + u_t \quad \text{eq.1} \]

where:

\[ i = \text{one-month Thai interbank interest rate} \]
\[ \pi^e = \text{anticipated rate of inflation at time } t+1 \text{ as of time } t \]
\[ i^* = \text{foreign interest rate (Eurodollar Rate)} \]
\[ D = \text{changes in domestic component of the monetary base} \]
\[ ERT = \text{the effective exchange rate index, i.e., the ratio of trade volume-weighted average of Thailand's trading partner CPIs relative to the Thai CPI.}^{35} \]
\[ G_{t-1} = \text{fiscal deficit in the last period} \]
\[ R_{t-1} = \text{foreign asset component of the monetary base in the last period} \]
\[ u = \text{the error term} \]

The estimation procedure in his study follows Makin's (1982) two-step methodology. That is, he first estimates the nominal interest rate as a function of monetary surprises and anticipated inflation only. In the second step, he then introduces other exogenous variables, as mentioned in the reduced form above, in the estimation. The Cochrane-Orcutt

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\(^{35}\) Forward premium rate was also tested.
methodology is employed to correct for serially correlated residuals in the estimated equation.\textsuperscript{36} The anticipated rate of inflation is derived from an ARIMA (0,2,1) model of the univariate time series of the monthly consumer price index of Thailand.\textsuperscript{37} The proxy for monetary surprises is the difference between the log of current domestic asset component of the monetary base and the log of the domestic asset component at time t anticipated as of time t-1.\textsuperscript{38} The estimation period is January 1979 - December 1984 which is the period of the U.S. dollar fixed exchange rate system.

He concludes from the estimation results that only foreign factors such as foreign interest rates and the lag of the net foreign assets component of the monetary base (or foreign exchange reserves), which capture the expected devaluation, greatly influence the domestic short-term nominal interest rates. In contrast, the domestic factors, such as money supply M1, monetary base, or unanticipated domestic component, the anticipated inflation, and the lagged value of

\textsuperscript{36} In fact, The Cochrane-Orcutt procedure can be used to correct only for the first order autoregressive residuals. If the residuals follow more complex ARMA process, a transfer function (which defines lag structure of exogenous variables and residuals in terms of the ratio of two polynomial in the lag operator) would be a more appropriate method.

\textsuperscript{37} ARIMA(0,2,1) represents $\Delta p_t = \Delta p_{t-1} + e_t + c_1e_{t-1}$ where $p_t = \log$ of monthly consumer price index, $e_t = \text{white noise error term}$.

\textsuperscript{38} This concept is along the line of the definition of money surprises in Makin (1982) which we will discuss further in the next section.
government deficit do not contribute much in explaining the movement of the domestic nominal interest rates.

Robinson, et.al (1991) investigate the degree of capital mobility in Thailand, using the interest rate model suggested by Edwards and Khan (1985). The observed domestic nominal interest rate is specified as a weighed average of the interest rate in a fully opened economy (which is determined by foreign interest rate, expected change in exchange rate, and risk premium) and the interest rate in a fully closed economy (which is the real interest rate plus the expected inflation). Thus, the degree of capital mobility is measured by the coefficient estimate of the foreign interest rate, adjusted by the expected exchange rate change. The real rate in a fully closed economy is determined by monetary disequilibrium, which can be defined in two ways. According to the first approach, it is defined as the difference between real money balance and the desired level of money demand, which is a function of real GDP, expected inflation and the equilibrium real interest rate (assumed to be constant). The second approach hypothesizes that the real interest rate is influenced by money surprises at least in the short-run. They

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The domestic interest rate is specified as:

\[ i_t = \psi i_t^o + (1-\psi) i_t^c \]  \quad \text{or} \quad i_t = \psi (i_t^f + x_t^e) + (1-\psi) D_F, \]

where \( i_t^o \) is the domestic interest rate in a fully open economy, \( i_t^c \) is the domestic interest rate in a fully closed economy, \( i_t^f \) is the foreign interest rate, \( x_t^e \) is the expected exchange rate change, and \( D_F \) is a vector of domestic factors, such as money surprises, and the expected inflation.
estimate two models of interest rates, using quarterly data for 1978-1990. The results of estimated reduced-form equations are shown below:

1) Standard specification

\[ i_t = 0.46i_{t-1} + 0.55i^*_t + 0.98\log y_t + 0.24\log M_{t-1} - 0.09\pi_t \]

\((4.9) \quad (4.9) \quad (0.2) \quad (0.1) \quad (0.6)\)

\[ R^2 = 0.76, \quad D-W = 2.0 \]

2) Money Surprise specification

\[ i_t = 0.43i_{t-1} + 0.54i^*_t - 0.32M^*_t - 0.16\pi_t \]

\((5.0) \quad (6.1) \quad (1.9) \quad (1.1)\)

\[ R^2 = 0.78, \quad D-W = 1.83 \]

where \( i = \) domestic interest rate, \( i^* = \) foreign interest rate (expected exchange rate change is assumed to be zero), \( y = \) real GDP, \( M = \) real M1 money supply, \( M^* = \) money surprises, measured by residuals obtained from regressing money growth on its own past seven lagged values, \( \pi^e = \) expected inflation, proxied by actual values of inflation rates.

They conclude that the domestic interest rate is determined mainly by the foreign interest rate although money surprises have some influence.\(^{41}\) Based on the above two regression equations, the degree of capital mobility in

\(^{40}\) The figures in the parentheses are t-values

\(^{41}\) The estimation results show that the money surprises specification generally performs slightly better, in terms of higher \( R^2 \), than the standard specification.
Thailand, as measured by the value of coefficient estimate of the foreign interest rate, is very high, approximately .5 in the short-run and nearly unity in the long-run.\footnote{According to a standard specification, the degree of capital mobility equals .55 in the short-run, and 1.01 (.46+.55) in the long-run. A money surprise specification implies that the degree of capital mobility equals .54 in the short-run, and .97 (.43+.54) in the long-run. (see also footnote 39)}

Although the work by Robinson, et.al. (1990) suggested useful findings of the determinants of interest rates and the degree of financial openness in Thailand, there were several points which could be improved upon. First, there was no investigation of the time-series properties of the variables used in the model. These results were probably unreliable if the variables in the model were non-stationary series. (see details discussion of empirical issues in chapter 5) Second, the study included both pre and post financial liberalization periods. It was more likely that parameter inconsistency may have occurred from policy regime shifts. Therefore, the degree of financial openness should be allowed to vary over time, and the model of interest rate determination should be able to take into account of the policy regime shifts. In other words, a formal investigation of the impact of financial liberalization policies should be done. Finally, the faster response of domestic interest rates to the movement in foreign interest rates is expected after capital controls have been
deregulated, therefore, a more frequent model (monthly model) of domestic interest rate is needed.\textsuperscript{43}

We intend to improve upon the shortcomings of previous studies mentioned above. Our study therefore contributes mainly on empirical issues and policy implications.

4.2 The Proposed Model of Interest Rate Determination

As mentioned in chapter 3, the authorities started the formal comprehensive financial reform programs with the abolishment of the interest rate ceilings in June 1989, then subsequently relaxed foreign exchange controls in three stages.\textsuperscript{44} Theoretically, the degree of the openness of the capital account greatly affects the determinants of the interest rate. If capital flows are completely unrestricted, the world interest rate, the expected change of exchange rate and risk factors determine the domestic interest rate via the interest parity relationship. (Edwards and Khan, 1985) Therefore, we would expect domestic interest rates to be more

\textsuperscript{43} Since Robinson, et.al (1991) suggests that degree of financial openness is nearly unity in the long-run, it implies that domestic interest rates take about three months or a quarter to completely adjust to the movement in foreign interest rates during the period of 1978-1990. The quarterly model of domestic interest rates cannot reflect the faster rate of adjustment which is less than a quarter because the coefficient estimate of foreign interest rate will always be one.

\textsuperscript{44} Due to data limitation, we estimate the interest rate model, using monthly data from July 1989 to November 1993, although the interest rate ceilings on all types of deposits and loans were completely removed in June 1992.
market-determined and greatly influenced by foreign factors
after the financial liberalization program has been
undertaken.

The model proposed here allows for the intermediate
features between fully closed and fully open economies, which
is the characteristics of most developing countries, including
Thailand. In other words, it takes into account the degree
of openness of the economy. In particular, the domestic
nominal interest rate can be specified as a weighted average,
or linear combination, of the nominal interest rate which
would prevail in a fully open economy and the nominal interest
rate in a fully closed economy as follows:

\[ i_t = \psi i^o_t + (1-\psi) i^e_t \]  

4.1)

where \( i^o_t \) = nominal interest rate under fully open economy
\( i^e_t \) = nominal interest rate under fully closed economy
\( \psi \) = an index measuring the degree of financial
openness of the country

If \( \psi = 1 \), the financial sector is fully open. If \( \psi = 0 \),
the financial sector is fully closed. In the intermediate
case, the parameter \( \psi \) lies between zero and one. It is
possible that the degree of the openness varies over time,

\[ 45 \] Though the model is based on Edwards and Khan (1985),
we suggest some modifications, including the model of interest
rates in a fully closed economy, the relaxation of the
constant degree of financial openness, and the empirical
estimation techniques.
especially through the process of liberalization. If foreign exchange controls are relaxed gradually and smoothly, $\psi$ can be modelled as a linear function of time as follows:\footnote{In the case that capital controls are loosened and tightened sporadically over time, the degree of the openness can be modeled alternatively as: $\psi_t = k_0 + k_1 D_t$, where $D_t$ is a dummy variable which equal to 1 when controls are loosened and equal to 0 when controls are tightened.}

$$\psi_t = k_0 + k_1 t \hspace{1cm} 4.2$$

where $t$ is time trend. To the extent that the liberalization process yields a higher degree of integration of the domestic and the world capital market, we would expect that $k_1 > 0$ and the coefficient estimates of the domestic factors ($\xi - \psi_t$) in the model decrease over time.

In the case of Thailand, the authorities have announced three main measures consecutively to relax foreign exchange controls. (see chapter 3) The third deregulation measure, however, occurred recently in February 1994, beyond the period of this study. Thereby, we may model $\psi$ as a function of two dummy variables to differentiate these effects. It is shown below:

$$\psi_t = k_0 + k_1 D_1 + k_2 D_2 \hspace{1cm} 4.2')$$

where $D_1 = 1$ from May 1990 to November 1993, $= 0$ otherwise

$D_2 = 1$ from April 1991 to November 1993, $= 0$ otherwise
The effects of these measures on the degree of openness can be tested by the statistical significance of the estimated coefficient: $k_1$, and $k_2$.\(^{47}\)

Nevertheless, in the empirical estimation we use an estimation method called "recursive least squares" (RLS) to first find the possible break points of the estimated model which could occur as a result of financial liberalization measures, and see time path of coefficient estimates.\(^{48}\) Then, we include dummy variables as proposed here to capture these break points. (see chapter 6)

In the case of the fully open economy

If the economy is completely open to the rest of the world, and there are no capital controls, no transaction and information costs, and economic agents are risk neutral, then the following arbitrage condition, known as "Uncovered Interest Parity" (UIP), holds.

\[ i_t = i_t^* + x_t^* \] \hspace{1cm} 4.3)


\(^{48}\) The use of RLS allows parameter estimates of not only the foreign interest rate and the expected exchange rate change in a fully open economy but also of other factors determining domestic interest rate in a fully closed economy to change over time.
where \( i^*_t \) = the world interest rate (the interest rate on the foreign financial asset with same characteristics as the domestic asset)

\( x^*_t \) = the expected change in the exchange rate, which is defined as the domestic price of foreign currency.

Due to the possibility of risk averse agents, an alternative relationship called "Covered Interest Parity" (CIP) is more likely to hold in a fully open economy than UIP. CIP is defined as equation 4.3)' below:

\[
i_t = i^*_t + \frac{(f_t - s_t)}{s_t} \quad 4.3)'
\]

where \( f_t \) is the forward exchange rate, \( s_t \) is the spot exchange rate. The second term on the right hand side of 4.3)' represents the forward premium, capturing both the expected change in the exchange rate and the (exchange) risk premium that investors attach to uncovered transactions.\(^{49}\) (see detailed derivation of CIP in Krugman and Obstfeld, 1991, p.346-348).

\(^{49}\) The deviation of CIP implies the existence of capital controls, transaction costs, differences in tax law, default of political risk. (Bernhiem and Shoven, 1991, p.241) If CIP holds, UIP may not hold, mainly because of two factors. First, the existence of time-varying risk premium (i.e., economic agents are not risk neutral). Second, the forward premium may not be a good proxy for the future exchange rate change, especially in the case that the forward exchange market is shallow, i.e., most of the transactions in the financial market is not covered by the forward premium.
Because of frictions arising from transaction costs and information lags, there exists the possibility that domestic interest rates respond with a delay to any changes in the foreign interest rate or in exchange rate expectations. This type of lagged response could be modeled in a partial adjustment framework as follows:

$$\Delta i_t = \theta [(i_t^* + x_t^e) - i_{t-1}] \tag{4.4}$$

where $\theta = \text{the adjustment parameter, } 0<\theta<1$. If the financial market adjusts rapidly, $\theta$ will tend toward unity. Conversely, a small value of $\theta$ would imply slow adjustment of the domestic interest rate. The solution of 4.4) in terms of domestic interest rate is:

$$i_t = \theta (i_t^* + x_t^e) + (1-\theta)i_{t-1} \tag{4.5}$$

In the case of the fully closed economy

Instead of modeling the interest rate as a function of excess money supply (actual money supply minus desired level of money demand) as Edwards and Khan (1985), we suggest a model of interest rates along the lines of Makin (1982; 1983), and Hoffman and Schlagenhauf (1985) which are based on a

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50 How fast the domestic financial market responds to foreign market is in fact an empirical issue. We will initially allow more than one lags of domestic interest rate to enter the estimation equation, and test whether they are significant, instead of restricting the number of lags to one from the outset.
The determinants of the real interest rate in the reduced form equation suggested in these studies are derived from a structural model which consists of standard IS, LM equations, and a Lucas-type aggregate supply equation (in which real output is specified as a function of money surprises).

By the same analogy of the decomposition of real output by Lucas (1973), the real interest rate can be decomposed into a long-run or a natural component and a short-run cyclical component. Under the Mundell-Tobin effect, the natural component of the real interest rate can be affected by the anticipated inflation. Mundell (1963) explains that a rise in the anticipated inflation depresses equilibrium real cash balances and subsequently increases the steady state level of real saving. Equilibrium is restored by a fall in the real interest rate, inducing a higher level of real investment until it equals the higher level of real saving. Tobin (1965) describes a similar phenomenon whereby an increase in the anticipated inflation causes a shift out of money balances into real capital, depressing the marginal product of capital and the equilibrium real rate. Hence, the natural component of the real rate is negatively correlated with the anticipated rate of inflation.

\[ \text{51 The previous work by Robinson, et.al. (1991) also suggests that the interest rate model under this approach performs slightly better than the standard approach adopted by Edwards and Khan (1985).} \]
The cyclical component of the real rate could be affected by money surprises and exogenous demand shocks, caused by exogenous shift factors to the IS curve, such as government expenditures, government deficits, and exports. (Makin, 1983, p377) If monetary growth is greater than its anticipated level and prices are sticky in the short-run, the excess money supply will lead to a drop in the real interest rate. However, the drop in the real interest rate is only temporary, when price and real income adjust sufficiently to absorb excess money supply in later periods, the real interest rate will be restored to the equilibrium level. This negative hypothesized impact of money surprises on the real rate can be explained alternatively as follows. According to Lucas-type supply equation, a rise in unanticipated money growth causes an increase in real income, which in turn elevates real saving. To restore equilibrium, a drop in the real rate is required to produce an equal increase in real investment. (Makin, 1983, p.376)

The impact of an exogenous shift in aggregate demand, caused by a shift in the IS curve, on the real interest rate is positive. However, the use of government budget deficit as a proxy may not give positive impacts. Since tax revenues are proportional to income, deficits are endogenous and typically countercyclical to economic growth. Thus the estimated coefficient of government deficit may be biased downward and
possibly negative. Therefore, Makin (1982, 1983) uses exports, both nominal and real terms, as measured of an exogenous demand shock, caused by a shift in the IS curve.

The above explanation of determinants of the interest rate can be summarized in the following equations:

\[ i_t = r_t + \pi_t^e \quad \text{(4.6)} \]
\[ r_t = r_t^n + r_t^c \quad \text{(4.7)} \]
\[ r_t^n = \alpha_0 + \alpha_1 \pi_t^e + \epsilon_1 t \quad (\alpha_0 > 0, \alpha_1 < 0) \quad \text{(4.8)} \]
\[ r_t^c = \beta_1 DS_t + \beta_2 (m_t^c - m_t^e) + \epsilon_2 t \quad (\beta_1 > 0, \beta_2 < 0) \quad \text{(4.9)} \]

where

- \( i_t \) = the nominal interest rate (interbank rate)
- \( r_t \) = the ex ante real interest rate (with \( r_t^n \) denoting the natural component and \( r_t^c \) denoting the cyclical component)
- \( m_t^c - m_t^e \) = unanticipated monetary growth, measured as the difference between the log of current money supply and the log of money supply at \( t \), anticipated as of \( t-1 \)
- \( DS_t \) = the exogenous aggregate demand shock, caused by a shift in the IS curve
- \( \pi_t^e \) = the anticipated inflation, proxied by the log of the price level at \( t+1 \), as expected at \( t \), less the log of the actual price level at \( t \) \( (p_{t+1}^e - p_t) \)

52 The use of government expenditure may also fail to capture the impact of exogenous aggregate demand on the real rate because of its countercyclical nature as a stabilizer, i.e., the government may spend more during the recession period to boost the economy.

53 Since actual monetary growth less anticipated monetary growth is written as \( (m_t - m_{t+1}) - (m_t^e - m_{t+1}) = (m_t - m_t^e) \).

66
\[ \varepsilon_i = \text{the error term} \]

Equation 4.6 indicates the Standard Fisher Hypothesis, 4.7 represents the two components of the real interest rate, 4.8 and 4.9 indicate the hypothesized factors affecting the natural component and the cyclical component of the real rate respectively.

Substituting equation 4.8 and 4.9 into 4.7 and substituting resulting 4.7 into 4.6 yields the reduced form equation for the nominal interest rate, in the fully closed economy, as a function of a constant term, anticipated inflation, exogenous demand shocks (government deficit), unanticipated money growth, and an error term. It is written as follows:

\[ i_t = \alpha_0 + (1-\alpha_1)\pi_t^e + \beta_1 DS_t - \beta_2 (m_t - m_t^e) + \varepsilon_t \quad 4.10 \]

where \( \varepsilon_i = \varepsilon_1 + \varepsilon_2 \)

In the general case where the economy is between the fully closed and the fully open situation, the degree of the openness is incorporated in the model of interest rates as shown in equation 4.1. Given that 4.3 represents the long-run equilibrium level of the nominal interest rate in a fully open economy, \( i^o \), and 4.10 represents the nominal interest rate in a fully closed economy, \( i^c \), we can combine 4.1, 4.3 and 4.10 to obtain the reduced form equation for the long-run equilibrium nominal interest rate as:
Equation 4.11) can also be written as:

\[ i_t = b_0 + b_1 (i_t^* + x_t^*) + b_2 \pi_t^g + b_3 DS_t + b_4 (m_t^e - m_t^s) + \mu_t \quad (4.11)' \]

where the composite parameters are

\[
\begin{align*}
  b_0 &= (1-\psi)\alpha_0 \\
  b_1 &= \psi \\
  b_2 &= (1-\psi)(1+\alpha_1) \\
  b_3 &= (1-\psi)\beta_1 \\
  b_4 &= (1-\psi)\beta_2
\end{align*}
\]

The coefficient estimate \( b_1 \) in equation 4.11)' measures the degree of financial openness or capital mobility, according to the "Uncovered Interest Parity" definition. When the expected exchange rate change, \( x_t^s \), is replaced by the forward premium, the coefficient estimate \( b_1 \) then measures the degree of capital mobility, according to the "Covered Interest Parity", which is the least stringent criterion, but widely used.\(^5^4\) (Obstfeld, 1986; Frankel, 1991; Argy, 1994) (see Appendix E)

\(^5^4\) Four definitions of the degree of international capital mobility or financial integration, corresponding to increasingly tighter conditions that need to be upheld, are covered interest parity, uncovered interest parity, real interest parity, and the Feldstein-Horioka definition of saving-investment correlation. (see Appendix E for more details)
CHAPTER 5
EMPIRICAL ISSUES AND PROCEDURES

5.1 Definitions and Sources of Data

Domestic nominal interest rate

As discussed in chapter 2, the banking system still dominates fund intermediation despite the recent surge in the importance of the equity market in Thailand. Neither quoted equity nor marketable debt securities approaches the value of the assets of the banking system.\(^{55}\) (see Table 1 and 5) Therefore, the interest rates which reflect the cost of liquidity in the banking system are the most important. They are the interest rates on bank deposits and loans, on the interbank market, and on the repurchase market.\(^{56}\) The interest rates which will be used in this study, however, must be market-determined, not regulated by the monetary authorities.\(^{57}\) Although both interbank market and repurchase

\(^{55}\) At the end of 1988, the capitalization of equities traded on the securities exchange and the value of marketable private debt securities was equivalent to 20 percent and less than 2 percent, respectively, of the banking system credit. (Easterly and Honohan, 1990, p.18)

\(^{56}\) In many countries the Treasury bill rate is the key money market interest rate, however, this is not the case for Thailand. Due to the improved fiscal situation in recent years, the supply of Treasury bills has dried up. The chief bidders for bills were public entities, the yield determined in the market therefore tended to be well below money market rates. (Easterly and Honohan, 1990)

\(^{57}\) The interest rate ceilings on all types of deposits and loans have just been completely eliminated since June 1992, therefore, the available series of market-determined deposit
market rates have this characteristics, the latter is occasionally influenced by the Bank of Thailand intervention in the open market operation. Thus, the interbank market rate best reflects the short-term liquidity condition in the domestic financial system. Due to data limitation, we use the average monthly interbank rate, weighted by the volume of transactions of each maturity, mainly one to seven days.

**Foreign nominal interest rate**

To be consistent with interest parity, the foreign interest rate which will be chosen should have similar characteristics (such as the degree of associated risk, the maturity) as the domestic interest rate, the interbank lending rate in this case. In this sense, the federal funds rate and the one-month treasury bill rate serve well as measures of the foreign interest rates. However, besides borrowing or investing in the domestic interbank market, Thai commercial banks and other financial institutions mainly borrow in the Eurodollar market (especially in Singapore, Hong Kong, and Japan) as an alternative source of funds. (Dejthamrong, 1988) Therefore, the better candidates are the Singapore interbank offered rates (SIBOR) and the London interbank offered rates (LIBOR), which usually move closely together. Since the SIBOR series before 1989 are not available, we use LIBOR.

**An exogenous shock to aggregate demand, caused by a shift in the IS curve**

and loan rates are too short to study.
There are several measures of an exogenous shock to aggregate demand, caused by a shift in the IS curve,\(^5^8\) such as the government budget deficit, fiscal surprises (measured as residuals from a univariate time-series model of government deficit), the government expenditure and exports. As mentioned earlier, the use of the government deficit in the estimation of the reduced form equation may cause endogeneity bias problems, downwardly biasing the estimator. Net exports, defined as the values of exports minus imports which is endogenously determined by income, also have the same problem. We will, therefore, experiment with government budget deficit, government expenditure, and exports as well.

**Expected exchange rate change**

Exchange rate in our model is defined as the price of foreign currency in terms of the domestic currency (Baht/U.S. dollar). The expected exchange rate change (expected rate of depreciation) may be proxied by the forward premium rate. However, Frankel and Froot (1990) point out that the drawback of using the forward premium rate is that if investors are risk-averse, then a time-varying risk premium may cause the

\(^{5^8}\) The IS curve describes the combinations of aggregate output and the real interest rate in which the goods market is in equilibrium, aggregate demand equals aggregate output produced. An exogenous change in any components of aggregate demand: consumer expenditure, investment spending, government spending, taxes, and net exports, which is unrelated to the real interest rate, causes a shift in the IS curve. (A change in the interest rate that affects equilibrium aggregate output only causes a movement along the IS curve) Mishkin (1992, p.554-585)

71
observed forward premium to deviate from the expected rate of depreciation that one wishes to measure. (see footnote 49 in chapter 4) Thus, they suggest using survey data as an alternative. Robinson, et.al. (1991) argue that for the case of Thailand, transactions in the forward exchange market are restricted. Therefore, the forward premium is not a good measure of the expected exchange rate change. They simply assume the expected exchange rate change equals zero since the nominal exchange rate during the period of their study is quite stable. Another approach is based on the assumption of the rational expectations, i.e., agents form expectations in the next period based on all relevant information available in the current period. As a result, the expected rate of depreciation in the next period will on average equal the actual rate of depreciation. In other words, this approach suggests the use of the actual values of exchange rate changes. (Pilbeam, 1992)

In the case of Thailand where a basket pegged exchange rate system is in use during the period of the study, the change in the level of international reserves may be a good proxy for the expected exchange rate change. If the level of international reserves falls (increase), the exchange rate is expected to depreciate (appreciate). Therefore, the change in the level of international reserves is negatively related to the expected rate of depreciation. Dejthamrong (1988) suggests another proxy for expected change in exchange rate,
the real effective exchange rate index, which is measured by the trade-weighted average of Thailand’s trading partners CPIs relative to the Thai CPI.\textsuperscript{59} A decrease in the index implies that Thai price is more expensive relative to foreign prices, increasing pressures for the devaluation of the Baht.\textsuperscript{60} Since survey data of the expected exchange rate and published series of the real effective exchange rate index are not available, we experiment with other proxies of expected exchange rate change: the forward premium, the change in the level of international reserves, the actual rate of changes in exchange rates, and an expected change in the exchange rate of zero.

**Anticipated inflation**

There are several ways to measure the expected price level or the expected inflation such as to model the price level as a univariate ARIMA process (Makin, 1982), or as an AR process (Edwards and Khan, 1985) or use the actual value (Robinson, et.al, 1991; Schadler, et.al., 1993). If the survey

\textsuperscript{59} The real effective exchange rate index may be defined in different alternatives. (see for example, Thanachanan, 1991, Suwanmana, 1992)

\textsuperscript{60} This is actually the case when the public expect the monetary authorities to adjust the nominal exchange rate in order to maintain the stable level of the real exchange rate, which is defined by the purchasing power parity (PPP) relation as \(X P' / P\). (The absolute form of PPP is shown as: \(P = P'X\) where \(P\) and \(P'\) are the domestic and the foreign prices, \(X\) is the exchange rate, defined as the domestic price of foreign currency) If \(P' / P\) decreases, \(X\) must increase (exchange rate devaluation) to keep \(X P' / P\) constant.
data are available, one can also use them.\(^{61}\) Another alternative which is employed by this study is atheoretical statistical procedure suggested by Mishkin (1982). The basic idea behind this approach is that a rationally formed expectation of a variable for period \(t\) should include any costless information available at time \(t-1\) that could be used to predict the variable. Thus the expected inflation specified under this method is in the form of a multivariate autoregressive model (MAR), rather than a univariate model. We will discuss more on the estimation procedure in section 5.4.

**Money surprise**

The money surprise or unanticipated money growth is measured by the difference between the log of current money supply and the log of the money supply at \(t\), anticipated as of \(t-1\) \((m_t - m_{t-1})\). The expected money supply can be estimated by the same method as the expected price level discussed above. The money surprise or unanticipated money growth is the residual from the estimated money growth equation. Both \(M1\), \(M2\) money supply are experimented.

The notations and definitions of the variables used in the models are shown in Table 8 in the appendix. Series of all domestic data are obtained from various issues of the Bank

\(^{61}\) The survey data for inflation expectations, called "Livingston data", are available for the U.S. and O.E.C.D. countries (Hoffman and Schlagenhauf, 1985).
of Thailand Quarterly Bulletin, except forward premium and monthly investment index which are obtained from Department of Economic Research, Bank of Thailand. Series of foreign data are obtained from various issues of International Financial Statistics (IFS).

5.2 Seasonally Adjusted Series

From figure 6.1, 6.2, 6.3 and 6.4, it is quite obvious that the series of monthly M1 and M2 money supply and their growth rates, proxied by the first difference of the log of the series, have seasonal components. Figure 7.1, 7.2, 8.1, 8.2, 8.3, 9.1, 9.2, and 9.3 also indicate seasonal pattern in monthly consumer price index (CPI), inflation (changes in log of CPI), government budget surplus (R-G), government expenditure (G), government revenue (R), net exports (X-M), exports (X), and imports (M) although at lesser degree than money supply. We therefore seasonally adjusted these series, using EZ-X11 program. The test results provided by the program indicate that the null hypothesis of no stable seasonality can be rejected (at 5% significant level) for all the series above. The program assumes that the series being adjusted

62 The money supply always increases at higher rates in June and reaches its peak in December. This could be a result of corporate income tax payments and then holiday season (New Year Day) during these two periods.

63 F-statistics for M1 = 70.33(.00), M2 = 36.25(.00), CPI = 11.68(.00), (R-G) = 10.13(.00), G = 10.71(.00), (X-M) = 3.74(.00), X = 5.27(.00), M = 3.67(.00). The series of investment index obtained from the Bank of Thailand do not
is the result of some combination (either multiplicative or additive) of non-seasonal factors, including trend-cycle and irregular components, and seasonal factors which are treated as "noise". By repeatedly estimating (using several types of centered moving averages) and extracting (by division or substraction) these components in various combinations, EZ-X11 eventually produces a final seasonally adjusted series which consists of the trend cycle and irregular components of the original series. Though there are other ways of dealing with seasonal variations such as the regression method using dummy variables, or the time series method (Box-Jenkins seasonal models or exponential smoothing), X11 is the most widely used and generally accepted method of seasonal adjustment. (Doan, 1990) Figures of all the seasonally adjusted series in this study are shown in the appendix.

5.3 Unit Root Tests of the Series

The first step we should do in estimating an economic time series model is to check whether the series of each variable in the model is generated by I(0) processes, ie.,

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show seasonal pattern. (see figure 10.1, 10.2) Its F-statistic is 1.033(.42), indicating that the null of no stable seasonality can not be rejected. We therefore use non-seasonally adjusted investment index.

whether the series is stationary. If the series is non-stationary but generated by integrated process (has a unit root in its autoregressive representation), the usual procedures of OLS analysis results in "spurious" correlations and valid inferences about the parameter estimates can not be made unless the variables in the system are cointegrated. (Stock and Watson, 1988) The standard test for a unit root is the Dickey-Fuller (DF) test based on the following equation:

\[ y_t = a + bt + cy_{t-1} + \epsilon_t \]  

5.1)

where \( a \) = constant term, \( t \) = time trend, \( y_t \) = the variable in question.

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65 The stochastic process is said to be weakly stationary if its mean, variance and covariances are independent of time. If it is also normally distributed, then it is strongly stationary. (Harvey, 1991, p.23-24)

66 This term was introduced by Granger and Newbold (1987) who gave special attention to the case where a random walk series is regressed on another independent random walk series.

67 This bias arises for two separate reasons. First, the estimates of the standard errors of the parameters are usually inconsistent due to considerable serial correlation which occurs as a result of a static regression. Second, the non-stationarity of the data induces "nuisance" parameters in the asymptotic distribution of the parameter estimates which means that the distribution of the parameter estimates is not generally normal. Thus, standard test statistics cannot be used without proper modifications.

68 In empirical applications in which knowledge of the value of the intercept \( a \) is unavailable, inclusion of a time trend is a prudent decision in performing unit-root tests because it makes the distribution of the autoregressive parameter estimate \( c \) independent of \( a \) even when the trend coefficient \( b \) is zero. (Schwert, 1989, p.150)
The DF test is simply a test of whether $c = 1$ in (5.1). In fact, it is common to rewrite (5.1) as:

$$\Delta y_t = a + bt + (c-1)y_{t-1} + \epsilon_t \quad 5.2$$

However, if $\epsilon_t$ in the above equation is not white noise which is usually the case in most time series, the asymptotic distribution of the $t$-statistic in DF tests depends on the correlation structure of the data. Therefore, to get rid of this dependency on nuisance parameters, the Augmented Dickey-Fuller (ADF) test is used instead. The ADF test is conducted by running OLS regression on the following equation:

$$\Delta y_t = a + bt + (c-1)y_{t-1} + \sum_{j=1}^{k} d_j \Delta y_{t-j} + \mu_t \quad 5.3$$

The null hypothesis to be tested is that the series has a unit root, i.e., $(c-1)$ in eq (5.3) = 0, and the alternative hypothesis is that the series is $I(0)$ or trend stationary.

Theoretically, the lag length ($k$) in the ADF test must be selected such that the residual ($\mu_t$) in the equation is a white noise.

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$^6$ The ADF test is basically based on the unit root test developed by Said and Dickey (1984). They argue that an unknown ARIMA $(p,1,q)$ process can be adequately approximated by an ARIMA $(k,0,0)$ where $k$ is a function of the number of observation. Schwert (1989) shows that when the data are not generated by a pure AR process but contains an MA component, the unit root test suggested by Said and Dickey (1984) is the best test in the sense that the distribution of the unit root test statistics is least sensitive to the presence of MA component, thus the test statistics are least different from the ones reported by Fuller (1976), Dickey and Fuller (1979, 1981). (see also McNown, 1989)
noise. In practice, the outcome of the test often depends on
the particular choice of $k$. The introduction of too many lags
may reduce the power of the test while too few lags may
adversely affect the size of the test. (Bonham, 1991) Here we
select the lag length according to a data-based procedure
suggested in Campbell and Perron (1991, p.155) because it is
likely to yield tests with better size and power properties. 70
The procedure is that to start with the upper bound on $k$,
called "$k_{max}$" where $k_{max} = \text{Int}\{12(T/100)^{1/4}\}$, $T$ = number of
observations, "Int" denoted integer, and estimate an
autoregression equation 5.3) of order $k_{max}$. If the last
included lag is statistically significant, $k = k_{max}$ is
selected. If not, we reduce the number of lags one by one
until the coefficient on the last included lag is significant.
If none is significant, $k_{max} = 0$ is selected, i.e, the ADF
test is equivalent to DF test in this case. Here, we start
with $k_{max} = 13$. 71 The results of the ADF tests of all the
series, including t-statistics and estimated coefficients of
the last lag of the first difference and of the first lag of
the level, are shown in Table 9 in the appendix. We find that

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70 Simulation evidence presented in Hall (1990) suggests
that such a data-based method induces little size distortion
in finite samples.

71 The period of the study here is January 1985 - November
1993, the number of observations is 107. "$k_{max}$" according to
the rule of thumb is $\{12(107/100)^{1/4}\} = 12.2$, rounded up to 13.
all the series considered in this study are non-stationary in levels.\textsuperscript{72} The next step is to check whether those series which are non-stationary in levels are stationary in first differences. Similarly, we apply unit root tests for these series, but in first difference forms. We find that all the above non-stationary series are stationary in the first difference form, except M2 money supply. Note that the first difference of the log of the consumer price index \((\log_{e}(P_{t}) - \log_{e}(P_{t-1}))\) measures the inflation rate and the first difference of log of money supply \((\log_{e}(M_{t}) - \log_{e}(M_{t-1}))\) measures the money growth rate. Both non-seasonally and seasonally adjusted inflation \((d\log_{e}(P), d\log_{e}(P))\) and M1 money growth rates \((d\log_{e}(M), d\log_{e}(M))\) are stationary while the M2 money growth rates are non-stationary.\textsuperscript{73} Further investigation

\textsuperscript{72} The series considered in this study are domestic interbank rate \((\text{inb})\), London-Eurodollar rate/London-interbank offer rate \((\text{lb})\), forward premium rate \((\text{fp})\), exchange rate, defined as domestic price of foreign currency \((\text{exch})\), international reserve, measured in U.S. dollar \((\text{IR})\), investment index \((\text{ivid})\), seasonally adjusted and unadjusted government budget surplus and government expenditure \((\text{gsur, sgsur, gep, sgep})\), seasonally adjusted and unadjusted M1, M2 money supply \((\text{m1, sm1, m2, sm2})\), seasonally adjusted and unadjusted consumer price index \((\text{p, sp})\). The complete definitions are shown in the appendix.

\textsuperscript{73} We initially selected lag length \((k)\) in ADF tests for the first difference of the log of seasonally unadjusted cpi \((\log_{e}(P))\) and seasonally adjusted cpi \((\log_{e}(P))\) according to the above procedure in which \(k = 11\) and \(7\) respectively. The ADF statistics show that \(d\log_{e}(P)\) and \(d\log_{e}(P)\) are \(I(1)\). Nevertheless, the residuals from the ADF test regression equations in both cases are not normally distributed. We then reduced the number of lag until we found the second significant lag which are 1 for \(d\log_{e}(P)\) and 2 for \(d\log_{e}(P)\). At these lag length, the ADF tests indicate that both \(d\log_{e}(P)\) and \(d\log_{e}(P)\) are \(I(0)\). Since the F-test
indicates that M2 money supply is I(2) and its growth rate is I(1). (see Table 11, Figure 11.2, and 11.4)

We must remind here that the above results of unit root tests are subjected to problems associated with a small sample size. First, the non-rejection of the null hypothesis of unit root may be due to misspecification of deterministic components regressors (such as a constant or a deterministic trend t). For example, if the deterministic regressors included in the unit root test omit a deterministic variable in the true data generating process (DGP), then the power of the test (the probability that the test rejects the null hypothesis of a unit root when a trend-stationary alternative hypothesis is true) reduces as the sample size increases. (Campbell and Perron, 1991, p.151) Thus, care must be exercised in choosing the appropriate deterministic regressors in order to have tests with reasonable power properties. 74

Second, in finite samples, any unit root process can be approximated arbitrarily well by a stationary process (in the sense that the autocovariance structures will be arbitrarily

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statistics show that the second to the eleventh lag for dlp and the third to the seventh lag for dlsp are jointly insignificant at 5% significant level, we decided to select k = 1 for dlp and = 2 for dlsp. Information criteria: SC, HQ, FPE also suggests selecting these lag length. Finally, the correlogram for both series (shown in the appendix) confirms that they are I(0).

74 Although a sequential test strategy as described in Perron (1988) may be useful when it is not clear which set of deterministic regressors should be included, we decide to include both a constant and a time trend. (see footnote 68)
close) and vice versa. This dual relationship may therefore give incorrect conclusions about unit root tests. For example, when the true DGP has a unit root but is close to being stationary, the unit root tests will have severe size distortions (increasing probability of type I error), i.e., they falsely reject the true hypothesis too often. In contrast, when the true DGP is stationary but has a root close to unity, the unit root tests will have very little power. (Campbell and Perron, 1991, p.159) Due to these problems associated with a small sample size, we must keep in mind that there exists the possibility of incorrect conclusions, especially when the results of unit root tests are not unambiguous such as the case of inflation (see footnote 73).

5.4 Proxies for Expected Inflation and Money Surprises

The method used in this study to measure the unobserved variables, the expected inflation rate and unanticipated money growth, is a theoretical statistical procedure suggested by Mishkin (1982). The basic idea behind this approach is that a rationally formed expectation of a variable for period \( t \) should include any costless information available at time \( t-1 \) that could be used to predict the variable. A set of macroeconomic variables (such as M1, M2, investment index, government deficits, international reserves, exchange rate)...

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75 Examples of other papers using this approach are Sheehy (1984), Hoffman and Schlenkner (1985) and Gochoco (1989).
can be tested based on the Granger-Causality tests whether they are in the information set that helps forecasting inflation in the next period.\textsuperscript{76} The expected inflation specified under this method is in the form of a multivariate autoregressive model (MAR). It is preferred, as compared to the univariate ARIMA model, since the ARIMA model assumes that the expected inflation is a function of only its own distributed lagged values and the distributed lagged values of error terms while the MAR model allows past values of any relevant variable to enter the expected inflation function. Granger-Causality, which is based on the hypothesis that "x causes y", can be tested by using OLS to estimate the following equation:\textsuperscript{77}

\[ y_t = \sum_{j=1}^{n} \alpha_j y_{t-j} + \sum_{j=1}^{g} \beta_j x_{t-j} + \mu_t \quad \text{(5.4)} \]

Then, testing the null hypothesis that the coefficients of \( x_{nj} \) for \( j = 1, \ldots, n \) are jointly insignificant. (ie, \( \beta_j = 0 \) for all \( j \)) If the null hypothesis is rejected, we conclude that x causes y, thus x is included in the forecasting equation for y. Note that in applying this approach, it is crucial to

\textsuperscript{76} The essence of Granger-Causality is that x causes y if taking into account of past values of x leads to improved predictions for y. The improvement of predictions for y is measured by the reduction in the variance of the one-step ahead prediction error. (see Harvey, 1991, pp.303-309)

\textsuperscript{77} Besides the Direct Test, there are also other types of Granger-Causality tests such as Sims' Test and Geweke's Test. (see Harvey, 1991, pp.306-307)
select the correct lagged length for \( x_t \) and \( y_t \) (\( m \) and \( n \)) to ensure that \( u_t \) is a white noise. We use the same method as selecting lag length in the ADF test. In addition, the variables \( x_{t,j} \) and \( y_{t,j} \) for all \( j \) must be stationary. If they are non-stationary and cointegrated, the Granger-Causality test must be conducted in the form of an error correction model.\(^78\) (see MacDonald, 1987 and McCullough, 1990) The results of Granger-Causality tests are shown in Table 12 in the appendix.

\(^78\) Since M1 money growth and inflation are both stationary series, the error correction model is not necessary.
CHAPTER 6
ESTIMATION RESULTS

6.1 The Estimated Equations for Inflation and Money Growth

The inflation rate and M1 money growth are found to be stationary during the period of the study, therefore, Granger-Causality tests are applied in the level form. Macroeconomic variables which are presumed to enter the information set of people's expectations of inflation rate and money growth rate include lagged values of inflation, money growth, changes in interest rates, the growth rate of government budget deficits, the growth rate of government expenditure, the growth rate of international reserve, and changes in the investment index (a measure of monthly economic activity). Granger-Causality tests show that the current value of the seasonally adjusted inflation rate is determined only by lagged values of inflation and lagged values of money growth rates while the current value of the seasonally adjusted M1 money growth rate

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79 Since "monthly GNP" is not available, the investment index is used as a proxy of economic performance. If monthly unemployment rate is available, it should also be included in the information set. Note that the investment index is defined as the weighted average of the percentage changes of 12-month backward moving average of the following components: construction areas permitted in municipal zone, domestic cement sales, domestic galvanized iron sheet sales, commercial banks' credit for construction and industrial firms, real private equity inflows, real value of machinery imports. The investment index data were obtained from the Bank of Thailand, Department of Economic Research.
is determined by lagged values of M1 money growth (dlsm),
lagged values of changes in the log of investment index
(dlivid), changes in interest rates (dinb) and changes in log
of seasonally-adjusted government expenditure (dlsgep). The
final estimated equations for the expected money growth
(dlsmi) and expected inflation rates (dlspi) are shown
below:

80 To test the jointly significance of the lagged values
of the presumed caused variable, the Lagrange Multiplier tests
(F-tests) for omitted dynamic variables are applied to the
model without the lagged values of caused variable. The null
hypothesis is that the lagged values of the presumed caused
variable are jointly insignificant (ie, the model without the
caused variable is correct), implying those are actually not
the caused variables. (see more details of the test in "PC-
GIVE: An Interactive Econometric Modelling System", Hendry,
1989, pp. 56-57) The results reject the null hypothesis, that
is, the lagged values of each of these variables are jointly
significant at 5% level. (see F-test statistics for Granger-
Causality tests in Table 12 in the appendix)

81 R^2 is the proportion of the variance of the dependent
variable which is explained by the variables in the
regression. It is defined as R^2 = \Sigma(y_t - \hat{y}_t)^2 / \Sigma(y_t - \bar{y}_t)^2 ; \bar{y}_t is the
mean of \bar{y}.

adr^2 is a measure of goodness of fit relative to \Sigma(\Delta y_t - s)^2
instead of \Sigma(y_t - \bar{y}_t)^2 in the denominator of \Sigma, where s denotes
the relevant seasonal mean. (eg. s is the monthly mean for
monthly data) Despite its definition, it can be negative which
implies that the fitted model does less well than a regression
of \Delta y_t on seasonal mean. (Hendry, 1989, p.42)

FPE = Final Prediction Error, SC = Schwarz Criteria, HQ
= Hannan-Quinn Criteria. They are information criteria in
selecting the best fitted model, defined as follows:

FPE = (T+k)\sigma^2/(T-k), SC = ln\sigma^2 + klnT/T, HQ = ln\sigma^2 +
2klnlnT/T where \sigma^2 = T\sigma^2/(T-k); \sigma^2 = equation error variance.

X^2 (r) and F-Form (r) are the Lagrange Multiplier test
for r\textsuperscript{th} order residual autocorrelation. (see critical values in
Table 10 in the appendix)

\sigma = Standard Error of the Regression, RSS = Residual Sum
of Squares, F(k-1, T-k) = F-statistics.

The numbers in the parentheses below the coefficient
estimates in the equations are t-statistics.
\[ \text{dlsm}_t^{e} = 0.02 - 0.029 \text{dlsm}_{t-1} + 0.003 \text{dlsm}_{t-2} + 0.049 \text{dlsm}_{t-3} \]
\[ \begin{align*}
& (3.80) \* (-0.265) \* (0.024) \* (0.455) \\
& - 0.042 \text{dlsm}_{t-4} - 0.092 \text{dlsm}_{t-5} + 0.027 \text{dlsm}_{t-6} \\
& (-0.385) \* (-0.871) \* (0.255) \\
& + 0.01 \text{dlsm}_{t-7} - 0.135 \text{dlsm}_{t-8} - 0.095 \text{dlsm}_{t-9} \\
& (0.095) \* (-1.29) \* (-0.878) \\
& + 0.0007 \text{dlsm}_{t-10} - 0.137 \text{dlsm}_{t-11} - 0.267 \text{dlsm}_{t-12} \\
& (0.006) \* (-1.272) \* (-2.51) \* \\
& + 0.131 \text{dliv}_{t-1} - 0.073 \text{dliv}_{t-2} + 0.026 \text{dliv}_{t-3} \\
& (1.64) \# (-0.853) \* (0.318) \\
& - 0.04 \text{dliv}_{t-4} - 0.125 \text{dliv}_{t-5} + 0.111 \text{dliv}_{t-6} \\
& (-0.507) \* (-1.56) \* (1.38) \\
& + 0.039 \text{dliv}_{t-7} - 0.062 \text{dliv}_{t-8} + 0.082 \text{dliv}_{t-9} \\
& (0.492) \* (0.772) \* (1.04) \\
& - 0.082 \text{dliv}_{t-10} - 0.118 \text{dliv}_{t-11} + 0.172 \text{dliv}_{t-12} \\
& (-1.03) \* (-1.47) \* (2.25) \* \\
& + 0.004 \text{dinb}_{t-1} + 0.039 \text{dlsgept}_{t-1} \\
& (2.30) \* (2.16) \* \text{eq. 6.1} \]

\[ R^2 = 0.39, \quad \text{ad}R^2 = 0.68, \quad F(26, 67) = 1.64(0.06) \]

\[ \text{FPE} = 0.0005, \quad \text{SC} = -6.83, \quad \text{HQ} = -7.26, \quad \text{RSS} = 0.028, \quad \sigma = 0.02 \]

\[ \text{DW} = 1.98, \quad \chi^2(6) = 5.086, \quad F\text{-Form}(6, 61) = 0.58(0.7436) \]

"*" and "#" above t-statistics indicate significance of the variable above, at 5% and 10% significant level respectively. These notations apply to all estimated equations in this study.
\[
dlspe_t = .003 -.106 dlspt_{t-1} -.129 dlspt_{t-2} -.021 dlspt_{t-3} \\
\quad (1.6) (-.98) (-1.21) (-.20) \\
+ .047 dlspt_{t-4} + .154 dlspt_{t-5} + .163 dlspt_{t-6} \\
\quad (.47) (1.53)^\# (1.61)^\# \\
+ .009 dlsmt_{t-1} - .017 dlsmt_{t-2} + .025 dlsmt_{t-3} \\
\quad (.44) (-.88) (1.25) \\
- .019 dlsmt_{t-4} + .008 dlsmt_{t-5} - .015 dlsmt_{t-6} \\
\quad (-1.01) (.04) (-.79) \\
+ .019 dlsmt_{t-7} + .023 dlsmt_{t-8} + .003 dlsmt_{t-9} \\
\quad (1.0) (1.17) (.14) \\
+ .002 dlsmt_{t-10} - .013 dlsmt_{t-11} - .055 dlsmt_{t-12} \\
\quad (.09) (-.69) (-2.81)^* \\
+ .009 dlsmt_{t-13} + .002 dlsmt_{t-14} + .079 dlsmt_{t-15} \\
\quad (.44) (.12) (3.87)^* \text{ eq. 6.2) }
\]

\[R^2 = .36, \quad \text{adR}^2 = .64, \quad F(21, 69) = 1.84 (.0313), \quad \sigma = .004\]

\[FPE = .00002, \quad SC = -10.27, \quad HQ = -10.63, \quad RSS = .001\]

\[DW = 2.05, \quad \chi^2(6) = 5.354, \quad \text{F-Form}(6, 63) = .66(.6848)\]

where \( p_t \) = the monthly consumer price index at time \( t \)

\( m_t \) = the M1 money supply at time \( t \)

\( dlspt \) = the first difference of the log of seasonally adjusted monthly consumer price index, measured inflation rate at time \( t \)

\( dlsm_t \) = the first difference of the log of seasonally adjusted M1 money supply, measured seasonally adjusted M1 money growth rate at time \( t \)
\[ \text{dinb}_t = \text{the first difference of the domestic interbank rate at time } t \]

\[ \text{dliv}_t = \text{the first difference of the log of investment index, measured the rate of change of the monthly investment index at time } t \]

\[ \text{dlsgep}_t = \text{the first difference of the log of seasonally adjusted government expenditure, measured the rate of change of the monthly government expenditure.} \]

"s" indicates seasonally adjusted, "d" indicates the first difference of the series, "I" indicates log, and "e" above \( \text{dlsPt} \) and \( \text{dls~} \) indicates "expected values".

We initially included the first to the twelfth lagged values of \( \text{dlsm} \) and of \( \text{dliv} \) in the estimated money growth equation, in which the summations of the coefficient estimates are -.701 and .184 respectively. To obtain a more parsimonious model for the expected money growth, we then excluded the first to the eleventh lags since the F-test statistics show that they are jointly insignificant at 5% level.\(^{82}\) For the estimated inflation equation, however, we cannot exclude the first to the eleventh or to the fourteenth lagged of \( \text{dlsm} \) though they are jointly insignificant because residuals from the regression equation are not normally

\(^{82}\) F-tests for adding \( \text{dlsm}_{t-1}, \text{dlsm}_{t-2}, \ldots, \text{dlsm}_{t-11} \) and \( \text{dlivid}_{t-1}, \text{dlivid}_{t-2}, \ldots, \text{dlivid}_{t-11} \) into 6.1) are \( F(11,67) = .54(.8720) \), and \( F(11, 78) = 1.58(.1205) \) respectively.
distributed without these lagged values.\textsuperscript{83} Equation 6.1) and 6.2) pass various diagnostic tests provided by the PC-GIVE program, including tests for autocorrelation, for unconditional and conditional heteroscedasticity, for normality, and for omitted variables. Thus we use the fitted values from equation 6.2) as the proxies for the expected rate of inflation (Figure 16) and the residuals from equation 6.1) as the proxies for unanticipated money growth or money surprises. (Figure 15.1 and 15.2)

We may explain people's expectation on money growth rate as follows: money growth this period is positively related to changes in investment index during last twelve months (d\textsubscript{liv}\textsubscript{ij} for \( j = 1, \ldots, 12 \)) and changes in interest rates and government expenditure last month (dinb\textsubscript{t}, dlsgep\textsubscript{t}) while negatively related to money growth rates during last twelve months (dlsm\textsubscript{ij} for \( j = 1, \ldots, 12 \)). That is, people believe that monetary authorities take into account both long-run and short-run indicators of market conditions and try to accommodate them. In other words, increases in interest rates, rate of change of the investment index and rate of change of the government expenditures in the past, indicating increases in the demand for credit, cause the authorities to pursue a "lean toward the wind" policy by raising money growth in this period. The authorities, however, make sure that money growth rate this

\textsuperscript{83} Chi-Squared Test for normality of residuals: \( \chi^2(2) = 22.577 \) for eq.6.2) when dlsm\textsubscript{t1}, \ldots, dlsm\textsubscript{t14} are excluded.
period is appropriate, compared to the rates during last twelve months. Expected inflation equation (6.2), in which the summations of the coefficient estimates of dlsp
i,j and dlsm
i,j are .108 and .053 respectively, implies that in forecasting the expected inflation rate this month, people take into account the inflation rate during last six months and M1 money growth rate during last fifteen months.

6.2 Cointegration Tests

As discussed in section 5.1 that we will experiment with a few proxies for expected changes in exchange rates, we proceed in this section with the case of forward premium first, then the case of zero expected changes in exchange rates, and finally the case of other proxies such as actual exchange rate changes and changes in international reserves.\(^4\)

a) The Case of Covered Interest Parity (Forward Premium)

Since the domestic interest rate (inb), the foreign interest rate plus forward premium (lbfp), and the seasonally adjusted government budget surplus, defined as revenue minus expenditure (sgsur) are found to be non-stationary (integrated at order 1), the OLS estimation on the semi-reduced form of the interest rate (4.11)', which is expressed in the level

\(^4\) Note that if economic agents are risk averse, forward premium will capture both expected changes in exchange rates and a risk premium. Other proxies capture purely expected exchange rate changes.
form, may lead to spurious regression as aforementioned. We must estimate the interest rate in first differences which are stationary. Nevertheless, if the long-run relationship among these three variables exists, i.e., they are cointegrated, then the "error correction model" for domestic interest is needed.85

Therefore, we conduct the "cointegration test", using the two-step procedure suggested by Engle and Granger (1991). First, using monthly data during the period of 1989.07-1993.11, we run OLS regression of domestic interbank rate (inb) on the London-interbank offered rate (LIBOR) plus forward premium (lbfp) and the seasonally-adjusted government budget surplus, revenue minus expenditure (sgsur). It yields the following cointegration equation: (refer to definitions of test statistics in Table 10 in the appendix)

\[
\text{inb}_t = 0.775 + 0.878 \text{lbfp}_t + 0.00007 \text{sgsur}_t \\
\text{eq.6.3)
\]

\[
R^2 = .873, \text{adR}^2 = .358, F(2,50) = 193.23(.00), \sigma = 1.124 \\
\text{DW} = 1.48, \chi^2(1) = 3.205^f, F-\text{Form}(1,49) = 3.15(.082)^f \\
\text{FPE} = 1.34, SC = .401, HQ = .3322, RSS = 63.209
\]

85 The integrated series, I(1), are said to be cointegrated if there exists a linear combination among them such that it is both I(0) and has a zero mean. (Engle and Granger, 1991)

The error correction model is considered to be superior, compared to the first difference form because it includes not only short-run dynamic specification but also long-run property of the variable which appears in the error correction term.
Note that in the cointegration equation, the parameter estimates are super-consistent but do not have standard normal distributions and its standard error estimate is biased and inconsistent. Therefore, the standard t-statistics (the numbers in the parentheses below coefficients estimates) though reported, are misleading. (Engle and Granger, 1987)86 We will discuss more on conducting inference from cointegration regressions in the next section.

In the second stage, we run an ADF test on the residuals (which is usually called "the error correction term") obtained from the above estimated equation, \( r_1_t \). (see Table 13 in the appendix) If the series are cointegrated, then the residual \( r_1_t \) will be stationary. Thus, the null hypothesis is that there is a unit root in the residuals (i.e., the null of non-cointegration) while the alternative hypothesis is that there exists at least one cointegrating relationship. The critical values of the unit root test on the residuals, however, are not the same as those for unit root tests applied to raw data. They also depend on the number of integrated regressors, and whether a constant or a time trend are included in the static regression. We use the critical values provided by Engle and Yoo (1987) where a constant is included in the static cointegrating regression. (see Table 15)

The results show that the null hypothesis is rejected at 5% significant level, thereby, the cointegrating (long-run

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86 See Section 5.1 for detailed explanation.
equilibrium) relations exist among these three series.\textsuperscript{87} However, the cointegrating parameters may not be unique because there are three I(1) series. Excluding one of the right-hand side variables or using different left-hand side variables may yield a different vector of cointegration parameters. Since the objective of this study is to find the determinants of the domestic interest rate, we always use the domestic interest rate (inb) as a left-hand side variable.\textsuperscript{88} Nonetheless, we estimate two other alternative cointegration regressions: one without government budget (sgsur), the other without foreign interest rate plus forward premium (lbfp), then examine their cointegration relations. Hall (1986) and Miller (1991) use this procedure and select the cointegration regression which has highest adjusted coefficient of determination ($R^2$) because it minimizes the potential bias in the estimates of the cointegration parameter.\textsuperscript{89} The other two cointegration regressions are shown below:

\begin{itemize}
  \item The ADF statistics is - 4.58. Its absolute value exceeds the critical value for three I(1) series in cointegrating vector which is 4.11 at 5\% significant level and for sample size equal to 50. (Engle and Yoo, 1987)
  \item $X^2(1)$ indicates significance of the first order autocorrelation of the errors at 10\% significant level.
  \item In other words, we assume that the variable "inb" (domestic interbank rate) has a nonzero coefficient (unity in this case) in the cointegrating vector.
  \item We may also use information criteria such as FPE, SC, and HQ in selecting the cointegration regression.
\end{itemize}

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\textsuperscript{88} In other words, we assume that the variable "inb" (domestic interbank rate) has a nonzero coefficient (unity in this case) in the cointegrating vector.

\textsuperscript{89} We may also use information criteria such as FPE, SC, and HQ in selecting the cointegration regression.
\[ \ln b_t = 0.845 + 0.924 \ln b_{fp_t} \quad \text{(1.68) (18.05) eq.6.4) \]
\[ R^2 = 0.86, \quad \text{ad}R^2 = 0.316, \quad F(1,51) = 325.85(0.00), \quad \text{FPE} = 1.37 \]
\[ DW = 1.36, \quad \chi^2(1) = 4.638^*, \quad F-\text{Form}(1,50) = 4.80(0.0332)^* \]

\[ \ln b_t = 6.906 + 0.0037 \text{ sgsur}_t \quad \text{(9.61) (4.16) eq.6.5) \]
\[ R^2 = 0.253, \quad \text{ad}R^2 = -2.77, \quad F(1,51) = 8.96(0.0043), \quad \text{FPE} = 7.56 \]
\[ DW = 0.851, \quad \chi^2(4) = 29.3^{**}, \quad F-\text{Form}(4,47) = 14.53(0.00)^{**} \]

The ADF test statistics for residuals from equation 6.4, \( r_{2t} \), and equation 6.5, \( r_{3t} \), are -4.171 and -2.310 respectively, i.e., the null hypothesis of non-cointegration can be rejected for eq. 6.4 but cannot be rejected for eq. 6.5 at the 5% significant level. The domestic interbank rate is not cointegrated with the seasonally adjusted government budget but is cointegrated with London Eurodollar rate plus forward premium. However, equation 6.3 indicates that domestic interbank rate may also be cointegrated with a linear combination of \( \ln b_{fp} \) and \( \text{sgsur} \). Hence, we conclude that there are two possible vectors of the long-run equilibrium equation of domestic interbank rates; equation 6.3 (with slightly higher \( R^2 \)) and equation 6.4.

---

\[ ^{90} \text{The correlogram indicates stationary errors from equation 6.4) and non-stationary errors from equation 6.5), confirming the ADF test results. Moreover, the very low value of DW statistics from equation 6.5) signals non-cointegration. (Miller, 1991) \]
b) The Case of "Zero" Expected Changes in Exchange Rates

Some previous studies of developing country cases (e.g. Robinson, et al., 1991; Techaratanawiroj, 1992) suggest the exclusion of forward premium from the regression equations above due to the following reasons. First, the institutional problem: forward exchange markets in most developing countries, including Thailand are quite shallow. Most of the transactions in financial markets are not covered by the forward rate, therefore, the forward premium is not a good measure of expected changes in exchange rates. Second, countries with fixed exchange rate systems and economic stability tend to have minimal exchange rate changes, therefore, it is reasonable to assume that economic agents expect zero changes in future exchange rates. Third, the econometric problem: commercial banks usually quote forward premium according to interest rate differentials, therefore, the inclusion of both forward premium and foreign interest rates may force the regression equation to be identity. As a result, coefficient estimates of other variables in the equation are more likely to be insignificant. To experiment with this assumption, we reestimate equation 6.3) and 6.4) without the forward premium and conduct cointegration tests.91

91 We experiment with this assumption because it is not only simple but also gives possible results of the other extreme case. The coefficient estimate of LIBOR approximates the possible minimum value for the degree of financial openness because the measure of expected exchange rate change
rate is not cointegrated with the LIBOR rate alone but is cointegrated with both the LIBOR rate and the government budget (sgsur). Therefore, the possible cointegration equation in the case of zero expected changes in exchange rates is shown below.

\[ \ln b_t = 2.69 + 0.901 \ln b_{t-1} + 0.0002 sgsur_t \]

(3.467) (7.175) (3.578)

\[ R^2 = 0.632, \text{ adj} R^2 = -0.86, F(2,50) = 42.96(.00), \text{ FPE} = 3.87 \]

\[ DW = 1.17, \text{ CHI}^2(7) = 14.198^*, F-\text{Form}(7,48) = 2.25(.0485)^* \]

The plot of interest rate differentials (unadjusted by forward premium) in figure 24.4 supports the above result of non-cointegration between domestic and foreign interest rates. The domestic interest rate did not move in line with the foreign interest rate during the period of 1985 to the beginning of 1986, and the period of 1989 to 1993. High values of interest rate differentials during the period of 1989 to the first half of 1991 could have occurred as a result of high credit demand since the economy was expanding rapidly. To induce more saving to keep up with higher level of investment, the authorities dismantled interest rate ceilings on time deposits in June 1989 and raised the interest rate is actually omitted.

92 The ADF for the residuals from the former (r5) and the latter cases (r6) are -4.345, and -2.466 respectively.
ceilings on saving deposit from 7.25 to 9 and 12 percent in March and November 1990 respectively. The authorities at the same time raised the interest rate ceilings on loans to restrain credit extension, especially in non-productive activities. The first deregulation of foreign exchange controls which occurred in May 1991 induced more capital inflows. The domestic interest rate decreased slightly as a result of high liquidity. However, the interest rate differential still prevailed, approximately 4 percent, during 1992 to 1993. Perhaps, this was due to political instability which occurred both domestically (the coup in May 1992) and abroad (in Russia in March 1993). (Chaiyasoot, 1992)

c) The Case of Other Proxies of Expected Changes in Exchange Rates

To investigate the case of international reserves as a proxy for expected devaluation, we regress changes in the log of exchange rates on lagged values of itself and lagged values of changes in the log of international reserves. None of the coefficient estimates are significant, implying that changes in international reserves do not (Granger) cause an ex-post expected devaluation. (see Figure 17.1, 17.2, and 17.3) We then experiment with the level of international reserves which is I(1) series by regressing the domestic interest rate on the LIBOR rate, the log of international reserves, and the
government budget (sgsur). The regression equation is shown below. 93

\[ \ln b_t = -68.33 + 1.85 \ln b_{t-1} + 6.85 \ln IR_t + .0001 \text{sgsur}_t \]
\[ (-2.18) \quad (4.64) \quad (2.28) \quad (3.47) \quad \text{eq. 6.6.a} \]
\[ R^2 = .667, \quad \text{ad}R^2 = -.68, \quad D-W = 1.01, \quad \chi^2(4) = 14.912^* \]

The coefficient of the log of international reserves has a wrong positive sign. Theoretically, a decrease in the level of international reserves leads to an expectation of a devaluation of the home currency, and thus a rise in the domestic interest rate, given that there is no sterilized intervention by the authorities. The positive sign here may appear, however, as a result of the endogeneity of the level of international reserves. A drop in the domestic interest rate in a relatively open economy with a fixed exchange rate regime induces capital outflows, and thus a decline in the level of international reserves.

Thus we experiment with another proxy of expected changes in exchange rates, the actual values. To be consistent with domestic and foreign interest rates which are measured in terms of percent per annum, we multiply the monthly changes of log of exchange rates by 1200 in order to have percentage

93 The estimated equation with the level of international reserves, IR, (instead of the log form) yields the same qualitative results, i.e., the coefficient of IR is positive.
changes of exchange rates per year (\%ydle). The regression equation is shown below.

\[ \text{inc}_t = 8.413 + .027 (\text{lb+\%ydle})_t + .0001 \text{sgrs}_t \]

(13.34) \hspace{1cm} (.386) \hspace{1cm} (2.987) \hspace{1cm} \text{eq. 6.6.b) } \\
R^2 = .152, \text{adR}^2 = -3.29, \text{D-W} = .46, \chi^2(4) = 37.632^*

Incorporating percentage changes in annualized monthly exchange rates with the foreign interest rate (LIBOR) depresses the estimated coefficient of the combined variable (lb+\%ydle). Experimentation with this approach is also unsatisfactory.\(^*\) Thus, we will focus only on the first two cases, forward premium and zero expected exchange rate changes, hereafter.

At this point, we must remind that problems with a small sample size exist for the cointegration tests as well as for unit root tests mentioned earlier. Every cointegrated process can be arbitrarily well approximated, in finite samples, by a non-cointegrated process and vice versa. In the case that these two processes are near-observational equivalent, the size and power of the tests are affected. Thus the results of cointegration tests could be inaccurate. (Campbell and Perron, 1991, p.183)

\(^*\) Schadler et.al. (1993, p.33) found similar results when experimenting with the same approach.
6.3 Asymptotically Efficient Estimations and Inferences of the Long-Run Cointegration Regressions

Let \( y_1_t \) be a scalar and \( y_2_t \) be a \((g\times1)\) vector satisfying the following equations:

\[
\begin{align*}
  y_1_t &= a + b'y_2_t + u_1_t \quad (6.7) \\
  y_2_t &= y_2_{t-1} + u_2_t \quad (6.8)
\end{align*}
\]

where \( y_1_t, y_2_t \) are both \( I(1) \), and \( u_1_t, u_2_t \) are both \( I(0) \). Thus \( n = (g+1) \) dimensional vector \((y_1_t, y_2_t)\) is cointegrated with cointegrating relation \( 6.7 \).

Although OLS estimates of the parameters in the cointegrated vector \((a \text{ and } b')\) are superconsistent, \(\text{(i.e., converge to the true values at faster rate } T, \text{ rather than the usual rate of } T^{1/2})\), they are biased in finite samples and their asymptotic distributions are nonstandard and depend on nuisance parameters.\(^{95}\) These nuisance parameters result in two typical problems: (Phillips and Hansen, 1990)

1. Serial correlation of the errors \( u_1_t \)
2. Endogeneity of the regressors \( y_2_t \), which occurs when the innovations in \( y_1_t, u_1_t \), Granger cause the innovations in \( y_2_t, u_2_t \).

Therefore, valid inferences about parameters in the cointegrating regression, based on the usual \( t \) and \( F-\)

\(^{95}\) Simulation studies (see, in particular, Banerjee et al., 1986) show that in finite samples the OLS procedure can lead to severe biases which often decrease only slowly with the sample size. (Campbell and Perron, 1991, p.186)
statistics, cannot be made without prior correction for these problems.  

6.3.1 Estimation Procedure

Previous literature suggests several correction methods (by the single equation estimation) so that the asymptotically efficient estimates of the cointegrating vector (which are equivalent to the full information maximum likelihood estimates, FIMLE) can be obtained and hypothesis testing is possible. They are, for example, a fully modified OLS estimator of Phillips and Hansen (1990), P-H, a modified NLS estimator of Phillips and Lorentan (1991), P-L, and a modified OLS estimator of Saikkonen (1991). We follow the correction procedure suggested by Saikkonen (1991) since it does not require the initial estimation of the model, which may be critical to the performance of the fully modified estimator,

\[ y_{2t} = Ay_{2t-1} + u_{2t}, \text{ eq. 6.8)' } \]

where \( A \) has stable roots, then 6.7) and 6.8)' is a conventional simultaneous equation model.

\[ \text{In the case that } y_{2t} \text{ is } I(0), \text{ for example, equation 6.8) is replaced by 6.8)' below} \]

\[ y_{2t} = Ay_{2t-1} + u_{2t}, \quad \text{eq. 6.8)' } \]

\[ \text{In standard estimation problems an asymptotically efficient estimator is an unbiased estimator which has minimum variance within the same class of other unbiased normal estimators. (Saikkonen, 1991, p.2) See formal definition in Judge et.al (1998, p.87)} \]

\[ \text{There are several reasons to consider single equation estimation methods. First, they are usually easier to apply. Second, pretesting issues for unit roots are likely to be more severe in systems estimation than in single equation estimation procedure. Third, in any system estimation, including Johansen (1988) approach, the estimates of one equation are sensitive to possible misspecification in another equation. (Campbell and Perron, 1991, p.188)} \]
as in P-H procedure. It also has a computational advantage over the NLS estimation of P-L.

Saikkonen (1991) procedure to correct for serial correlation of the errors and possible endogeneity bias of the regressors in the cointegrated system is illustrated as follows.99

First, adding lags and leads of $\Delta y_2_t$ and $\Delta y_3_t$ to the cointegration regression 6.7), then OLS estimating the resulting equation, as written below:

$$y_1_t = a + b'y_2_t + \sum c'_j \Delta y_{2t_j} + \sum d'_j \Delta y_{3t_j} + z_t \quad 6.9$$

where $y_1_t$ is a scalar, $y_2_t$ is a (gx1) vector, $y_3_t$ is a (hx1) vector, $z_t$ is I(0) and uncorrelated with $\Delta y_{2t_j}, \Delta y_{3t_j}$ for all $j$. $\Delta y_3_t$ is a vector of stationary variables, capturing some features of the short-run dynamics of equation 6.7) or the deviation from the long-run equilibrium $y_1_t$, that cannot be explained by $\Delta y_2_t$ (or $u_2_t$). The inclusion of $\Delta y_3_t$ should reduce the variance of the regression equation and improve the efficiency of the estimation of equation 6.7). (Saikkonen, 1991, p.10)

Thus the regression equation 6.9) captures both long-run and short run dynamic of $y_1_t$: the coefficient estimates of $b'$ capture the long-run impacts of $y_2_t$, while the coefficient

99 Non-technical elaboration of this procedure and examples suitable for applied researchers is also available in Hamilton (1994, p.608-612)
estimates of current values of $\Delta y_2_t$ and $\Delta y_3_t$ ($c'_j$ and $d'_j$ for $j=0$) capture the short-run impacts of $\Delta y_2_t$ and $\Delta y_3_t$ on $\Delta y_1_t$, respectively. The coefficients of lags and leads in the equation may be difficult to interpret in economic sense because it is merely a result of a statistical procedure to correct for serial correlation of the errors and the endogeneity of the regressors respectively. \(^{100}\) (Saikkonen, 1991, p.12)

Theoretically, the number of leads and lags ($-m, -n, m, n$) should be so large that the vectors of estimates $c'$ and $d'$ are effectively zero for $|j| > m, n$, then $z_t$ is serially uncorrelated. It is not feasible, however, for OLS estimation if $k$ is too large compared with the sample size $T$. In practice, some experiment with a few number of $k$ may be advisable. Furthermore, leads may not be necessary if there are prior reasons to believe that $y_2_t$ or $y_3_t$ are strongly exogenous.

Second, in the case that $z_t$ in equation 6.9), is not white noise, we approximate its data generating process by a $p$-order autoregressive model, AR($p$). Let $r_t$ denote the sample residual resulting from OLS estimation of equation 6.9), then regress $r_t$ on $p$ of its own lags, as below.

\(^{100}\) Since $u_1_t$ Granger causes $u_2_t$, future values of $u_2_t$ will contain information that is useful in predicting $u_1_t$. By adding lags and leads of $\Delta y_2_t$, which is equivalent to $u_2_t$ to equation 6.7), we can purge from $u_1_t$ the part which is correlated with $y_2_t$. 

104
where $e_t$ is white noise error.

Third, to test the hypothesis about coefficient estimates of the cointegrated vector $y_t$ in equation 6.7), the OLS t or F statistics obtained must be modified as follows.

$$t^* = t \times \left( \frac{\sigma_t}{\lambda} \right)$$

$$F^* = F \times \left( \frac{\sigma_t}{\lambda} \right)^2$$

where $\times$ denotes multiplication

$\sigma_t$ is the standard error of the regression of equation 6.9)

$$\lambda = se/(1 - \alpha_0 - \alpha_1 - \ldots - \alpha_p);$$  
se and $\alpha_j$ are the standard error of the regression and coefficient estimates of equation 6.10) respectively.  

The modified OLS t and F statistics, $t^*$ and $F^*$, can be compared with the usual t and F tables for hypothesis tests.

In conclusion, the procedure just described estimates the regression equation 6.9) by OLS and makes adjustments to the usual t and F statistics. It is the simplest approach but yields asymptotically efficient estimators of the cointegrating system, which are equivalent to a full system MLE. Furthermore, the regression equation 6.9) requires

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101 If the residual $z_t$ is white noise, the OLS estimation of the AR(p) model in the second step can be skipped, then $\lambda = 1$ in this case.

102 More recent approach, by Stock and Watson (1993), suggests first OLS estimating equation 6.7), then using the residuals to construct a consistent estimate of the
incorporates both the long-run equilibrium relation and short-run dynamics of the system of variables. Thus, the estimation of the error correction model, following Engle and Granger's two-step procedure, is not necessary. In fact the Saikkonen's procedure is superior in the sense that we can also test whether the coefficient estimates of the variables in the long-run cointegration relation are significant.

6.3.2 Estimation Results

The results of cointegration tests from section 6.2 suggest three possible cointegrating equations, two for the case of forward premium as a proxy for the expected change in exchange rate (equation 6.3, 6.4) and one for the case of zero expected change in exchange rate (equation 6.6). In this section, we investigate the variables which significantly determine both the long-run equilibrium and the short-run movement of the domestic interest rate by the estimation procedure and hypothesis tests described in section 6.3.1.

a) The Case of Forward Premium as a Proxy for Expected Changes in Exchange Rates

The regressors, $y_{2t}$, in our study are London interbank offered rates plus forward premium (lbfp) and the seasonally adjusted government surplus (sgsur), defined as government revenue minus government expenditure (R-G) while the

autocorrelation of $z_t$ as in equation 6.8) and finally reestimating the equation by generalized least squares (GLS). The resulting GLS standard errors could be used to construct asymptotically $\chi^2$ hypothesis tests. (Hamilton, 1994, p.613)
stationary series, $\Delta y^3_t$, are seasonally adjusted expected inflation ($dlsp^t$) and unanticipated M1 money growth ($dlusml^t$). Since the theoretical model proposed in chapter 4 suggests that expected inflation may affect the natural component of the real rate while money surprise influences short-run cyclical components of the real rate, we expect that including them in the regression equation 6.7) will result in more efficient estimators of the long-run cointegrating parameters.

All the regressors are less likely to be strongly exogenous: the forward premium may be determined by interest rate differentials, and the government budget surplus includes tax revenue which is endogenously determined by income. Therefore, we initially include both lags and leads of the regressors to correct for possible endogeneity bias.\[^3\] The numbers of lags and leads are limited by a small sample size of 50, (89.07–93.08). We thereby arbitrarily started with 4 lags and 3 leads for each regressors, then followed Hendry's "General-to-Specific" modeling strategy to eliminate lags and leads with insignificant parameter estimates.\[^4\] This strategy essentially consists of formulating and estimating a general unrestricted autoregressive distributed lag (ADL)


\[^4\] For detailed elaboration and examples of "General-to-Specific" modeling method, see Charemza and Deadman (1992); Hendry (1986, 1987, 1989); Gilbert (1986); Davidson, et.al. (1978); Miller (1991).
model, and successive testing for particular restrictions by the use of Lagrange Multiplier (LM or LMF) or Wald tests. (Chremza and Deadman, 1992)

After 11 steps of model reduction procedure by the use of test statistics provided in PC-GIVE software, we end up with the final corrected cointegration regression written below.\(^\text{105}\)

\[
\ln b_t = 2.409 + .73\ lbf_{t} + .00067\ sgsur_t
\]
\[
\begin{align*}
(4.168)^* & \quad (12.306)^* \quad (1.505) \\
- .015\ %usm_{t} & - .104\ %usm_{t+1} & - .17\ %usm_{t+2} & + .30\ dBfp_t \\
(-.215) & \quad (-1.373) & \quad (-2.149)^* & \quad (2.30)^* \\
+ .005\ sgst_{t+1} & - .034\ sgst_{t+2} & - .039\ sgst_{t+3} \\
(.356) & \quad (-2.37)^* & \quad (-2.687)^* & \text{eq. 6.11}
\end{align*}
\]

\[
R^2 = .908, \ aR^2 = .63, \ F(9,40) = 44.05(.00), \ \sigma = .939
\]

\[
DW = 2.095, \ \chi^2(5) = 6.217, \ F-\text{Form}(5, 35) = .99(.4356)
\]

\[
SC = .4343, \ HQ = .1976, \ FPE = 1.06, \ RSS = 35.31
\]

"sgst\text{h}" denoted the rate of change (per month) of the seasonally adjusted government surplus, and "%usm\text{1}" denoted

\(^{105}\) The LMF test statistic for the validity of each restriction imposed in each step of model reduction and the information criteria (Schwarz criterion, RSS, and standard error of the regression) are reported in the appendix. Note that all the models in the reduction process pass standard diagnostic tests: LM tests for autocorrelated residuals and autoregressive conditional heteroscedasticity (ARCH), tests for unconditional heteroscedasticity, normality, and functional form mispecification. (see Hendry, 1989, p.54-58)
the unanticipated M1 money growth rate (percent per month). The definitions of the other variables are the same as above.

The diagnostic tests and correlogram of the residuals of equation 6.11) suggest that they are white noise, i.e., serially uncorrelated and normally distributed with zero mean and constant variances. Thus λ in this case equals to 1. (refer to Section 6.3.1) We only need to multiply the usual t-statistics by the standard error of the regression equation 6.11, σ, which equals to .939. The figures in the parentheses under coefficient estimates are the "modified" t-statistics.

The regression results show that only the foreign interest rate adjusted by forward premium (lbfp), has positive significant impact on the long-run equilibrium domestic interest rate. Although domestic factors such as expected inflation, money surprises, and government budget, do not have a direct long-run impact, they may influence domestic interest rates indirectly through their impacts on the forward premium. For example, a fiscal shock which results in a large current account deficit and reducing international reserves may cause an expectation of devaluation, captured by a rise in the forward premium. The domestic interest rate increases as a

106 The usual t-statistics for lbfp and sgdef equal 13.099 and 1.602, respectively. F-test statistic for the joint significance of $sgat_h,_{+j}$, for $j = 1, 2, 3$ is $F(3, 43) = 3.43(.0253)$.

107 Seasonally-adjusted government budget is significant only at 10% level.
result. The regression equation of the domestic interest rate without forward premium in the next section (case b) would support this argument if the coefficient estimates of the government surplus, expected inflation, or money surprises become significant or have higher values.

The summation of the coefficient estimates of $\%usml_t; t = 0, \ldots, 2$, and its t-statistic are -.289 and -2.368, implying that although money surprises are not in the long-run cointegrating relationship, it negatively influences the movement of domestic interest rates in the short-run.\textsuperscript{108} This result is consistent with the theoretical model in chapter 4 which explains that if actual money growth rate is greater than the expected rate and prices are sticky in the short-run, then the unanticipated money will depress the real rates. When prices and real income adjust sufficiently to absorb the excess money, the interest rate will be restored to equilibrium level in the long-run. Since the coefficient estimates of the money surprise in the current and the last period are insignificant, its impact on domestic interest rates occurs with a two period lag. The short-run movement of domestic interest rate is also positively influenced by the change in foreign interest rates (LIBOR) plus forward premium.

Based on equation 6.11), we conclude that domestic interest rates are mainly determined by foreign interest rates

\textsuperscript{108} The F-test statistic for joint significance of $\%usml_t; j$, for $j = 0,1,2$ is $F(3,40) = 2.56(.0683)$. 

110
and forward premium, both in the long-run and short-run although a domestic factor: unanticipated money growth does have slight temporary impact.

b) The Case of Zero Expected Changes in Exchange Rates

Due to the possible problems associated with the inclusion of forward premium in the regression as discussed in the previous section, we reestimate the model of the domestic interest rate without forward premium, using the same procedure. The final corrected cointegration equation is shown below.

\[
\ln b_t = 4.03 + .689 \ln b_t + .00023 \text{sgsur}_t \\
(5.324)^* \quad (9.503)^* \quad (5.353)^* \\
-.096 \%\text{usm}_t - .283 \%\text{usm}_{t+1} -.428 \%\text{usm}_{t+2} \\
(-.931) \quad (-2.594)^* \quad (-3.735)^* \\
+.067 \%\text{usm}_{t+1} -.251 \%\text{usm}_{t+2} -.189 \%\text{usm}_{t+3} \\
(.646) \quad (-2.468)^* \quad (-1.868)^* \\
-.026 \text{sgst}_{t+1} -.058 \text{sgst}_{t+2} -.057 \text{sgst}_{t+3} \\
(1.175) \quad (-2.759)^* \quad (-2.70)^* \quad \text{eq. 6.12)
\]

\[R^2 = .811; \text{adR}^2 = .236, F(11,38) = 14.79(.00), \sigma =1.385\]

\[\text{DW} = 1.72, \chi^2(4) = 2.293, \text{F-Form}(4, 34) = .41(.8012)\]

\[\text{SC} = 1.32, \text{HQ} = 1.03, \text{FPE} = 2.38, \text{RSS} = 72.94\]

As in equation 6.11), the residuals of equation 6.12) are white noise, therefore, \(\lambda\) in this case also equals 1. The
modified t-statistics indicate that both foreign interest rates and the seasonally adjusted government surplus significantly determinate the long-run equilibrium domestic interest rate. The coefficient estimates of foreign interest rates with or without forward premium (equation 6.11 and 6.12 respectively), which measure the degree of financial openness (or capital mobility) in the long-run, are approximately the same, 0.7. It implies that the Thai financial market (the money market in this case) during the interest rate liberalization period (July 1989 - November 1993) was relatively open. If the annualized foreign interest rate increase 10 percentage points and other factors remain constant, the annualized domestic interest rate will increase about 7 percentage points within a month.

The summation of the coefficient estimates of money surprises ($\text{usm}1_{ij}; j=0,1,2$) in this case equals $-0.808$, larger

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109 The usual t-statistics for $\text{lb}$, and $\text{sgsur} = 6.862$, and 3.864 respectively.

110 Refer to the derivation of the degree of financial openness in the theoretical model in section 4.2

111 Edwards and Khan (1985) found that the degree of financial openness for Singapore during 1976-1983 where there were virtually no restrictions on trade and capital flows was approximately unity. Gochoco (1989) found that the degree of financial openness for the Philippines during 1981-1985, the period in which interest rates were liberalized but some restrictions on foreign exchange transactions still existed, was about 0.85.
than -.289 which is the case when forward premium is included.\textsuperscript{112} Similar situation occurred with the coefficient of the seasonally adjusted government surplus (sgsur), defined as government revenue minus government expenditure (R-G). That is, it becomes significant and has greater magnitude, compared to the case with forward premium (equation 6.11). These results support the aforementioned argument that the forward premium captures some impact of money surprises and the government surplus on the domestic interest rate.

Based on equation 6.12, a 100 million Baht rise in government surplus will elevate domestic interbank rates by 2 basis points if other factors remain constant.\textsuperscript{113} The sign of the estimated coefficient of "sgsur" is unexpected. If government budget deficit (G-R) measures the exogenous demand shocks, the coefficient estimate of (G-R) should have positive sign and that of government surplus (R-G), sgsur, should have negative sign. In the Keynesian IS-LM analysis, an exogenous upward shift in aggregate demand as a result of an exogenous fiscal shock push up the real rate, crowding out private investment in order to restore equilibrium in the goods market. However, the positive sign of (R-G) here can be explained by the impact of tax revenue which is endogenously

\textsuperscript{112} The t-statistic for the summation of $\%usm_{1j}$; $j=0,1,2$ is 4.671. The F-statistic for the test of joint significance of $\%usm_{1j}$; $j=0,1,2$ is $F(3,95) = 8.786(.00)$

\textsuperscript{113} Government surplus is measured in terms of millions of baht.
determined by income. This is confirmed by the regression equation in which seasonally-adjusted government surplus (R-G) is replaced by seasonally-adjusted government revenue. Although it is not cointegrated, the coefficient of seasonally-adjusted government revenue (sgrev) has positive sign as expected. (see equation r8, in Table 13) Government budget is therefore not a good proxy for exogenous fiscal shocks. The impacts of the government budget deficit or surplus on the real rate and output are ambiguous when tax revenue does not include only lump sum tax but also income tax. Therefore, we experiment with another proxy, seasonally-adjusted government expenditure (sgep). The expected result is again not observed. The regression of domestic interest rates on foreign interest rates (LIBOR) and seasonally-adjusted government expenditure results in non-cointegration relation (see equation r7, in Table 13). The coefficient estimate of seasonally-adjusted government expenditure (sgep) has negative sign. In fact government expenditure may not be a good proxy for exogenous aggregate demand shocks either. First, a permanent increase in government expenditures may cause the private sector to reduce a large amount of consumption due to a decline in the

114 The significance of leads of the growth rate of government budget (sgdth) in equation 6.10) also support the endogeneity of government budget.

115 In Thailand at the end of 1992, about 31% of total tax revenues comes from income tax, and 45% comes from sale taxes.
permanent (disposable) income. The real saving does not
decline much, therefore, the real interest rate may not be
affected.  Secondary, government expenditure may serve as a
stabilizer, i.e., the government increase spending during the
recession when private aggregate demand declines. Thereby,
its countercyclical nature may bias the measured impact on the
domestic interest rate toward zero, or even negative. (Makin,
1983, p. 377)

In order to test the impact on domestic interest rates of
an exogenous shock to aggregate demand, caused by a shift in
the IS curve, while avoiding the problems associated with
using government expenditures as discussed above, Makin (1983)
suggests the use of export data. He argues that a qualitative
result of an exogenous shift in exports should be identical to
that of an exogenous shift in government expenditures. Here
we use seasonally adjusted exports. The results show that the
domestic interest rate is not cointegrated with the foreign
interest rate and exports. Furthermore, the coefficient
estimate of exports has negative wrong sign. (see equation
r10, in Table 13)

Since neither the use of seasonally adjusted government
expenditure, government revenue, nor exports results in

---

116 On the other hand, a temporary increase in the
government spending may lead to a rise in the real rate. The
private sector reduces consumption only a small amount because
the government spending increases only temporary, thus do not
affect their permanent income. As a result, real saving
declines and real rate has to rise to restore equilibrium.
cointegration relation, we maintain the seasonally adjusted government budget surplus (sgsur) in the equation 6.12 as one of the determinants of domestic interest rates but not the proxy for exogenous demand shock. It may be viewed as a proxy for a monthly economic growth, as an alternative to the investment index.

In conclusion, the long-run level of the domestic interest rate during the liberalization period is mainly determined by the foreign interest rate although the government budget surplus has some influence when the expected exchange rate change is assumed to be zero. Money surprise has slight negative temporary impacts on the movement of domestic interest rates. Its impacts on the domestic interest rate when we adjust the foreign interest rate with the forward premium are smaller than when we assume that the expected exchange rate change is zero. Forward premium may capture some impact of money surprise on the domestic interest rate.

117 In fact, when we look at the actual data, we found that the Thai government budget has been in surplus, (T-G) > 0, since 1988. (see figure 4 in the appendix) Therefore, the discussion of a crowding out effect of a large government budget deficit on a rise in the domestic interest rate is probably irrelevant for the case of Thailand during this period.

118 The regression of domestic interest rate on the LIBOR rate and the investment index results in non-cointegration relations. (see equation r9, in Table 13)

119 The summation of the coefficient estimates of %usmlj for j = 0,1,2 equals -.289 for the case of forward premium and equal -.808 for the case of zero expected exchange rate changes.
The expected inflation has no direct impact, either in the short-run or long-run, on domestic interest rates.

Before we end this section, we must mention here the difficulty in conducting inferences on the two generated regressors, the expected inflation and money surprises, in our domestic interest rate model. Pagan (1984) shows that an OLS estimation on the equation with regressors obtained from another regression (generated regressors) gives downwardly biased estimated standard errors of the generated regressors, given that these errors are uncorrelated with the explanatory variables in the equation. Standard t and F statistics will overstate their true values, therefore, correct computation of the standard errors by the system estimation such as FIME is suggested.

Here we cannot reject the null hypothesis of zero coefficient estimates (jointly insignificance) of current and lagged expected inflation in the domestic interest rate model. This conclusion cannot be reversed by corrected standard errors because the corrected F statistic would be lower than the original one here. Nevertheless, there may be a possibility of reserved results of the jointly significance of

120 Pagan provides a range of representative models in which specific conclusions about consistency, efficiency, and inferences of the estimators can be obtained. However, we found that our model here does not coincide with any of his representative models. Perhaps, the closest would be Model 5, which includes both predictor- and residual-generated regressors. (see Pagan, 1984, p.233-235) Our model also includes other explanatory variables, in addition to these generated regressors.
unanticipated money growth since the corrected F and t statistics which are lower than the original ones here could be lower than the critical values. Yet we believe that this possibility is minimal, especially for the case of zero expected exchange rate changes where the value of the F-statistic of unanticipated money, $F(3, 95) = 8.786(.00)$, is high with zero significant level.

6.4 Tests of Parameter Constancy of the Domestic Interest Rate Model and the Implications on the Degree of Financial Openness (Capital Mobility)

6.4.1 The Use of Recursive Least Squares Estimation

As mentioned in chapter 3, the authorities have introduced various deregulation measures to the Thai financial sector during the last five years. These measures may cause structural changes, therefore, parameter estimates in the model may not be constant over time. The degree of financial openness which is captured by the coefficient estimate of foreign interest rates plus expected changes in the exchange rates may also vary. To see the time paths of these coefficient estimates and to identify possible break points within the sample periods, we estimate the corrected cointegration model of the domestic interest rate by recursive least squares (RLS).\footnote{The RLS estimation is proceeded as follows: OLS estimate the small sub sample of $t = 1, 2, \ldots, n$, where $n > k$ parameters. Then, extend the sample period by one observation} First, we
extend the estimation period to include both pre and post interest rate liberalization, from January 1985 to November 1993, and test whether the cointegration relationship among the domestic interest rate, the foreign interest rate, and the seasonally adjusted government surplus still exists.\textsuperscript{122} The results of cointegration tests with this extended period indicate that a cointegrating relationship still exist among these three variables when the foreign interest rate is adjusted by the forward premium but it does not exist when zero expected exchange rate change is assumed.\textsuperscript{123} There are two possible explanations for the non-cointegration result in the latter case. One is that structural changes may have occurred during this longer period, probably as a result of

to \( t = 1, 2, \ldots, n+1 \), and re-estimate the model. Continue this procedure until the estimation period is the complete sample \( t = 1, 2, \ldots, T \). For each regression, the values of coefficient estimates and the residuals are obtained. These values are plotted against the latest time period in the sample estimation of that regression, then are used as diagnostic tools for the tests of structural breaks of the model. (See Charemza and Deadman, 1992, chapter 3.6 or Hendry, 1989, p.42 - 45 for the detailed calculation of these tools)

\textsuperscript{122} We start the estimation period from January 1985 in order to avoid the impact of the change in exchange rate regime from a U.S. dollar pegged system to a basket of currency pegged system in November 1984. (see chapter 2) However, the actual estimation period is from September 1986 to August 1993. We lose several initial observations because of the lags in the expected inflation and expected money growth models. The last three observations are also omitted due to the leads included in the regressions.

\textsuperscript{123} The ADF statistics for the case of forward premium (r1b) and the case of zero expected exchange rate changes (r5b) are -6.868, and -3.281, respectively. (see Table 14)
liberalization measures. Alternatively, the assumption of zero expected changes in exchange rates may not be appropriate. Forward premium may in fact be an important determinant of domestic interest rates, regardless of the period of the study. Therefore, excluding forward premium from the regression results in non-cointegration relationship.

Then, we proceed by OLS regression with the inclusion of forward premium and apply Saikkonen's procedure to obtain a corrected cointegration equation (equation 6.13 shown below), then reestimate this equation by RLS.

\[
\ln b_t = 2.594 + .721 \ln b_{f,t} + .00068 \text{sgsur}_t \\
(7.792)^* \quad (13.414)^* \quad (2.055)^*
\]
\[-.038 \%usm_{1,t} -.101 \%usm_{1,t-1} -.119 \%usm_{1,t-2} \\
(-.809) \quad (-2.034)^* \quad (-2.372)^*
\]
\[+.045 \%usm_{1,t+1} -.11 \%usm_{1,t+2} \\
(.950) \quad (-2.089)^*
\]
\[+.0015 \text{sgst}_{t+1} -.028 \text{sgst}_{t+2} -.044 \text{sgst}_{t+3} \\
(.130) \quad (-2.366)^* \quad (-3.779)^* \quad \text{eq. 6.13}
\]

R^2 = .914, adR^2 = .593, F(10,73) = 77.43(.00), \sigma = .839

DW = 1.63, \chi^2(6) = 5.457, F-Form(6, 67) = .78(.5917)

SC = .0891, HQ = -.1013, FPE = .796, RSS = 51.4

The regression results above, including both pre and post interest rate liberalization periods, are similar to that of equation 6.11, which includes only post interest rate
liberalization. There are only two slight different features. First, the coefficient estimate of the seasonally adjusted government budget surplus of the above equation becomes significant, however, its sign and magnitude are the same as those in equation 6.11). Second, regarding short-run impact, only money surprise significantly influences the change in domestic interest rates during both pre and post liberalization periods while both money surprise and the change in foreign interest rates plus forward premium have short run impact on the change in domestic interest rate during the post liberalization period.\textsuperscript{124}

After estimating equation 6.13) by recursive least squares (RLS), we examine three graphical diagnostic tools: the plots of scaled recursive Chow test statistics (\textsuperscript{11} CHOWs), one-step residuals (RESID), and recursive least squares coefficients.\textsuperscript{125}

Figure 18 in the appendix shows that the values of one-step residuals lie outside error bands of $\pm 2^*\text{S.E.}$ in March 1990, June 1990, October 1991, November 1992, and March 1993. The values of scaled recursive Chow test statistics in Figure

\textsuperscript{124} The summation of the coefficient estimates of $\%\text{usm}_{ij}$; $j=0,1,2$ and its t-statistic are $-0.26$ and $-3.073$ respectively.

\textsuperscript{125} Since PC-GIVE (version 6) only estimates RLS with maximum number of parameters equals to 11, we exclude $\%\text{usm}_{1,1}$, and $\%\text{usm}_{1,2}$ from equation 6.11). In fact, they are jointly significant at only 10% significant level (F-statistic is $F(2, 73) = 0.0813$) and the regressions results are similar with or without them.
19 are also greater than one during the same periods. This results suggest either "outlier" values of domestic interest rates or some alterations in the structural parameters of the model during these periods. Time path of recursive coefficient estimate of the foreign interest rate plus forward premium (1bfp) in Figure 20 shows moderate upward trend since May 1990, which was the period that the first stage of foreign exchange control deregulation started. It implies that the degree of financial openness or capital mobility gradually increases over time after this deregulation measure, which was the announcement of the official acceptance of the obligation under Article 8 of the IMF's Articles of Agreement. It allowed commercial banks to approve applications for all types of current account transactions involving foreign currencies without prior approval of the Bank of Thailand. After foreign exchange controls have been relaxed, we also expect the influences of domestic factors on domestic interest rates to decline over time as the degree of financial openness increases. This argument is supported by the evidence of time path of estimated coefficient of seasonally-adjusted government budget surplus (in Figure 21), displaying downward trend from May 1990 till February 1992. The coefficient estimate of unanticipated money growth is, 

126 The Value of scaled recursive Chow test statistic which is greater than unity implies that the null hypothesis of no structural change between periods t-1 and t is rejected at the 5% significant level.
however, quite stable over time, except a sharp drop in February 1990, a once and for all jump in August 1991 and a slight drop in March 1993. (see Figure 22)

We conclude that structural changes or parameter inconstancy are more likely to have occurred in June 1990, October 1991, and March 1993, which are the periods suggested by all three diagnostic tools. The first break point probably occurred as a result of the liberalization of foreign exchange controls in the first stage. The causes of the other two structural changes are more difficult to determine, however, we discuss several possibilities as follows. The domestic interest rate continuously decreased from 11.67% in July 1991 to the level of 6.28% in October 1991, approximately 5.4 percentage points decrease. This indicated high liquidity in the financial market which may have occurred because of two reasons. First, the early redemption of government bonds held by commercial banks has increased treasury cash balance in circulation by 31,274 million baht in a relatively short time. (BOT Annual Economic Report 1991) Second, the deregulation of portfolio management of commercial banks has allowed them to hold securities insured by the Ministry of Finance as additional components of liquidity assets in reserve requirement. 127 Commercial banks therefore had more excess

127 This measure which was introduced in September 1991 was the extension of deregulation on reserve requirement. The main measure which was introduced three month earlier was the change from "cash" reserve requirement to "liquidity" reserve requirement. (see details in chapter 3)
cash reserves which could have increased liquidity in the system during that period.

The third break point which occurred in March 1993 was the opposite situation. The liquidity condition in the financial system during this period was tight instead. The domestic interest rate went up to 10.24%, approximately 3.65 percentage points increased from February. This was mainly due to two major factors. First, the increased volatility in the foreign exchange markets as a result of the political situation in Russia made commercial banks more cautious about bringing in foreign funds. Second, most financial institutions maintained more cash reserves for possible large-scaled deposit withdrawal due to the liquidity crisis problem which one finance company (First City Investment) faced during this period. (BOT Quarterly Bulletin, March 1993) Many deregulation measures introduced during this period such as the relaxation of regulations concerning international banking and the relaxation of foreign exchange controls have allowed capital to flow between countries easier. The domestic financial market has been more vulnerable to foreign conditions. Consequently capital outflows remarkably increased during this period and the tight liquidity condition in the domestic financial market became more complicated.

The relaxation of branch opening requirement for commercial banks to hold government bonds as a proportion of total deposit was also introduced in June and September 1991.
However, the Bank of Thailand had provided liquidity by accommodating loan demand both through loan windows and repurchase market. The tight liquidity was gradually eased towards the first week of April 1991.

6.4.2 The Use of Dummy Variables

Since the impacts of liberalization measures on the degree of financial openness may have occurred with some delay, (not necessary to occur immediately at the point of policy implementation), we first use recursive least squares estimation to find possible break points as discussed in the previous section. In this section, we then use dummy variables to test whether the first two foreign exchange control deregulations significantly affected the degree of financial openness at the suggested break points.  

An index measuring the degree of financial openness, $\psi_t$, is modeled as a function of two dummy variables as below:

$$\psi_t = k_0 + k_1 D_1 t + k_2 D_2 t$$  \hspace{1cm} eq 6.14)

where $D_1 t = 1$ for June 1990 to November 1993, = 0 otherwise

$D_2 t = 1$ for October 1991 to November 1993, = 0 otherwise

Therefore, from January 1985 to May 1990 ($D_1 = D_2 = 0$), $\psi_t = k_0$.

From June 1990 to September 1991 ($D_1 = 1$, $D_2 = 0$), $\psi_t = k_0 + k_1$, and

$D_2$ Deregulation of foreign exchange controls occurred in three stages in May 1990, April 1991, and February 1994, respectively. (see Chapter 3) We cannot investigate the impact of third measure because it occurred very recently. The period of this study covers only until November 1993.
from October 1991 to November 1993 (D1=D2=1), \( \psi = k_0 + k_1 + k_2 \).

Substituting equation 6.14 above into equation 4.11 in Chapter 4, which is the reduced form equation for domestic nominal interest rates in the general case, yields the following equation:

\[
\ln b_t = (1-k_0 - k_1D1_t - k_2D2_t)\alpha_0 + (k_0 + k_1D1_t + k_2D2_t) \ln b_f, \\
(1-k_0 - k_1D1_t - k_2D2_t) \beta_1 \text{sgdef}_t + u_t \tag{6.15}
\]

where \( \ln b_f \), \( \text{sgdef}_t \) denote \((i' + x') \), and DS in equation 4.11), respectively. Equation 6.15 can be rewritten as:

\[
\ln b_t = (1-k_0)\alpha_0 - k_1\alpha_0 D1_t - k_2\alpha_0 D2_t + k_0 \ln b_f, \\
+ k_1 D1\ln b_f + k_2 D2\ln b_f + (1-k_0)\beta_1 \text{sgdef}_t \\
- k_1\beta_1 D1\text{sgdef}_t - k_2\beta_1 D2\text{sgdef}_t + u_t \tag{6.16}
\]

Note that we exclude expected inflation and money surprise from the long-run cointegration relation because unit root tests indicate that they are both \( I(0) \) while \( \psi \) here measures the degree of financial openness in the long-run. However, we include them when we actually estimate equation 6.16), followed Saikkonen (1991) procedure discussed in
section 6.3.1, to capture short-run dynamic of domestic interest rates. The estimation result is shown below:  

\[ \ln b_t = 3.64 -3.43 D1_t + 3.62 D2_t + .55 \text{lbfp}_t + .303 \text{D1lbfp}_t \]
\[ (5.97)'(-1.73)'(1.45)(4.70)'(1.643)' \]
\[-.351 \text{D2lbfp}_t + .00019 \text{sgsur}_t - .00005 \text{D1sgsur}_t \]
\[ (-1.087)'(2.38)'(-.292) \]
\[-.00007 \text{D2sgsur}_t - .004 \%usml_t - .107 \%usml_{t+1} \]
\[ (-.451)'(-.086)'(-2.089) \]
\[-.142 \%usml_{t+2} + .07 \%usml_{t+1} - .089 \%usml_{t+2} \]
\[ (-2.74)'(1.45)'(-1.73)' \]
\[+.009 \text{sgst}_{t+1} - .027 \text{sgst}_{t+2} - .038 \text{sgst}_{t+3} \]
\[ (.675)'(-2.17)'(-3.24)' \]
\[ R^2 = .92, \text{adR}^2 = .632, F(16,67) = 49.64(.00), \sigma = .852 \]
\[ \text{DW} = 1.78, \chi^2(5) = 3.873, F-\text{Form}(5, 62) = .60 (.6999) \]
\[ \text{SC} = .3034, \text{HQ} = .009, \text{FPE} = .833, \text{RSS} = 46.41 \]

The coefficient estimates of $D_2_t$, $D2lbfp_t$, $D2sgsur_t$ are not significant, implying that the second deregulation of the foreign exchange controls did not have significant impact either on the slope or the constant of the estimated domestic interest rate equation. Therefore, we reestimate the above equation without these three variables. That is we use only

129 The figures in the parenthesis below variables in the estimated equation are modified t-statistics. The summation of the coefficient estimates of $%usml_{t,j}$ for $j=0,1,2$ is -.253.
one dummy variable, $D_{1t}$, to capture the impact of the first deregulation. The estimated equation is shown below:

$$\ln b_t = 3.599 - 1.495 D_{1t} + .556 \ln b_{f petroleum} + .195 D_{1bfp}$$

(5.98) (-1.824) (5.365) (1.707)

$$+ .00019 \text{sgsur}_t - .00011 D_{1\text{sgsur}} - .004 \%\text{usml}_t$$

(2.606) (1.356) (-.418)

$$- .114 \%\text{usml}_{t+1} - .131 \%\text{usml}_{t+2} + .058 \%\text{usml}_{t+3}$$

(-2.29) (-2.62) (1.23)

$$- .102 \%\text{usml}_{t+2} + .0066 \text{sgsth}_{t+1} - .027 \text{sgsth}_{t+2}$$

(-2.03) (.521) (-2.29)

$$- .039 \text{sgsth}_{t+3}$$

(-3.428) 6.18

$R^2 = .92$, $adR^2 = .62$, $F(16,67) = 49.64 (.00)$, $\sigma = .927$

$DW = 1.71$, $\chi^2(5) = 2.952$, $F-Form(5, 65) = .47 (.7947)$

$SC = .1766$, $HQ = -.066$, $FPE = .798$, $RSS = 47.89$

The significance (at 10% level) of the coefficient estimate of $D_{1bfp}$ suggests that the first deregulation of foreign exchange controls in May 1990 had significant impacts on the degree of financial openness. That is, the degree of financial openness approximately equals $0.56 (k_0)$ and $0.76 (k_0 + k_1)$ before and after May 1990 respectively. The coefficient estimate of $D_{1}$ ($= -k_1\alpha_0$ in equation 6.16) captures the impact of the first deregulation of foreign exchange controls on the portion of the natural real rate which is unaffected by the
expected inflation, $\alpha_0$ in equation 4.8 in the theoretical model in Chapter 4. Therefore, the negative significance of this coefficient implies that the level of this component of the natural real rate dropped after the first deregulation. The significance of the summation of the coefficient estimates of $%usml_{tj}; \; j=0,1,2 \; (-.249)$ implies that money surprises have significant impact on the short-run movement of the domestic interest rate, as explained before.
CHAPTER 7
CONCLUSIONS AND SUGGESTIONS

Thailand has undertaken comprehensive financial reform since 1989, especially in four major areas: the deregulation of the financial system, the improvement of supervision and examination of financial institutions, the development of the capital market and the promotion of new financial instruments, and the improvement of the payment system. This study focuses only on the first area of the liberalization, which consists of the elimination of interest rate ceilings, the deregulation of foreign exchange controls, and the deregulation of financial institutions. The main objectives of the study are to empirically investigate the determinants of the domestic interest rate after the regulated interest rate ceilings have been removed in July 1989, and to test whether the foreign exchange deregulations had significant impacts on the degree of financial openness (or capital mobility).

The model of the interest rate proposed here is modified from that of Edwards and Khan (1985), which is specified as a weighted average of domestic factors such as expected inflation, money surprises, and government budget deficit, and foreign factors such as foreign interest rate, and expected changes in exchange rates. This weight is an index measuring the degree of financial openness which can vary over time as a result of financial liberalization measures. This study
deals with several empirical issues, including seasonal adjustment, unit roots and cointegration tests, and proxies for unobserved variables. Possible problems of serial correlation and endogeneity bias associated with the cointegration regressions are also corrected so that the asymptotically efficient estimation and hypothesis tests on the coefficient estimates of the long-run cointegration regressions can be done. Finally, the recursive least squares estimation and dummy variables are used to test the parameter constancy of the estimated model of domestic interest rates.

7.1 Major Findings and Policy Implications

1. Assuming rational expectation, expected inflation and expected money growth are modeled as multivariate autoregressive process (MAR). The estimation results show that the expected inflation is determined by the actual inflation in the last six months and M1 money growth in the last fifteen months. The money surprise variable is obtained from the residuals of the expected money growth equation, which is determined by M1 money growth and rates of changes in investment index in the last twelve months, changes in domestic interest rates and rates of changes in the government expenditure last month.

2. All the series in the study are found to be I(1) in levels, and I(0) in the first differences, except M2 money supply, which is found to be I(2), and M2 money growth is
Since the series of the nominal domestic interest rates is $I(1)$ while the expected rate of inflation is $I(0)$, they cannot be cointegrated. Therefore, the long-run cointegration relation between the nominal interest rate and the expected inflation, according to Fisher equation, for the case of Thailand during the interest rate liberalization period, July 1989 - November 1993, did not exist. Nevertheless, long-run equilibrium relationships exist among the nominal domestic interest rate (the interbank rate) the foreign interest rate (the LIBOR rate), and seasonally adjusted government surplus both in the case where the forward premium is used as a proxy for the expected change in exchange rate and in the case where the expected change in exchange rate is assumed to be zero. When the period of the study is extended to include both pre and post interest rate liberalization periods (January 1985 - November 1993), the cointegrating relationship among those variables did not exist in the case of zero expected exchange rate changes.

3. The long-run equilibrium level of the domestic interest rate is mainly determined by the foreign interest rate although money surprises have some lagged influence on the short-run movement of domestic interest rates. The

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$^{130}$ We use M1 money growth which is $I(0)$ in our study because it is easier to control by the authorities, compared to M2 money which includes broader scope. Nevertheless, future research may test whether M2 money growth, which is $I(1)$ is cointegrated with domestic and foreign interest rates and the government surplus.
coefficient estimate of the foreign interest rate (with or without incorporating forward premium) is about .7, implying that a rise in the foreign interest rate of 10 percentage points will result in a rise in the domestic interest rate of 7 percentage points if other factors remain constant. This coefficient estimate also suggests that the degree of financial openness or capital mobility of the Thai financial market (the interbank market in this case) is relatively high.

4. The results of the recursive least squares estimation of the domestic interest rate model, including both pre and post interest rate liberalization periods (January 1985 to November 1993), show that the degree of financial openness increases gradually over time after the first deregulation of foreign exchange controls was implemented in May 1990. The impact of domestic factors on the domestic interest rate, captured by the coefficient estimate of the seasonally adjusted government surplus, decreased over time. When the degree of financial openness is modeled alternatively as a function of a dummy variable to capture the possible impact of the deregulation of foreign exchange controls. The estimation yields similar results, i.e., the first deregulation which occurred in May 1990 significantly increased the degree of financial openness from .56 to .76, given other factors constant.

These findings suggest the following policy implications. First, for a country with the relatively open financial market
under a fixed exchange rate regime like Thailand, a monetary policy surprise still has a significant impact on the movement of the domestic interest rate in the short-run although the long-run equilibrium level of the domestic interest rate is mainly determined by foreign factors.

Second, the finding of higher degree of financial openness (or capital mobility) as a result of the first deregulation of foreign exchange controls, which was the formal announcement of the official acceptance of the obligation under Article 8 of the IMF, suggests the importance of the government to provide the public concrete recognition of its policy stance toward financial liberalization. In practice, the system of foreign exchange controls in Thailand has been in conformity with the Article 8 requirements (i.e., no restrictions on foreign exchange transactions based on the current account) for many years before the official announcement in May 1990. (Wibulswasdi and Tanvanich, 1993) The second deregulation, on the other hand, did not significantly further the degree of financial openness because substantial controls on capital outflows still existed although almost all the controls on capital inflows were eliminated. That is, the degree of capital mobility depends on both ways of capital controls. If the authorities intend to liberalize the Thai financial market, the controls on capital outflows should be further eliminated to allow more capital mobility. However, further deregulation on capital
outflows may have some other impacts (for example, the stability of the domestic financial market), which the authorities also need to consider.

7.2 Limitation of the Study and Suggestions for Future Research

1. The model of domestic interest rates in this study is specified in nominal terms so that the degree of capital mobility (according to the least stringent and widely used criterion, the covered interest parity) of the Thai financial markets can be measured directly from the estimated equation of the domestic interest rate. (see Appendix E for the definitions of the degree of capital mobility) However, the real cost of capital affecting the economy is the real interest rate, which is defined as the difference between the nominal interest rate and the expected rate of inflation. Further study should, therefore, includes the determinants of the real rate, and the impacts of policy regime shifts on the movement of the real rate. Examples of previous work on these issues are Mishkin (1984), Huizinga and Mishkin (1986), Cunningham and Cunningham (1990).

2. We use the interbank rate, which is a short-term money market rate, as a measure of domestic interest rate because interest rate ceilings on all types of deposits and loans have just been completely removed in June 1992. When more data of domestic lending rates are available, it would be interesting
to examine whether the determinants of the lending rates, which reflects long-term cost of borrowing in the financial system, are the same as those determining short-term money market rates. By the same analogy, the coefficient estimate of foreign lending rates on domestic lending rates could suggest the degree of financial openness in the long-term capital market. An alternative extension could be the study of the linkage between short-term money market rates and long-term bank lending rates since the stickiness of bank lending rates with respect to the changes in money market rates is often regarded as an obstacle to the smooth transmission of monetary policy impulse. An empirical estimation of the degree of the lending rate stickiness, therefore, provides the implications on the ultimate impact of monetary policy on the economy. (Cottarelli and Kourelis, 1994)

3. The degree of capital mobility found in this study is obtained from the coefficient estimate of the foreign interest rate on the domestic interest rate model. To check the robustness of the results, other approaches in measuring the degree of capital mobility could also be used. For example, the Argy and Kouri (1974)'s offset coefficient which measures the degree to which capital flows offset the effect on money supply of a change in net domestic asset (Schadler, et.al. 1993), the Feldstein-Horioka approach, measuring the degree to which an exogenous change in domestic national saving crowding out domestic investment rate (Bernheim and Shoven, 1991), and
the Haque and Monteil's Approach (1990), where the degree of capital mobility is obtained from the estimation of money demand function.

4. The estimation results, including unit root and cointegration tests, as well as policy implications drawn in this study, are subjected to the problems associated with a small sample size as mentioned earlier. Thus, care must be exercised when using any of these conclusions. To overcome the problems of generated regressors, especially residual-generated regressor, full information maximum likelihood (FIML) estimation which is fully restricted by a priori imposition of unit roots such as a cointegrated VAR approach proposed by Johansen (1988) and Johansen and Juselius (1990) is recommended for future research.
### APPENDIX A: TABLES

**Table 1. Key Economic Indicators of Thailand (1970-1993)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Economic Growth (% of real GDP)</th>
<th>Inflation (% per annum)</th>
<th>Current Account (% of GDP)</th>
<th>Saving (% of GNP)</th>
<th>Investment (% of GNP)</th>
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<td>Avg. 61-69</td>
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Sources: Economic Growth, Inflation, and Current Account are obtained from various issues of BOT Annual Economic Report. Saving and Investment from 1961 to 1982 are obtained from Kangwangpornsiri (1985), and from 1983 to 1991 are obtained from various issues of BOT Quaterly Bulletin.
### Table 2. Assets of Financial Institutions (1970-1990)

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Sources: Data provided by the Thai authorities and IMF staff estimates.

*Excludes the Bank of Thailand.*
Table 3. Credit Extended by Financial Institutions:
Outstanding Amounts at Year End
(as percentage share of total)

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Table 4. Household Savings at Financial Institutions
(as percentage share of total)

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Total 100.00 100.00 100.00 100.00 100.00 100.00 100.00 100.00

Note: Figures in parentheses are annual growth rates (%)
Table 5. Size of Primary Financial Markets (1980-1990)

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Memorandum items:

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Source: Data provided by the Thai authorities.

1 As of September 1990.

2 Issued by Citibank, Chase Manhattan Bank, and the Industrial Finance Corporation of Thailand (IFC).

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Sources: Bank of Thailand


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<th>Months of Imports</th>
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Sources: Bank of Thailand
Table 8. Definitions of variables in the model

\[ \text{inb} = \text{Average domestic interbank rate, weighted by trade} \]
\[ \text{volume of all maturities, ranging from 7 days to 3 months}. \]
\[ \text{lb} = \text{Weighted average Eurodollar rate at London (London} \]
\[ \text{interbank offer rate)} \]
\[ \text{tb} = \text{U.S. Treasury bill rate} \]
\[ \text{fp} = \text{Forward premium/discounted rate } \% \text{ per annum} = \]
\[ (\text{fp}_2/S) \times 12; \text{ fp}_2 = \text{Forward premium/discounted rate} \]
\[ \text{(Stang/month), S = average spot rate (exchange rate) at month} \]
\[ \text{t} \]
\[ \text{dlp} = \text{First difference of log of monthly consumer price} \]
\[ \text{index = monthly inflation rate} \]
\[ \text{dlm}_1 = \text{First difference of log of M1 money supply =} \]
\[ \text{monthly M1 money growth rate} \]
\[ \text{dlm}_2 = \text{First difference of log of M2 money supply =} \]
\[ \text{monthly M2 money growth rate} \]
\[ \text{usm}_1 = \text{Unanticipated money growth = Monthly money surprise} \]
\[ \text{gsur = Government budget, defined as government revenue} \]
\[ \text{minus government expenditure (government surplus if positive,} \]
\[ \text{government deficit if negative)} \]
\[ \text{gep = Government expenditure} \]
\[ \text{grev = Government revenue} \]
\[ \text{gsth = Rate of changes of the government budget surplus} \]
\[ \text{dc = Domestic component of total assets in the financial} \]
\[ \text{system, including Bank of Thailand and commercial banks} \]
Table 8. (Continued) Definitions of variables in the model

ivid = Monthly investment index, measuring economic performance in each month

IR = Level of international reserves, measured in U.S. dollar

exch = Average exchange rate of month t, mean average of dairy rate.

x = Values of of exports

nx = Net exports = Values of exports minus imports (Trade Balance)

Notes: "s" denoted seasonally adjusted data by X11 program, "e" denoted expected values, "l" denoted log values, and "d" denoted first difference.

M1, M2, dc, gdef, grev, gep, x, nx are measured in Millions of Baht
Table 9. Results of Unit Root Tests

ADF Test: $\Delta y_t = a + b_t + (c-1)y_{t-1} + \sum d_j\Delta y_{t-j}$

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<th>Variable</th>
<th>k</th>
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<th>$d_k$</th>
<th>$t(y_{t-1})$</th>
<th>(c-1)</th>
<th>FPE</th>
<th>SC</th>
<th>HQ</th>
<th>$X^2(6)$</th>
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Notes: "l" denoted log, "$\Delta$" denoted the first difference.

"*" above $t(y_{t-1})$ values indicate that the null hypothesis of unit root is rejected, i.e., the series is stationary, at 5% significant level. The tabulated ADF test statistics, $t_T$, are obtained from Table D in Harvey (1991, p.368), for 100 observations equal -4.04 at 1%, -3.45 at 5%, -3.15 at 10% significant level.
Table 9. (Continued) Results of Unit Root Tests

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<th>y</th>
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<th>d_k</th>
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Notes: "l" denoted log, "Δ" denoted the first difference.

"*" above t(Yt-1) values indicate that the null hypothesis of unit root is rejected, i.e., the series is stationary, at 5% significant level. The tabulated ADF test statistics, τₜ, are obtained from Table D in Harvey (1991, p.368), for 100 observations equal -4.04 at 1%, -3.45 at 5%, -3.15 at 10% significant level.
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Notes: "l" denoted log, "Δ" denoted the first difference.

"*" above t(Yt-1) values indicate that the null hypothesis of unit root is rejected, i.e., the series is stationary, at 5% significant level. The tabulated ADF test statistics, τ_t, are obtained from Table D in Harvey (1991, p.368), for 100 observations equal -4.04 at 1%, -3.45 at 5%, -3.15 at 10% significant level.
Table 10. Definitions of Test Statistics

\( R^2 = \) Squared Multiple Correlation Coefficient

\( adR^* \) is a measure of goodness of fit relative to difference and seasonal. It can be negative which implies that the fitted model does less well than a regression of the first difference form

\[ F(k-1,T-k) = \text{F-Statistics} \]

\( DW = \) Durbin-Watson Statistics

\( t = \) Student t Statistics

\( \sigma = \) Standard Error of the Regression

\( \text{FPE} = \) Final Prediction Error

\( \text{SC} = \) Schwarz Criteria

\( \text{HQ} = \) Hannan-Quinn Criteria

\( X^2(r), F\text{-form}(r) = \) Lagrange Multiplier Test for \( r^{th} \) order residual autocorrelation.

Critical values of

\[ X^2(1) = 3.841 (.05), = 6.635 (.01), = 2.706 (.1) \]

\[ X^2(4) = 9.49 (.05), = 13.28 (.01), = 7.779(.1) \]

\[ X^2(5) = 11.07 (.05), = 15.09 (.01), = 9.236 (.1) \]

\[ X^2(6) = 12.59 (.05), = 16.81 (.01), = 10.64 (.1) \]

\[ X^2(7) = 14.067 (.05), = 18.48 (.01), = 12.02 (.1) \]

Table 11. Correlogram / Autocorrelations (ac) of inflation (dlp, dlsp) and money growth (dlm, dlsm)

<table>
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106 (Sum of 20 Squares "variable" Autocorrelation)

43.407  36.559  176.859  13.758  79.345  111.66
Table 12. F-Statistics for Granger - Causality Tests

Expected Inflation Model (dlsp^8)

We used Schwert (1987)'s Rules of Thumb in selecting lag length for both resulted (y) and caused variables (x) in Granger - Causality tests. We start with "kmax" for y = 13, but the first significant lag is the eighth lag. Then we conduct the F-tests for omitted variable (x), based on y lagged one to eight. We use the same procedure in selecting lag length for x, and use information criteria (FPE, SC, HQ) in the case that no lag is significant. The estimated equation is shown below:

\[ dlsp_t = a + \Sigma b_i dlsp_{t-i} + \Sigma c_j x_{t-j} \]

Testing the null hypothesis: \( c_j = 0 \) for all j. The test results are shown as follows:

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<th>Var x</th>
<th>k</th>
<th>FPE</th>
<th>SC</th>
<th>HQ</th>
<th>( \chi^2(6) )</th>
<th>F-Statistics</th>
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<td>F(15,67)=1.44(.153)</td>
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<td>F(15,66)=.81(.6618)</td>
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<td>F(6,79)=.88(.5141)</td>
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<td>F(15,67)=1.66(.08)*</td>
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<td>4.09</td>
<td>F(3,80)= 1.68(.177)</td>
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<tr>
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<td>-10.73</td>
<td>1.42</td>
<td>F(4,79)= 1.53(.214)</td>
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</table>

Note: "*" indicates that the null hypothesis is rejected at 5% significant level, i.e., \( c_j \) for \( j = 1, \ldots, k \) are not jointly insignificant. Therefore, x causes y.
Table 12. (Continued) F-Statistics for Granger - Causality Tests

Expected Money Growth (dlsm$^6$)

By the same procedure as in expected inflation, we end up with the length for dlsm = 12. Thus the estimated equation is:

\[ dlsm_t = a + \sum b_i dlsm_{t-1} + \sum c_j x_{t-j} \]

The results of F-tests are shown below:

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<tr>
<th>Var x</th>
<th>k</th>
<th>FPE</th>
<th>SC</th>
<th>HQ</th>
<th>$\chi^2(6)$</th>
<th>F-Statistics</th>
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<td>F(1,80)=6.33(.014)*</td>
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<td>3.71</td>
<td>F(1,78)=3.61(.0612)*</td>
</tr>
</tbody>
</table>

Note: "*" indicates that the null hypothesis is rejected at 5% significant level, i.e., $c_j$ for $j = 1, \ldots, k$ are not jointly insignificant. Therefore, $x$ causes $y$. 

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Table 13. Results of Cointegration Tests and Cointegrating Regressions
Post-Interest Rate Liberalization Period: 89.07-93.11
(Dependent Variable: Domestic Interbank Rate)

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<th></th>
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<th>sgep</th>
<th>lb</th>
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Notes: *** indicates significant at 5 percent significance level
**** indicates significant at 1 percent significance level
### indicates significant at 10 percent significance level

lbfp = London Interbank Offered Rate plus forward premium
lb = London Interbank Offered Rate
sgdef = seasonally-adjusted government budget, defined as
government revenue minus government expenditure (R-G)
sgep = seasonally-adjusted government expenditure (G)
sgrv = seasonally-adjusted government revenue (R)
dlsm2 = seasonally-adjusted M2 money growth
ivid = investment index, measured monthly economic growth
sx = seasonally-adjusted monthly exports
snx = seasonally-adjusted monthly net exports, defined as
exports minus imports
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</table>

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**** indicates significant at 1 percent significance level
**#** indicates significant at 10 percent significance level

lbfp' = London Interbank Offered Rate plus forward premium
lb = London Interbank Offered Rate
sgdef = seasonally-adjusted government budget, defined as government revenue minus government expenditure (R-G)
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<td>72.096*</td>
<td>-2.71</td>
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level

level

level

premium

ined as

ure (R-G)
Table 15. Critical Values for the Cointegration Test

(for 50 observations)

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<tr>
<th>No. of Vars</th>
<th>Significant Level</th>
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<td>2</td>
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<tr>
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<td>4.94</td>
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<td>5.41</td>
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(for 100 observations)

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<td>4</td>
<td>4.75</td>
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<tr>
<td>5</td>
<td>5.18</td>
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- Central Bank (1/3/1942)
- Commercial Banks (16/2/1906)
- Domestic (14/2/1888)
- Foreign (1/4/1946)
- Government Savings Bank (1/4/1946)
- Bank for Agriculture & Agricultural Cooperatives (1/104/1966)
- Government Housing Bank (1/3/1953)
- Finance Companies (94/37/1069)
- Credit Foncier Companies (18/0/1969)
- Industrial Finance Corporation of Thailand (1/6/1959)
- Small Industries Finance Office (1/0/1964)
- Life Insurance Companies (12/842/1929)
- Agricultural Cooperatives (1357/0/1916)
- Savings Cooperatives (827/0/1946)
- Pawnshops (357/0/1866)

1/ Figures in parentheses are numbers of institutions, numbers of branches, and the years in which they began operations in Thailand.

2/ Numbers of institutions are estimated.
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Figure 3. Ex-post Domestic Real Interest Rates (1962-1992)

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Figure 5. Domestic Nominal Exchange Rates (1970-1992)
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Figure 6.2. Non-Seasonally Adjusted Monthly M2 Money Supply (1985-1993)
Figure 6.3. Non-Seasonally Adjusted Monthly M1
Money Growth Rates (1985-1993)

Figure 6.4. Non-Seasonally Adjusted Monthly M2
Money Growth Rates (1985-1993)
Figure 7.1. Non-Seasonally Adjusted Monthly Consumer Price Index (1985-1993)

Figure 7.2. Non-Seasonally Adjusted Monthly Inflation Rates (1985-1993)
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APPENDIX D: DEFINITIONS OF THE DEGREE OF CAPITAL MOBILITY
(FINANCIAL OPENNESS)

Frankel (1991) distinguishes four definitions of the degree of capital mobility, according to tighter conditions required for each definition.

The first is the degree to which covered interest parity, which is written below, holds

\[ i_t = i_t^* + (f_t - s_t) \]

where \( i_t \) is the domestic interest rate, \( i_t^* \) is the foreign interest rate, \( f_t \) is the log of the forward rate, \( s_t \) is the log of the spot exchange rate, and \( (f_t - s_t) \) is the forward premium. Equation 1) can be rewritten as:

\[ i_t - i_t^* - (f_t - s_t) = k \]

where \( k = 0 \) in the case of perfect capital mobility. When \( k \) differs from zero, it measures the deviation from covered interest parity which captures all barriers to integration of financial markets between countries, including transaction costs, information costs, capital controls, and tax laws that discriminates by country of residence. Nevertheless, \( k \) does not capture the exchange rate risk since it is already covered by the forward rate, \( f_t \).

\[ f_t = E_t s_{t+1} + r \]

where \( E_t s_{t+1} \) is the expected exchange rate in the next period, as expected in the current period, "r" is a risk premium.

The second definition is the degree in which the
uncovered interest parity holds, i.e.,

\[ i_t = i_t^* + (E_t s_{t+1} - s_t) \]  

Substituting \( f_t \) from 2) into 1)' yields the following equation.

\[ i_t = i_t^* + (E_t s_{t+1} - s_t) + r + k \]  

Thus, for uncovered interest parity to hold, both \( r \) and \( k \) in equation 4) must equal zero. In other words, this second definition of financial integration requires more stringent conditions than the first, i.e., not only covered interest parity to hold but also zero risk premium.

The third definition is the one where ex-ante real interest parity, written below, holds.

\[ r_t - r_t^* = 0 \]  

where \( r_t, r_t^* \) are ex-ante domestic and foreign real interest rates respectively. Equation 5) can be rewritten as below:

\[ (i_t - \pi_t^e) - (i_t^* - \pi_t^{e*}) = 0 \]  

or \( (i_t - i_t^*) = (\pi_t^e - \pi_t^{e*}) \)  

where \( \pi_t^e, \pi_t^{e*} \) are domestic and foreign expected rates of inflation.

Using equation 4) and 6)' , we arrives at

\[ (E_t s_{t+1} - s_t) + r + k = (\pi_t^e - \pi_t^{e*}) \]  

Equation 7) indicates that for real interest parity to hold, not only \( r \) and \( k \) must equal zero but also ex-ante relative Purchasing Power Parity (PPP), which is written as equation 8) below, must holds.

\[ \pi_t^e - \pi_t^{e*} = E_t s_{t+1} - s_t \]
That is the expected change in exchange change equals the expected inflation differentials.

The last definition of the degree of capital mobility, which is the most restrictive one, is the degree to which domestic investment depends on exogenous changes in domestic saving. Feldstein-Horioka (1980) argues that if capital perfectly mobiles between countries, an exogenous decrease in domestic national saving (i.e., in either private saving or government budgets) can be easily financed by borrowing from abroad at the world real interest rate, and thus need not crowd out domestic investment (except for the case that the country is large in the world financial market). In other words, perfect capital mobility, according to this definition requires zero coefficient estimate of the national saving rate of the below equation.

\[(I/Y)_t = a + b(S/Y)_t + u_t \quad 9\]

where \(I\) is the level of domestic capital formation, \(Y\) is national output, \(S\) is national saving, measured as private saving minus budget deficits, and \(u_t\) is error term, capturing other factors, rather than the real interest rate, which determines the domestic investment rate. In order to have "b" in equation 9) equal zero, not only the domestic real interest rate has to be tied with the world real interest rate, which is exogenous (i.e., real interest parity holds), but it is also necessary that there is no correlation between \(u_t\) and \(S/Y)_t\) (i.e., other factors which determines the domestic investment
rate must be uncorrelated with the national saving rate). This additional condition is unlikely to hold because both saving and investment rates respond to the population and productivity growth rates.
REFERENCES


and Income", Federal Reserve Bank of St. Louis (March/April): 58-78.


